Barcelona, Spain
September 7-11
CIRSE 2019

**ABSTRACTS &
AUTHOR INDEX**

- S66 PART 1: Controversy Sessions**
Clinical Evaluation Courses
Focus Sessions
Fundamental Courses
Honorary Lectures
Hot Topic Symposia
CIRSE Meets Sessions
- S188 PART 2: Free Papers**
News on Stage
- S241 PART 3: Posters**
- S511 PART 4: Author Index**

Online Publication Number:
10.1007/s00270-019-02282-x

Barcelona, Spain
September 7-11
CIRSE 2019

PART 1

**Abstracts of
Controversy Sessions
Clinical Evaluation Courses
Focus Sessions
Fundamental Courses
Honorary Lectures
Hot Topic Symposia
CIRSE Meets Sessions
sorted by presentation
numbers**

Focus Session

Technologies and techniques in peripheral vascular disease: evolution and outstanding questions

101.1

Practice guidelines across societies: status and critical review

J.A. Kaufman

Dotter Interventional Institute/Interventional Radiology, Oregon Health & Science University Hospital, Portland, OR, US

Learning Objectives

1. To learn about the most recent guidelines
2. To learn about the level of evidence of the different treatment modalities for PAD
3. To review the guidelines for PAD

No abstract available.

101.2

Calcium solutions: which calcium needs treatment and how?

K. Rocha-Singh

Interventional Cardiology, Vascular and Endovascular Medicine, Prairie Heart Institute, St. John's Hospital, Springfield, IL, US

Learning Objectives

1. To learn the different characteristics of calcium
 2. To learn how to manage heavily calcified lesions
 3. To compare the different devices available for calcium debulking
- Vascular calcification, regardless of the vascular bed, is a significant challenge that defines the limits of acute procedural and device-related success and limits clinical durability of interventional therapies. Our early experiences in endovascular approaches especially balloon angioplasty, in heavily calcified internal carotid arteries, renal arteries and calcified aortoiliac and infrainguinal atherosclerotic lesions have borne this out. Importantly, vascular calcification is a general marker for global atherosclerotic burden and, in some studies, a marker of increased cardiovascular related mortality. Calcium has been, is, and will continue to be a major challenge in cardiovascular percutaneous interventions.

There is a growing understanding of the multiple pathways by which vascular calcification occurs. These pathways are complex, interrelated and involve endocrine, inflammatory, hormonal and metabolic pathways. As such, vascular calcification is a very biologically active disease process and does not represent "dead tissue" as is commonly perceived. Evolving technologies and therapies have targeted metabolic pathways that lead to vascular calcification and future therapies will help address and potentially prevent the progression to severe grades of calcification. At present, there are multiple non-invasive and invasive modalities used for assessment of calcification in a variety of vascular beds. Coronary artery calcium scoring using CTA and its potential to predict future cardiovascular events is well established. In the periphery, CT and MR imaging are highly sensitive methods to assess the degree and extent of VC. However, both imaging modalities use contrast agents (iodinated for computed tomography and gadolinium-based for MR), which are associated with potential nephrotoxicity, and CT exposes patients to ionizing radiation. CTA remains an important noninvasive imaging modality. Intravascular ultrasound is the best assessment for the degree and extent of VC. Unfortunately, this is not widely used, in part, because it is not uniformly reimbursed and its associated expense. As such, fluoroscopy remains the most practical and uniformly available modality for the assessment of femoropopliteal calcification. Despite this, fluoroscopy underestimates the extent and location of calcification in the femoropopliteal artery and particularly in tibial vessels. As such, these discrepant modalities add to our challenge in developing uniform scoring systems and assisting the physician in assessing the extent of vascular calcification, both pre- and

post-intervention and its impact on both acute procedural success and clinical durability.

Vascular Calcium Scoring Systems

There are at least seven different calcium scoring systems published or disclosed as core lab scoring systems which have been used in investigational trials. Frequently cited calcium scales include the PARC and PACSS scales, and grading scales used by angiographic core labs in recently presented the IN.PACT Global SFA registry and the Philips ILLUMINATE trial. Additionally, Dr. Antonio Micari and investigators published a grading scale used in a multicenter, core lab adjudicated assessment of the IN.PACT™Admiral™DCB in long SFA lesions. These scales have many similarities: they primarily look at the circumferential nature of the calcification (i.e., present on both sides of the vessel wall as assessed by fluoroscopy) and the extent of the circumferential calcium as a function of total lesion length. Importantly, these grading scales remain hypothetical as none has been independently validated their potential impact on acute procedural success or 12-mo. maintenance of primary lesion patency.

VIVA Calcium Index Score

VIVA Physicians, in collaboration industry partners, sought to understand how vascular calcification impacts the acute procedural outcomes and impact on 12-month primary patency of DCBs. An independent angiographic core lab analyzed the varying degrees of femoropopliteal artery calcification assessed by standard fluoroscopy to determine its impact on loss of 12-month primary patency in a patient level de-identified data set of 1,185 lesions in 1,135 claudicants enrolled in DCB arms of the IN.PACT™SFA and Illuminate randomized controlled trials, the IN.PACT™SFA Global and Illuminate Global Studies, and the IN.PACT™Long Lesion sub-study. Respective angiographic core laboratories provided initial angiographic analyses for reference vessel diameter, % diameter stenoses and dissection grades for the IN.PACT™SFA and the Illuminate Trials. Angiograms from both studies were then reviewed at a Central Core Laboratory using a novel fluoroscopy-based vascular calcification scoring system by observers blinded to the clinical outcomes. 1,184 lesions were analyzed with co-registration of 12-month target lesion assessment of primary patency adjudicated by an independent duplex-ultrasound core lab. Primary patency failure was the primary endpoint of the analysis. Univariate predictors of primary patency failure were identified and a multivariate logistic regression model was constructed using candidate variables with univariate p-value <0.10. Lesion calcium burden was determined by a quantitative assessment of the length of calcium measured on both sides of the lesion and normalized to both lesion length and treatment length. The overall 12-month loss of primary patency was 23.0%. The multivariate analysis predictive of 12-month primary patency failure included the presence of exophytic calcium (OR 3.13; p<0.001), total calcium length (OR 1.004; p=0.028) and total bilateral calcium length normalized to treatment length (OR 1.01; p=0.013). This analysis of a large de-identified patient-level data set determined that the total calcium lesion length (unilateral + bilateral) and the total bilateral calcium length normalized to total treatment length, defined using standard fluoroscopy, were important predictors of 12-month loss of primary patency after DCB angioplasty.

Calcium-Directed Technologies for Vessel Preparation

The pursuit of these essential questions is drawn from the initial results of the DEFINITIVE AR trial. This small, randomized pilot trial combined vessel pre-treatment using directional atherectomy with post-atherectomy treatment with the Cotavance® drug-coated balloon. In a post-hoc analysis of a sub-cohort in this hypotheses-generating trial, a potential positive treatment effect in improving the 1-year primary patency was suggested when atherectomy and DCB were combined in long, calcified lesions compared to DCB alone. The REALITY study will build on this positive signal in a more robust and thorough evaluation of combining directional atherectomy vessel preparation with DCB and extend the evaluation of the potential treatment effect through 24 months. The REALITY study (diRectional atherEctomy + drug coAted balloon to treat long calcified femoropopLiteal arterY stenoses) is a multi-center, prospective, single-arm observational assessment of the safety and effectiveness of directional atherectomy debulking of long, severely calcified

lesions prior to drug-coated balloon treatment in patients with life-style limiting claudication due to obstructive atherosclerotic femoropopliteal disease. The study utilized angiographic and duplex Doppler core labs to independently adjudicate primary patency and freedom of clinically driven target lesion revascularization through 12-months. REALITY study recently completed enrollment of 101 patients at US and German sites and studied the combination of vessel preparation with the HawkOne™ or TurboHawk™ atherectomy systems prior to the use of the Medtronic IN.PACT™ Admiral™ drug-coated balloon. To date, REALITY is the most rigorous independently adjudicated study to evaluate the combined use of the two technologies to address severely calcified, long femoropopliteal lesions. In addition to assessing the effectiveness of the HawkOne™ and TurboHawk™ atherectomy debulking, the study will validate the procedural, 30-day and 12-month impact of severe vascular calcification using a unified calcium-scoring index.

The use of adjunct technologies, including a variety of atherectomy devices, and emerging novel specialty balloons including the intravascular lithotripsy (IVL™) system (Shockwave Medical, Fremont, CA) using pulsatile sonic pressure waves to modify intimal and medial calcium, may be used in combination with drug coated balloons to address more complex vascular lesions and promote acute procedural success and long-term clinical durability.

References

1. Fanelli F, Cannavale A, Gazzetti M, et al. Calcium burden assessment and impact on drug eluting balloons in peripheral arterial disease. *Cardiovasc Intervent Rad.* 2014; 37(4): 898-907.
2. Micari A, Nerla R, Vadala G, et al. 2-year results of paclitaxil-coated balloons for long femoropopliteal artery disease. Evidence from the SFA-Long Study. *JACC Cardiovasc Interv* 2017; 10: 728-34.
3. Thukkani A, Kinlay S. Endovascular interventions for peripheral artery disease. *Circ Res* 2015; 116: 1599-613.
4. Tepe G, Beschorner U, Ruether C, et al., Drug-eluting balloon therapy for femoropopliteal occlusive disease: Predictors of outcomes with a special emphasis on calcium. *J Endovasc Ther* 2015; 22:727-33
5. Roberts D, Niazi K, Miller W, Krishnan P, Gammon R, Schreiber T, Shammas NW, and Clair D. Effective endovascular treatment of calcified femoropopliteal disease with directional atherectomy and distal embolic protection: final results of the DEFINITIVE Ca++ trial. *Catheter Cardiovasc Interv.* 2014; 84: 236-244.
6. Stavroulakis K, Bisdas T, Torsello G, Stachmann A, Schwindt A. Combined directional atherectomy and drug-eluting balloon angioplasty for isolated popliteal artery lesions in patients with peripheral artery disease. *J Endovasc Ther.* 2015; 22(6):847-852.
7. Rocha-Singh KJ, Zeller T, Jaff MR, et al. Peripheral arterial calcification: prevalence, mechanism, detection, and clinical implications. *Catheter Cardiovasc Interv.* 2014; 83: E212-E220.
8. Cioppa A, Stabile E, Popusoi G, et al. Combined treatment of heavy calcified femoro-popliteal lesions using directional atherectomy and a paclitaxel coated balloon: one-year single centre clinical results. *Cardiovasc Revasc Med.* 2012; 13:219-223.
9. Guzman RJ, Brinkley DM, Schumacher PM, et al. Tibial artery calcification as a marker of amputation risk in patients with peripheral arterial disease. *J Am Coll Cardiol.* 2008; 51:1967-1974.
10. Zeller T, Langhoff R, Rocha-Singh K, et al., Directional atherectomy followed by paclitaxel drug coated balloon to inhibit restenosis and maintain vessel patency: Twelve month results for the DEFINITIVE AR Study. *Circ Cardiovasc Interv.* 2017; 10:e004848
11. Brodmann M, Werner M, Holden A, et al. Primary outcomes and mechanism of action of intravascular lithotripsy in calcified, femoropopliteal lesions: Results of Disrupt PAD II. *Catheter Cardiovasc Interv.* 2019; 93:335-342
12. Yin D, Maehara A, Shimshak T, et al. Intravascular ultrasound validation of contemporary angiographic scores evaluating the severity of calcification in peripheral arteries. *J Endovasc Therapy* 2017; 24:478-87

101.3

Overcoming angiography limitations: rationale for IVUS-guided revascularisation

F. Fanelli¹, G. Falcone²

¹Vascular and Interventional Radiology Department, "Careggi" University Hospital, Florence, IT, ²Vascular and Interventional Radiology, Careggi University Hospital, Florence, IT

Learning Objectives

1. To understand the limitations of digital subtraction angiography
2. To learn the advantages of IVUS in the peripheral vessels
3. To learn how to conduct a correct IVUS evaluation in the peripheral vessels

Intravascular ultrasound (IVUS) was first described in 1972, when miniaturized piezoelectric transducers were positioned on the tip of a catheter generating high-resolution, ultrasonic imaging of various cardiac and vascular structures.

Since the first experience a progressive technological improvement has been performed and nowadays IVUS can be considered an ideal adjunctive imaging modality in peripheral vascular interventions.

Real-time computerized processing systems have transformed the technology into a user-friendly tool that can provide information to facilitate interventions in the arterial and venous systems.

Due to recent technology improvements leading to higher probe resolution, IVUS can be now considered not only for the characterization of stenosis morphology and degree in the peripheral arteries, but also as a valid tool for precise evaluation of large calibre vessel diameter.

The advantages of IVUS evaluation is the accuracy in determining luminal cross-sectional measurements and detailed information on lesion morphology.

The limitations of digital subtraction angiography (DSA) are well known especially due to the bidimensional visualization of the vessel. IVUS has emerged as a useful and often necessary adjunctive tool in fact allows physicians to acquire images of diseased vessels from inside the artery. IVUS plays an important role not only in the diagnostic phase but also during the intervention. It can be very helpful in the selection of the most appropriate treatment modality (angioplasty, stent, etc) It also provide information on the correct placement of a device (stent) and monitor the efficacy of the intervention. While angiography underestimates, IVUS evaluates precisely the degree of stenosis and can contribute to the detection of the cause of endovascular failure.

Successful percutaneous transluminal angioplasty (PTA) of peripheral arterial lesions requires an accurate measurement of vessel diameter, assessment of the calcific nature of the plaque, evaluation of the wall morphology, and the ability to verify the final result. IVUS not only outline the luminal and adventitial surfaces of the vessels but also discriminate between normal and diseased components.

For example in the muscular arteries, the media appears as an echolucent layer sandwiched between the more echodense intima and adventitia, and defines the outer limits of any noncalcified plaque with the luminal circumference defining the inner limits.

IVUS accurately detected the presence of dissections, the entity of the intimal tear, plaque fractures, internal elastic lamina ruptures, and thinning of the media that occurred during angioplasty.

Intravascular ultrasound plays also a crucial role in the patency rate after ballooning and stenting. Several studies showed a correlation between vessel and stent diameters. In those cases where an incorrect stent was selected primary patency was lower. In peripheral vessels angiography-guided stent deployment results in incorrect positioning or expansion in 20% to 40% of cases.

IVUS is a powerful tool for the assessment of stent adaptation and recognition of underdeployment, which is the main cause of restenosis. In this scenario IVUS can play a fundamental role in the correct measurement of the vessel diameter and consequent correct stent selection.

Another interesting application of IVUS in the peripheral area is in sub-intimal recanalization. In fact IVUS can easily guide the operators to

orientate the catheter and the guidewire in the correct direction, within the true lumen. Moreover a re-entry IVUS guided system is available facilitating the recanalization of chronic total occlusions.

Another important consideration is related to the fact that "side-looking" IVUS provides only a cross-sectional image, so that IVUS-guided wire insertion into the true lumen remains a major challenge. When the guidewire is unable to pass the lesion, current IVUS probes are blind to the obstruction. However, utilization of transvenous IVUS may be beneficial in reducing the sheath size for the IVUS probe when utilizing the subintimal method, thus reducing the risk of hemorrhage after sheath removal and compression.

Several studies performed comparisons between IVUS and non IVUS guided angioplasties or stentings demonstrated lower rates of reinterventions in the IVUS group.

Two other advantages are correlated with this system: reduction of contrast media and radiation exposure.

Using IVUS many steps of an interventional procedure can be performed without the use of radiation and without the injection of contrast media. The advantages, not only for the patients but also for the operators are pretty clear.

Several methods have been studied to avoid or reduce the use of contrast media such as Carbon Dioxide (CO₂) as a radiopaque agent for angiography, and Duplex-ultrasound as an additional guidance. However all of these present significant limitations especially when compared to IVUS. For example CO₂ requires dedicated systems to be injected and specific software to elaborate the final image that is a summation of single frames. As reported this tremendously increases the radiation dose. IVUS is also useful in those patients with allergies to iodinated contrast medium.

References

1. Baker AC, Humphries MD, Noll RE Jr, et al. Technical and early outcomes using ultrasound-guided reentry for chronic total occlusions. *Ann Vasc Surg.* 2015;29:55–62
2. Takahashi Y, Sato T, Okazaki H, et al. Transvenous intravascular ultrasound-guided endovascular treatment for chronic total occlusion of infrainguinal arteries. *J Endovasc Ther.* 2017;24:718–726
3. Ascher E, Marks NA, Hingorani AP, et al. Duplex-guided endovascular treatment for occlusive and stenotic lesions of the femoral popliteal arterial segment: a comparative study in the first 253 cases. *J Vasc Surg.* 2006;44:1230–1238.
4. Iida O, Mano T. Role of IVUS in the Endovascular Treatment of Calcified Femoropopliteal Lesions. *CJ Endovasc Ther.* 2019 Apr 2
5. Sangiorgi G, Martelli E, De Luca F, et al. IVUS-Guided Recanalization of Peripheral CTOs: No More Eyes Wide Shut for Physicians? *J Endovasc Ther.* 2017 Oct;24(5):727-730.
6. Zasada W, Slezak M, Pociask E, et al. In vivo comparison of key quantitative parameters measured with 3D peripheral angiography, 2D peripheral quantitative angiography and intravascular ultrasound. *Int J Cardiovasc Imaging.* 2019 Feb;35(2):215-223.
7. Kurata N, Iida O, Shiraki T, et al. Impact of Stent-to-Vessel Diameter Ratio on Restenosis in the Superficial Femoral Artery After Endovascular Therapy. *Circ J.* 2018 Apr 25;82(5):1412-1417.
8. Shammas NW, Torey JT, Shammas WJ, et al. Intravascular Ultrasound Assessment and Correlation With Angiographic Findings Demonstrating Femoropopliteal Arterial Dissections Post Atherectomy: Results From the iDissection Study. *J Invasive Cardiol.* 2018 Jul;30(7):240-244.

101.4

Drugs, doses and excipients: DCBs under the spotlight

G. Tepe

Diagnostic and Interventional Radiology, Medical Centre of Rosenheim, Rosenheim, DE

Learning Objectives

1. To understand the characteristics of paclitaxel
2. To learn about the role of excipients
3. To learn the technical characteristics of the different drug-coated balloons

No abstract available.

101.5

Distinguishing between class effect and device/brand-specific features: how to decide what deserves adoption?

M. Brodmann

Clinical Division of Angiology, Medizinische Universität Graz, Graz, AT

Learning Objectives

1. To understand the technical differences between drug-coated balloons
2. To learn about class effect
3. To understand the safety issues of drug-coated balloons

No abstract available.

101.6

Dissections: do they matter and how can they be managed?

T. Zeller

Angiology, Herz-Zentrum Bad Krozingen, Bad Krozingen, DE

Learning Objectives

1. To learn the differences between the different types of dissections
2. To understand how to manage dissections
3. To learn the complications correlated to a flow-limited dissection

No abstract available.

Focus Session

Pancreatic cancer: role of IR

102.1

Pain management

M. Tsitskari

2nd Department of Radiology, Unit of Interventional Radiology, ATTIKON University General Hospital, Athens, GR

Learning Objectives

1. To learn about percutaneous options of pain management in pancreas carcinoma
2. To learn about techniques
3. To discuss results and complications

Pancreatic cancer (PC) is one of the most aggressive tumours with less than 5% survival at 5 years (1). The majority of these tumours, more than 80%, are detected at an advanced stage because of the difficulty of diagnosis. (2) Beside its poor prognosis and its late diagnosis, pancreatic cancer remains one of the most painful malignancies. Abdominal and back pain are one of the most debilitating symptoms in patients with PC with more than 50% of patients with PC suffering from pain. (3) Optimal management of pain in this cancer represents a real challenge for the oncologist whose objective is to ensure a better quality of life to

his patients. Most cancer related pain is controlled by pharmacological oral treatments. The optimal management is based on the World Health Organization (WHO)'s analgesic ladder, with a progressive administration of nonopioids (aspirin and paracetamol); then, as necessary, mild opioids (codeine); then strong opioids, until reaching pain relief. (4) Despite all the available analgesics and the possibility of combination of different molecules, the pharmacological management is frequently associated with incomplete, inadequate pain relief as well as drug-related adverse effects like nausea, vomiting, constipation, dry mouth, and drowsiness. (5) Moreover, visceral pain mechanisms are dynamic and changes with disease progression necessitating neurolytic blocks as adjuvants to reduce opioid consumption.

Therefore, as a management strategy, a multidisciplinary approach is recommended, involving a combination of an interventional treatment with neurolysis (chemical neurolysis with alcohol or phenol) and pharmacotherapy. Neurolysis alleviates pain by disrupting pain signals along the neural pathway. Pancreatic cancer pain is mediated by splanchnic nerves via celiac plexus to brain and is amenable to treatment by neurolysis of two anatomically distinct structures: celiac plexus and splanchnic nerves. (6) The splanchnic nerves are preganglionic sympathetic afferent fibers, retro-crural in location at the level of twelfth thoracic vertebra and consist of greater (T5-T10), lesser (T10-T11), and least (T12) splanchnic nerves. (7,8) These splanchnic nerves coalesce to form celiac plexus anterior to aorta surrounding the origin of celiac trunk. The celiac plexus is made up of the right and left ganglia, surrounding the aorta at the level of the celiac artery. It consists of visceral afferent, as well as sympathetic, and parasympathetic efferent fibers (9), and is located in the peri-aortic fat pads at the level of the diaphragmatic hiatus and celiac artery. There are commonly two to five celiac ganglia lying between T12 and L2 (10). Sympathetic nerve fibers run from the spinal cord to the sympathetic chain and then synapse in the celiac ganglia. In turn, pain from the foregut and midgut travels retrograde via parasympathetic visceral afferent nerve impulses from the celiac plexus through the splanchnic nerves to the central nervous system. (11)

Celiac plexus block (CPB), splanchnic nerve block (SNB) or neurolysis constitute alternative minimal invasive therapies for the treatment of pancreatic cancer related pain. (12-14)

CPB is the most common cancer pain intervention performed and is highly effective for upper abdominal visceral pain. The effectiveness of CPB in pancreatic cancer has been demonstrated in numerous RCTs. (15-17) A Cochrane review of RCTs found statistically significant difference in the mean VAS score and opioid consumption at 4 weeks in favour of CPB compared with control group in patients with unresectable pancreatic cancer pain. (18)

CPB should be considered early in the course of the illness where celiac axis is free and there is no contraindication as such an approach is associated with best pain relief, increased life expectancy, and last but not the least risks of neurolysis increases with disease progression. The CPB can be performed with patient in prone or supine position via an anterior or posterior approach. Image guidance inclusive of fluoroscopy, ultrasonography (USG), or computerized tomography (CT) help guide accurate needle placement and reduce complication during percutaneous CPB. The neurolytic agents most frequently applied for CPB are alcohol (50-100%) and phenol (5-10%). Because of the high affinity of phenol for vascular structures, alcohol is the agent of choice for CPB. (12,13)

Recently, the thoracic splanchnic nerve block has gained renewed interest because the thoracic splanchnic nerve exists in a less variable anatomical relationship with surrounding structures, as it lies in a small triangular space with well-defined landmarks and boundaries and is therefore easier to reach compared to the conventional celiac plexus block. (19) SNB involves blocking the splanchnics which are branches of thoracic sympathetic and constitutes nerve supply to the celiac plexus. This procedure is performed percutaneously with patient in prone position with the needle insertion in a tunnel view at the concave middle portion of the T11 vertebral body. Splanchnic nerve block requires a smaller volume of alcohol. In the past years in addition to chemical neurolysis, percutaneous

radiofrequency lesioning of the splanchnic nerves and to a lesser extent of the celiac plexus is also a technique gaining wide acceptance.

Complications of CPN are rare, occurring in approximately 1.5-2% of patients. Possible complications, however, do include transient, usually asymptomatic hypotension, retroperitoneal abscess, and severe self-limited post-procedural pain. Transient complications include post-procedural diarrhea and hypotension due to sympathetic blockade. Permanent, unremitting diarrhea has been reported in very rare cases. (20) In splanchnic nerve block, complications like orthostatic arterial hypotension are unusual because the procedure is less likely to involve the lumbar sympathetic chain than is celiac plexus block. Pneumothorax, intradural injection, and intravascular injection can be avoided with precise CT guidance. (21)

In conclusion management of pancreatic cancer related pain can be quite challenging. Timely treatment with percutaneous celiac plexus and splanchnic nerve neurolysis is safe and has demonstrated efficacious pain control. It has also shown to decrease the requirements of narcotics, and thus decrease opioid related side effects.

References

1. Global cancer statistics. Jemal A, Bray F, Center MM, Ferlay J, Ward E, Forman D, CA Cancer J Clin. 2011 Mar-Apr; 61(2):69-90
2. Pancreatic adenocarcinoma: ESMO-ESDO Clinical Practice Guidelines for diagnosis, treatment and follow-up. Seufferlein T, Bachet JB, Van Cutsem E, Rougier P, ESMO Guidelines Working Group. Ann Oncol. 2012 Oct; 23 Suppl 7():vii33-40
3. Pain sensation in pancreatic diseases is not uniform: the different facets of pancreatic pain. D'Haese JG, Hartel M, Demir IE, Hinz U, Bergmann F, Büchler MW, Friess H, Ceyhan GO. World J Gastroenterol. 2014 Jul 21; 20(27):9154-61
4. Morphine and alternative opioids in cancer pain: the EAPC recommendations. Hanks GW, Conno F, Cherny N, Hanna M, Kalso E, McQuay HJ, Mercadante S, Meynadier J, Poulain P, Ripamonti C, Radbruch L, Casas JR, Sawe J, Twycross RG, Ventafridda V, Expert Working Group of the Research Network of the European Association for Palliative Care. Br J Cancer. 2001 Mar 2; 84(5):587-93.
5. Pain management in patients with pancreatic carcinoma. Caraceni A, Portenoy RK. Cancer. 1996 Aug 1; 78(3 Suppl):639-53.
6. Shwita AH, Amr YM, Okab MI. Comparative Study of the Effects of the Retrocrural Celiac Plexus Block Versus Splanchnic Nerve Block, C-arm Guided, for Upper Gastrointestinal Tract Tumors on Pain Relief and the Quality of Life at a Six-month Follow Up. Korean J Pain. 2015 Jan; 28(1):22-31.
7. Brogan S, Junkins S. Interventional therapies for management of cancer pain. J Support Oncol 2010;8:52-9.
8. Levy MJ, Wiersema MJ. EUS-guided celiac plexus neurolysis and celiac plexus block. Gastrointest Endosc 2003;57:923-30.
9. Initial report of laparoscopic celiac plexus block for pain relief in patients with unresectable pancreatic cancer. Strong VE, Dalal KM, Malhotra VT, Cubert KH, Coit D, Fong Y, Allen PJ, J Am Coll Surg. 2006 Jul; 203(1):129-31.
10. The celiac ganglia in man: normal anatomic variations. Ward EM, Rorie DK, Nauss LA, Bahn RC. Anesth Analg. 1979 Nov-Dec; 58(6):461-5.
11. Gebhardt GF. Visceral pain mechanisms. In: Chapman CR, Foley KM, editors. Current and emerging issues in cancer pain. New York: Raven Press, 1993:99.
12. Ischia S, Ischia A, Polati E, Finco G. Three posterior percutaneous celiac plexus block techniques. A prospective, randomized study in 61 patients with pancreatic cancer pain. Anesthesiology 1992;76:534-40.
13. Jain P, Dutta A, Sood J. Coeliac plexus blockade and neurolysis: An overview. Indian J Anaesth 2006;50:169-77
14. Gangi A, Dietemann JL, Schultz A, Mortazavi R, Jeung MY, Roy C. Interventional radiologic procedures with CT guidance in cancer pain management. Radiographics. 1996 Nov; 16(6):1289-304

15. Wong GY, Schroeder DR, Carns PE, Wilson JL, Martin DP, Kinney MO, et al. Effect of neurolytic celiac plexus block on pain relief, quality of life, and survival in patients with unresectable pancreatic cancer: A randomized controlled trial. *JAMA* 2004;291:1092-9.
16. Staats PS, Hekmat H, Sauter P, Lillemoe K. The effects of alcohol celiac plexus block, pain, and mood on longevity in patients with unresectable pancreatic cancer: A double-blind, randomized, placebo-controlled study. *Pain Med* 2001;2:28-34
17. Kawamata M, Ishitani K, Ishikawa K, Sasaki H, Ota K, Omote K, et al. Comparison between celiac plexus block and morphine treatment on quality of life in patients with pancreatic cancer pain. *Pain* 1996;64:597-602.
18. Arcidiacono PG, Calori G, Carrara S, McNicol ED, Testoni PA. Celiac plexus block for pancreatic cancer pain in adults. *Cochrane Database Syst Rev* 2011
19. Loukas M, Klaassen Z, Merbs W, Tubbs RS, Gielecki J, Zurada. A review of the thoracic splanchnic nerves and celiac ganglia. *A Clin Anat*. 2010 Jul; 23(5):512-22
20. Davies DD. Incidence of major complications of neurolytic coeliac plexus block. *J R Soc Med*. 1993 May; 86(5):264-6.
21. Kurdziel JC, Dondelinger RF. Percutaneous lysis of neural structures. In: Dondelinger RF, Rossi P, Kurdziel JC, Wallace S, eds. *Interventional radiology*. New York, NY: Thieme, 1990; 768-780.

102.2

Irreversible electroporation

M.R. Meijerink

Radiology and Nuclear Medicine, Amsterdam UMC, Amsterdam, NL

Learning Objectives

1. To discuss the latest developments
2. To discuss latest results
3. To discuss future perspectives

Pancreatic adenocarcinoma is the fourth leading cause of cancer deaths in Europe and the United States¹. Five-year relative survival of patients with pancreatic cancer is currently as low as 8%¹. An important factor attributing to the dismal survival rate is that most patients are diagnosed with advanced disease, due to the lack of symptoms at early-stage pancreatic cancer¹. Surgical resection with adjuvant chemotherapy is regarded as the best treatment option for long-term survival. However less than 20% of patients present with resectable disease, and even in this subset of patients median overall survival (mOS) after successful resection and adjuvant therapy is only approximately 28 months². Furthermore, one third of the patients develop isolated local recurrence after resection³, which unfortunately is most often unresectable because of vascular involvement⁴.

About 30% of patients present with locally advanced pancreatic cancer (LAPC; American Joint Committee on Cancer [AJCC] stage III), defined as >180° circumference tumor encasement of the superior mesenteric artery or coeliac arteries, or any unreconstructable venous involvement². For these patients gemcitabine based regimens, with or without radiation, have long been the standard of care, resulting in a mOS of approximately 9-11 months⁵⁻⁷. The use of FOLFIRINOX chemotherapy (5-fluorouracil, leucovorin, irinotecan, and oxaliplatin) has clearly improved survival, although the prognosis for LAPC remains poor with a median OS of approximately 12-14 months⁸⁻¹⁰.

Given the poor survival of patients with LAPC, even without early distant metastases, several groups are focusing on combining systemic chemotherapy with local ablative therapies. Due to the unacceptable complication rate caused by the heat-related injury to critical blood vessels, bile ducts and gastro-intestinal structures radical thermal ablation in the pancreas has largely been abandoned, though the Verona and Utrecht groups (PELICAN study) continue to investigate partial debulking RFA, heating only the central part of the tumor, for LAPC patients¹¹. Irreversible electroporation (IRE) is a primarily nonthermal ablative technique, in which high-voltage electrical pulses irreversibly

damage the cellular membrane by creating nanopores, inducing cell death through apoptosis¹². Several studies confirmed the safety profile of IRE with encouraging survival outcomes and median survival times reaching 15 - 32 months from diagnosis¹¹. Most studies, however, are retrospective, limited in sample size and have a relatively short follow-up. The aim of the PANFIRE-1 and PANFIRE-2 trials was to stepwise and critically assess the efficacy and long-term safety of percutaneous IRE for LAPC and isolated unresectable local recurrences following surgical resection of pancreatic cancer and to compare with the current standard of care FOLFIRINOX +/- radiotherapy. FOLFIRINOX plus percutaneous IRE was superior to a matched group of patients treated with FOLFIRINOX alone with regards to overall survival, disease - and local progression free survival. The currently ongoing phase II/III Amsterdam based CROSSFIRE trial compares FOLFIRINOX plus IRE to FOLFIRINOX plus MR-guided SBRT. The FDA embedded and US-based DIRECT project will in the near future compare FOLFIRINOX +/- SBRT to FOLFIRINOX plus IRE and combine this with a prospective 15-center registry.

Although, in the absence of a direct comparison, the approach will be topic for debate for decades to come, the results from retrospective series seem to indirectly favor a percutaneous approach¹³⁻¹⁵. With lower complication rates, shorter hospital stay and on average longer median survival times from literature, presumably including a 25% worse-off subgroup of poor-prognosis patients with imaging-occult peritoneal disease and/or liver metastases that would not have gotten open-IRE following that approach, it seems just to prefer the less-invasive percutaneous route. In the PANFIRE-1 trial it was shown for the first time that tumor ablation through IRE in humans can open a therapeutic window leading to activation of tumor-specific effector T cells¹⁶. A consistent and selective post-IRE up-regulation of PD-1 on both CD4+ and CD8+ T cells in peripheral blood (revealing a phenotype likely amenable to PD-1 blockade) and increased frequencies of WT-1 specific T cells (by IFN-gamma elispot) were detected. This data delivers important first-in-man evidence of bona fide T cell activation and in vivo vaccination after IRE. These results were recently confirmed by Pandit et al. in a study showing decreased T-regs in peripheral blood at day 3-5 following in-human surgical IRE¹⁷. In mouse models, contrary to thermal ablation, cryotherapy and ionizing radiation, IRE has proven highly immunogenic, leading to the release of free ATP and HMGB1, and T cell induction, and to have a synergistic effect with PD-1 blockade achieving highly efficient tumor control with durable complete responses and in the majority of mice complete resistance to regrowth when rechallenged^{18, 19}. These mesmerizing animal-study results will be put to the test in humans in the future PANFIRE-3 trial comparing and combining IRE with local immune boosting drugs (CPG as toll-like receptor 9 ligand) plus immune checkpoint inhibition (PD-1 blockade) in oligometastatic pancreatic cancer.

To conclude, evidence to support the use of IRE over chemotherapy alone in LAPC patients is gradually surfacing and the results from prospective studies seem to confirm earlier retrospective data. The remarkable immune-modulatory effect of using pulsed electrical fields in pancreatic cancer, with the advent to increase neo-antigen presentation, to reduce immune-suppression and induce a pro-inflammatory micro-environment has opened an immense platform for future research and it may radically change the treatment paradigm for pancreatic cancer patients as well as the way we as interventional radiologists will treat pancreatic cancer in the future.

References

1. Siegel RL, Miller KD, Jemal A: Cancer Statistics, 2017. *CA Cancer J Clin* 67:7-30, 2017
2. Tempero MA, Malafa MP, Al-Hawary M, et al: Pancreatic Adenocarcinoma, Version 2.2017, NCCN Clinical Practice Guidelines in Oncology. *J Natl Compr Canc Netw* 15:1028-1061, 2017
3. Van den Broeck A, Sergeant G, Ectors N, et al: Patterns of recurrence after curative resection of pancreatic ductal adenocarcinoma. *Eur J Surg Oncol* 35:600-4, 2009

4. Comito T, Cozzi L, Zerbi A, et al: Clinical results of stereotactic body radiotherapy (SBRT) in the treatment of isolated local recurrence of pancreatic cancer after R0 surgery: A retrospective study. *Eur J Surg Oncol* 43:735-742, 2017
5. Huguet F, Andre T, Hammel P, et al: Impact of chemoradiotherapy after disease control with chemotherapy in locally advanced pancreatic adenocarcinoma in GERCOR phase II and III studies. *J Clin Oncol* 25:326-31, 2007
6. Chauffert B, Mornex F, Bonnetain F, et al: Phase III trial comparing intensive induction chemoradiotherapy (60 Gy, infusional 5-FU and intermittent cisplatin) followed by maintenance gemcitabine with gemcitabine alone for locally advanced unresectable pancreatic cancer. Definitive results of the 2000-01 FFCD/SFRO study. *Ann Oncol* 19:1592-9, 2008
7. Loehrer PJ, Sr., Feng Y, Cardenes H, et al: Gemcitabine alone versus gemcitabine plus radiotherapy in patients with locally advanced pancreatic cancer: an Eastern Cooperative Oncology Group trial. *J Clin Oncol* 29:4105-12, 2011
8. Vincent A, Herman J, Schulick R, et al: Pancreatic cancer. *Lancet* 378:607-20, 2011
9. Rombouts SJ, Walma MS, Vogel JA, et al: Systematic Review of Resection Rates and Clinical Outcomes After FOLFIRINOX-Based Treatment in Patients with Locally Advanced Pancreatic Cancer. *Ann Surg Oncol* 23:4352-4360, 2016
10. Suker M, Beumer BR, Sadot E, et al: FOLFIRINOX for locally advanced pancreatic cancer: a systematic review and patient-level meta-analysis. *Lancet Oncol* 17:801-810, 2016
11. Ruars A, Vroomen L, Puijk R, et al: Locally Advanced Pancreatic Cancer: A Review of Local Ablative Therapies. *Cancers (Basel)* 10, 2018
12. Rubinsky B, Onik G, Mikus P: Irreversible electroporation: a new ablation modality--clinical implications. *Technol Cancer Res Treat* 6:37-48, 2007
13. Martin RC 2nd, Kwon D, Chalikonda S, et al: Treatment of 200 locally advanced (stage III) pancreatic adenocarcinoma patients with irreversible electroporation: safety and efficacy. *Ann Surg* 262:486-94 2015
14. Narayanan G, Hosein PJ, Beulaygue IC, et al: Unresectable, Locally Advanced Pancreatic Adenocarcinoma. *J Vasc Interv Radiol* 28:342-348 2017
15. Leen E, Picard J, Stebbing J, et al: Percutaneous irreversible electroporation with systemic treatment for locally advanced pancreatic adenocarcinoma. *J Gastrointest Oncol* 9:275-281 2018
16. de Grujil T, Stam A. From local to systemic treatment: leveraging antitumor immunity following irreversible electroporation. Chapter 17 from Meijerink M, Scheffer H, Narayanan G, et al. *IRE in clinical practice*. Springer Verlag 2018
17. Pandit H, Hong YK, Li Y, et al: Evaluating the Regulatory Immunomodulation Effect of Irreversible Electroporation (IRE) in Pancreatic Adenocarcinoma. *Ann Surg Oncol* 26:800-806 2019
18. Zhao J, Wen X, Tian L, et al: Irreversible electroporation reverses resistance to immune checkpoint blockade in pancreatic cancer. *Nat Commun* 10:899 2019
19. Shao Q, O'Flanagan S, Lam T, et al: Engineering T cell response to cancer antigens by choice of focal therapeutic conditions. *Int J Hyperthermia* 36:130-138 2019

102.3

Thermal ablation

K.P. van Lienden

Interventional Radiology, Academic Medical Center, Amsterdam, NL

Learning Objectives

1. To describe the technique of RFA of pancreas
2. To give an overview of the literature and the role of RFA compared to other ablation techniques
3. To discuss results and complications

No abstract available.

102.4

Intra-arterial chemotherapy

T. Tanaka

Radiology, Nara Medical University, Kashihara, JP

Learning Objectives

1. To talk about indication
2. To explain the technique
3. To give an overview of the literature on preliminary results

Systemic chemotherapy has been widely used as a standard therapy for unresectable pancreatic cancer. FOLFIRINOX and gemcitabine combined with nab-PTX have been developed. However, the response rate and survival benefit are limited. In addition, severe adverse events of not only hematological toxicity but also fatigue and neuropathy frequently occurred.

Intra-arterial therapy is one of the expected therapies for chemo-resistant cancer patients. Several published literatures of intra-arterial therapy have demonstrated interest and promising results. The response rates of 30 to 80% and the median survival times of 9 to 22 months have been reported. When we conduct intra-arterial chemo-infusion for pancreatic cancer, we must consider the drug distribution. Firstly, we reported the drug distribution in advanced pancreatic cancer evaluated by CT during arterial injection of contrast material, using the hybrid CT and angiography system [1]. Our results indicated that both the pancreatic head and the body cancer required chemo-infusion from the celiac and the superior mesenteric arteries. From this result, we conducted a clinical study, in which 5-FU was infused from both the celiac and superior mesenteric arteries and concurrently extra-beam radiotherapy was delivered [2]. This chemoradiotherapy using the dual arterial infusion technique achieved a high response rate of 70% and median survival time of 11 months. However, the side effects of diarrhea and hyoalbuminemia occurred due to the chemoinfusion into the superior mesenteric artery. Then, we developed a new technique to convert the dual pancreatic blood supply into a single one from the celiac artery [3]. With the embolization of the pancreatic branches which arise from the superior mesenteric artery, the whole tumor was supplied from the celiac artery alone in the selected patients. Using this technique, we conducted a phase I/ II study of intra-arterial 5-FU combined with full-dose systemic gemcitabine [4]. In phase I portion, we assessed the recommended dosage of intra-arterial 5-FU with the dose escalation study. In phase II portion, the tumor response, the survival duration and the adverse events were evaluated. The recommended dose of intra-arterial 5-FU was determined as 1000mg/m². The high response rates of 68.8% was achieved without any severe toxicity. The progression free survival was 6 months and overall survival was 9.8 months for the patient with liver metastases. The outstanding high tumor response of intra-arterial 5-FU can be explained by the pharmacokinetic study. In an animal study using pig, the AUC of 5-FU in the pancreatic head was around 2.5 times higher in the intra-arterial with superior mesenteric balloon occlusion group compared with those in the intra-venous group and the intra-arterial without occlusion group [5]. Intra-arterial therapy could be effective for a neoadjuvant setting, prior to surgery or radiotherapy, because of the high possibility of tumor size reduction [6].

Postoperative hepatic recurrence is frequently seen, in 30 to 60% in clinical and in 80 to 90% in autopsy. Hepatic recurrence often occurs within short period after surgery, and usually induce short survival after recurrence. Previous randomized control trials showed the hepatic recurrence rates of over 30% after standard adjuvant chemotherapy using gemcitabine. To prevent hepatic recurrence, we developed novel adjuvant strategy combined intra-arterial 5-FU infusion combined with systemic gemcitabine [7]. In our study, overall hepatic recurrence rate was only 13%. The 2-year survival rate was 75%. After pancreatic surgery, occasionally the catheter placement is difficult due to tortuous and stenotic of celiac and/or hepatic arteries. To overcome the difficulty, we used the coaxial indwelling catheter system [8]. Regarding the safety of arterial infusion chemotherapy after pancreaticoduodenectomy (PD), we have to carefully evaluate the possibility of biliary complications. We reported the ratio of complication was only 6.5% by hepatic arterial hemoinfusion after PD [9]. TACE using irinotecan eluting bead is also effective for liver metastases from pancreatic cancer. The results of multi-center registry showed the response rate was 80% and OS was 9.3 months after the refractory of standard chemotherapy. We also have experienced several cases in which DEBIRI were effective for multiple liver metastases from pancreatic cancer. In conclusion, intra-arterial therapy has a high potential to become the breakthrough in the treatment of pancreatic cancer.

References

1. Tanaka T, Sakaguchi H, Anai H, Yamamoto K, Morimoto K, Nishiofuku H, Kichikawa K: Catheter position for adequate intra-arterial chemotherapy for advanced pancreatic cancer: evaluation with CT during arterial injection of contrast material. *J Vasc Interv Radiol* 2004, 15:1089-1097.
2. Tanaka T, Sakaguchi H, Anai H, Yamamoto K, Morimoto K, Tamamoto T, Kichikawa K. Arterial infusion of 5-fluorouracil combined with concurrent radiotherapy for unresectable pancreatic cancer: results from a pilot study. *Am J Roentgenol* 2007, 189:421-428.
3. Tanaka T, Sakaguchi H, Sho M, Yamamoto K, Nishiofuku H, Nakajima Y, Kichikawa K. A novel interventional radiology technique for arterial infusion chemotherapy against advanced pancreatic cancer. *Am J Roentgenol* 2009, 192:w168-187.
4. Tanaka T, Sho M, Nishiofuku H, Sakaguchi H, Inaba Y, Nakajima Y, Kichikawa K. Unresectable pancreatic cancer: arterial embolization to achieve a single blood supply for intraarterial infusion of 5-Fluorouracil and full-dose IV gemcitabine. *Am J Roentgenol* 2012, 198:1445-52.
5. Tanaka T, Yamamoto K, Sho M, Nishiofuku H, Inoue M, Sueyoshi S, Anai H, Sakaguchi H, Nakajima Y, Kichikawa K. Pharmacokinetic evaluation of pancreatic arterial infusion chemotherapy after unification of the blood supply in an animal model. *J Vasc Interv Radiol* 2010, 21:116-121.
6. Tanaka T, Nishiofuku H, Tamamoto T, Sho M, Anai H, Sueyoshi S, Sakaguchi H, Hasegawa M, Nakajima Y, Kichikawa K. Intra-arterial chemoinfusion prior to chemoradiotherapy with full-dose systemic gemcitabine for management of locally advanced pancreatic cancer. *Anticancer Res* 2011, 31:3909-12.
7. Sho M, Tanaka T, Yamada T, Nomi T, Akahori T, Doh J, Yamato I, Hokuto D, Nishiofuku H, Marugami N, Kanehiro H, Kichikawa K, Nakajima Y. Novel postoperative adjuvant strategy prevents early hepatic recurrence after resection of pancreatic cancer. *J Hepatobiliary Pancreat Sci* 2011, 18:235-9.
8. Hashimoto A, Tanaka T, Sho M, Nishiofuku H, Masada T, Sato T, Marugami N, Anai H, Sakaguchi H, Kanno M, Tamamoto T, Hasegawa M, Nakajima Y, Kichikawa K. Adjuvant Hepatic Arterial Infusion Chemotherapy After Resection for Pancreatic Cancer Using Coaxial Catheter-Port System Compared with Conventional System. *CVIR* in press.
9. Hashimoto A, Nishiofuku H, Tanaka T, Sho M, Anai H, Nakajima Y, Kichikawa K. Safety and optimal management of hepatic arterial infusion chemotherapy after pancreatectomy for pancreatobiliary cancer. *Am J Roentgenol* 2012, 198:923-30.

Fundamental Course Management of benign musculoskeletal tumours

103.1

Diagnostics and imaging

A. Feydy

Radiologie B, Hôpital Cochin, Paris, FR

Learning Objectives

1. To understand the value of imaging for diagnosis
2. To know about technical considerations when performing MSK biopsy
3. To become familiar with the most common benign bone tumours

No abstract available.

103.2

Benign bone tumours: local therapies

U. Pua

Diagnostic Radiology, Tan Tock Seng Hospital, Singapore, SG

Learning Objectives

1. To become familiar with the most common indications
2. To know about technical considerations
3. To know about evidence-based practice

Local ablative techniques are well accepted in the ablation of malignant tumors; such as liver, renal, lungs and other soft-tissue. Extension of local ablative techniques into benign bone tumor is particularly attractive due to its minimally invasive nature, and utility of similar devices and technologies. While percutaneous ablation of osteoid osteoma using radiofrequency, is perhaps the most studied and established benign bone tumor treated using ablative technique. Benign bone tumors of other cellular matrix (e.g. chondroid, vascular, fibro/lipomatous, etc) are increasing being treated using local ablative techniques. Coupled with advances in image-guidance and ablation devices, with the attendant improvement in safety and procedural success, demand for this treatment technique is likely increase. The aim of this presentation is to discuss the common indications, techniques and current evidence surrounding local ablation in benign bone tumors.

References

1. Rosenthal D, Callstrom MR. Critical review and state of the art in interventional oncology: benign and metastatic disease involving bone. *Radiology*. 2012 Mar;262(3):765-80.
2. Perry BC, Monroe EJ, McKay T, Kanal KM, Shivaram G. Pediatric Percutaneous Osteoid Osteoma Ablation: Cone-Beam CT with Fluoroscopic Overlay Versus Conventional CT Guidance. *Cardiovasc Intervent Radiol*. 2017 Oct;40(10):1593-1599.
3. Filippidis DK, Tutton S, Mazioti A, Kelekis A. Percutaneous image-guided ablation of bone and soft tissue tumours: a review of available techniques and protective measures. *Insights Imaging*. 2014 Jun;5(3):339-46.

103.3

Desmoids and desmoid fibromatosis: the case for ablation

J. Garnon

Interventional Radiology, University Hospital of Strasbourg, Strasbourg, FR

Learning Objectives

1. To become familiar with the most common indications
 2. To know about technical considerations
 3. To know about literature evidence
- Desmoid tumours are rare benign soft-tissue tumours, which can occur either sporadically or in the setting of a genetic disease such as the

Gardner syndrome. Because of their local aggressive behaviour, they are usually classified as sarcoma-like lesions. The spontaneous history of these tumours is variable from one patient to another, with some lesions exhibiting a very quick increase in size while other may stay stable or even spontaneously involute. The management of these lesions therefore remain extremely difficult. Surgery is no more proposed as a first option because it is associated with high rates of local recurrence and a high morbidity. Radiation therapy is also not without consequences in this young population. Recently, percutaneous thermal ablation has been proposed as a salvage therapy for the local management of these lesions with interesting initial results. Among all ablative modalities, cryoablation seems notably particularly adapted for the treatment. The simultaneous activation of several cryoprobes allows to ablate very large tumours that are frequently encountered in clinical practice. Real-time monitoring of the ablation zone thanks to the visualisation of the iceball enables to assess proper coverage of the lesion while limiting the risk of unintended injury to surrounding organs (notable nerves and bones). Ideally, the perfect case for ablation is a small tumour located at least one centimetre away from any nerve and bony structure. Such features allow to treat aggressively the lesion with safety margins, potentially increasing the chance of complete local remission even though evidences to support this affirmation are extremely limited. Unfortunately, this ideal scenario is rare in daily practice. Many tumors are very large at the time of treatment (more than 5 or even 10cm) and usually also about some vulnerable(s) organ(s). Management of these lesions with ablation is therefore frequently challenging, and the interventional radiologist should be familiar with all protective measures in order to reduce as much as possible the risk of complications. Patient should be informed pre-operatively of complications (nerve, skin, bone damage depending on the case), the risk of incomplete treatment and the risk of secondary tumor regrowth on the margins of ablation (that is very frequent but not always clinically significant). Patient selection by the IR should be extremely cautious, and multidisciplinary discussion is as always mandatory. The IR should also be aware of the possibility to manage these tumours with systemic treatments in case thermal ablation seems too risky.

103.4

MR-guided focused ultrasound ablation for salvage treatment of desmoids

S.M. Tutton

Department of Radiology, Medical College of Wisconsin, Milwaukee, WI, US

Learning Objectives

1. To become familiar with the most common indications
2. To know about technical considerations
3. To know about literature evidence

No abstract available.

Clinical Evaluation Course Ilio-femoral venous stenting masterclass

104.1

Pre-operative imaging

C.W.K.P. Arnoldussen

Radiology and Interventional Radiology, VieCuri Medical Centre, Venlo, NL

Pre-interventional evaluation of the central deep veins in chronic venous occlusive disease is essential in both selecting patients eligible for an endovascular reconstruction as well as procedural planning. It is now accepted that recanalization, PTA and stenting of the deep veins should be performed from a healthy to healthy deep vein segment. Accurate 3D pre-interventional assessment with ideally MR-Venography

allows for an approach selection (antegrade or retrograde or both) and assessment of the patency of potentially crucial zones for an adequate reconstruction. These include the common femoral vein confluence and the ilioacaval configuration as well as the drainage from the caval vein into the heart.

This evaluation should include at least the inferior caval vein (supra- and infrarenal), the common and external iliac veins, the (common) femoral and profunda femoral veins. Abnormal findings in the popliteal and/or calf veins have less impact on patient and procedure selection and can be included if ancillary findings with duplex ultrasound indicate severe disease specifically at the level of the popliteal vein / proximal calf veins. If in addition to initial duplex ultrasound evaluation MR-Venography is not available or feasible, (indirect) CT-Venography provides comparable information to a certain extend regarding the deep vein anatomy, the presence of obstruction, (residual) lumen diameter and collateral patterns. Intraluminal changes that in our practice affect procedural technique and selection of an optimal (distal) landingzone is in our experience optimally assessed with MR-Venography.

In our experience the following subgroups of deep vein obstruction can be identified:

Type I

Iliac vein stenosis (most common variation is the May-Thurners' syndrome but there are many variations) and/or non-thrombotic iliac vein lesion (NIVL)

Type II

Iliac and/or caval vein obstruction limited to the caval vein and/or common and/or external iliac vein without involvement of the common femoral vein / femoral veins

Type III

Iliac and/or caval vein obstruction including the common femoral vein but with a patent femoral vein confluence and patent proximal femoral and profunda femoral vein

Type IV

Iliac and/or caval vein obstruction including the common femoral vein, femoral and/or profunda femoral vein(s)

Regarding outcomes, type I and II perform excellent in both patency (close to 100% in type 1 and >90% in type 2) and clinical success (reduction of symptoms, improvement in quality of life). Pre-requisite for success is to ensure the entire diseased tract is stented.

Type III requires specific attention regarding the distal landingzone during the procedure to ensure the inflow is optimally preserved. In some cases we can rely on pre-interventional imaging for the landingzone, in other cases the assistance of IVUS during the procedure ensures accurate stent placement maintaining patent inflow from both the femoral and profunda femoral veins. In those cases where inflow is optimally preserved, both patency and clinical success are almost equally high as in type I and II. Loss of either the profunda femoral or femoral vein inflow hampers patency and clinical success.

In type IV inflow is the main issue. In our experience for type IV endovascular ilioacaval reconstruction is feasible but without sufficient inflow due to the extensive scarring in the common femoral and both the femoral veins patency is often problematic. Experts in the field apply different approaches in these cases varying from conservative treatment, an endovascular only approach (with a distal landingzone in either the common femoral vein or the 'dominant' inflow vessel being either the femoral or profunda femoral vein) and hybrid techniques including endoflebectomy of the groin (common femoral vein and its inflow veins) with adjunctive AV-fistula creation. Patency and clinical success varies and is reported at around 50% for these extensive cases. Additionally, (multiple) re-interventions are common in this group.

In context of these outcomes an extensive and accurate pre-interventional imaging assessment is crucial to inform patients correctly about the status of their veins, what is (technically) possible and feasible and to offer them the right treatment. In particular in extensive cases counselling based on (non-invasive) imaging is equally important as in the choice to intervene or stay conservative.

References

1. The clinical impact of iliac venous stents in the management of chronic venous insufficiency. Raju S1, Owen S Jr, Neglen P. *J Vasc Surg.* 2002 Jan;35(1):8-15.
2. Unexpected major role for venous stenting in deep reflux disease. Raju S1, Darcey R, Neglén P. *J Vasc Surg.* 2010 Feb;51(2):401-8.
3. Value of magnetic resonance venography and computed tomographic venography in lower extremity chronic venous disease. Arnoldussen CW, de Graaf R, Wittens CH, de Haan MW. *Phlebology.* 2013 Mar;28 Suppl 1:169-75.
4. Minimally invasive treatment of chronic iliofemoral venous occlusive disease. Friedrich de Wolf MA, Arnoldussen CW, Grommes J, Hsien SG, Nelemans PJ, de Haan MW, de Graaf R, Wittens CH. *J Vasc Surg Venous Lymphat Disord.* 2013 Apr;1(2):146-53.
5. Reconstruction of the femoro-ilio-caval outflow by percutaneous and hybrid interventions in symptomatic deep venous obstruction. van Vuuren TMAJ, de Wolf MAF, Arnoldussen CWKP, Kurstjens RLM, van Laanen JHH, Jalaie H, de Graaf R, Wittens CHA. *Eur J Vasc Endovasc Surg.* 2017 Oct;54(4):495-503.
6. New horizons in deep venous disease management – Arnoldussen CWKP Baekgaard N., Fanelli F., O'Sullivan G. J. 2017 ISBN-10: 8877118938 ISBN-13: 978-8877118936
7. Gadobutrol versus gadofosveset-trisodium in MR-venography of the lower extremities Arnoldussen CWKP, Lam Y, Ito N, Winkens B, Kooi ME, Wittens CHA, Wildberger JE *Eur Radiol.* 2017; 27(12): 4986–4994.

104.2

How to plan for ilio-femoral venous reconstruction: what kit do you need?

A. Bravo De Laguna Taboada¹, D. Cubillo Prieto¹, E. Buceta Cacabelos¹, A. Martín Sanchez², S. Moreno Casas², F. Acosta de Bilbao²

¹Interventional Radiology, Hospital Insular de Gran Canaria, Las Palmas, ES, ²Internal Medicine, H. Universitario Insular de Gran Canaria, Las Palmas, ES

Learning objects: To show technical tips and tricks of iliofemoral venous stenting for post-thrombotic syndrome (PTS)
Background: Deep venous obstruction is a relatively prevalent condition caused by post-thrombotic vein damage or extraluminal venous compression or a combination of the two. Post-thrombotic syndrome (PTS) develops in up to 50% of patients in the months or years following a deep venous thrombosis (DVT). Pathophysiology of PTS is based on vein wall stiffening, intraluminal scarification and valvular damage, all associated with the local inflammatory response following an acute DVT. Endovascular treatment of deep venous obstruction has been taking a giant leap forward. It has been shown that high technical success is achievable and patency rates are at least as good as from its surgical predecessor. Moreover, clinically, patients improve significantly after recanalization of the obstructed iliofemoral and caval veins.
Procedure Details: The stenting procedure itself encompasses access to both right jugular vein and bilateral femoral veins under ultrasound guidance. Therefore, angiography in multiple projections is helpful. By use of hydrophilic guidewires, the obstruction can be passed in most cases. Scrupulous preparation of the veins is mandatory for a correct positioning of the stents. Tips and tricks are shown in this presentation to deal with complicated cases from access to the end.
Conclusion: Endovascular treatment of iliofemoral obstructions is generally accepted and technically feasible in virtually all cases and shows very high patency rates. Dedicated venous materials and special tricks could help to finish in technical and clinical success.

References

1. Neglen P, Hollis KC, Olivier J, Raju S. Stenting of the venous outflow in chronic venous disease: long-term stent-related outcome, clinical, and hemodynamic result. *Journal of vascular surgery.* 2007;46(5):979-90.
2. Kahn SR, Shrier I, Julian JA, Ducruet T, Arsenault L, Miron MJ, et al. Determinants and time course of the postthrombotic syndrome after acute deep venous thrombosis. *Annals of internal medicine.* 2008;149(10):698-707.
3. de Wolf MA, de Graaf R, Kurstjens RL, Penninx S, Jalaie H, Wittens CH. Short-term clinical experience with a dedicated venous nitinol stent: initial results with the sinus-venous stent. *European journal of vascular and endovascular surgery: the official journal of the European Society for Vascular Surgery.* 2015.
4. Seager MJ, Busuttil A, Dharmarajah B, Davies AH. Editor's Choice - A systematic review of endovenous stenting in chronic venous disease secondary to iliac vein obstruction. *European journal of vascular and endovascular surgery: the official journal of the European Society for Vascular Surgery.* 2016;51(1):100-20.
5. Vogel D, Comerota AJ, Al-Jabouri M, Assi ZI. Common femoral endovenectomy with iliofemoral endoluminal recanalization improves symptoms and quality of life in patients with postthrombotic iliofemoral obstruction. *Journal of vascular surgery.* 2012;55(1):129-35.

104.3

How in-flow determines the access point

N. Karunanithy

Department of Interventional Radiology, Guy's and St. Thomas Hospitals NHS Foundation Trust, London, UK

A fundamental principle required for successful iliofemoral venous stenting is to ensure that in-flow is optimal. Good pre-operative work-up will help determine if adequate in-flow is present [1]. The venous access point should aim to preserve as much in-flow to the stented segment as possible and allow the entire diseased segment of vein to be treated – stenting is performed from 'healthy – healthy vein segment' [2].

A further consideration will be the need to place relatively large (typically 9 Fr) sheaths. Haemostasis is achieved relatively easily for vein punctures. However concomitant use of thrombolysis, either alone or in combination with mechanical thrombectomy will increase the risk of access site complications.

One of the primary aims of reintervention on stented venous segments is to maximize what is likely to be compromised in-flow. In these instances careful consideration needs to be given to the access point to allow this to be achieved.

References

1. Helyar VG, Gupta Y, Blakeway L, Charles-Edwards G, Katsanos K, Karunanithy N. Depiction of lower limb venous anatomy in patients undergoing interventional deep venous reconstruction: the role of balanced steady state free precession MRI. *Br J Radiol.* 2018 Feb;91(1082):20170005
2. Black S, Gwozdz A, Karunanithy N et al. Two Year Outcome After Chronic Iliac Vein Occlusion Recanalisation Using the Vici Venous Stent(®). *Eur J Vasc Endovasc Surg.* 2018 Nov;56(5):710-718

104.4

Balloon angioplasty or balloon angioplasty plus stent

S.D. Qanadli

Radiology and Interventional Radiology, University Hospital of Lausanne, Lausanne, CH

Endovascular management of iliac venous obstruction has become more common with improved pre and intraprocedural imaging (IVUS)

as well as recent advances in building dedicated technologies to venous obstructions.

Balloon angioplasty is frequently used and the main indication of stent should be vessel recoil after balloon dilation alone. Actually, due to characteristics of the iliac vein anatomy and considering venous obstruction specificities, stents are mandatory in many clinical situations. The ideal venous stents should have high radial resistive force, high chronic outward force, high resistance to crush and have a balanced compromise between vessel conformability and rigidity.

This short lecture will focus on indications of venous stent placement with or without primary balloon angioplasty. These indications include chronic thrombotic venous obstructions (chronic venous insufficiency), non-thrombotic obstructions (extrinsic compression, tumors) and adjunctive to thrombectomy in acute iliac obstructions. Left iliac vein compression by the right common iliac artery (May-Thurner syndrome) is the most frequent non-thrombotic condition, estimated up to 50% of left lower extremity disease. Stenting of iliac vein in the May-Thurner syndrome is challenging for the interventionist. The optimal stent deployment in the target region often needs to be guided by IVUS or Cone-Beam CT. Despite the absence of strong data regarding long-term outcomes of venous stents, non-thrombotic lesions had better outcome than thrombotic obstructions.

104.5

Surgical salvage options

A. Gombert¹, M.E. Barbat¹, M.K. Razavi², H. Jalaie¹

¹European Vascular Center Aachen-Maastricht, Department of Vascular Surgery, RWTH University Hospital Aachen, Aachen, DE, ²Department of Interventional Radiology, St. Joseph Hospital, Orange, CA, US

Objective

Deep venous thrombosis may lead to chronic venous occlusion (CVO) related to post-thrombotic (PTS) in a relevant proportion of the affected patients. Especially if the ilio-caval tract is involved, the percentage of PTS is still underestimated among patients and professionals, although the impact on patients' quality of life is undisputable (1). In this context, interventional treatment for deep vein thrombosis and symptomatic chronic venous obstruction of the femoro-iliac and caval tract as a causal treatment of PTS has gained attendance within the last decade (2-4). In certain cases, the CVO-changes extending below inguinal ligament may involve the femoral tributaries such as femoral vein (FV) and the deep femoral vein (DFV). In such cases, the sole venous recanalization using a stent-angioplasty of the femoro-iliac and caval tract may be inadequate, as the venous inflow remains impaired (5). Here another attempt seems necessary to improve the venous inflow. In this article, we will focus on three different techniques to improve the venous inflow from an affected leg during deep venous recanalization. The advantages as well as the disadvantages will be mentioned and discussed against the background of the current literature and our experience. Besides the discussed option to perform an endophlebectomy of the affected common femoral vein (CFV), an autologous or prosthetic veno-venous bypass (orthograde or crossover) may be applied to enable venous outflow from an affected leg. Yet, in addition to high rate of complications such as surgical site infections, a moderate patency rate of 62% has been reported for this invasive type of treatment (6).

Classification of CVO

The complexity of venous pathology with multifactorial determinants of treatment outcome necessitate the introduction of a universal classification in scoring the deep venous obstruction to aid scientific reporting as well as support therapeutic decisions. To ensure clinical utility, we propose a simple and practical classification based on the current knowledge of anatomic influencers of venous stent outcome. Based on the available evidence, the additional involvement of inferior vena cava has a relatively low effect on decision making for intervention and its result; hence, a separate category for IVC occlusion has not been included. We suggest the following classification based on anatomical extension of the chronic

pathology and paying heed to the importance of inflow. In this article, we will focus on "extensive CVO" which includes type IV and V according to the used classification.

Endophlebectomy

At the beginning of the procedure, a bolus of 5000 IE unfractionated heparin will be administered and the activated clotting time will retain greater than 200 seconds.

After successful passage of the obstructed femor-ilio-caval tract by interventional means, a groin incision is performed with exposure of the CFV and all its tributaries (7). Post-thrombotic trabeculation is removed from the CFV, ostium of DFV and FV. A bovine patch is used to close the venotomy, afterwards a femoro-femoral arteriovenous fistula is constructed using a loop-shaped, external supported 6mm PTFE-prosthesis. After closure of the venotomy, the venous recanalization will be completed by angioplasty and stenting. The incision is closed in separate layers using resorbable suture material. Closed incision negative pressure therapy (CINPT), namely PREVENA is placed under sterile conditions in the OR, applying a continuous negative pressure of 125 mmHg which interacts on the closed wound. The device will remain for 5-7 days (8).

Postoperative care

Anticoagulation will be continued during the procedure, which is also a risk factor for the surgical site infection (SSI). A minimum of 12 months of oral anticoagulation will be recommended. A longer period of oral anticoagulation should be decided based on patients' characteristics, underlying hypercoagulability, extension of pathology and the quality of inflow.

An elastic compression bandage will be applied directly after end of procedure in OR. As we recommend immobilization for at least 2 days after groin incision combined with endophlebectomy and femoral AV fistula, intermittent pneumatic compression will be applied until discharge from hospital. Furthermore, patients will be mobilized 48h after surgery. Clinical follow-up assessments includes duplex ultrasound at discharge from hospital, after 2 weeks, 3, 6 and 12 months and yearly afterwards. During follow-up, if the stent is patent and the geometry seems appropriate, interventional occlusion of the AV fistula will be performed interventional 6 weeks postoperative.

Outcome

As the invasive treatment option of endophlebectomy is reserved for the most extended cases of CVO (type IV a), the patency rate is worse if compared with type I-III cases. Furthermore, based on the increased rate of lymphatic drainage in the affected legs, the therapeutic anticoagulation and the extensive operation time, the rate of surgical site infections (SSI) is relevant (9). Based on ongoing research projects of the presenting department, CINPT is used in each case, as a decreased SSI rate was observable (8). Furthermore, based on our own experience, we recommend a careful consideration of endophlebectomy as treatment option, especially in patients with a history of intravenous drug abuse, a "hostile groin" after surgical thrombectomy or in case of a relevant risk for SSI such as severe obesity, diabetes, smoking and ongoing immunosuppressive therapy.

References

1. Catarinella F, Nieman F, de Wolf M, Wittens C. Short-term follow-up of Quality-of-Life in interventional treated patients with post-thrombotic syndrome after deep venous occlusion. *Phlebology*. 2014;29(1 suppl):104-11.
2. Wittens C, Davies AH, Baekgaard N, Broholm R, Cavezzi A, Chastanet S, et al. Editor's Choice - Management of Chronic Venous Disease: Clinical Practice Guidelines of the European Society for Vascular Surgery (ESVS). *European journal of vascular and endovascular surgery : the official journal of the European Society for Vascular Surgery*. 2015;49(6):678-737.
3. Vedantham S, Goldhaber SZ, Kahn SR, Julian J, Magnuson E, Jaff MR, et al. Rationale and design of the ATTRACT Study: a multi-center randomized trial to evaluate pharmacomechanical catheter-directed thrombolysis for the prevention of postthrombotic syndrome in patients with proximal deep vein thrombosis. *American heart journal*. 2013;165(4):523-30.e3.

4. Vedantham S, Goldhaber SZ, Julian JA, Kahn SR, Jaff MR, Cohen DJ, et al. Pharmacomechanical Catheter-Directed Thrombolysis for Deep-Vein Thrombosis. *The New England journal of medicine*. 2017;377(23):2240-52.
5. Jalaie H, Schleimer K, Barbati ME, Gombert A, Grommes J, de Wolf MA, et al. Interventional treatment of postthrombotic syndrome. *Gefasschirurgie : Zeitschrift für vaskuläre und endovaskuläre Chirurgie : Organ der Deutschen und der Österreichischen Gesellschaft für Gefasschirurgie unter Mitarbeit der Schweizerischen Gesellschaft für Gefasschirurgie*. 2016;21(Suppl 2):37-44.
6. Jost CJ, Glociczki P, Cherry KJ, Jr., McKusick MA, Harmsen WS, Jenkins GD, et al. Surgical reconstruction of iliofemoral veins and the inferior vena cava for nonmalignant occlusive disease. *Journal of vascular surgery*. 2001;33(2):320-7; discussion 7-8.
7. de Wolf MA, Jalaie H, van Laanen JH, Kurstjens RL, Mensink MJ, de Geus MJ, et al. Endophlebectomy of the common femoral vein and arteriovenous fistula creation as adjuncts to venous stenting for post-thrombotic syndrome. *The British journal of surgery*. 2017.
8. Gombert A, Barbati ME, Wittens C, Grommes J, Jalaie H. Effect of a new incision management system (PREVENA(R)) on wound healing after endophlebectomy of the common femoral vein: a case series. *Journal of medical case reports*. 2016;10:130.
9. Gombert A, Barbati ME, Grommes J, Kurstjens RL, deWolf MA, Wittens CH, et al. Wound complications after common femoral vein endophlebectomy: Influence on outcome. *Phlebology*. 2018;33(6):407-17.

104.6

Post-operative care

A. Diamantopoulos

Interventional Radiology, Guy's and St. Thomas' NHS Foundation Trust, King's Health Partners, London, UK

No abstract available.

Hot Topic Symposium Hot debates on drug-eluting technologies

201.1

RCTs, registries and the real world: what evidence is needed? What is doable and what is utopian?

W.A. Gray

Division of Cardiovascular Diseases, Lankenau Heart Institute, Philadelphia, PA, US

No abstract available.

201.2

Is safety a real issue for drug-eluting devices in peripheral arterial disease?

K.N. Katsanos

Interventional Radiology, Patras University Hospital, Patras, GR

Several randomized controlled trials (RCTs) have previously shown that paclitaxel-coated balloons and stents significantly reduce the rates of vessel restenosis and target lesion revascularization after lower extremity interventions. We have recently shown that use of paclitaxel-coated balloons and stents in the femoropopliteal artery of the lower limbs is associated with a significantly increased risk of death (1). An updated long-term meta-analysis - at the time of this writing - 16 studies with

2,723 patients reported the incidence of all-cause patient death at 2 years. Calculated risk ratio was 1.48 (95% CI, 1.06–2.08), absolute risk difference was 3.0% (95% CI, 1.2–4.7%), and there was no evidence of systematic publication bias. At 5 years, 4 studies (THUNDER, IN.PACT SFA, LEVANT II & ZILVER-PTX) reported all-cause mortality for a total of 1,340 cases. Calculated risk ratio was 1.62 (95% CI, 1.20–2.17), absolute risk difference was 6.4% (95% CI, 2.7–10.1%), and there was no evidence of systematic publication bias. Trial sequential analysis excluded false-positive findings with 99% certainty.

In addition, the authors will present updated summary-level (meta-regression) and individual-patient level data (Cox regression) covariate analyses that document (i) a significant dose-response relationship between femoropopliteal paclitaxel application and death in claudicant patients, and (ii) a significant inverse relationship between paclitaxel application and background mortality risk depending on the vascular risk profile of the patient. In summary, there is strong evidence from statistical inference that the risk of death is significantly increased beyond the first year following application of paclitaxel-coated balloons and stents in the femoropopliteal artery of the leg in patients with intermittent claudication. Actual causes remain unknown and further clinical investigations are urgently warranted, while collection and reporting of longer-term follow-up in case for all clinical studies is recommended.

References

1. Katsanos K, Spiliopoulos S, Kitrou P, Krokidis M, Karnabatidis D. Risk of Death Following Application of Paclitaxel-Coated Balloons and Stents in the Femoropopliteal Artery of the Leg: A Systematic Review and Meta-Analysis of Randomized Controlled Trials. *J Am Heart Assoc*. 2018 Dec 18;7(24):e011245. doi: 10.1161/JAHA.118.011245.

201.3

Meta-analysis: critical review of the methods

P. Jüni

Applied Health Research Centre, St. Michael's Hospital, Toronto, ON, CA

No abstract available.

201.4

Where do we stand? Overview of current positions

F. Fanelli¹, G. Falcone²

¹Vascular and Interventional Radiology Department, "Careggi" University Hospital, Florence, IT, ²Interventional Radiology, Careggi University Hospital, Florence, IT

Since their introduction in the market in 2009 paclitaxel-eluting technologies have been established as valid and safe therapy for the endovascular treatment of femoral-popliteal arterial disease. Since then, more than 15 paclitaxel coated balloons (DCB) and two paclitaxel drug eluting stents (DES) are available in the European market. Moreover 3 DCB and 1 DES received also FDA approval.

Many studies have been performed to validate these devices in comparison to the traditional one.

Recently released practice guidelines from the Society for Cardiovascular Angiography and Interventions (SCAI) have elected DCB as first line endovascular therapy with I-A, highest level of recommendation for the treatment of a wide array of femoral-popliteal indications.

Katsanos et al. published a meta-analysis of 28 randomized trials of paclitaxel-coated devices in the femoral-popliteal arteries. The findings and conclusions were striking in that the analysis concluded that there is an increased risk of all-cause death at 2 years and 5 years, following application of paclitaxel-coated balloons and stents.

Initial criticisms to the article were that DCB and DES were taken as a single homogenous device class, in spite of substantial differences across device features; that patient level data were missing, condition necessary

to adequately inform the search of a mechanistic relation to death; and death from all-cause was taken as the primary safety measure, ignoring the verdict of lack of relation between patient's death and study devices as adjudicated by the clinical event committees in most of the studies. Authors finally state they could not find any plausible causality between death and paclitaxel used for the treatment of lower limb artery disease. Only 2 of 28 trials showed a significant higher all-cause mortality in their study arms vs. control (1 in 2 years and 1 in 5 years), it is clear that, in the absence of patient level data, a large number of possible associations to death may not be properly looked at, other than hypothesizing just paclitaxel, to finally discern a certain versus a spurious causality. Recently FDA sent out a letter suggesting a more accurate evaluation of the use of drug eluting devices. Patients must be informed about the potential increase of death rate and, if possible, alternative technologies must be selected.

We are looking forward for more data analysis that can give a more straight direction to all physicians to better understand the situation and select the most appropriate device.

References

1. Tepe G, Laird J, Schneider P, Brodmann M, Krishnan P, Micari A, Metzger C, Scheinert D, Zeller T, Cohen DJ, Snead DB, Alexander B, Landini M, Jaff MR; IN.PACT SFA Trial Investigators. Drug-coated balloon versus standard percutaneous transluminal angioplasty for the treatment of superficial femoral and popliteal peripheral artery disease: 12-month results from the IN.PACT SFA randomized trial. *Circulation*. 2015 Feb 3;131(5):495-502
2. Rosenfield K, Jaff MR, White CJ, Rocha-Singh K, Mena-Hurtado C, Metzger DC, Brodmann M, Pilger E, Zeller T, Krishnan P, Gammon R, Muller-Hulsbeck S, Nehler MR, Benenati JF, Scheinert D; LEVANT 2 Investigators. Trial of a paclitaxel-coated balloon for femoropopliteal artery disease. *N Engl J Med*. 2015;373:145-153
3. Schroeder H, Werner M, Meyer DR, Reimer P, Krüger K, Jaff MR, Brodmann M; ILLUMENATE EU RCT Investigators. Low-Dose Paclitaxel-Coated Versus Uncoated Percutaneous Transluminal Balloon Angioplasty for Femoropopliteal Peripheral Artery Disease: One-Year Results of the ILLUMENATE European Randomized Clinical Trial (Randomized Trial of a Novel Paclitaxel-Coated Percutaneous Angioplasty Balloon). *Circulation*. 2017 Jun 6;135(23):2227-2236
4. Krishnan P, Faries P, Niazi K, Jain A, Sachar R, Bachinsky WB, Cardenas J, Werner M, Brodmann M, Mustapha JA, Mena-Hurtado C, Jaff MR, Holden AH, Lyden SP. Stellarex Drug-Coated Balloon for Treatment of Femoropopliteal Disease: Twelve-Month Outcomes From the Randomized ILLUMENATE Pivotal and Pharmacokinetic Studies. *Circulation*. 2017 Sep 19;136(12):1102-1113
5. Micari A, Brodmann M, Keirse K, Peeters P, Tepe G, Frost M, Wang H, Zeller T; IN.PACT Global Study Investigators. Drug-Coated Balloon Treatment of Femoropopliteal Lesions for Patients With Intermittent Claudication and Ischemic Rest Pain: 2-Year Results From the IN.PACT Global Study. *JACC Cardiovasc Interv*. 2018 May 28;11(10):945-953
6. Thieme M, Von Bilderling P, Paetzel C, Karnabatidis D, Perez Delgado J, Lichtenberg M; Lutonix Global SFA Registry Investigators. The 24-Month Results of the Lutonix Global SFA Registry: Worldwide Experience With Lutonix Drug-Coated Balloon. *JACC Cardiovasc Interv*. 2017 Aug 28;10(16):1682-1690
7. F.Vermassen. SAVER: rationale and merits for an all-comers DCB e-Registry. LINC 2017 oral presentation
8. Feldman DN, Armstrong EJ, Aronow HD, Gigliotti OS, Jaff MR, Klein AJ, Parikh SA, Prasad A, Rosenfield K, Shishehbor MH, Swaminathan RV, White CJ. SCAI consensus guidelines for device selection in femoral-popliteal arterial interventions. *Catheter Cardiovasc Interv*. 2018 Apr 24
9. Cortese B, Granada JF, Scheller B, Schneider PA, Tepe G, Scheinert D, Garcia L, Stabile E, Alfonso F, Ansel G, Zeller T. Drug-coated balloon treatment for lower extremity vascular disease intervention: an international positioning document. *Eur Heart J*. 2016 Apr 7;37(14):1096-103
10. Katsanos K. Paclitaxel-Coated Balloons in the Femoropopliteal Artery: It Is All About the Pharmacokinetic Profile and Vessel Tissue Bioavailability. *JACC Cardiovasc Interv*. 2016 Aug 22;9(16):1743-5
11. M.Brodmann. Is there a clinical class effect of drug-coated balloons in peripheral arteries? Oral presentation LINC 2016
12. Giacoppo D, Cassese S, Harada Y, Colleran R, Michel J, Fusaro M, Kastrati A, Byrne RA. Drug-Coated Balloon Versus Plain Balloon Angioplasty for the Treatment of Femoropopliteal Artery Disease: An Updated Systematic Review and Meta-Analysis of Randomized Clinical Trials. *JACC Cardiovasc Interv*. 2016 Aug 22;9(16):1731-42
13. Katsanos K, Spiliopoulos S, Paraskevopoulos I, Diamantopoulos A, Karnabatidis D. Systematic Review and Meta-analysis of Randomized Controlled Trials of Paclitaxel-Coated Balloon Angioplasty in the Femoropopliteal Arteries: Role of Paclitaxel Dose and Bioavailability. *J Endovasc Ther*. 2016 Apr;23(2):356-70
14. Cremers B, Biedermann M, Mahnkopf D, Böhm M, Scheller B. Comparison of two different paclitaxel-coated balloon catheters in the porcine coronary restenosis model. *Clin Res Cardiol*. 2009 May;98(5):325-30
15. Gongora CA, Shibuya M, Wessler JD, McGregor J, Tellez A, Cheng Y, Conditt GB, Kaluza GL, Granada JF. Impact of Paclitaxel Dose on Tissue Pharmacokinetics and Vascular Healing: A Comparative Drug-Coated Balloon Study in the Familial Hypercholesterolemic Swine Model of Superficial Femoral In-Stent Restenosis. *JACC Cardiovasc Interv*. 2015 Jul;8(8):1115-1123
16. Peterson S, Hasenbank M, Silvestro C, Raina S. IN.PACT™ Admiral™ drug-coated balloon: Durable, consistent and safe treatment for femoropopliteal peripheral artery disease. *Adv Drug Deliv Rev*. 2017 Mar;112:69-77
17. Schorn I, Malinoff H, Anderson S, Lecy C, Wang J, Giorgianni J, Papandreou G. The Lutonix® drug-coated balloon: A novel drug delivery technology for the treatment of vascular disease. *Adv Drug Deliv Rev*. 2017 Mar;112:78-87
18. Fusaro M, Cassese S, Ndrepepa G, King LA, Tada T, Ott I, Kastrati A. Paclitaxel-coated balloon or primary bare nitinol stent for revascularization of femoropopliteal artery: a meta-analysis of randomized trials versus uncoated balloon and an adjusted indirect comparison. *Int J Cardiol*. 2013 Oct 9;168(4):4002-9
19. Katsanos K, Spiliopoulos S, Karunanithy N, Krokidis M, Sabharwal T, Taylor P. Bayesian network meta-analysis of nitinol stents, covered stents, drug-eluting stents, and drug-coated balloons in the femoropopliteal artery. *J Vasc Surg*. 2014 Apr;59(4):1123-1133
20. Cassese S, Ndrepepa G, Kufner S, Byrne RA, Giacoppo D, Ott I, Laugwitz KL, Schunkert H, Kastrati A, Fusaro M. Drug-coated balloon angioplasty for in-stent restenosis of femoropopliteal arteries: a meta-analysis. *EuroIntervention*. 2017 Jul 20;13(4):483-489
21. Katsanos K, Spiliopoulos S, Kitrou P, Krokidis M, Karnabatidis D. Risk of Death Following Application of Paclitaxel-Coated Balloons and Stents in the Femoropopliteal Artery of the Leg: A Systematic Review and Meta-Analysis of Randomized Controlled Trials. *J Am Heart Assoc*. 2018;7:e011245. DOI: 10.1161/JAHA.118.011245
22. Smith GD, Ebrahim S. Data dredging, bias, or confounding. *BMJ*. 2002 Dec 21;325(7378):1437-8
23. Torii S, Kolodgie FD, Virmani R, et al. IN.PACT™ Admiral™ drug-coated balloons in peripheral artery disease: current perspectives. *Med Devices (Auckl)*. 2019 Feb 12;12:53-64.
24. Secemsky EA, Kundi H, Weinberg I, et al. Association of Survival With Femoropopliteal Artery Revascularization With Drug-Coated Devices. *JAMA Cardiol*. 2019 Feb 12

25. Lindquist J, Schramm K. Drug-Eluting Balloons and Drug-Eluting Stents in the Treatment of Peripheral Vascular Disease. *Semin Intervent Radiol*. 2018 Dec;35(5):443-452

Fundamental Course

Ablative therapies: the basics

202.1

Radiofrequency ablation

J.M. Abadal Villayandre

Interventional Radiology, Hospital Universitario Severo Ochoa, Madrid, ES

Learning Objectives

1. To learn about the basic principle and typical systems
2. To understand typical indications and limitations
3. To learn about current evidence

RF is a thermal ablative therapy mainly used in local treatment of malignant tumors. It is based on an electromagnetic source (450-500Khz) that creates an alternating current inside the tumor (around the antenna), creating ionic agitation, frictional heat and coagulative necrosis.

Systems may be monopolar or bipolar and a large variety of antennas are available (straight, cluster, umbrella) with different technologies (internally cooled, perfused...) to obtain spherical ablation volumes up to 5 cm. Classic and scientifically proven indications of RF are malignant tumors in liver (metastasis/hepatocarcinoma), kidney and lung. There are other clinical applications of RF in tumors in other organs: adrenal, lymph nodes, bone, breast... Recently, RF has demonstrated good results in benign symptomatic tumors like myoma and thyroid.

The main indication is to treat tumoral lesions in different organs. Lesions should be <5 and <3.5-5cm and the goal of treatment is to obtain a 5- to 10mm treatment margin beyond the tumor volume.

Limitations inherent to the RF energy delivery are heat sink effect (caused by peritumoral large vessels) and somewhat tumoral ablation predictably depending on tissue properties that can impede complete tumoral necrosis. RF is also limited by the maximum size of the ablation volume that can be achieved. Multiple probes, repositioning or overlapping ablations may be needed.

RF ablation is usually performed as a minimally invasive, percutaneous (outpatient) procedure under conscious sedation and CT/Ultrasound guidance. In surgical settings, RFA can be performed laparoscopically or during open surgery. There are fewer complications when compared to surgery. Probe temperature has a cautery effect that decreases bleeding complications.

Overall, the primary success rates of RFA in liver, kidney, lung and bone tumors range from 70-95%, depending on the tumor localization and type. Long term follow-up studies are available with RF demonstrating results similar to surgery in certain tumors.

References

1. Tiong, L., & Maddern, G. J. (2011). Systematic review and meta-analysis of survival and disease recurrence after radiofrequency ablation for hepatocellular carcinoma. *British Journal of Surgery*, 98(9), 1210-1224.
2. Weng, M., Zhang, Y., Zhou, D., Yang, Y., Tang, Z., Zhao, M., ... & Gong, W. (2012). Radiofrequency ablation versus resection for colorectal cancer liver metastases: a meta-analysis. *PloS one*, 7(9), e45493.
3. Ellis, L. M., Curley, S. A., & Tanabe, K. K. (Eds.). (2003). *Radiofrequency Ablation for Cancer: Current indications, techniques, and outcomes*. Springer Science & Business Media.
4. Vogl, T. J., Helmberger, T. K., Mack, M. G., & Reiser, M. F. (Eds.). (2008). *Percutaneous tumor ablation in medical radiology*. Springer-Verlag Berlin Heidelberg.
5. Kunkle, D. A., Egleston, B. L., & Uzzo, R. G. (2008). Excise, ablate or observe: the small renal mass dilemma—a meta-analysis and review. *The Journal of urology*, 179(4), 1227-1234.

6. Lencioni, R., Cioni, D., Crocetti, L., Franchini, C., Pina, C. D., Lera, J., & Bartolozzi, C. (2005). Early-stage hepatocellular carcinoma in patients with cirrhosis: long-term results of percutaneous image-guided radiofrequency ablation. *Radiology*, 234(3), 961-967.

202.2

Microwave ablation

R. Cioni

Division of Interventional Radiology, University of Pisa, Pisa, IT

Learning Objectives

1. To learn about the basic principle and typical systems
2. To understand typical indications and limitations
3. To learn about current evidence

Microwave (MW) ablation refers to tumor destruction from electromagnetic energy sources using devices with frequencies from 300 MHz to 300 GHz. Currently available microwave ablation devices function at the 915-MHz or 2.45-GHz frequencies. In the case of MW ablation, differences between devices do not lie as much in the morphology of the applicators (which are straight needles without hooks, in all cases), but rather in antenna caliber (variable between 11G and 18G); and in maximum available generator power, which determines maximum dimension of the ablation volume (60W-195W). Moreover the number of antennas that can be used simultaneously with a single generator may vary. The simultaneous use of several applicators determines a more uniform, larger and more spherical ablation area.

Few studies regarding comparison between radiofrequency (RF) and MW ablation in the treatment of early HCC are available. In a cohort study local tumor progression was significantly lower for MW than for RF (8.8% vs 17.7%, $p=0.04$), despite non significant differences were observed in overall survival [1]. Subsequently in a propensity score matched population, MW ablation showed better results in term of overall survival and local recurrence free survival in patients with HCC within Milan criteria ($p=0.02$ and $p<0.001$ respectively). Similar results in MW- and RF-treated patients were observed in the presence of a single HCC < 3 cm [2]. A single phase II RCT is available regarding the comparison of RF and MW for the treatment of HCC. In this study MW was not more effective than RF ablation in patients with HCC lesions of 4 cm or smaller, with no difference between the two groups of patients in the proportion of lesions with local tumour progression. At the moment therefore there is not enough evidence to support MW over RF in HCC < 3cm [3]. Easiness of use, reproducibility and size of volumes of ablation together with short procedural times make MW ablation widely used and often preferred as thermal ablation modality.

Recently published primary efficacy rates (complete ablation after the first procedure) of RF and MW ablation for small colorectal cancer metastases have approached the reported resection recurrence rates for similar sized lesions [4,5]. In fact, regardless of the thermal ablation modality used, ablation margins >5 mm are critical for local tumor control, with no local tumor progression noted for margins over 10 mm. Unlike RF, the efficiency of MW ablation is not affected for peri-vascular tumors [6].

References

1. Potretzke TA, Ziemelewiecz TJ, Hinshaw JL, et al. Microwave versus Radiofrequency Ablation Treatment for Hepatocellular Carcinoma: A Comparison of Efficacy at a Single Center. *J Vasc Interv Radiol*. 2016 May;27(5):631-8.
2. Liu W, Zheng Y, He W, et al. Microwave vs radiofrequency ablation for hepatocellular carcinoma within the Milan criteria: a propensity score analysis. *Aliment Pharmacol Ther*. 2018 Sep;48(6):671-681.
3. Vietti Violi N, Duran R, Guiu B, et al. Efficacy of microwave ablation versus radiofrequency ablation for the treatment of hepatocellular carcinoma in patients with chronic liver disease: a randomised controlled phase 2 trial. *Lancet Gastroenterol Hepatol*. 2018 May;3(5):317-325

4. Ruers T, Van Coevorden F, Punt CJ, et al; European Organisation for Research and Treatment of Cancer (EORTC); Gastro-Intestinal Tract Cancer Group; Arbeitsgruppe Lebermetastasen und Tumoren in der Chirurgischen Arbeitsgemeinschaft Onkologie (ALM-CAO); National Cancer Research Institute Colorectal Clinical Study Group (NCRI CCSG). Local Treatment of Unresectable Colorectal Liver Metastases: Results of a Randomized Phase II Trial. *J Natl Cancer Inst.* 2017 Sep 1;109(9).
5. Nielsen K, van Tilborg AA, Meijerink MR, et al. Incidence and treatment of local site recurrences following RFA of colorectal liver metastases. *World J Surg.* 2013 Jun;37(6):1340-7.
6. Shady W, Petre EN, Do KG, et al. Percutaneous Microwave versus Radiofrequency Ablation of Colorectal Liver Metastases: Ablation with Clear Margins (A0) Provides the Best Local Tumor Control. *J Vasc Interv Radiol.* 2018 Feb;29(2):268-275.

202.3

Cryoablation

J.Y. Won

Radiology, Severance Hospital, Yonsei University College of Medicine, Seoul, KR

Learning Objectives

1. To learn about the basic principle and typical systems
2. To understand typical indications and limitations
3. To learn about current evidence

Cryoablation is a treatment modality based on *in situ* destruction of tumor cells using low temperature. It induces cellular dehydration, protein denaturation, and microcirculatory failure during the repeated freezing and thawing process. Cryoablation is based on the cyclic application of low temperature through a probe that is inserted in the tumor. In the early stage, due to a lack of adequate diagnostic imaging modalities and the large profiles (5-10mm) of cryoablation probes, every cryoablation was performed in an open surgical setting. With the development of a cryoablation system equipped with a 17-gauge (1.47mm), thin cryoprobe, remarkable progress has been made in the application of percutaneous cryoablation to tumors of organs such as lung, kidney, prostate and liver. Current cryo-system uses a high-pressure freezing gas (argon) based on the Joule-Thomson effect denoting the physical principle that gas changes temperature by expansion through a narrow port into the low-pressure zone that occurs at the tip of a probe. As compressed argon gas which has a boiling point of -186°C passes through the cryoablation needle, the tip is cooled, forming an ice ball that destroys tumor cells. Usually, the protocol for one session of cryoablation includes a cycle of repeating freezing and thawing.

Various animal experiments and clinical trials have demonstrated the safety and effectiveness of cryoablation for the treatment of the malignant tumors. In lung cancer, several studies have reported more than 60% complete tumor necrosis and the treatment outcomes were equivalent to those of radio-frequency ablation (RFA). It was therefore concluded that percutaneous cryoablation could be used as an alternative to RFA. Also for the liver tumor, recent reports have demonstrated that cryoablation is performed under a route of access that is almost identical to RFA and that treatment efficiency is also comparable to RFA. They have also reported that cryoablation caused almost no damage of the adjacent organs and that the severity of pain is lower than that associated with RFA. The most well known limitation of cryoablation of HCC is the smaller ablation volume than RFA with a probe of the same profile. Use of multiple cryoprobes is recommended to avoid incomplete ablation and local recurrence after the cryoablation. The other known complications such as cryoshock syndrome, liver dehiscence, and thrombocytopenia rarely occur with current low profile cryoprobe.

References

1. Kim GM, Won JY, Kim MD, et al. Cryoablation of hepatocellular carcinoma with high-risk for percutaneous ablation: Safety and efficacy. *Cardiovascular and interventional radiology* 2016; 39:1447-1454.
2. Lee SM, Won JY, Lee DY, et al. Percutaneous cryoablation of small hepatocellular carcinomas using a 17-gauge ultrathin probe. *Clinical radiology.* 2011;66(8):752-759.
3. Kwon JH, Won JY, Han K, Han S, Kim D, Kim H, Kim GM, Kim MD, Lee DY. Safety and Efficacy of Percutaneous Cryoablation for Small Hepatocellular Carcinomas Adjacent to the Heart. *J Vasc Interv Radiol.* 2019 Apr 5. pii: S1051-0443(18)31825-6. doi: 10.1016/j.jvir.2018.12.030. [Epub ahead of print]
4. Kim DK, Kwon JH, Won JY, Han K, Kim GM, Kim MD, Lee DY. Ablation Volume Measurement After Percutaneous Cryoablation Using a Two-cryo-probe Technique for Small Hepatocellular Carcinomas. *Cardiovasc Intervent Radiol.* 2019 Feb;42(2):220-229
5. Park SY, Won JY, Oh YT, Jung DC, Kim GM, Kim MD. Assessment of cold sink effect in postulated renal cryoablation by analyzing radiographic ice ball on computed tomography. *Br J Radiol.* 2018 Jul 27;20170951. doi: 10.1259/bjr.20170951. [Epub ahead of print]
6. Park SY, Oh YT, Han K, Jung DC, Kim MD, Won JY. Changes in Perioperative Systolic Blood Pressure in Percutaneous Renal Mass Cryoablation. *Cardiovasc Intervent Radiol.* 2018 Feb;41(2):291-297. doi: 10.1007/s00270-017-1772-4. Epub 2017 Aug 21.
7. Yang Y, Wang C, Lu Y, et al. Outcomes of ultrasound-guided percutaneous argon-helium cryoablation of hepatocellular carcinoma. *Journal of hepato-biliary-pancreatic sciences* 2012; 19:674-684.
8. Song KD. Percutaneous cryoablation for hepatocellular carcinoma. *Clin Mol Hepatol.* 2016;22(4):509.
9. Tatli S, Acar M, Tuncali K, Morrison PR, Silverman S. Percutaneous cryoablation techniques and clinical applications. *Diagn Interv Radiol* 2010; 16:90-95.
10. Kopelman D, Kopelman Y, Spolianski G, Zaretski A, Shechtman L, Hashmonai M. Thermal bile duct and duodenal protection during pancreatic cryoablation. *Cryobiology* 2012; 64:235-239.

202.4

Irreversible electroporation

H.J. Scheffer

Radiology, Amsterdam University Medical Centers, Amsterdam, NL

Learning Objectives

1. To learn about the basic principle and typical systems
2. To understand typical indications and limitations
3. To learn about current evidence

Irreversible electroporation is a relatively new technique in the arsenal of interventional oncology. It uses electrical energy, rather than thermal energy, to achieve cell destruction. Through the delivery of multiple short (70-90 ms), high voltage (+/- 3000 V) electrical pulses, the existing cellular membrane potential is disrupted. As a result, little holes appear in the cellular membrane and the cell loses its homeostatic capabilities. Eventually, the cell dies through apoptosis.

The big advantage of IRE as opposed to the common thermal ablation techniques is that with IRE only the cells are damaged, but - in the absence of heat - the extracellular matrix structures that provide strength and stability to the tissue, remain intact. As a result, vascular and biliary walls as well as urinary and possibly neural structures remain patent after ablation, making IRE suitable to treat lesions in the vicinity of these vulnerable structures. Herein lies the - currently sole - indication for IRE; unresectable tumors that are similarly unsuitable for thermal ablation due to their proximity to thermally sensitive structures. Examples of these tumors are primary and secondary centrally located liver lesions, locally advanced pancreatic carcinoma, centrally located renal tumors and prostate tumors.

Several studies have investigated the safety and efficacy of IRE for these indications. Overall, the technique appears safe with little damage to the vascular, biliary and urinary structures. Efficacy is also promising, with complete ablation varying for the different indications, influenced by tumor type and size. Currently, thermal ablation still seems to yield better local control rates than IRE.

A lot is still unknown about the working mechanism of IRE and the optimal ablation parameters for different tumor types, which is a focus of current research. Furthermore, recent evidence has shown that the release of apoptotic tumor fragments after IRE may result in an effective antitumor immune response that could potentially be harnessed to delay or even prevent the outgrowth of lesions elsewhere in the body, for example in patients with pancreatic cancer. This is another major focus in the field of research concerning IRE. We expect that with growing knowledge on the working mechanism of IRE leading to technical improvements of the ablation device, efficacy will further improve and IRE will be increasingly used worldwide. The combination of IRE with immunotherapy might further broaden the indications and could provide a bridge between local and systemic treatment.

Focus Session

Future trends in spine treatments

203.1

Cements in the spine: percutaneous polymethylmethacrylate and beyond

X. Buy¹, J. Palussière², V. Catena¹

¹Interventional Radiology, Institut Bergonie, Bordeaux, FR, ²Radiology, Institut Bergonié, Bordeaux, FR

Learning Objectives

1. To become familiar with the most common cement types
2. To know about technical considerations for the use of different cements
3. To know about literature evidence

Polymethylmethacrylate (PMMA) was the first cement used in orthopedic surgery in 1950. By mixing a radio-opacifier with PMMA, Deramond was the first to perform a percutaneous vertebroplasty in 1987, to treat an aggressive vertebral hemangioma. Since then, consolidation of osteoporotic compression fractures and stabilization of painful metastases or myeloma have become the major indications of percutaneous vertebroplasty.

PMMA has many advantages: mechanically efficient, easy to inject, stability over time and low cost. The radio-opacity of the cement can be adapted by adding a contrast dye. However, few drawbacks still persist: exothermic reaction during polymerization, absence of bone integration and excessive stiffness. Indeed, the Yong's modulus of PMMA is about 5 to 8 times more than the one of cancellous bone. This excessive stiffness may lead to an increase rate of subsequent vertebral fractures in osteoporotic patients. However, this point remains controversial, as many authors consider that occurrence of new fractures is related to the natural course of osteoporosis.

To overcome the drawbacks of PMMA, alternative cements have been developed. Ceramic cements have shown similar clinical results and adverse events rates, compared to PMMA. Silicone cements are less stiff, but series report a high rate of venous leakage and lung embolism due to a long setting time and a lower radio-opacity. Calcium-phosphate cements have a lower Young's modulus, low exothermic reaction and their partial resorption allows some osteo-integration. However, they are difficult to inject without prior cavity, due to poor viscosity. Their lower resistance also raises concerns about the risk of delayed cement failure. Composite cements mixing PMMA and calcium-phosphate cement have been developed to reduce stiffness and to achieve a better bone integration. Thus, they may show a possible benefit in osteoporosis, to reduce the risk of subsequent fractures.

In oncology, several research projects are ongoing, trying to promote cement as a potential therapeutic vector. Animal studies report the use of chemotherapy- and radionuclide-loaded cements, but major concerns remain unsolved: only drugs not modified by exothermic reaction can be loaded; the amount of drug that is released from the cement is poorly controlled; finally, in case of cement leakage, vulnerable structures may be inadvertently exposed to the drug.

In conclusion, PMMA is still the most commonly used cement. It is cheap and easy to handle. Moreover, its mechanical properties and its stability over time allow its use in various clinical indications, particularly osteoporosis and oncology.

203.2

Spine implants

A.D. Kelekis

^{2nd} Department of Radiology, National and Kapodistrian University of Athens, ATTIKON University General Hospital, Athens, GR

Learning Objectives

1. To become familiar with the most common spine implants
2. To know about technical considerations for each implant
3. To know about literature evidence

Spine implants theoretically should provide a more stable substrate than injectates for vertebral body stabilization. There is even literature supporting they can correct the kyphotic angle. In selected cases of extreme fractures, implants can work as anchors, providing extra support against shearing forces, where the risk of cement failure is higher [1]. Thus far, there are no completed and published clinical studies proving the concept of structural support superiority to standard cement or evidence of superiority of one device over the other. Materials include stents, jacks, PEEK cages and fracture reduction systems. Indications for implants include osteoporotic or traumatic fractures as well as primary or metastatic neoplastic spine disease. The contraindications are similar to those for standard vertebral augmentation techniques, including asymptomatic fractures, pain relief with conservative therapy, local or systemic infection, severe coagulopathy and severe cardio-respiratory disease [2,3].

Vertebral body stenting (VBS): Vertebral body stenting is an expandable cobalt-chromium device, deployed inside the vertebral body by a percutaneous approach. The stent access kit includes guide wires, trocars and working sleeves, drill and blunt plungers, vertebral body balloons and inflation system, vertebral body catheters and stents as well as cement and a cement delivery system. The balloons and stents are available in three sizes; size selection is based on the preoperative planning via Computed Tomography scan. Usually the stents are non-retrievable once expanded.

Spine Jack®: The concept of SpineJack® is to achieve height restoration of the vertebral body. The expansion of the implant is progressive and can be maintained until the cement is injected. The device has been designed to expand the implant under the most compressed portion of the vertebral fracture. The access kit for spine jack implant includes trocar, Kirschner wire, reamer and template, the implant introduction system and the cement delivery system. Once Spine Jack is expanded there is no retrieval of the implant.

Osseofix®: Osseofix is an intra-vertebral expandable titanium mesh cylinder. During expansion the surrounding trabecular bone is compacted and the vertebral height is partially restored and the kyphotic deformity decreased [2]. The implant acts as scaffold augmenting the vertebral fracture stabilization and creating channels for subsequent cement injection. Osseofix is indicated for compression fractures at the T6-L5 levels. Once Osseofix is expanded there is no retrieval of the implant.

VERTELIFT: This is a nitinol implant of different sizes and configurations. The implant also has the feature of being able to be repositioned. This nitinol implant is composed of super-elastic struts designed for vertebral endplates support and fracture reduction. During cement injection, the polymer flows around and through the struts interdigitating with the cancellous bone.

KIVA system: This is a spiraled coiled PEEK-OPTIMA implant loaded with 15% barium sulfate. The implant has a distal marker and is indicated for treatment of thoracic and lumbar spinal fractures (T6-L5 levels). The access kit of the KIVA system includes needles, guide pins, a working cannula, a deployment system containing the nitinol coil and the PEEK polymer cage as well as a cement delivery system. During the expansion of the nitinol coil the system is retrievable and repositionable. Once the PEEK material is deployed, there is no possibility of withdrawal. Most biomechanical and other clinical comparative studies versus standard augmentation techniques thus far report non-inferiority of spine implants with a reduced volume of injected cement [4]. The disadvantage of all implants is their higher initial cost when compared to that of standard vertebral augmentation techniques. Other disadvantages of vertebral implant include the aspect that it is somewhat more invasive, the implants are irretrievable and there is an absence of adapted material for implantation in the cervical, upper thoracic spine and in the sacrum [5].

References

1. Kelekis A., Filippiadis D., Velonakis G., Mazioti A., Malagari A., Broutzos E., Kelekis N.L. Vertebral augmentation with biocompatible polymer (KIVA implant) in AO-Magerl A2 and A3 (split or incomplete burst) Fractures: Clinical experience and preliminary results *Journal of Vascular and Interventional Radiology*, Volume 24, Issue 7, 1077
2. Guglielmi G, Andreula C, Muto M, Gilula LA. Percutaneous vertebroplasty: indications, contraindications, technique, and complications. *Acta Radiol.* 2005; 46(3): 256-68.
3. Muto M, Perrotta V, Guarnieri G et al. Vertebroplasty and kyphoplasty: friends or foes? *Radiol Med.* 2008; 113(8):1171-84.
4. Tutton SM, Flugmacher R, Davidian M, Beall DP, Facchini FR, Garfin SR. KAST Study: The Kiva System As a Vertebral Augmentation Treatment-A Safety and Effectiveness Trial: A Randomized, Noninferiority Trial Comparing the Kiva System With Balloon Kyphoplasty in Treatment of Osteoporotic Vertebral Compression Fractures. *Spine (Phila Pa 1976)*. 2015; 40(12): 865-75
5. M. Muto S, Marcia G, Guarnieri V, Pereira. Assisted techniques for vertebral cementoplasty: Why should we do it? *Eur J Radiol.* 2015; 84(5): 783-8.

203.3

Intervertebral disc regeneration techniques

D.P. Beall

Radiology, Clinical Radiology of Oklahoma, Oklahoma City, OK, US

Learning Objectives

1. To become familiar with the most common regeneration techniques
2. To know about technical considerations for each technique
3. To know about literature evidence

Background: Degenerative disc disease and discogenic back pain are ubiquitously common and the leading cause of disability in the United States; affecting over a quarter of a billion people worldwide, threatening quality of life, and increasing the risk of significant morbidity. Stem cell delivery to the intervertebral disc has been shown to be effective in small series and clinical trials but there remains a paucity of clinical evidence showing the benefits of disc augmentation in larger randomized controlled trials.

Methods 236 subjects with painful discogenic low back pain were screened at 15 U.S. sites with 224 entering the trial which was divided into a treatment group, a non-surgical management (NSM) group and a placebo control group with a 3.5:1:1 randomization ratio. The first 24 participants were also assessed with a one month visit after enrollment. Two co-primary endpoints - back pain Visual Analog Scale (VAS) and Oswestry Disability Index (ODI) were evaluated along with safety data including reported adverse events (AEs) and changes in lab tests. Data was collected at baseline, and at 3, 6 and 12 months. Structural outcomes

were evaluated by x-rays and MRI at 12 months. This trial is registered on www.clinicaltrials.gov (NCT03709901).

Findings: At the 6- and 12-month time points, VAS back pain improved from 58.13, 60.0 and 59.75 in the allograft, placebo and NSM subjects respectively to 16.40, 28.60, and 16.0 at 6 months, and 9.85, 27.0 and 6.0 at 12 months. At three months the VAS of the NSM group was 55.0 and all crossed over to allograft treatment. At the 6 and 12-month time points, ODI improved from 54.67, 50.40 and 51.75 in the allograft, placebo and NSM subjects respectively to 19.73, 15.25, and 22.50 at 6 months and 12.85, 17.5 and 20.0 at 12 months. At three months the ODI of the NSM group was 65.5 and all crossed over to allograft treatment. At one year there were no AE's in the first 24 participants and the Magnetic Resonance (MR) imaging evaluation showed anatomic improvement of the disc and enhanced nucleus signal.

Interpretation: The first 24 subjects in this large triple-arm prospective randomized control trial showed that a percutaneous disc injection with a viscous cellular allograft can be done safely with no AE's in the initial subjects followed up to one year. The patients injected with allograft had a high level of pain decrease and functional improvement compared to the placebo and NSM cohorts, and those NSM subjects crossing over to allograft supplementation attained similar pain and functional improvements to those initially randomized to receive the active treatment. The safety data was not powered for statistical significance but the prominent improvements in pain and function support the possibility of statistically significant differences at the final analysis of the data. Improvements in intervertebral disc anatomy and signal were also noted.

References

1. Wu T, Song HX, Don Y, Li Jh. Cell-Based Therapies for lumbar discogenic low back pain – Systematic Review and Single Arm Meta-Analysis. *Spine* 2018 Jan 1;43(1):49-57. doi: 10.1097/BRS.0000000000001549.

203.4

Minimally invasive therapies for spinal stenosis

S. Marcia

Radiology SS Trinita' Hospital, ATS Sardegna, Cagliari, IT

Learning Objectives

1. To become familiar with the most common indications
2. To know about technical considerations
3. To know about literature evidence

Lumbar spinal stenosis (LSS) with neurogenic intermittent claudication is one of the most commonly treated spinal conditions, usually affecting people older 50 years and causing disability and reduction in quality of life. This condition identifies the narrowing of the lumbar spinal canal, the lateral nerve root canals or the intervertebral neural foramina, due to progressive hypertrophy of any of the surrounding osteocartilaginous and ligamentous elements, and may result in neurogenic or vascular compression of the contents of the spinal canal at one or more levels.

The pain is exacerbated by a prolonged standing in the upright posture and relieved by a flexed position of the lumbar spine and an associated diminished walking distance. In fact, standing positions narrows the neural foraminal and canal area resulting in impingement, whereas flexing positions (sitting, biking) increases the area relieving impingement. Diagnosis can be done by means of anamnesis and clinical examination and using MRI or CT. Electromyography is the diagnostic tool most commonly used.

Conservative treatment, such as administration of non-steroidal anti-inflammatory drugs, physical therapy, brace support for instability and epidural steroids injections, is the first option in most cases, resulting in a satisfactory outcome in a significant number of patients with mild to moderate symptoms after 3-months; upon failure of conservative therapy, surgical decompression results in similar outcome to earlier intervention. However, surgery typically requires general anesthesia, and thus it may not always be feasible in the growing elderly population with NIC.

In the last years, interspinous implants, requiring minimal open surgery, have been proposed. Early small-randomized controlled trials showed favorable outcomes in patients with NIC treated with the X-Stop IPS compared to conservative therapy with successful outcomes published to 4-years post treatment. Subsequent clinical series are characterized by more variable clinical outcome rates, and higher re-operation rates. More recently, totally percutaneous devices have been introduced. The procedure is performed under local anesthesia and mild sedation. Under fluoroscopy, a trocar is introduced and advanced toward interspinous space using AP and LL view; the percutaneous insertion of increasing size trocars (usually 8-10-12-14-16mm devices are available) allows to chose the more appropriate trocar size able to achieve the optimal decompression. When the access needle is suitable, it is removed and a correspondent measurement device is then introduced. The implant is positioned through a progressive wings deployment (Figure 1) in order to keep it strongly in place. Several non-randomized prospective studies assessed the efficacy of totally percutaneous interspinous spacers achieving pain relief and reducing disability and also demonstrating significant increases in spinal canal and foraminal cross-sectional areas at the treated level.

References

- Kalichman L, Cole R, Kim DH, Li L, Suri P, Guerazzi A, et al. Spinal stenosis prevalence and association with symptoms: The framingham study. *The spine journal : official journal of the North American Spine Society*. 2009;9:545-550
- Battie MC, Jones CA, Schopflocher DP, Hu RW. Health-related quality of life and comorbidities associated with lumbar spinal stenosis. *The spine journal : official journal of the North American Spine Society*. 2012;12:189-195
- Amundsen T, Weber H, Nordal HJ, Magnaes B, Abdelnoor M, Lilleas F. Lumbar spinal stenosis: Conservative or surgical management?: A prospective 10-year study. *Spine (Phila Pa 1976)*. 2000;25:1424-1435; discussion 1435-1426
- Kondrashov DG, Hannibal M, Hsu KY, Zucherman JF. Interspinous process decompression with the x-stop device for lumbar spinal stenosis: A 4-year follow-up study. *J Spinal Disord Tech*. 2006;19:323-327
- Bono CM, Vaccaro AR (2007) Interspinous process devices in the lumbar spine. *J Spinal Disord Tech*, 20(3):255-261
- Zucherman JF, Hsu KY, Hartjen CA, et al. (2005) A multicenter, prospective, randomized trial evaluating the X STOP interspinous process decompression system for the treatment of neurogenic intermittent claudication: two-year follow-up results. *Spine (Phila Pa 1976)*, 30(12):1351-1358
- Anderson PA, Tribus CB, Kitchel SH. Treatment of neurogenic claudication by interspinous decompression: Application of the x stop device in patients with lumbar degenerative spondylolisthesis. *J Neurosurg Spine*. 2006;4:463-471
- Epstein NE. A review of interspinous fusion devices: High complication, reoperation rates, and costs with poor outcomes. *Surgical neurology international*. 2012;3:7
- Stromqvist BH, Berg S, Gerdhem P, Johnsson R, Moller A, Sahlstrand T, et al. X-stop versus decompressive surgery for lumbar neurogenic intermittent claudication: Randomized controlled trial with 2-year follow-up. *Spine (Phila Pa 1976)*. 2013;38:1436-1442
- Nardi P, Cabezas D, Rea G, Pettorini BL (2010) Aperius PercLID stand alone interspinous system for the treatment of degenerative lumbar stenosis: experience on 152 cases. *J Spinal Disord Tech*, 23(3):203-207
- Fabrizi AP, Maina R, Schiabello L (2011) Interspinous spacers in the treatment of degenerative lumbar spinal disease: our experience with DIAM and Aperius devices. *Eur Spine J*, 20 Suppl 1:S20-26
- Menchetti PP, Postacchini F, Bini W, Canero G (2011) Percutaneous surgical treatment in lumbar spinal stenosis with Aperius-PercLID: indications, surgical technique and results. *Acta Neurochir Suppl*, 108:183-186
- Galarza M, Fabrizi AP, Maina R, Gazzeri R, Martinez-Lage JF (2010) Degenerative lumbar spinal stenosis with neurogenic intermittent claudication and treatment with the Aperius PercLID System: a preliminary report. *Neurosurg Focus*, 28(6):E3
- Marcia S, Hirsch JA, Chandra RV, Marras M, Piras E, Anselmetti GC, Muto M, Saba L. Midterm Clinical and Radiologic Outcomes after Percutaneous Interspinous Spacer Treatment for Neurogenic Intermittent Claudication. *J Vasc Interv Radiol*. 2015 Nov;26(11):1687-93.e1-2.
- Masala S, Marcia S, Taglieri A, Chiaravalloti A, Calabria E, Raguso M, Piras E, Simonetti G. Degenerative lumbar spinal stenosis treatment with Aperius™ PercLID™ system and Falena® interspinous spacers: 1-year follow-up of clinical outcome and quality of life. *Interv Neuroradiol*. 2016 Apr;22(2):217-26.

Focus Session Real-world endovascular management of claudication

301.1

How to treat long CTOs

Y. Gouëffic

Vascular Surgery, University Hospital of Nantes, Nantes, FR

Learning Objectives

- To discuss the different treatment modalities for chronic total occlusions
- To learn about the results of endovascular procedures for chronic total occlusions
- To learn how to select the most appropriate endovascular technique

The recent european guidelines for the treatment of femoropopliteal lesions were published in 2017. In these guidelines, endovascular repair is indicated for lesions shorter than 250 cm whereas bypass surgery is recommended to treat more extensive disease. Recent advances in endovascular techniques have led to widespread applicability of endovascular repair for more severe femoropopliteal lesions. Even though lesions are more distal and longer, the technical success does not seem to be altered. In addition, the use of new techniques and devices such as retrograde approach and re-entry catheters improves the technical success rates following failed initial procedure. According to some authors, failure of endovascular repair does not preclude the possibility of infrainguinal bypass. Thus, the use of endovascular treatment to treat long chronic total (CTO) femoropopliteal lesions is promising. However, the type of treatment such bare metal stent, cover stent or drug eluting devices for longer femoropopliteal lesions is still controversial. The purpose of the presentation is to provide some information to cross, to prepare and to treat these long CTO femoropopliteal lesions.

301.2

CTO crossing: true lumen or subintimal?

C. Hohl

Radiologie, St. Marienkrankenhaus Siegen, Siegen, DE

Learning Objectives

- To discuss the results of endoluminal and subintimal recanalisation
- To learn how to perform a subintimal recanalisation
- To discuss the technical aspects of endoluminal and subintimal recanalisation

Subintimal recanalization should be precisely be called extraluminal recanalization or even better "who knows where you are" recanalization. It is likely that many CTOs are in a subintimal manner without the operator knowing.

However, subintimal recanalization is a worthwhile alternative to classic endoluminal recanalization since first introduced by Bolia et al. in 1990. In my daily practice subintimal recanalization of femoropopliteal CTO-lesions plays a major role and in this focus session I will present the technique, the results and the caveats.

Mainly there are two different strategies for extraluminal recanalization: Most commonly an attempt is made to pass the occlusion in the standard way, but the wire does not make progress. If this happens, exchange for an angled tip hydrophilic guide wire (e.g. Terumo), advance it until it forms a loop. If the loop can be advanced with relative low resistance you have entered the subintimal space. Go as far as the artery is refilled by collateral flow. Now you are entering the difficult part of the intervention, reentering the true lumen of the vessel. Not too seldom the wire drops spontaneously back into the true lumen of the artery. If not, it takes a considerable amount of time to find your way back with the use of a shaped catheter and a wire.

A different approach is to deliberately enter the vessel wall above the occlusion with the help of a straight wire and a shaped catheter (e.g. Berenstein or Aachen-1). Sometimes it is necessary to use the "evil end" of the wire; take great care to avoid transmural recanalization. Once a subintimal position is achieved, the hydrophilic wire is advanced in a loop as above.

In cases where the reentry into the true lumen is impossible or extremely difficult, a dedicated reentry-device (e.g. Outback-catheter) can be quite helpful.

After subintimal recanalization is established, the whole subintimal route is dilated with a standard balloon catheter. Depending on the morphologic result, post-dilation with a drug-coated balloon or stenting is performed. Many publications have proven a high technical success rate and excellent long-term results.

References

1. Bolia A, Miles KA, Brennan J et al (1990) Percutaneous transluminal angioplasty of occlusions of the femoral and popliteal arteries by subintimal dissection. *Cardiovasc Intervent Radiol* 13:357–363
2. Siablis D, Diamantopoulos A, Katsanos K et al (2012) Subintimal angioplasty of long chronic total femoropopliteal occlusions: long-term outcomes, predictors of angiographic restenosis, and role of stenting. *Cardiovasc Intervent Radiol* 35:483–490
3. Radeleff, B., Sumkauskaitė, M., Kortes, N. et al. (2016) Subintimale Rekanalisation. *Radiologe* 56: 266–274.

301.3

Is vessel preparation required for all lesions?

E. Blessing

Abteilung Innere Medizin und Angiologie, SRH Klinikum Karlsbad-Langensteinbach gGmbH, Karlsbad, DE

Learning Objectives

1. To learn the concept of vessel preparation
2. To learn how to perform vessel preparation
3. To understand when to perform vessel preparation

Vessel preparation gained increasing recognition in recent years. There are several definitions of vessel preparation, mostly including either a change of vessel compliance or lesion debulking. Favourable compliance change can be achieved by longer inflations or inflating with higher pressures but also by the use of so-called specialty balloons (cutting, scoring or focal force balloons) or intravascular lithotripsy (Shockwave). Specialty balloons can be used as stand-alone therapy but are mostly followed by drug coated balloon angioplasty. The concept of specialty balloons are to either reduce the need for bail-out stenting or to enhance penetration depth of antiproliferative drugs and therefore improve patency. Proper lesion preparation is also mandatory prior implantation of interwoven vascular implants (Supera stents). Subgroup analysis of the Superb trial clearly demonstrated that poor implantation technique (mainly driven through poor lesion preparation) clearly resulted in poorer patency and higher rates of target lesion revascularization.

Debulking technologies (directional, orbital, rotational atherectomy etc.) are also used to avoid the need for bail-out stenting and to remove diffusion barrier prior drug coated balloon inflations. Whereas specialty balloons can be used rather easy, debulking technologies add substantial cost and complexity to the endovascular procedure and are therefore mostly limited to special situations or lesion characteristics (young patients, moving segments, in-stent restenosis etc.). Whereas clinical data of specialty balloons are mostly limited to single arm registries, there is rather robust data for directional atherectomy (Definitive LE study). Patency was reported to be 78% after 12 month with a bail-out stent rate as low as 3,2%. More randomized controlled data are needed to clarify the role for both specialty balloons as well as for debulking technologies.

301.4

Role of debulking: lumen gain or more than that?

R. Sachar

North Carolina Heart & Vascular, UNC Health Care, Raleigh, NC, US

Learning Objectives

1. To learn the debulking technologies
2. To understand when to debulk a lesion
3. To learn about complications and results of debulking

No abstract available.

301.5

Drug-eluting technologies in long, real-world fem-pop segments: review of evidence

M.K. Razavi

Interventional Radiology, St. Joseph Vascular Institute, Orange, CA, US

Learning Objectives

1. To review the results of the drug-eluting balloons and drug-eluting stents in the femoro-popliteal segments
2. To become familiar with the evidence for drug-eluting devices
3. To understand when to use drug-eluting devices

No abstract available.

301.6

DCB, DES or BMS?

K.R. Deloose

Vascular Surgery, AZ St. Blasius, Dendermonde, BE

Learning Objectives

1. To review the results of DCB, DES and BMS
2. To understand the actual role of BMS
3. To understand how to select the most appropriate device

No abstract available.

Clinical Evaluation Course Intrahepatic cholangiocarcinoma

302.1

Update on recent guidelines

M. Bezzi

Department of Radiological Sciences, University of Rome La Sapienza, Rome, IT

Cholangiocarcinomas (CCA) encompass all tumors originating in the epithelium of the bile duct and represent almost 3% of all gastrointestinal cancers. More than 90% are adenocarcinomas and are classified

according to the anatomical location as intrahepatic (iCCA), perihilar (pCCA), and distal CCA (dCCA). Intrahepatic cholangiocarcinomas are divided in three sub-types based on their growth pattern: mass forming (MF-iCCA, 90%), periductal-infiltrating (PI-iCCA), and intraductal growing (IG-iCCA). Extrahepatic cholangiocarcinomas are more common, the incidence of intrahepatic cholangiocarcinoma, however, is constantly increasing in the last years.

Diagnosis and staging

Patients with intrahepatic cholangiocarcinoma, due to their often late presentation, are more likely to present with nonspecific symptoms and advanced disease; in 20-25% of cases, however, diagnosis of iCCA is an incidental finding.

Multiphasic CT/MRI with IV contrast of the abdomen and pelvis and a chest CT are recommended from all guidelines.

Up to 81% of iCCA are characterized by a progressive contrast uptake from the arterial to the venous and especially in the delayed phase. This effect may reflect fibrosis which is slow to enhance but retains the intravenous contrast agent. In contrast, HCC is characterized by rapid enhancement during the arterial phase and relative washout in the venous or delayed phases. However, nodule <3 cm frequently show a pattern of contrast medium wash-in and wash-out similar to HCC by CT.

On MRI, iCCA appear hypointense on T1-weighted and hyperintense on T2-weighted images, and may also show central hypointensity corresponding to areas of fibrosis. Dynamic images show peripheral enhancement in the arterial phase followed by progressive and concentric filling-in of the tumor with contrast material. Pooling of contrast on delayed images is indicative of fibrosis and suggestive of an iCCA in the right clinical setting. MRI with cholangiopancreatography (MRI/MRCP) can be helpful to visualize the ductal system and vascular structures and thereby to determine the anatomic extent of tumor.

In the ESMO guidelines MRI with MRCP, contrast-enhanced and diffusion-weighted imaging is pointed out as the best diagnostic tool, while CT is considered less useful.

For NCCN panel and EASL guidelines, EGD and colonoscopy are recommended as part of initial workup, since a mass diagnosed as adenocarcinomas could be a metastatic disease. The NCCN suggest a possible role of FDG-PET in the staging of an extrahepatic disease, but its role is controversial for EASL and ESMO.

For the EASL guidelines pathological diagnosis is required for a definitive diagnosis of iCCA, however a presumed radiographic diagnosis is sufficient in non-cirrhotic patients in whom a decision has been made to proceed with resection.

For patients undergoing resection, biopsy is usually not necessary because of the risk of tumor seeding for the NCCN and ESMO guidelines.

In patients who are not resectable, biopsy is the ideal workup of iCCA. According to all guidelines the 8th edition of the AJCC/UICC staging system is preferred for iCCA staging.

Treatment

All guidelines concur that complete resection with negative margins is the only potentially curative treatment, although most patients are not candidates for surgery due to the presence of advanced disease at diagnosis. Since node metastasis is an important prognostic indicator of survival, lymphadenectomy should be considered at the level of the hepato-duodenal ligament during surgery. Extensive hepatic resections are often necessary in order to obtain negative margins.

Multifocal liver disease, nodal metastases beyond the porta hepatis and distant metastases contraindicate surgery, but in highly selected situations, resection can be considered. The preoperative staging strategy may include laparoscopy.

Patients who have undergone an R0 resection may be followed with observation alone for all guidelines.

NCCN recommendation for intrahepatic cholangiocarcinomas that are resected with microscopic margins (R1) is fluoropyrimidine chemoradiation, or fluoropyrimidine-based or gemcitabine-based chemotherapy. For intrahepatic resections with residual local disease (R2), gemcitabine/cisplatin combination therapy is a category 1 recommendation by the NCCN, after a revision of all the options by a multidisciplinary team.

Enrollment in clinical trials, and fluoropyrimidine-based or gemcitabine-based chemotherapy are also options.

EASL recommendation for patient with non-curative resection is the enrollment in studies of adjuvant therapy (gemcitabine/cisplatin).

For management of patients with unresectable or metastatic disease, NCCN makes the following recommendations:

- Gemcitabine/cisplatin combination therapy
- Fluoropyrimidine or gemcitabine chemotherapy
- Fluoropyrimidine chemoradiation
- Locoregional therapy
- Supportive care

EASL guidelines for unresectable iCCA suggest in case of intrahepatic disease local-regional therapy (RF/TACE/TARE), or chemotherapy with gemcitabine and cisplatin, as suggested in case of extrahepatic disease. In the EASL guidelines it is, however, stated that there are no established first-line local-regional therapeutic options for patients with non-resectable iCCA.

Locoregional therapies

The panel of the NCCN has included locoregional therapies as a treatment option that may be considered for patients with unresectable disease or metastatic cancer without extrahepatic disease.

RFA, TACE, DEM-TACE and TARE with yttrium-90 microspheres have been shown to be safe and effective in retrospective series of patients with unresectable iCCA. RFA seems to prolong survival in inoperable iCCA amenable to complete ablation.

The efficacy of DEM-TACE with irinotecan was similar to that of gemcitabine and oxaliplatin.

A systematic review of 12 studies showed that TARE with yttrium-90 microsphere in unresectable iCCA is a safe and effective treatment.

Due the rarity of this disease, none of these locoregional approaches has been evaluated in randomized clinical trial.

Hepatic arterial infusion (HAI) chemotherapy is recommended only in the context of a clinical trial or at experienced centers. OS and tumor response were greater for HAI compared with TACE, DEM-TACE and TARE, though grade III/IV toxicity was higher. Patients who received a combined regimen of HAI and other chemotherapy agent had greater OS, relative to patients receiving chemotherapy without HAI.

Radiation therapy is another option for iCCA. For the EASL guidelines External Beam RT cannot be recommended as standard therapy for patients with unresectable iCCA. TACE and TARE, according to EASL, have shown anti-tumor effects with acceptable toxicities in patients with iCCA but require further examination in appropriately designed clinical trials and therefore cannot be recommended as standard therapy for patients with unresectable iCCA. Ablation approaches may be considered for small, single lesions <3 cm if surgery is not an option, but additional clinical trials are needed to establish its role in this population. Ablation may have survival benefits when compared with other palliative treatment methods in patients with small, single iCCA lesions.

In ESMO guidelines Radioembolisation is a local therapy considered for patients with inoperable iCCA, usually after first-line chemotherapy. In responding patients with initially inoperable disease a salvage surgery could be suggested after downstaging.

From a clinical point of view, all guidelines suggest that iCCA should be managed by dedicated centres provided with multidisciplinary expertise where personalized diagnostic workup and management can be performed.

Liver Transplantation

Liver Transplantation (LT) is usually not recommended for iCCA or mixed HCC-iCCA, since results are well below those published for standard indications; however, this recommendation is based on limited data. For EASL guidelines LT should only be offered in centers with designed clinical research protocols employing adjuvant or neoadjuvant therapy.

References

1. NCCN hepatobiliary cancers guidelines vers 2. 2019
2. Bridgewater J, Galle PR, Khan SA, et al. Guidelines for the diagnosis and management of intrahepatic cholangiocarcinoma. *J Hepatol*. 2014;60 (6):1268-1289.

3. Valle JW, Borbath I, Khan SA, Huguet F, Gruenberger T, Arnold D. Biliary cancer: ESMO. Clinical Practice Guidelines for diagnosis, treatment and follow-up. *Ann Oncol*. 2016 Sep; 27(suppl 5): v28-v37
4. Banales JM, Cardinale V, Carpino G, et al. Expert consensus document. Cholangiocarcinoma: current knowledge and future perspectives consensus statement from the European Network for the Study of Cholangiocarcinoma (ENS-CCA). *Nat Rev Gastroenterol Hepatol*. 2016 May;13(5):261-80.

302.2

Established systemic therapies and pivotal trials

M. Ponz, J.I. Bilbao

Radiology, Clínica Universidad de Navarra, Pamplona, ES

Cholangiocarcinoma is a rare tumor type that arises from bile duct cells. Nowadays it is classified in relation to its anatomical origin. Therefore, the main types are intrahepatic cholangiocarcinoma (iCCA) and extrahepatic cholangiocarcinoma. The extrahepatic cholangiocarcinoma includes the perihilar and distal subtypes. Treatment of iCCA is defined by its resectability after an adequate workup that should include CT/MRI, surgical consultation, liver function tests with CA 19-9 and discussion in a multidisciplinary tumor board. If patient is assessed as non resectable/metastatic the standard of care would include systemic chemotherapy with Gemcitabine/Cisplatin. It is recommended to perform MSI/MMR and molecular testing (Genetic profile) in those patients if possible before starting first line chemotherapy. The percentage of iCCA patients that have an IDH, ERBB or FGFR2 mutation that may allow the patient to be treated inside a phase 3 trial in a first-line setting, with drugs inhibiting those proteins, is higher than for extrahepatic cholangiocarcinoma patients. There are other chemotherapy alternatives in the first and second line setting but in this subset of patients diagnosed with this rare tumor type, clinical trial participation should be highly encouraged to be able to increase the current armamentarium of systemic therapies which is very limited.

302.3

The surgeon's perspective

D. Seehofer

Department of Visceral, Vascular, Thoracic and Transplant Surgery, University Hospital Leipzig, Leipzig, DE

Surgical resection is the mainstay of curative treatment of intrahepatic cholangiocarcinoma (iCCA). Resection should be offered to patients with locally resectable tumors in the absence of distant metastases. Due to the lack of a surveillance opportunity and specific early symptoms, many patients present with large tumors or advanced tumor stages. This often requires extended hepatectomies or complex liver resections. On the other hand, a certain proportion of iCCA present in liver cirrhosis, as risk factor for the development of iCCA. In these patients impaired liver function may preclude major liver resections. In very selected patients with an iCCA less than 3 cm (or less than 2 cm) in concomitant liver cirrhosis, liver transplantation is investigated as an additional option. In patients with iCCA < 2 cm and negative lymph nodes status, a 5 year survival rate of 65 to 70% has been reported in retrospective series. The goal of surgical resection is complete resection of the tumor with negative surgical margins (R0-resection). In addition, a regional lymphadenectomy is performed in many centers, although the value of routine lymphadenectomy is still unclear when lymph node involvement is not clinically apparent. In case of a resectable tumor, which is consistent with iCCA in the CT or MRI a preoperative tumor biopsy is not mandatory. In all cases, the possibility other gastrointestinal tumors with liver metastases has to be excluded by gastroscopy and colonoscopy. In case of non-surgical therapies a pre-therapeutic biopsy is recommended. There is some evidence, that an adjuvant chemotherapy with capecitabine improves the prognosis after R0 or R1 resection of cholangiocarcinomas and should therefore be considered.

In patients with borderline resectable locally advanced or multifocal disease downsizing strategies might be considered. For these neo-adjuvant approaches a systemic chemotherapy or intra-arterial treatment modalities (mainly SIRT) might be used. The benefit of neoadjuvant approaches has been shown in single center experiences, but larger prospective trials are missing. In one single center analysis, neoadjuvant therapy by using chemotherapy or SIRT of irresectable iCCA resulted in a secondary resection rate in 39 out of 74 (53%) patients. The overall survival rate after resection showed no significant differences between patients after neo-adjuvant therapy and patients with primary resectability. Therefore, multimodal treatment modalities should be considered in the setting of a multidisciplinary tumor board. The benefit of a neo-adjuvant therapy in clearly resectable cases is still unproven.

In case, liver limited tumors, which are irresectable, e.g. due to vascular involvement of the three major liver veins or impaired liver function, local ablative or locoregional arterial treatment modalities should be considered. In patients with relevant extrahepatic metastases, palliative chemotherapy represents the standard of care. However, if the hepatic tumor burden is the clinically leading manifestation, a local hepatic tumor therapy might also be considered in selected cases.

302.4

Is ablation alone enough?

R. Duran

Radiology and Interventional Radiology, Lausanne University Hospital and University of Lausanne, Lausanne, CH

Intrahepatic cholangiocarcinoma (ICC) is the second most common primary liver cancer after hepatocellular carcinoma. The worldwide incidence of this malignancy is increasing [1]. Surgical resection is the treatment of choice with best reported outcomes. However, the vast majority of patients are diagnosed at an advanced stage disease for which surgery is not an option. Moreover, even in surgical candidates, the recurrence after resection is high (50-60%), with the liver being the most common site of recurrence [2-4]. Thermal ablations are a good therapeutic option for ICC patients with limited disease (lesion ≤3cm) who are not considered surgical candidates and who recur after surgery. For patients with intermediate size lesions (~5cm) who are not surgical candidates, the combination of ablation and transarterial chemoembolization (vs. radioembolization) could be considered [5].

References

1. Razumilava, N. and G.J. Gores. Cholangiocarcinoma. *Lancet* 2014;383:2168-79.
2. Endo I, Gonen M, Yopp AC, Dalal KM, Zhou Q, Klimstra D, et al. Intrahepatic cholangiocarcinoma: rising frequency, improved survival, and determinants of outcome after resection. *Ann Surg* 2008;248:84-96.
3. Choi SB, Kim KS, Choi JY, Park SW, Choi JS, Lee WJ, et al. The prognosis and survival outcome of intrahepatic cholangiocarcinoma following surgical resection: association of lymph node metastasis and lymph node dissection with survival. *Ann Surg Oncol* 2009;16:3048-3056.
4. Yamamoto M, Takasaki K, Otsubo T, Katsuragawa H, Katagiri S. Recurrence after surgical resection of intrahepatic cholangiocarcinoma. *J Hepatobiliary Pancreat Surg* 2001;8:154-157.
5. Bridgewater, J., et al. Guidelines for the diagnosis and management of intrahepatic cholangiocarcinoma. *J Hepatol* 2014;60:1268-89.

302.5

Intra-arterial therapies: transcatheter arterial chemoembolisation first

F. Orsi, G.M. Varano

Division of Interventional Radiology, IEO European Institute of Oncology, Milan, IT

Cholangiocarcinoma is the second more frequent liver primary cancer, accounting for 5–10% of liver malignancies [1]. Its incidence and mortality is increasing worldwide, at a higher rate than that of hepatocellular carcinoma [2]. Surgical resection represents the only curative option, but the disease is often discovered in an advanced stage [3], and only 54–70% of patients are eligible for surgery at the time of diagnosis [4]. The prognosis for unresectable patients is poor, with an estimated median survival between 3–8 months [3]. After curative-intent surgical resection, a 71% recurrence rate has been reported, with a 85.5% involving the liver and 14.5% extrahepatic tissues [5].

Patients not eligible for surgery, could receive palliative systemic chemotherapy. Standard of care first line regimen, is the combination of gemcitabine and cisplatin, which resulted in a prolonged median OS of 11.7 months, compared to 8.1 months with gemcitabine alone [6]. Side effects during systemic therapy are common, often conditioning patients' therapy tolerance and quality of life. Because of the poor results with standard systemic therapy, the role of intra-arterial therapies is increasingly being investigated for these patients.

A recent meta-analysis focused on comparative effectiveness of intra-arterial therapies (IAT). The authors evaluated the overall survival (OS), tumor response and treatment related toxicity [7]. The median OS across the entire cohort was 14.5 months and 80% of the patients demonstrated a tumor regression or stable disease. Per patient analysis, they found less than 1 adverse event per patient. Main bias of the analysis was that almost all of treated patients were receiving systemic therapy up to and probably after their locoregional therapies; the results likely reflect the combination of systemic and regional therapy for some patients. [7]

Among IAT, transcatheter arterial chemoembolization (TACE), both c-TACE and DEB-TACE, are the techniques more extensively explored in different clinical settings.

Park et al compared c-TACE (72 patients) and supportive care (83 patients) in unresectable ICC, finding a survival benefit, in the group treated with c-TACE, with the median OS of 12.2 months versus 3.3 months [8]. Vogl et al. [9] reported effectiveness of c-TACE with four different chemotherapeutic agents protocol, in unresectable colangiocarcinoma. Mitomycin C alone was employed in 20.9% of patients, Gemcitabine alone in 7%, Mitomycin C together with Gemcitabine in 47% and combination of Gemcitabine, Mitomycin C and Cisplatin in 25.1%. Local tumor controls were reported: partial response in 8.7%, stable disease in 57.4% and progressive disease in 33.9% of patients. The median and mean survival times from the start of TACE were 13 and 20.8 months. Survival rate from the start of TACE was 52% after 1-year, 29% after 2-years and 10% after 3-years. It is relevant that no statistically significant difference between patients treated with different chemotherapy protocols was noted. On the contrary, Gusani et al. [10] demonstrated better survival when cTACE was performed with gemcitabine in combination with cisplatin or oxaliplatin, compared to gemcitabine alone (13.8 vs 6.3 months). The use of cTACE as an adjuvant therapy after surgery, showed prolonged survival compared to the control surgery group (1-, 3- and 5-year OS of 69.8%, 37.7% and 28.3% vs. 54.2%, 25.0% and 20.8%). The median OS in the adjuvant cTACE group was twelve months and surgery only resulted in a median OS of five months. However, cTACE did not delay the recurrence of the disease in this setting [11].

The DEB-TACE was also largely used to treat Intra-hepatic ColangioCarcinoma. Kuhlman et al [12] reported increased OS of 11.7 months in 26 patients treated with irinotecan DEB-TACE, compared to 5.7 months in patients treated with cTACE (mitomycin C); DEB-TACE was not superior compared to the 11 months OS of patients treated with systemic chemotherapy with gemcitabine and oxaliplatin. Another meta-analysis

[13] of 16 studies reported safety, tolerance and effectiveness of cTACE and DEB-TACE treatment of ICC patients. The 30-day mortality was 0.7% with a 18.9% of severe toxicities ($\geq$ grade 3) following TACE procedures. OS was 13.4 months from the time of the first TACE session. It was concluded that TACE confer a survival benefit of 2 to 7 months compared with systemic chemotherapy.

The use of oxaliplatin-preloaded (50 mg) microspheres combined with systemic chemotherapy (oxaliplatin and gemcitabine) in the treatment of hepatic malignancies (seven ICC) was examined in a small retrospective comparative study including nine patients. The cohort that received DEB-TACE was compared to a retrospectively acquired group of eleven patients, who were treated with chemotherapy (FOLFOX) only. According to RECIST criteria, four patients (44%) in the DEB-TACE group achieved PR and five patients (56%) showed SD. The median OS after DEB-TACE and chemotherapy was 30 months compared to 12.7 months for chemotherapy alone [14]

Despite the absence of randomized controlled trials, current literature indicates evidence in supporting the use of IAT and particularly of TACE for patients with unresectable ICC. These techniques have been proven to be feasible, safe and effective, in inducing local tumor response. TACE studies are retrospective in nature and used a wide range of chemotherapeutic agents and different embolization materials and non-standardized treatment schedules, and nevertheless, the low level of evidence from the literature, suggests prolonged survival without severe impairment of the quality of life of patients in a palliative setting.

References

1. Blechacz B, Gores GJ. Cholangiocarcinoma: advances in pathogenesis, diagnosis, and treatment. *Hepatology* 8(1), 308–321 (2008).
2. Shaib YH, Davila JA et al.: Rising incidence of intrahepatic cholangiocarcinoma in the United States: A true increase? *J Hepatol* 2004;40:472–477.
3. Endo I, Gonen M, et al.: Intrahepatic cholangiocarcinoma: Rising frequency, improved survival, and determinants of outcome after resection. *Ann Surg* 2008;248:84–96.
4. Weber SM, Jarnagin WR et al. Intrahepatic holangiocarcinoma: resectability, recurrence pattern, and outcomes. *J Am Coll Surg* 2001;193(04): 384–391
5. Spolverato G, Kim Y et al. Management and outcomes of patients with recurrent intrahepatic cholangiocarcinoma following previous curative-intent surgical resection. *Ann Surg Oncol*. 2016;23(1):235–243.
6. Valle J, Wasan H et al. Cisplatin plus gemcitabine versus gemcitabine for biliary tract cancer. *N Engl J Med*. 2010; 362(14):1273–1281.
7. Boehm LM, Jayakrishnan TT, et al. Comparative effectiveness of hepatic artery based therapies for unresectable intrahepatic cholangiocarcinoma. *Surg Oncol*. 2015 Feb;111(2):213–20.
8. Park SY, Kim JH et al. Transarterial chemoembolization versus supportive therapy in the palliative treatment of unresectable intrahepatic cholangiocarcinoma. *Clin Radiol*. 2011;66(4):322–328.
9. Transarterial chemoembolization in the treatment of patients with unresectable cholangiocarcinoma: results and prognostic factors governing treatment success
10. Gusani NJ, Balaa FK, et al. Treatment of unresectable cholangiocarcinoma with gemcitabine-based transcatheter arterial chemoembolization (TACE): a single-institution experience. *J Gastrointest Surg*. 2008;12(1):129–137
11. Shen WF, Zhong W, et al. Adjuvant transcatheter arterial chemoembolization for intrahepatic cholangiocarcinoma after curative surgery: retrospective control study. *World J Surg*. 2011;35(9):2083–2091
12. Kuhlmann JB, Euringer W, et al. Treatment of unresectable cholangiocarcinoma: onventional transarterialchemoembolization compared with drug eluting beadtransarterialchemoembolization and systemic chemotherapy.*Eur J Gastroenterol Hepatol*. 2012;24(4):437–443

13. Ray CE Jr, Edwards A, et al. Metaanalysis of survival, complications, and imaging response following chemotherapy-based transarterial therapy in patients with unresectable intrahepatic cholangiocarcinoma. *J Vasc Interv Radiol*. 2013;24(8):1218-1226
14. Poggi G, Amatu A, et al. OEM-TACE: a new therapeutic approach in unresectable intrahepatic cholangiocarcinoma. *Cardiovasc Intervent Radiol* 2009;32:1187-92

302.6

Intra-arterial therapies: transarterial radioembolisation first

T.K. Helmberger

Institut für Radiologie, Neuroradiologie und minimal-invasive Therapie, Klinikum Bogenhausen, Munich, DE

Surgery is the first choice in peripheral intrahepatic cholangiocarcinoma (ICC). In non-surgical candidates, transarterial therapies as hepatic arterial infusion (HAI), transarterial chemoembolization (TACE), and radioembolization (RE) are offering response rates of about 85 % and survival rates between 16 and 44 months, the latter achievable by RE in therapy naive patients. Side effects in terms of hepatic portal embolization syndrome are comparable between all intra-arterial therapies while the systemic adverse events are the lowest in RE. Nevertheless, there is still an insufficient data base comparing HAI, TACE, and RE, therefore, current guidelines consider RE as a potential effective treatment in ICC but are still reluctant to provide a definitive treatment recommendation.

References

1. Boehm LM et al. (2015). "Comparative effectiveness of hepatic artery based therapies for unresectable intrahepatic cholangiocarcinoma." *J Surg Oncol* 111(2): 213-220
2. Valle JW et al. (2016). Biliary cancer: ESMO Clinical Practice Guidelines for diagnosis, treatment and follow-up. *Annals of Oncology* 27 (Supplement 5): v28-v37
3. Cucchetti A et al. (2017). "Improving patient selection for selective internal radiation therapy of intra-hepatic cholangiocarcinoma: A meta-regression study." *LiverInt* 37(7): 1056-1064

Focus Session Lymphatic interventions

303.1

Classification and diagnosis of lymphatic malformations

A. Alonso Burgos

Radiology, Clinica Universidad de Navarra, Madrid, ES

Learning Objectives

1. To learn about the current classification
2. To understand non-invasive and invasive diagnostic techniques
3. To learn appropriate diagnostic algorithms

Lymphatic malformations (LM) are congenital slow-flow lesions composed of anomalous channels or pockets of lymphatic fluid that ultimately lead to abnormal lymphatic flow, often beneath the skin. Embryologically, they are thought to originate from the sequestration of lymphatic tissue during the development of lymphaticovenous sacs, which then fail to communicate with the remainder of the lymphatic or venous system. Later on the sequestered lymphatic tissues dilate, which results in the cystic morphology of the lesion. Lymphatic malformations, regardless of size, can potentially cause functional impairment of nearby structures or organs and disfigurement of affected areas. Lymphatic malformations are associated with hypertrophy and swelling of any affected area including the lips, tongue, jaws, cheeks, arms, legs, fingers or toes. Lymphatic malformations affecting the chest can cause wheezing, chest pain, chest pressure, dyspnea and potentially airway compromise. Lymphatic malformations affecting the gastrointestinal tract or pelvis can cause

constipation, bladder obstruction, recurrent infection or protein loss. When lymphatic malformations are widespread in bone and soft tissue, the condition may be referred to as lymphangiomatosis.

Several different terms were once used to describe conditions now grouped under the umbrella term "lymphatic malformations." These terms have been abandoned because some of the outdated terms imply a relationship to cancer. Lymphatic malformations are not cancerous and there is no known risk of malignant transformation.

Synonyms of Lymphatic Malformations

Cavernous lymphangioma

Cystic hygroma

Cystic lymphangioma

Lymphangioma

lymphangioma circumscriptum

lymphangiomatosis

Macrocystic lymphatic malformation

Microcystic lymphatic malformation

LMs can be divided according to their size into Microcystic, Macrocystic or combined lesions. The Macrocystic type is made up of large cysts, more than 2 cms in diameter; the Microcystic type is made up of smaller cysts or soft tissue enlargement without cyst formation. Most lymphatic malformations have both Macrocystic and Microcystic portions and histologically there is no difference between these categories. Histologically, Macrocystic LMs are large, interconnected lymphatic cysts, lined by a thin endothelium without increased mitotic activity. These are filled with a proteinaceous fluid containing a variable number of lymphocytes and macrophages and occasional erythrocytes and may have valves. On the other hand, Microcystic LMs are composed of smaller lymphatic channels that may interdigitate with tissue elements. Combined LMs, as the name suggests, consist of lesions with characteristics of both Microcystic and Macrocystic lymphatic channels.

LMs may occur in any area of the body (except the brain), but two-thirds of all the reported cases are found in the head and neck. LM can be also found at the axillae, mediastinum, retroperitoneum and perineal area. They are present at birth and are normally detected before age.

Clinically, LMs present in various ways, depending on the location and dimension. Small, superficial lesions may appear as fluid-filled vesicles, while larger lesions can cause severe swelling and deformity. LMs are non-pulsatile, non-compressible and their dimensions, unlike venous malformations, are not affected by positioning.

The pathogenesis of LMs remains unclear. It is now accepted that these are true malformations (and not neoplasms) and some genes involved in normal lymphangiogenesis have been identified as possible candidates for these anomalies.

Primary lymphedema is a subtype of lymphatic malformations with aplasia or hypoplasia of the lymphatic network. Primary lymphedema is a subtype of LM characterized by abnormal accumulation of interstitial fluid due to inefficient uptake and reduced flow, causing swelling and disability, mostly in the extremities. This is a hereditary pathology that can have a congenital, pre-pubertal or late (after 35 years) onset. Mutations in VEGFR-3 gene, its ligands VEGF-C and VEGF-D, CCBE1, FOXC2, SOX18 and other genes, transcription factors and connexins involved in this pathway have been linked to pathogenesis of primary lymphedema. Secondary lymphedema because of trauma, surgery, and filariasis must be excluded.

DIAGNOSIS

The diagnosis of lymphatic malformations is based on clinical history and presentation as well as imaging evaluation.

Ultrasound (US) is usually the first imaging approach to a LM. US usually shows a multicystic lesion with internal septations and no blood flow is detected on Color Doppler. This is particularly helpful in detecting the different vascular characteristics of mixed vascular malformations and it also differentiates hemangiomas from vascular malformations. Macrocystic LMs may be identified as hypoechoic, multilobulated cystic structures with posterior acoustic enhancement, while Microcystic lesions may appear hyperechoic, due to the small cysts and multiple intervening septa or soft tissue. On Doppler US, cysts in LMs show no flow, even though the septa may show some vascularity.

Due to the great soft-tissue resolution, MRI is the preferred image modality for the assessment of these lesions. Macrocystic LMs appear as clearly defined cysts and septa. The cysts have low signal-intensity in T1-weighted images and are hyperintense in T2-weighted images. They may contain fluid-fluid levels, due to the protein or blood content. The cysts do not enhance after intravenous contrast administration (unlike venous malformations), but the septa and walls may do.

On the other hand, Microcystic LMs normally appear as diffuse areas of low signal-intensity in T1-weighted images and high signal-intensity in T2-weighted images, as the cysts are too small to be identifiable as discrete structures in MRI.

Patients with suspected or confirmed primary lymphedema can be evaluated with MR lymphangiography, both contrast- and non-contrast-enhanced techniques. Contrast-enhanced MR lymphangiography allows a functional assessment of the lymphatic vessels transportation whereas noncontrast MR lymphography does not provide any functional information, however the precise anatomic information can be used to identify sites for lymph node transplantation or suitable sites for lympho-venous anastomosis and to optimize mapping of the manual lymphatic drainage as treatment of lymphedema.

CTA imaging is usually not required for the evaluation of LMs, though it can be useful to evaluate their relations with adjacent structures (particularly with bone). These appear as low-attenuation, non-enhancing cystic masses with thin or imperceptible walls.

The International Society for the Study of Vascular Anomalies (ISSVA) divides vascular malformations into:

Simple malformation, when only one type of vessel is involved.

Combined malformations, when two or more types of vessels are involved.

Malformations of major named vessels.

Vascular malformations associated with other anomalies.

According to the predominant type of channel abnormality and associated flow dynamics, vascular malformations can also be classified into slow-flow and fast-flow anomalies. Combined vascular malformations occur when two or more vascular malformations are present in the same patient. Similarly to simple vascular malformations, these can be divided into slow-flow and fast-flow malformations, and are frequently associated with other clinical features, taking part in complex clinical syndromes. Therefore, patients with combined vascular malformations should be accompanied by multi-disciplinary teams that can address the diverse and complex nature of these lesions. Diagnosis is based on clinical history and presentation and imaging studies, such as Doppler ultrasonography or magnetic resonance image. Combined vascular malformations and most commonly associated syndromes, including the Klippel-Trénaunay syndrome (KTS), the Parkes Weber Syndrome and the CLOVES Syndrome (congenital lipomatous overgrowth, vascular malformations, epidermal nevi and scoliosis or skeletal and spinal anomalies — CLOVES).

SIMPLE AND COMBINED VASCULAR MALFORMATIONS.

SIMPLE VASCULAR MALFORMATIONS

Fast-flow malformations

Arteriovenous malformations and Fistulae

Slow-flow malformations

Venous malformations

Capillary malformations

Lymphatic malformations

COMBINED VASCULAR MALFORMATIONS

Fast-flow malformations

Capillary-arteriovenous malformations

Capillary-lymphatic-arteriovenous malformations

Capillary-venous-arteriovenous malformations

Capillary-lymphatic-venous-arteriovenous Malformations

Slow-flow malformations

Capillary-lymphatic malformations

Lymphatic-venous malformations

Capillary-lymphatic-venous malformations

Capillary-venous malformations

References

1. Carqueja IM, Sousa J, Mansilha A. Vascular malformations: classification, diagnosis and treatment. *Int Angiol.* 2018;37:127-142.
2. Arrivé L, Derhy S, Dahan B, El Mouhadi S, Monnier-Cholley L, Menu Y, Becker C. Primary lower limb lymphoedema: classification with non-contrast MR lymphography. *Eur Radiol.* 2018;28:291-300.
3. McCuaig CC. Update on classification and diagnosis of vascular malformations. *Curr Opin Pediatr.* 2017;29:448-454.
4. Ramashankar, Prabhakar C, Shah NK, Giraddi G. Lymphatic malformations: A dilemma in diagnosis and management. *Contemp Clin Dent.* 2014;5:119-22.

303.2

Interventional therapy for malformations

R. Müller-Wille

Department of Radiology, University Medical Center Regensburg, Regensburg, DE

Learning Objectives

1. To learn about therapeutic indications
2. To understand various therapeutic approaches
3. To learn about therapeutic efficacy and potential complications

No abstract available.

303.3

Paediatric lymphatic malformations

W.A. Wohlgemuth

Universitätsklinik und Poliklinik für Radiologie, Universitätsklinikum Halle, Halle, DE

Learning Objectives

1. To understand the specific classification and treatment indications
2. To learn about specific therapeutic techniques
3. To learn about therapeutic efficacy and potential complications

No abstract available.

303.4

Challenging chylothorax and chyloperitoneum

W. Prevoo

Radiology, Netherlands Cancer Institute-Antoni van Leeuwenhoek Hospital, Amsterdam, NL

Learning Objectives

1. To learn about the differential diagnosis
 2. To understand the therapeutic indications and the potential therapeutic techniques
 3. To learn about therapeutic efficacy and potential complications
- Leakage of lymph from the lymphatic ducts causes chylothorax (CT) or chylous ascitis chyloperitoneum(CA). This may happen for unknown reasons and may also be caused by trauma after thoracic, abdominothoracic and abdominopelvic surgery.

Most patients with CT or CA benefit from observation, rest, and supportive measures alone. Drainage of the fluid may be necessary, but then loss of protein, fat, and lymphoid cells introduce new risks and require careful replacement. Low-fat diets with MCT and parenteral nutrition decrease fluid production while allowing adequate nutritional input. Imaging of the lymphatic system is indicated when the leaks persist. Thoracic duct embolization (TDE) has become the method of choice for the treatment of patients with chylous leaks in the thorax. TDE is associated with less morbidity and better clinical success than conservative management or surgical intervention in both traumatic and nontraumatic causes of chylothorax.

Also in chylous ascites lymphangiography has been shown to be effective in diagnosis and therapeutic effect to some degree. Percutaneous treatment with glue, coils and sclerosing agents may be contributory to an effective minimal invasive therapy. To be considered in cases of mesenteric chyle leakage is retrograde lymphangiography and embolization. Treatment options are: only (nodal) lymphangiography, lymphatic disruption, thoracic duct embolization, nodal glue embolization, or balloon occluded retrograde abdominal lymphatic embolization (BORAL(E)). Given the low risk of procedural complications, early intervention is encouraged.

In this presentation indications, therapeutic options and techniques will be discussed for treatment of chylothorax and chyle ascites/peritoneum.

References

1. Cardiovasc Interv Radiol 2018 Mar;41(3):366-376. Modern Techniques of Lymphangiography and Interventions: Current Status and Future Development. Itkin M, Nadolski GJ.
2. Tech vasc interv Radiol 2016 Dec;19(4):277-285. Lymphangiography for Thoracic Duct Interventions. Stecker MS, Fan CM.
3. Eur Radiol 2016 Aug;26(8):2482-93. The thoracic duct: clinical importance, anatomic variation, imaging, and embolization. Johnson OW, Chick AF, Chauhan NR, Fairchild AH, Fan CM, Stecker MS, Killoran TP, Suzuki-Han A.
4. Cardiovasc Interv Radiol 2018 Mar;41(3):415-423. Lymphangiography and Lymphatic Embolization for the Treatment of Refractory Chylous Ascites. Nadolski GJ, Chauhan NR, Itkin M.
5. Eur J Radiol. 2018 Dec;109:41-47. Lymphatic interventions for isolated, iatrogenic chylous ascites: A multi-institution experience. Majdalany BS, Khayat M, Downing T, Killoran TP, El-Haddad G, Khaja MS, Saad WA.
6. Vasc Interv Radiol 2016 Dec;27(12):1890-1896. US-Guided, Direct Puncture Retrograde Thoracic Duct Access, Lymphangiography, and Embolization: Feasibility and Efficacy. Guevara CJ, Rialon KL, Ramaswamy RS, Kim SK, Darcy MD.
7. Ann Vasc Surg 2018 May;49:49-56. Endolymphatic Balloon-Occluded Retrograde Abdominal Lymphangiography (BORAL) and Embolization (BORALE) for the Diagnosis and Treatment of Chylous Ascites: Approach, Technical Success, and Clinical Outcomes. Srinivasa RN, Gemmette JJ, Osher ML, Hage AN, Chick JFB.

Focus Session Superior vena cava syndromes

304.1

Malignant occlusion

L. Tselikas

Interventional Radiology, Gustave Roussy - Cancer Campus, Villejuif, FR

Learning Objectives

1. What to look for in pre-op imaging
2. Are the techniques for balloon angioplasty and stent the same as for iliac veins?
3. What to do with thrombotic malignant SVCO?

No abstract available.

304.2

Catheter-related superior vena cava syndromes

J.G. Caridi

Vascular and Interventional Radiology, Tulane University Medical Center, New Orleans, LA, US

Learning Objectives

1. To learn how to evaluate patients in the office
2. To learn what pre-op imaging is needed
3. To get to know the top 5 technical tips and tricks

Every year in the US it is estimated that 15,000 to 19,000 people suffer from superior vena cava syndrome (SVCS). Superior vena cava syndrome is the collection of clinical symptoms and signs resulting from obstruction of blood flow through the superior vena cava (SVC). The SVCS syndrome was originally described by William Hunter in 1757 in a patient with a large syphilitic saccular aortic aneurysm compressing the superior vena cava (SVC). Currently, although many whimsically call any stenosis or obstruction of the SVC the superior vena cava syndrome purists actually differentiate between stenosis or occlusion with no symptoms vs. stenosis or occlusion with resulting clinical sequella.

To this group and more accurately true SVCS does indeed have stenosis or occlusion of the SVC but is accompanied by a number of symptoms. Swelling of the head, face and neck is the most common sign but other signs and symptoms include proptosis, laryngeal edema, headache, tinnitus, hoarseness, Horner's syndrome, chest pain, dysphagia, nasal stuffiness, nausea, orthopnea, cerebral edema, pleural effusion, wheezing and dyspnea. Dyspnea is the most common symptom and is seen in 60% or better of patients. The extent to which these symptoms are clinically important and emergent usually depends on the timing and extent of the onset of the stenosis/occlusion of the SVC.

Clinically, aside from head, face and neck swelling approximately 1/3 of patients develop distended veins of the neck and chest occasionally with plethora, petechiae and cyanosis. Obviously patients with slow prolonged onset of severe disease favor these changes. These patients are commonly short of breath and their symptoms are exacerbated when in the supine or bending forward position.

Typically an obstructed SVC responds with collateral venous return to the heart from the upper half of the body through four principal pathways. These include the azygous venous system, which includes the azygos vein, the hemiazygos vein, and the connecting intercostal veins. The second pathway is the internal mammary venous system plus tributaries and secondary communications to the superior and inferior epigastric veins. The long thoracic venous system, with its connections to the femoral veins and vertebral veins, provides the third and fourth collateral routes, respectively. This accounts for the chronic changes seen on physical exam. There are 2 major causes of SVC stenosis/occlusion; benign and malignant. Because the SVC lies in a relatively confined space and is surrounded by several lymph node groups it is predisposed to compression, invasion, or involvement in inflammatory and malignant conditions. Up until the turn of the century SVCS was approximately 50/50 benign vs malignant etiology. Malignant causes, commonly bronchogenic carcinoma, can readily compress the thin walled low pressure SVC and now account for approximately 60% of patients with SVCS. Other common malignant causes include small cell carcinoma, squamous cell carcinoma, adenocarcinoma, large cell carcinoma and non-Hodgkin lymphoma. Many other malignancies have been reported; essentially, any mediastinal mass may compress or invade the SVC.

The other 40% of SVCS is made up of a variety of benign causes. Some of these include benign tumors (goiter, thymoma, teratoma, cystic hygroma), aortic aneurysm, infection (TB, actinomycosis, histoplasmosis) radiation, and mediastinitis. However, approximately 70% of benign causes are the result of intravascular devices such as catheters and cardiac leads. In fact this percentage is increasing in frequency due to the concomitant increase use of intravenous devices. The intima of the SVC is one cell thick. Irritating and denuding these cells from friction stimulates the coagulation cascade, platelet aggregation, intimal hyperplasia and at worst stenosis, occlusion

and thrombosis. It is estimated that this occurs approximately 25% of the time or .003% to 0.2% for each day the device is in place.

There have been several risk factors proposed for catheter related stenosis/occlusion. These include the number of SVC catheters, larger catheter diameter, longer duration, subclavian or left sided approach and catheter related infection. However SVC stenosis and occlusion can occur in hemodialysis patients even without previous catheter placement. This may be the result of an inflammatory response.

For individuals who like to categorize, SVC stenosis/occlusion has been broken down into 4 varieties according to Stanford and Doty, SVC I-IV. Type I: includes a high-grade SVC stenosis but a normal direction of blood flow through the SVC and azygos veins. There is also an increased collateral circulation through the hemiazygos and accessory hemiazygos veins.

Type II: there is a >90% stenosis or occlusion of the SVC. This is also associated with a normal direction of blood flow through the azygos vein. Type III: there is occlusion of the SVC with retrograde flow in both the azygos and hemi- azygos veins.

Type IV: there is extensive occlusion of the SVC, innominate, and azygos veins with chest wall and epigastric venous collaterals.

It is imperative to evaluate the type and extent of disease prior to deciding on method of treatment. Ultrasound can be used for evaluation of the extent and severity of occlusion of the peripheral veins (subclavian/jugular) and can also be used for access of patent or occluded vessels.

MRV (magnetic resonance venography) or CTV (computed tomographic venography) have been used to evaluate patent and occluded central veins yielding a road map for treatment. CTV has been the method of choice as it can show the location and severity of the SVC obstruction, superimposed thrombosis, a mediastinal mass or lymphadenopathy, collateral vessels and associated lung masses. One study demonstrated the sensitivity and specificity of CT at 96 and 92%.

In some patients especially those on dialysis or with elevated creatinine CTV and MRV utilizing iodinated contrast are not recommended due to NSF (neurogenic systemic fibrosis) and CIN (contrast induced nephropathy) respectively. In these patients we use CO₂ venography. A simple 25-gauge needle in each hand vein is used to gently deliver 10-20 cc's of CO₂. This not only defines the extremity and central veins but because of its low viscosity will opacify collaterals and cross midline unlike liquid contrast. We have found this ideal and preferable for road mapping central veins. Treatments available for benign causes of SVCS include both surgical and endovascular repair. Endovascular repair has had good success with few complications and is the method of choice. One review reported technical success of 96%, 0% mortality and regression of symptoms in 97%. This is achieved by obtaining access to the stenosis/occlusion followed by performing PTV (percutaneous transluminal venoplasty) or and or stenting. Reviewing the literature approximately 75% are treated with stents vs angioplasty alone. In each method thrombectomy may be necessary as well. A variety of stents have been used including self/ balloon expandable and stent grafts but the Wallstent appears most popular and used in more than 50% of patients. Outside the U.S. some use balloon expandable covered stents because of their lower risk of thrombosis and their higher patency rate. However covered stents still bear a higher risk of stent migration and can occlude other venous input such as the brachiocephalic or azygos vein.

Complications (approximately 3%) of PTV and stent placements are minimal but include thrombosis, stent migration, hemopericardium and transient chest pain.

Access to the SVC is essential for treatment. How the SVC is accessed is determined by the extent of disease. Tools to use for access include hydrophilic wires, catheters and guide catheters. Other important components may include ultrasound, thrombectomy device, blunt needle and snare catheter. Ultrasound is used to gain access to one of many veins supporting the method of treatment. In totally occluded vessels ultrasound can also be used to access the vein with a blunt needle and direct its path to a potentially patent vein. This needle can also be used as purchase to promote antegrade passage of a hydrophilic guidewire to a patent vessel.

Prior to any significant intervention, once accessed any acute thrombus should be addressed and removed with any one of a number of thrombectomy methods. This can include suction catheters, pharmacomechanical devices, mechanical devices or thrombolytics. This may allow improvement in flow but often exposes an underlying stenosis/occlusion which must be addressed.

It is typical to gain access to the central veins peripheral to the occlusion (e.g. subclavian or jugular) as well as from a peripheral vein from below usually the femoral vein. If the femoral veins and or IVC are not patent the hepatic vein can be accessed. These accesses may result in traversing the obstruction alone but is also imperative to maintain through and through control with the guidewire. This lower access can also assist with snare placement for gun site access. Additionally, if snared it is easier to pull a catheter or wire through a stenosis/occlusion rather than pushing. However the most important reason for through and through control is to prevent stent migration into the heart. If the wire enters the neck and exits the groin if the stent accidentally mis deploys it is prevented from entering the heart. Therefore the eventual removing the stent can be done in a more controlled environment without the concern for embolization. A combination of hydrophilic wire, catheter and guidewire allow purchase and muscle to pick at an occluded vessel in an attempt to traverse the obstruction or stenosis. This is often most useful if the occluded vessel ends in a beak. The wire and catheter are advanced until a patent vessel is reached and then a definitive firm wire placed. Balloon and stent placement follow.

If the occlusion ends in a cul de sac a similar approach can be used but is much more difficult. If unsuccessful a gun site approach can be used placing a snare in the patent vessel and after multiple projections perforating the cul de sac with a needle or end of a wire to capture the wire with the snare. The snare can be withdrawn, a catheter can then be advanced followed by a firm wire over which the balloon and stent can follow.

Accessing an occluded vessel has also be used using a laser. This may be more invasive than using a wire. The low pressure of the venous system is forgiving to a puncture but perhaps not as forgiving if the wall is disrupted or destroyed by a laser or radiofrequency.

It is imperative to remember the anatomy of the pericardium. Ballooning the SVC can result in rupture into the pericardium resulting in pericardial tamponade. This is an immediate emergency requiring catheter drainage before the blood coagulates and causes irreversible pericardial tamponade. Therefore ultrasound and drainage catheter access must be readily available.

As indicated above PTV is attempted first but often results in elastic recoil resulting in stent placement. The type of stent varies and is dependent on the operator. Again, to be safe, stent deployment should be performed with through and through control.

SVCS is a consequence of benign or malignant stenosis or occlusion of the SVC. Its clinical manifestations are related to the etiology, location of the pathology and the rate of onset. Considering the aging population and the increase in both malignant disease and the use of endovascular wires and catheters the incidence of SVCS is increasing. Endovascular procedures have proven to be technically successful, have little complications and yield significant clinical success.

304.3

Techniques for recanalisation

M. Guimaraes, A. Uflacker, D.T. Johnson, R. Yamada
Vascular Interventional Radiology, Medical University of South Carolina, Charleston, SC, US

Learning Objectives

1. To learn why pre-op high-quality imaging is essential
2. To learn about fusion techniques and how to employ them
3. To learn why and how to use the radiofrequency wire

Purpose: Central venous occlusion (CVO) is not an infrequent problem in patients who had long-term venous catheters. The recanalization of CVO's using conventional techniques may fail in up to 24% of cases. Among the

sharp recanalization techniques, we have used the radiofrequency wire puncture technique in symptomatic patients associated with image fusion, that may include integrated registration. M&M: Patients presented with swollen arm and/or face secondary to benign CVO's related to tunneled catheters. 3-phase chest CTA is obtained with MPR reconstructions and the plan is discussed with the patient at the VIR clinic. CTA is key to assess the CVO anatomy and the surrounding structures. All SVC recanalization procedures have a pericardium window prepped and draped upfront to immediately treat potential cardiac tamponade. All CVO cases using RF wire technique are performed under GA. Venous accesses are obtained ipsilateral to the CVO side and in the groin. Simultaneous central venograms from both accesses is performed to define the CVO. The CTA and the central venogram are fused just before starting the case. It increases safety and accuracy for the RF wire (advanced over a 5-Fr semi-curved catheter into one venous stump) to reach the 10 mm snare (used as a target) in the opposite venous stump. The alignment between the RF wire tip direction and the snare position is always checked in PA, RAO, LAO despite having image fusion. The RF wire should be advanced in a few mm each time and the alignment checked in 3 views. Once the RF reaches the target, it is snared out and body floss technique is used. Pre-stent 4mm balloon PTA is followed typically by 10mm stent placement. In all CVOs located in the SVC segment, a covered stent is always used to prevent cardiac tamponade. For precise deployment, balloon expandable stents are preferred in the SCV and brachiocephalic vein. Self-expandable stents are typically used in the subclavian veins. We avoid stenting the subclavian-brachiocephalic transition. All patients are kept under double antiaggregation for 6 months. In case there is thrombophilia and early stent thrombosis, we anticoagulate the patient *ad infinitum*. Clinical and venogram F/U's are scheduled at 3, 6, 9 and 12 months, then every 6 months afterwards. Results: The majority of the complex CVO cases can be successfully treated with RF wire and image fusion techniques. Technical details to reduce complications will be presented. Conclusion: RF wire technique associated with image fusion is a good alternative in benign CVO's when conventional techniques have failed. It is an alternative in the management of symptomatic patients. Thorough technique must be used in the order to minimize potential complications.

References

1. Marcelo Guimaraes, Claudio Schonholz, Christopher Hannegan, Michael Bret Anderson, June Shi, Bayne Selby Jr. Radiofrequency Wire for the Recanalization of Central Vein Occlusions that Have Failed Conventional Endovascular Techniques. *Journal of Vascular and Interventional Radiology*, 2012, Vol. 23, Issue 8, p1016-1021.
2. G. Sivananthan, D. MacArthur, S. Hakham, R. Marcus, K.P. Daly, N. Halin. Radiofrequency wire recanalization of chronic central venous occlusions is effective but not without the potential for complications. *Journal of Vascular and Interventional Radiology*, 2014, Vol. 25, Issue 3, S16
3. Gajan Sivananthan, David W. Allen, Neil J. Halin. Extraluminal Left Brachiocephalic Vein Superior Vena Cava (SVC) Confluence Reconstruction Using a Radiofrequency Wire to Treat SVC Syndrome. *Journal of Vascular and Interventional Radiology*, 2014, Vol. 25, Issue 11, p1837-1839.
4. Eric J. Keller, Suraj A. Gupta, Sergey Bondarev, Kent T. Sato, Robert L. Vogelzang, Scott A. Resnick. Single-Center Retrospective Review of Radiofrequency Wire Recanalization of Refractory Central Venous Occlusions. *Journal of Vascular and Interventional Radiology*, 2018 Vol. 29, Issue 11, p1571-1577
5. Emil I. Cohen, Christopher Beck, Jesse Garcia, Ryan Muller, Hyun J. Bang, Keith M. Horton, Farris Hakki. Success Rate and Complications of Sharp Recanalization for Treatment of Central Venous Occlusions. *CardioVascular and Interventional Radiology*, 2018, Volume 41, Issue 1, pp 73-79.
6. Joseph L. McDevitt, Ravi N. Srinivasa, Joseph J. Gemmete, Anthony N. Hage, Rajiv N. Srinivasa, Jacob J. Bundy, Jeffrey Forris Beecham Chick. Approach, Technical Success, Complications, and Stent Patency of Sharp Recanalization for the Treatment of Chronic Venous Occlusive Disease: Experience in 123 Patients. *CardioVascular and Interventional Radiology*, 2019, Volume 42, Issue 2, pp 205-212.

304.4

Other therapeutic options

M.E. Barbaty¹, A. Gombert¹, M.K. Razavi², H. Jalaie¹

¹European Vascular Center Aachen-Maastricht, Department of Vascular Surgery, RWTH University Hospital Aachen, Aachen, DE, ²Interventional Radiology, St. Joseph Vascular Institute, Orange, CA, US

Learning Objectives

1. To discuss if all patients need a therapeutic manoeuvre
2. To learn the role of surgery
3. To learn the role of extra-anatomic bypass

Introduction

Superior vena cava (SVC) syndrome involves a spectrum of central venous disease which leads to obstruction of blood flow through the SVC and varies considerably in etiology, manifestations, implications and approach to therapy. Malignant obstruction, external compression or indwelling venous devices (e.g. central venous catheter, pacemaker) are some of the main reasons for stagnation of flow and thrombosis (1-4).

Compression of the neurovascular structures that traverse the thoracic outlet can trigger correspondingly diverse neurogenic (in 90% of those affected), arterial (1 - 2% of the patients) or venous pathologies (3%), which are collectively referred to as the upper thorax aperture neurovascular compression syndrome (5). The therapeutic procedure depends on the compressed structure, the cause, the extent of the symptoms and the general condition of the patient. This review will focus on the pathophysiology, etiology, clinical presentation, and diagnostic evaluation of SVC syndrome as well as different treatment options in patients with SVC syndrome.

Pathophysiology and anatomy

The pathogenesis of the SVC syndrome implies chronic mechanical irritation associated with vessel wall fibrosis, thrombus formation, and stenosis of the SVC (6). SVC compression induces venous hypertension responsible for clinical manifestations of SVC syndrome. In patients with obstruction of the SVC, the cervical venous pressure is usually increased to 20 to 40 mm Hg (normal range, 2 to 8 mm Hg) (7-9). The severity of the symptoms depends on the location and the degree of stenosis of the central thoracic veins and the speed of the onset of the narrowing. While many cases are caused by malignant lesions of the mediastinum, some are related to benign causes (10). The most common tumor entity is the bronchial carcinoma consisting of small cell lung carcinoma (80%) and squamous cell carcinoma (20%). Lymphomas cause SVC syndrome in 10-20%, with Non-Hodgkin's lymphoma leading the way (11, 12). The spectrum of non-malignant causes is manifold. In addition to inflammatory processes (mediastinitis, pericarditis) and benign tumors, iatrogenic damage due to central venous devices like pacemaker electrodes, central venous catheters and peritoneo-venous shunts are becoming more frequent (2, 13).

Preprocedural evaluation

Initial evaluation of the patient begins with a focused history and physical examination, and review of any available imaging. Cross-sectional imaging with either contrast-enhanced computed tomography (CT) or magnetic resonance (MR) is extremely helpful to delineate the anatomy of the lesion and assist in procedural planning. Both CT and MR can be used to diagnose any underlying pathology. Thin section, contrast-enhanced CT is especially useful to determine the amount of venous stenosis/occlusion, identify prominent collateral vessels, and identify anatomic landmarks to avoid during recanalization. MR may be useful for patients who cannot tolerate the contrast medium. Venography is

generally warranted only when an intervention (recanalization, placement of a stent or surgery) is planned.

Treatment

Management is guided by the severity of the symptoms and the underlying conditions as well as by the anticipated response to treatment. For example, in patients with obstruction of the superior vena cava resulting from intravascular thrombus associated with an indwelling catheter, removal of the catheter in conjunction with anticoagulation therapy should be considered. Whereas in patients with venous thoracic outlet syndrome (VTOS), the surgical decompression with first rib resection followed with PTA and stent implantation maybe a better choice (14). Endovascular treatment with stenting of the involved vein, however, has emerged as a treatment armamentarium for both malignant and nonmalignant SVC syndrome. It establishes luminal patency immediately and provides rapid symptomatic relief, which results in a high clinical success rate (11, 15).

When comparing different treatment options for SVC syndrome, Rizvi et al. showed that patient treated with open surgery were exposed to more complications and had longer hospital stays after surgery than those treated by endovascular reconstruction. They showed a low periprocedural morbidity rate of 4 % in patients treated with endovascular repair as opposed to 19 % in the open surgical repair group (16).

Intervention

Percutaneous dilatation with or without stent placement to treat the obstruction and restore the flow of the central thoracic veins is a minimally invasive option. For this purpose, access for percutaneous stenting is typically obtained via the femoral vein, but the internal jugular vein or brachial venous route could also be used if the guidewire could not cross the obstruction through the femoral route (2, 17, 18). The severity and location of the venous stenosis will be confirmed by venography. Initial balloon dilatation is an important maneuver as it reestablishes the luminal patency, which facilitates subsequent stent deployment. The stents are usually introduced through the common femoral veins. Final angiography or using intravascular ultrasound (IVUS) is necessary to check the result of the intervention. Using IVUS instead of angiography will reduce the amount of radiation and contrast needed for the intervention. Additionally, IVUS can be used to determine the optimal proximal and distal landing zones of the stent. Most institutions recommend anticoagulation following stent placement but the type and duration of anticoagulation therapy varies depending on the institution. During follow-up evaluations, patients will be assessed for resolution of their clinical symptoms. Chest x-ray will be usually performed in two planes to verify the location of the stent and the stent geometry.

A review comparing the two operative treatments (open surgical versus interventional) by SVC syndrome reported a technical success rate of 95.6% for endovascular group. Thirty day mortality was 0%. Regression of symptoms was reported in 97.3%. The results of this review suggest that endovascular repair is less invasive but equally effective in the mid-term (19).

Surgery

Surgical bypass grafting is infrequently used to treat the SVC syndrome. Several techniques for bypass of the SVC to relieve severe symptoms have been described; these techniques have used spiraled saphenous vein grafts (20, 21), femoral vein grafts (22), and polytetrafluoroethylene grafts (23) as conduits. There are few reports of extra-anatomic subcutaneous bypass between the jugular vein and the femoral vein (24). The more common approach is sternotomy or thoracotomy with extensive resection and reconstruction of the SVC. Surgery involving the replacement or repair of a patent SVC is challenging as it requires the interruption of the upper body venous return which can lead to life-threatening conditions if not appropriately managed (25). Fifteen per cent of re-operation, most commonly for graft thrombosis or stenosis has been reported in a review of open surgical treatment of SVC syndrome (19). Case series indicate an operative mortality of approximately 5% and patency rates of 80 to 90% (26, 27). Although surgical reconstruction has been reported for palliative treatment, it is not considered the main treatment of choice owing in part to the high rate of operative morbidity and mortality (28). It remains as the

last choice for patients who are not suitable for endovascular repair or in whom the endovascular repair fails. However, surgical reconstruction in this review was associated with a significant incidence of complications before discharge.

First rib resection (FRR) by VTOS

VTOS accounts for approximately 5% of all cases of thoracic outlet syndrome and has an estimated incidence of 3000 to 6000 cases per year in the United States (29). Patients often present with axillosubclavian vein thrombosis from compression of the subclavian vein within the costoclavicular space. Surgical treatment of acute axillosubclavian vein thrombosis from VTOS traditionally involves catheter-directed thrombolysis, surgical FRR and scalenectomy in combination with balloon angioplasty (30, 31). FRR can be accomplished through several different surgical approaches (transaxillary, supraclavicular, or paraclavicular approaches) based on surgeon's preference (32). The timing of FRR for VTOS in patients with DVT who undergo preoperative thrombolysis remains controversial. Machleder et al. initially advocated for delaying surgery as long as three months after thrombolysis to minimize complication risk caused by acute inflammation from DVT and to avoid the thrombogenicity of a recently thrombophlebitic vein (33). However, Ryan et al. showed in a study that symptom control and return to function can be effectively achieved with FRR regardless of preoperative thrombolysis or the timing of surgery after thrombolysis (34).

In patients with chronic SVC syndrome, an extensive recoil of subclavian vein in costoclavicular space during recanalization should be considered as VTOS. In these cases, PTA alone or in combination with stent will not remain patent. We recommend PTA with stent implantation shortly after decompression by performing FRR.

Conclusion

SVC syndrome is now more common as the use of indwelling catheters for dialysis and cardiac therapy expands. Endovascular is the first line of treatment for SVC syndrome caused by intravenous devices, while surgery is most often performed for mediastinal fibrosis. In highly selected patients, FRR is necessary to ensure the patency and relief of symptoms.

References

1. Friedman T, Quencer KB, Kishore SA, Winokur RS, Madoff DC. Malignant Venous Obstruction: Superior Vena Cava Syndrome and Beyond. *Seminars in interventional radiology*. 2017;34(4):398-408.
2. Garcia Monaco R, Bertoni H, Pallota G, Lastiri R, Varela M, Beveraggi EM, et al. Use of self-expanding vascular endoprostheses in superior vena cava syndrome. *European journal of cardio-thoracic surgery : official journal of the European Association for Cardio-thoracic Surgery*. 2003;24(2):208-11.
3. Kalra M, Sen I, Gloviczki P. Endovenous and Operative Treatment of Superior Vena Cava Syndrome. *The Surgical clinics of North America*. 2018;98(2):321-35.
4. Kee ST, Kinoshita L, Razavi MK, Nyman UR, Semba CP, Dake MD. Superior vena cava syndrome: treatment with catheter-directed thrombolysis and endovascular stent placement. *Radiology*. 1998;206(1):187-93.
5. Landry GJ, Moneta GL, Taylor LM, Jr., Edwards JM, Porter JM. Long-term functional outcome of neurogenic thoracic outlet syndrome in surgically and conservatively treated patients. *Journal of vascular surgery*. 2001;33(2):312-7; discussion 7-9.
6. Aryana A, Sobota KD, Esterbrooks DJ, Gelbman AI. Superior vena cava syndrome induced by endocardial defibrillator and pacemaker leads. *The American journal of cardiology*. 2007;99(12):1765-7.
7. Gonzalez-Fajardo JA, Garcia-Yuste M, Florez S, Ramos G, Alvarez T, Coca JM. Hemodynamic and cerebral repercussions arising from surgical interruption of the superior vena cava. *Experimental model. The Journal of thoracic and cardiovascular surgery*. 1994;107(4):1044-9.
8. Kishi K, Sonomura T, Mitsuzane K, Nishida N, Yang RJ, Sato M, et al. Self-expandable metallic stent therapy for superior vena cava syndrome: clinical observations. *Radiology*. 1993;189(2):531-5.

9. Yamagami T, Nakamura T, Kato T, Iida S, Nishimura T. Hemodynamic changes after self-expandable metallic stent therapy for vena cava syndrome. *AJR American journal of roentgenology*. 2002;178(3):635-9.
10. Akoglu H, Yilmaz R, Peynircioglu B, Arici M, Kirkpantur A, Cil B, et al. A rare complication of hemodialysis catheters: superior vena cava syndrome. *Hemodialysis international International Symposium on Home Hemodialysis*. 2007;11(4):385-91.
11. Uberoi R. Quality assurance guidelines for superior vena cava stenting in malignant disease. *Cardiovascular and interventional radiology*. 2006;29(3):319-22.
12. Wilson LD, Detterbeck FC, Yahalom J. Clinical practice. Superior vena cava syndrome with malignant causes. *The New England journal of medicine*. 2007;356(18):1862-9.
13. Warner P, Uberoi R. Superior vena cava stenting in the 21st century. *Postgraduate medical journal*. 2013;89(1050):224-30.
14. Katana VG, Weiss JS. Venous Thoracic Outlet Syndrome: The Role of Early Rib Resection. *Military medicine*. 2016;181(11):e1706-e10.
15. Minguez C, Roca B, Gonzalez-Mino C, Simon E. Superior vena cava syndrome during the treatment of pulmonary tuberculosis in an HIV-1 infected patient. *The Journal of infection*. 2000;40(2):187-9.
16. Rizvi AZ, Kalra M, Bjarnason H, Bower TC, Schleck C, Gloviczki P. Benign superior vena cava syndrome: stenting is now the first line of treatment. *Journal of vascular surgery*. 2008;47(2):372-80.
17. de Gregorio Ariza MA, Gamboa P, Gimeno MJ, Alfonso E, Mainar A, Medrano J, et al. Percutaneous treatment of superior vena cava syndrome using metallic stents. *European radiology*. 2003;13(4):853-62.
18. Kim YI, Kim KS, Ko YC, Park CM, Lim SC, Kim YC, et al. Endovascular stenting as a first choice for the palliation of superior vena cava syndrome. *Journal of Korean medical science*. 2004;19(4):519-22.
19. Sfyroeras GS, Antonopoulos CN, Mantas G, Moulakakis KG, Kakisis JD, Brountzos E, et al. A Review of Open and Endovascular Treatment of Superior Vena Cava Syndrome of Benign Aetiology. *European journal of vascular and endovascular surgery : the official journal of the European Society for Vascular Surgery*. 2017;53(2):238-54.
20. Doty DB. Bypass of superior vena cava: Six years' experience with spiral vein graft for obstruction of superior vena cava due to benign and malignant disease. *The Journal of thoracic and cardiovascular surgery*. 1982;83(3):326-38.
21. Doty DB, Baker WH. Bypass of superior vena cava with spiral vein graft. *The Annals of thoracic surgery*. 1976;22(5):490-3.
22. Marshall WG, Jr., Kouchoukos NT. Management of recurrent superior vena caval syndrome with an externally supported femoral vein bypass graft. *The Annals of thoracic surgery*. 1988;46(2):239-41.
23. Avasthi RB, Moghissi K. Malignant obstruction of the superior vena cava and its palliation: report of four cases. *The Journal of thoracic and cardiovascular surgery*. 1977;74(2):244-8.
24. Panneton JM, Andrews JC, Hofer JM. Superior vena cava syndrome: relief with a modified saphenous bypass graft. *Journal of vascular surgery*. 2001;34(2):360-3.
25. Perentes JY, Erling CC, Ris HB, Corpataux JM, Magnusson L. A simple bypass technique for superior vena cava reconstruction. *Interactive cardiovascular and thoracic surgery*. 2011;12(1):15-9.
26. Chen KN, Xu SF, Gu ZD, Zhang WM, Pan H, Su WZ, et al. Surgical treatment of complex malignant anterior mediastinal tumors invading the superior vena cava. *World journal of surgery*. 2006;30(2):162-70.
27. Inoue M, Minami M, Shiono H, Miyoshi S, Takeda S, Ohta M, et al. Efficient clinical application of percutaneous cardiopulmonary support for perioperative management of a huge anterior mediastinal tumor. *The Journal of thoracic and cardiovascular surgery*. 2006;131(3):755-6.
28. Porte H, Metois D, Finzi L, Lebuffe G, Guidat A, Conti M, et al. Superior vena cava syndrome of malignant origin. Which surgical procedure for which diagnosis? *European journal of cardiothoracic surgery : official journal of the European Association for Cardio-thoracic Surgery*. 2000;17(4):384-8.
29. Illig KA, Doyle AJ. A comprehensive review of Paget-Schroetter syndrome. *Journal of vascular surgery*. 2010;51(6):1538-47.
30. Brooke BS, Freischlag JA. Contemporary management of thoracic outlet syndrome. *Current opinion in cardiology*. 2010;25(6):535-40.
31. Molina JE, Hunter DW, Dietz CA. Paget-Schroetter syndrome treated with thrombolytics and immediate surgery. *Journal of vascular surgery*. 2007;45(2):328-34.
32. Siracuse JJ, Johnston PC, Jones DW, Gill HL, Connolly PH, Meltzer AJ, et al. Infraclavicular first rib resection for the treatment of acute venous thoracic outlet syndrome. *Journal of vascular surgery Venous and lymphatic disorders*. 2015;3(4):397-400.
33. Machleder HI. Evaluation of a new treatment strategy for Paget-Schroetter syndrome: spontaneous thrombosis of the axillary-subclavian vein. *Journal of vascular surgery*. 1993;17(2):305-15; discussion 16-7.
34. Ryan CP, Mouawad NJ, Vaccaro PS, Go MR. A Patient-Centered Approach to Guide Follow-Up and Adjunctive Testing and Treatment after First Rib Resection for Venous Thoracic Outlet Syndrome Is Safe and Effective. *Diagnostics (Basel, Switzerland)*. 2018;8(1).

Controversy Session Fibroids and adenomyosis

305.1

UFE is a fertility-preserving procedure: pro

J.B. Spies

Department of Radiology, MedStar Georgetown University Hospital, Washington, Dc, DC, US

Learning Objectives

1. To learn about the current evidence supporting UFE in fertility
 2. To get familiar with what is known and unknown
 3. To get familiar with the controversy using a pro UFE example
- As most interventionalists who perform uterine fibroid embolization (UFE) know, gynecologists often counsel patients that they cannot or should not become pregnant after UFE and direct them to other therapies. The most common alternative recommendation for women wishing to preserve fertility is myomectomy. This approach has been a great disservice to patients, as it ignores the substantial body of evidence that demonstrates acceptable fertility outcomes after UFE, and also fails to account for patient-specific characteristics and preferences that should influence treatment recommendations.
- There is relatively little data from randomized trials that shines light on the question of whether reproductive outcomes are superior with myomectomy or uterine embolization. The one randomized trial comparing the two was published in 2008 and reported the two year reproductive outcomes (1). In that study, one hundred twenty-one patients were randomized to UFE or myomectomy (either laparoscopic or open). The study demonstrated no difference in mean follicle stimulating hormone levels at six months, suggesting both procedures have similar and limited impact on ovarian reserve. No patients became amenorrheic after either intervention.
- The study protocol called for myomectomy at 6 months after UFE if there were any fibroids remaining (viable or not) greater than 5 cm. Thirty-two percent of UFE patients underwent myomectomy after UFE based on this protocol. This led to a significant confounding of the study, as the UFE arm had substantial "contamination" with the comparator procedure. In addition, the protocol recommended waiting 6 months after that intervention to attempt pregnancy. Thus, the window for possible

pregnancy within two years after treatment for this subgroup of UFE patients was much shorter than the myomectomy group. With these limitations in mind, there were better reproductive outcomes in the myomectomy group, with a relative risk of failing to get pregnant after UFE of 2.2, failure to deliver 1.54 and likelihood to spontaneously abort of 2.79. It was on the basis of this study that the most recent Cochrane review of UFE suggested that there was very low quality evidence that there were better reproductive outcomes after myomectomy and should be regarded with extreme caution (2). A recent systematic review from 2018 confirmed the weak evidence that is available and that better studies are needed before conclusions can be drawn (3).

With regard to pregnancy outcomes, the evidence is similarly uncertain. One commonly referenced study by Homer and Saridogan (4) compared all the reported pregnancies after UFE in early publications to a cohort of patients with fibroids from several published papers. Unfortunately, although attempts were made to control for fibroid location and age, they did not control for fibroid burden or prior interventions. Many of the earliest reported pregnancies were in older patients with extensive fibroids and often with prior myomectomies. Therefore, it is difficult to know whether the authors' conclusions that the rate of miscarriage is higher and that there is an increased risk of Cesarean section and postpartum hemorrhage are valid.

What cannot be denied is that women do regularly become pregnant after uterine embolization and successfully deliver healthy babies. In one large series by Pisco et al (5), the spontaneous pregnancy rate with live birth after the current standard of limited embolization was 37% and successful pregnancies have been reported in many other studies. Clearly, larger and better designed studies are needed to improve the data upon which we base our patient counselling. However, it is clear that UFE does not preclude successful pregnancy and while it is possible myomectomy has better reproductive outcomes, it may not be the best choice for every or even most patients. Each recommendation of therapy should be made holistically, considering prior therapies, fibroid burden, strength of interest in pregnancy, time interval to desired pregnancy, surgical risk and, perhaps most important, patient preferences. Most patients who are provided a summary and uncertainty of our knowledge, can come to their own decision on therapy based on her priorities and life choices.

References

1. Mara M, Maskova J, Fucikova Z, Kuzel D, Belsan T, Sosna O. Midterm clinical and first reproductive results of a randomized controlled trial comparing uterine fibroid embolization and myomectomy. *Cardiovasc Intervent Radiol*. 2008;31(1):73-85.
2. Gupta JK, Sinha A, Lumsden MA, Hickey M. Uterine artery embolization for symptomatic uterine fibroids. *Cochrane Database Syst Rev*. 2012;5:CD005073.
3. Karlsen K, Hrobjartsson A, Korsholm M, Mogensen O, Humaidan P, Ravn P. Fertility after uterine artery embolization of fibroids: a systematic review. *Arch Gynecol Obstet*. 2018;297(1):13-25.
4. Homer H, Saridogan E. Uterine artery embolization for fibroids is associated with an increased risk of miscarriage. *Fertil Steril*. 2010;94:324-30.
5. Pisco JM, Duarte M, Bilhim T, Branco J, Cirurgiao F, Forjaz M, et al. Spontaneous Pregnancy with a Live Birth after Conventional and Partial Uterine Fibroid Embolization. *Radiology*. 2017;285(1):302-10.

305.2

UFE is a fertility-preserving procedure: con

A. Torre¹, A. Fauconnier², J. Thornton¹, J.-P. Pelage³

¹Division of Child Health, Obstetrics & Gynaecology, University of Nottingham, Nottingham, UK, ²Gynaecology, Université de Versailles Saint Quentin en Yvelines, Poissy, FR, ³Department of Radiology, University Hospital and Medical Center, Caen, FR

Learning Objectives

1. To learn about the current evidence against UFE in fertility
2. To get familiar with what is known and unknown
3. To get familiar with the controversy using an example against UFE

There is currently no evidence base to support the recommendation to use uterine fibroid embolisation for women of childbearing age desiring pregnancy.

Fertility after uterine fibroid embolisation (UFE) has been in question since the beginning of the technique. Although numerous pregnancies have followed UFE (1), many complications have been reported including hysterectomy (2-4), amenorrhea (2, 4, 5), synechia (6-8), subsequent fibroid surgery (9), alteration of markers of ovarian reserve and menopause (10), all of detrimental to fertility. The sole randomized controlled trial comparing traditional embolization to myomectomy, in women wishing to conceive, favoured surgery (11) but has claimed to be biased. The initial technique used was considered too aggressive for reproductive organs, so that a "fertility sparing" UAE was proposed (12-14). However this has only been validated in an animal model and needs very skilled interventional radiologists who may not be available.

In summary current evidence does not support UAE use in women wishing to preserve their fertility. Learned societies recommend full discussion between the patient and a reproductive specialist before UAE (15), or even completely discourage practitioners to propose UAE in women of childbearing age wishing to conceive (16-18). In the context of more and more medico-legal medicine, women in whom UAE had been performed with a too liberal indication could complain and claim for compensation. Nevertheless, myomectomy is a major operation and may also impair the fertility of women desiring to conceive (adhesion formation, synechia; uterine scar) and alternatives should be considered. Our experience with the two open label trial of UFE among women with multiple uterine fibroid with no other infertility factors, the LUNE 1 (19) and LUNE 2 studies suggests that patients are likely to give birth in up to 50 % of cases with immediate desire for pregnancy. However in this situation patients with genuine infertility and absence of other associated infertility factors are rare. Recruitment will be difficult but is the only way to validate the potentially important innovation of "fertility sparing" UAE as an alternative to poly-myomectomy. It is time for a large (Europe, or worldwide) non-inferiority trial comparing "fertility sparing" UAE to surgery. We will present here the design of such a study.

References

1. Torre A, Paillusson B, Fain V, Labauge P, Pelage JP, Fauconnier A. Uterine artery embolization for severe symptomatic fibroids: effects on fertility and symptoms. *Hum Reprod*. 2014 Mar;29(3):490-501.
2. Pron G, Bennett J, Common A, Wall J, Asch M, Sniderman K. The Ontario Uterine Fibroid Embolization Trial. Part 2. Uterine fibroid reduction and symptom relief after uterine artery embolization for fibroids. *Fertil Steril*. 2003 Jan;79(1):120-7.
3. Spies JB, Spector A, Roth AR, Baker CM, Mauro L, Murphy-Skrynarz K. Complications after uterine artery embolization for leiomyomas. *Obstet Gynecol*. 2002 Nov;100(5 Pt 1):873-80.
4. Walker WJ, Pelage JP. Uterine artery embolisation for symptomatic fibroids: clinical results in 400 women with imaging follow up. *BJOG*. 2002 Nov;109(11):1262-72.
5. Spies JB, Ascher SA, Roth AR, Kim J, Levy EB, Gomez-Jorge J. Uterine artery embolization for leiomyomata. *Obstet Gynecol*. 2001 Jul;98(1):29-34.

6. Honda I, Sato T, Adachi H, Kobayashi Y, Shimada K, Watanabe H, et al. [Uterine artery embolization for leiomyoma: complications and effects on fertility]. *Nihon Igaku Hoshasen Gakkai Zasshi*. 2003 Jul;63(6):294-302.
7. Mara M, Horak P, Kubinova K, Dunder P, Belsan T, Kuzel D. Hysteroscopy after uterine fibroid embolization: evaluation of intrauterine findings in 127 patients. *J Obstet Gynaecol Res*. 2012 May;38(5):823-31.
8. Mara M, Kubinova K, Maskova J, Horak P, Belsan T, Kuzel D. Uterine artery embolization versus laparoscopic uterine artery occlusion: the outcomes of a prospective, nonrandomized clinical trial. *Cardiovasc Intervent Radiol*. 2012 Oct;35(5):1041-52.
9. Gupta JK, Sinha A, Lumsden MA, Hickey M. Uterine artery embolization for symptomatic uterine fibroids. *Cochrane Database Syst Rev*. 2012;5:CD005073.
10. Goodwin SC, McLucas B, Lee M, Chen G, Perrella R, Vedantham S, et al. Uterine artery embolization for the treatment of uterine leiomyomata midterm results. *J Vasc Interv Radiol*. 1999 Oct;10(9):1159-65.
11. Mara M, Maskova J, Fucikova Z, Kuzel D, Belsan T, Sosna O. Midterm clinical and first reproductive results of a randomized controlled trial comparing uterine fibroid embolization and myomectomy. *Cardiovasc Intervent Radiol*. 2008 Jan-Feb;31(1):73-85.
12. Pelage JP, Fauconnier A. Uterine fibroid embolization: where are we and where should we go? *Ultrasound Obstet Gynecol*. 2005 Jun;25(6):527-34.
13. Pelage JP, Le Dref O, Beregi JP, Nonent M, Robert Y, Cosson M, et al. Limited uterine artery embolization with tris-acryl gelatin microspheres for uterine fibroids. *J Vasc Interv Radiol*. 2003 Jan;14(1):15-20.
14. Pelage JP, Laurent A, Wassef M, Bonneau M, Germain D, Rymer R, et al. Uterine artery embolization in sheep: comparison of acute effects with polyvinyl alcohol particles and calibrated microspheres. *Radiology*. 2002 Aug;224(2):436-45.
15. Royal-college-of-Obstetricians-&-Gynaecologists. Clinical recommendations on the use of uterine artery embolisation (UAE) in the management of fibroids. 2013.
16. American-Society-for-Reproductive-Medicine. Myomas and reproductive function. *Fertil Steril*. 2008 Nov;90(5 Suppl):S125-30.
17. Collège-National-des-Gynécologues-et-Obstétriciens-Français. [Myoma management recommendations]. *J Gynecol Obstet Biol Reprod*. 2011;40(8):693-962.
18. Society-of-Obstetricians-and-Gynaecologists-of-Canada. The Management of Uterine Fibroids in Women With Otherwise Unexplained Infertility. *J Obstet Gynaecol Can*. 2015;37(3):277-28.
19. Torre A, Fauconnier A, Kahn V, Limot O, Bussières L, Pelage JP. Fertility after uterine artery embolization for symptomatic multiple fibroids with no other infertility factors. *Eur Radiol*. 2017 Dec 13.

305.3

Embolisation for adenomyosis: pro

P.N.M. Lohle

Radiology, Elisabeth Tweesteden Ziekenhuis, Tilburg, NL

Learning Objectives

1. To learn about the current evidence supporting UFE for adenomyosis
 2. To get familiar with what is known and unknown
 3. To get familiar with the controversy using a pro UFE example
- Hysterectomy is a good and definite treatment option for adenomyosis. Meantime, hysterectomy is also considered to be a major surgical procedure with a long recovery time and possible long term sequelae. Furthermore, some patients desire uterus preserving options, also when conception is no longer warranted. This justifies exploration of alternatives to hysterectomy such as uterine artery embolisation (UAE) in the treatment of symptomatic adenomyosis.

Clinical outcomes with seven year follow-up after UAE in the treatment of symptoms caused by adenomyosis have been published. The seven year post-intervention outcomes were health related quality of life (HRQOL), symptom severity scores (SSS), patient satisfaction, menopause and re-intervention rates which were assessed with standardized questionnaires. Twenty-nine patients with adenomyosis (15 in combination with fibroids) were included and treated with UAE between September 2006 and January 2010. Seven years after treatment 5 of 28 patients (18 %) had a secondary hysterectomy due to persisting complaints. The initially significantly improved HRQOL after UAE remained stable throughout the years up to seven years. The SSS showed a small statistical significant difference in favor of the adenomyosis in combination with fibroids group compared to the pure adenomyosis group. It was concluded that in 82% of patients UAE results in preservation of the uterus. 72% of patients were satisfied and two third responded well to UAE in terms of improvement of HRQOL and SSS.

In addition, the result of a systematic review and meta-analysis has been reported evaluating the effect of UAE on symptomatic adenomyosis. They evaluated patients from 30 prospective and retrospective cohorts. Four groups were evaluated: short-term (< 12 months) pure adenomyosis, short-term adenomyosis with fibroids (combined adenomyosis), long-term (> 12 months) pure adenomyosis, and long-term combined adenomyosis. Improvement of symptoms occurred in 83.1% (872/1049) of patients. Reported symptom reduction was 4.8% greater in the short-term combined group ($P = 0.169$) and 11.4% greater in the long-term combined group ($P = 0.003$) compared to pure adenomyosis groups. Hysterectomy rate in the short term group varied from 2.6% in the pure adenomyosis group and 1.4% in the combined group. The long term group showed a comparable hysterectomy rate of 7.2% in the pure adenomyosis group compared to 7.0% in the combined group. The weighted absolute uterine volume reduction at 3 months was reduced in all patients, however it was statically greater in the pure adenomyosis group. The effects of UAE on symptom improvement and uterine volume reduction in patients with adenomyosis are successful. More evidence for this treatment would be desirable, for example by conducting comparative (preferably randomized) trials. Therefore the QUESTA (*Quality of Life after Embolization vs Hysterectomy in Adenomyosis*) trial was designed and ongoing to evaluate the effectiveness of UAE in comparison to hysterectomy. UAE offers a long term valuable alternative to hysterectomy and is non-inferior in terms of HRQOL. We consider it substandard care if UAE is not being offered as part of a treatment option in patients with symptomatic adenomyosis. Standardized independent information is important in order to let the patient make a good choice.

305.4

Embolisation for adenomyosis: con

F. Sorbi

Department of Biomedical, Experimental and Clinical Sciences, Division of Obstetrics and Gynecology, University of Florence, Florence, IT

Learning Objectives

1. To learn about the current evidence against UFE for adenomyosis
2. To get familiar with what is known and unknown
3. To get familiar with the controversy using an example against UFE

No abstract available.

305.5**HIFU is better than embolisation: pro****M. Matzko***Abt. fuer Interventionelle und Diagnostische Radiologie, Helios Amper Klinikum Dachau, Dachau, DE***Learning Objectives**

1. To learn about the current evidence for HIFU for adenomyosis/ leiomyomata
 2. To get familiar with what is known and unknown
 3. To get familiar with the controversy using a pro HIFU example
- Uterine fibroids are the most common benign tumors of the uterus with an estimated incidence of 20-40% in women during their reproductive years. New data on uterine adenomyosis show a prevalence of 20 to 35% in women respectively that uterine Adenomyosis was previously under-reported and under-diagnosed resulting in even more need for sufficient treatment options in addition to fibroids treatments.
- The preservation of the uterus and keeping fertility is becoming more and more important for many women. Especially invasive or minimal invasive treatments like surgery and UFE with a substantial risk-profile regarding the preservation of fertility and organ integrity is leading the interest on non-invasive and low-risk profile treatment like MRgFUS. The lack of radiation exposure and the high-selective treatment of the target volume alone without damaging the endometrium are advantages of MRgFUS compared to other therapy options. In general the coagulation necrosis obtained with HIFU/MRgFUS is much less painful compared to ischemic necrosis obtained by UAE.
- Patient selection and preparation for MRgFUS is mandatory in advance to obtain good treatment outcomes. Especially highly-vascular tissue is draining the thermal energy out of the focal-point with limited success to heat up the tissue effectively for ablation. A free beam pathway has to be obtained to access the target tissue.

References

1. Modern Myoma Treatment in the Last 20 Years: A Review of the Literature. El-Balat A, DeWilde RL, Schmeil I, Tahmasbi-Rad M, Bogdanyova S, Fathi A, Becker S. Biomed Res Int. 2018 Jan 24;2018:4593875. doi: 10.1155/2018/4593875. eCollection 2018. Review.
2. Uterine fibroid therapy using interventional radiology mini-invasive treatments: current perspective. Masciocchi C, Arrigoni F, Ferrari F, Giordano AV, Iafrate S, Capretti I, Cannizzaro E, Reginelli A, Ierardi AM, Floridi C, Angileri AS, Brunese L, Barile A. Med Oncol. 2017 Apr;34(4):52. doi: 10.1007/s12032-017-0906-5. Epub 2017 Feb 24. Review.
3. MRI predictors of clinical success in MR-guided focused ultrasound (MRgFUS) treatments of uterine fibroids: results from a single centre. Mindjuk I, Trumm CG, Herzog P, Stahl R, Matzko M. Eur Radiol. 2015 May;25(5):1317-28. doi: 10.1007/s00330-014-3538-6. Epub 2014 Dec 16.
4. Minimally invasive treatment of adenomyosis. Dueholm M. Best Pract Res Clin Obstet Gynaecol. 2018 Aug;51:119-137. doi: 10.1016/j.bpobgyn.2018.01.016. Epub 2018 Feb 15. Review.
5. Magnetic resonance imaging features influencing high-intensity focused ultrasound ablation of adenomyosis with a nonperfused volume ratio of $\geq 90\%$ as a measure of clinical treatment success: retrospective multivariate analysis. Keserci B, Duc NM. Int J Hyperthermia. 2018;35(1):626-636. doi: 10.1080/02656736.2018.1516301. Epub 2018 Oct 11.

305.6**HIFU is better than embolisation: con****J.-P. Pelage***Department of Radiology, University Hospital and Medical Center, Caen, FR***Learning Objectives**

1. To learn about the current evidence against HIFU for adenomyosis/ leiomyomata
2. To get familiar with what is known and unknown
3. To get familiar with the controversy using an example against HIFU

No abstract available.

**CIRSE meets
CIRSE meets APSCVIR****306.1****Interventional radiology for the management of trauma patients****C.W. Kim***Radiology, Pusan National University Hospital, Busan, KR*

Trauma is one of the leading causes of mortality across all ages and the main cause of death in children. Trauma patients lose blood and become hypotensive, hypothermic, coagulopathic, hypoxic, and acidotic unless the bleeding stops. Most preventable deaths from trauma are caused by unrecognized and untreated hemorrhage. Early management is focused on resuscitation and the diagnosis and treatment of life threatening bleeding. The main interventional radiology (IR) method for trauma care is the embolization and success rates of greater than 90% have been reported when embolization was used to achieve hemostasis.

Traumatic vascular injuries, such as thoracic aortic injuries, also can be treated via endovascular methods. Improvements in delivery systems and imaging modalities have resulted in a significant interest in the application of endovascular techniques to vascular injuries throughout the body. IR management of trauma is potentially easier, cost-effective, safer, and may prevent altogether or make smaller, limited surgery. There has been an expanding role for IR in hemodynamically stable and unstable patients due to technological advances in interventional radiology. Currently, there is an emphasis on non-surgical management of hemodynamically stable patients who have suffered traumatic injuries. Deciding between surgeries, IR or a combined procedure early on is imperative and can potentially change outcomes for these patients. For efficient management of trauma patients, a standardized institutional workflow algorithm for effective and time sensitive triaging of them is recommended using a multidisciplinary team. Effective integration of IR with surgery and emergency medicine requires adequate staffing, organized multidisciplinary evaluation and direct communication with quick response times. Recently, there are 17 trauma centers in Korea and interest in serious trauma is rising. We are conducting a registry of trauma intervention administered by KIST (Korean Interventional Society for Trauma). I would like to introduce the Korean experience of IR management for trauma patients.

306.2

New developments in TACE: super-selective and balloon-assisted TACE

T. Hasebe, T. Matsumoto, S. Kamei, K. Tomita, S. Suda, K. Hashida, Y. Natsuyama, Y. Imai
Department of Radiology, Tokai University Hachioji Hospital/Tokai University School of Medicine, Hachioji, Tokyo, JP

Transarterial chemoembolization (TACE) for hepatocellular carcinoma (HCC) has been performed for more than 30 years. Now, TACE is the most frequently used treatment for unresectable HCC. Conventional TACE (C-TACE) performed using Lipiodol (LPD) emulsion mixed with anticancer drugs followed by porous gelatin sponge particles, has been in mainstream use in Japan. Dense LPD accumulation after C-TACE is one of the significant prognostic factors affecting local recurrence (1, 2). In Asian countries, particularly in Japan/Korea, a more selective treatment (super-selective or ultra-selective) has been pursued, with the theory that more of the targeted drug is delivered while preserving more liver function, which could lead to a survival benefit.

Recently, Irie *et al.* noted that balloon-occluded TACE (B-TACE) using a first generation microballoon catheter induced dense LPD accumulation in HCC nodules in most treatments in which balloon-occluded arterial stump pressure (BOASP) was 64 mmHg or less (3). B-TACE has rapidly become popular in Japan over the past few years since the emergence of reports that B-TACE has the potential to improve cancer nodule control locally, compared with C-TACE (4, 5), and second and third generation microballoon catheters have come to the fore. In B-TACE, a new platinum-based anticancer agent, miriplatin hydrate (MPT), which is easily suspended in Lipiodol, has been widely used as an anticancer drug (6, 7).

The B-TACE procedure is as follows: The microballoon was inflated to a diameter 5–10% larger than that of the occluded artery on DSA (3). LPD suspension infusion was continued under balloon occlusion until the HCC nodule was filled with LPD suspension or the portal venous branches were beginning to be filled with LPD suspension. Gelatin sponge 1mm-particles were injected to obstruct the tumor-feeding branch under microballoon inflation (6). As treatment outcome of B-TACE, Matsumoto and Hasebe *et al.* reported that B-TACE at lobar hepatic artery should be avoided for performing effective B-TACE and B-TACE at A1, 4, 8 and anterior segmental hepatic arteries may become less effective than at the other segmental or subsegmental hepatic arteries (8). The results may explain that blood inflow through the communicating artery in the hilum, which is an anastomosis between the right and left hepatic arteries and originates mainly from A4 on the left side and from the anterior segmental hepatic artery or the right hepatic artery on the right side (9), blocks decrease of the BOASP. Further prospective studies are needed to remedy this.

References

1. Mondazzi L, *et al.*, *Hepatology* 1994;19:1115-23.
2. Takayasu K, *et al.*, *AJR Am J Roentgenol* 2001;176:681-8.
3. Irie T, *et al.*, *Cardiovasc Intervent Radiol* 2013;36:706-13.
4. Arai H, *et al.*, *Hepatol Res* 2015;45:663-6.
5. Ogawa M, *et al.*, *Hepatol Res* 2016;46:E60-9.
6. Matsumoto T, Hasebe T, *et al.*, *Minim Invasive Ther Allied Technol* 2015;24:94-100.
7. Matsumoto T, Hasebe T, *et al.*, *Anticancer Res* 2017;37:3183-7.
8. Matsumoto T, Hasebe T, *et al.*, *Minim Invasive Ther Allied Technol* 2016;25:22-8.
9. Tohma T, *et al.*, *Radiology* 2005;237:361-5.

306.3

Experience in developing an IR practice in Myanmar, a developing country in Asia

K.Z. Ya
Radiology, DSMA/ No.2 MH 500 beds. Myanmar Radiology Society, Yangon, MM

Interventional Radiology (IR) specialty practice was started in Myanmar around late 1980s. Because of limitation of '3Ms' (Man, Money and materials), progress, development and effectiveness of IR in daily clinical practice and patient care was not sufficient up to early 2000s period. In early 2000s, collaboration, cooperation and academic support as hands on training with SGH- VIR center got the initiatives for chances of international exposure and networking with varieties of well established IR societies all over the world such as CIRSE and SIR via the APSCVIR. Because of invaluable helps and supports of various IR societies and enthusiasm of IR trained local practitioners, remarkable developments in IR specialty in recent decade can be seen. Academic activities, international collaborations, case loads, needs for further development in IR, future plan and ambition of VIR section of MRS will be discussed.

Clinical Evaluation Course Management of patients with benign prostate hyperplasia

605.1

Underlying pathology and work-up

M.J. Speakman
Urology, Taunton and Somerset NHS Trust, Trull, Taunton, UK

Lower urinary tract symptoms (LUTS) are common and can be caused by a multitude of conditions and therefore symptoms need to be evaluated carefully. LUTS can be divided into storage, voiding and post-micturition symptoms, they cause bother and can significantly impair QoL. The underlying pathology is likely to be benign prostatic hyperplasia that is causing LUTS, but it is usually thought that it is the relief of benign prostatic obstruction (BPO) that is the principal goal of surgical intervention. It is a common perception that surgical rather than medical treatment becomes appropriate in patients with bothersome LUTS due to benign prostatic obstruction (BPO), who are unwilling to try medical therapies, or in cases where medical therapies are ineffective or not well tolerated, and especially in patients with complicated LUTS, such as recurrent retention or bladder stones. However, with the advent of more minimally invasive treatments the threshold for surgical intervention has become much lower. Patients need a thorough assessment of their symptoms, which is usually achieved with the help of an International Prostate Symptom Score (IPSS) and a frequency volume chart. Preservation of erectile and ejaculatory function is often one of the reasons why patients select minimally invasive treatments (MITs) and therefore the use of an erectile and ejaculatory score can also be valuable (e.g. IIEF and MSHQ-EjD). Renal function blood tests and a full blood count are routinely measured, and a PSA test is usually included, partly as a 'screening' test for prostate cancer risk and also as a useful additional marker of prostate volume and risk of progression of LUTS/BPO. Flow rate and post-void residual volumes should be measured before surgical intervention and formal pressure flow urodynamic studies should be considered in borderline cases. It is usually considered that patients considered for surgical intervention will have at least moderate LUTS with an IPSS >8/35 (but often considerably higher) and a flow rate of less than 12-15mL/sec.

Traditionally prostate volume assessment was not carried out before surgery however, with the advent of newer modalities of treatment this has become more widely adopted, usually by trans-rectal ultrasound although this is usually achieved at least as well my pre-treatment MRI

scanning in patients being considered for PAE. Pre-treatment imaging will be discussed in the next presentation.

Patient choice for surgical intervention is important, and it is important to bear in mind, that patients' and clinicians' expectations of outcomes from treatment may differ. For instance, patients may prefer treatment options that are less effective if they result in a smaller risk of complications or a faster return to normal activities, rather than a dramatic improvement in flow rate. There is little doubt that there is a desire from patients for MITs. Once MITs become more widely available, special care is needed when the relatively strict entry criteria for RCTs are relaxed in general clinical practice and a broader group of patients are treated with the newer treatments like PAE.

References

1. Gravas S, Cornu JN, Drake MJ, et al. Guidelines on the management of non-neurogenic male lower urinary tract symptoms (LUTS), incl. benign prostatic obstruction (BPO) Presented at the EAU Annual Congress Copenhagen 2018. Arnhem, The Netherlands: EAU Guide-lines Office; 2018.978-94-92671-01-1 In: <http://uroweb.org/guideline/treatment-of-non-neurogenic-male-luts/>
2. Hashim H & Abrams P. Transurethral resection of the prostate for benign prostatic obstruction: will it remain the gold standard. *Eur Urol* 2015; 67: 1097-1098

605.2

Imaging

T. Bilhim

Interventional Radiology, CHULC, Saint Louis Hospital, Lisbon, PT

Bladder ultrasound (US) may be useful to exclude bladder cancer, stone, or diverticulum and to evaluate the bladder wall thickness (that increases with long-standing bladder outlet obstruction - BOO due to hypertrophy). Bladder US is considered first-line approach as a screening tool in men with lower urinary tract symptoms to measure the post-void residual volume (PVR) and thus exclude severe BOO.

Renal US may be useful to exclude renal cancer or obstruction due to BPH. Transrectal US (TRUS) of the prostate is the most reliable and less expensive technique to determine the prostate volume (transverse diameter × anteroposterior diameter × length × 0.52) and should be performed before surgery or minimally-invasive therapies (MIST) to help choose the best treatment option. The anteroposterior diameter (AP) is most accurately measured in the sagittal plane to avoid the "salami" distortion of measurements in the axial plane. TRUS also allows exploring the zonal anatomy and BPH patterns and identifying and measuring the protrusion index of the median lobe into the bladder base that may be associated with poorer outcomes after MIST procedures. Total prostate volume, proportion of central gland/total prostate volume, presence of one or more adenomas with more than 1 cm in the central-gland and lobar distributions have potential for the subtyping of BPH for effects on outcome.

Magnetic resonance imaging (MRI) in BPH patients is used to exclude cancer when high clinical suspicion and negative biopsy are present. MRI also depicts the zonal anatomy and the protrusion index of the median lobe that may be predictors of treatment response. Multiparametric MRI with perfusion imaging is able to quantify the vascularity of the prostate and detect ischemia after embolization that may be important prognostic factors after prostate artery embolization (PAE). Diffusion imaging before and after PAE is another potential predictor of outcome after PAE. MR angiography (MRA) to depict the anatomy of the prostatic arteries and help plan/guide the embolization has shown promising results.

CT Angiography (CTA) is a valuable pre-procedural tool to help plan the procedure and study the vascular anatomy of the male pelvic arteries. Also allows to measure prostate volume. The use of high concentrations and volumes of iodine (100–120 mL at a concentration of 350–370 mg/mL iodine) is an important feature to obtain enough opacification of the PAs. We also give the patient a vasodilator before the acquisition (Nitromint 0.5 mg, sublingual) to help identify the PAs. With this protocol

the threshold for acquisition can be placed as high as 200 HU. With 16-row CT scanners, the acquisition time for the pelvis is approximately 13 s (scan range of around 30 cm). When using 64 or higher multirow detector CT scanners, it is important to adjust the pitch to have a scan time that is not too fast (below 10 seconds) because it may not give enough time to allow correct PA opacification.

Cone-beam CT (CBCT) is an essential tool for PAE. When no pre-procedural CTA is present, CBCT can be used to map the arterial anatomy of the pelvis with injections from the aorta or internal iliac arteries. CBCT should also be used after reaching the prostatic arteries to certify correct catheter placement and to identify anastomoses that may lead to non-target embolization. We always use power-injection for CBCT with the following protocols: aorta - 35 mL; 3 mL/s; arrival time 3 seconds; internal iliac artery - 20 mL; 2 mL/s; arrival time 2 seconds; selective in the prostatic arteries - 6 mL; 0.5mL/s; arrival time 1.5 seconds. We use non-diluted contrast 350 mg I/mL; 10-second rotational scan of 180° at 18° rotation per second; Image acquisition every 0.5°; Source power of 125 kVp; 316 matrix images (512x512 voxels). Computer assisted identification of the prostatic arteries and embolization guidance using dedicated softwares may also help during PAE. Overlay from CBCT images to 2D-fluoroscopy images can guide interventionalists into the prostatic arteries without the need for further injections of contrast media. We limit the use of DSA runs for PAE and have replaced them largely with CBCT because CBCT has much lower radiation exposure. We use roadmap or overlay guidance to reach the prostatic arteries.

References

1. Wasserman NF. Benign prostatic hyperplasia: a review and ultrasound classification. *Radiol Clin North Am.* 2006;44:689–710.
2. Barentsz JO, Richenberg J, Clements R, et al. ESUR prostate MR guidelines 2012. *Eur Radiol.* 2012;22:746–57.
3. Foster HE, Barry MJ, Dahm P, et al. Surgical Management of Lower Urinary Tract Symptoms Attributed to Benign Prostatic Hyperplasia: AUA Guideline. *J Urol.* 2018;200:612–9.
4. Oelke M, Bachmann A, Descaseaud A, et al. EAU guidelines on the treatment and follow-up of non-neurogenic male lower urinary tract symptoms including benign prostatic obstruction. *Eur Urol.* 2013;64:118–40.
5. Bilhim T, Pisco JM, Rio Tinto H, et al. Prostatic arterial supply: anatomic and imaging findings relevant for selective arterial embolization. *J Vasc Interv Radiol.* 2012;23:1403–15.
6. Bagla S, Rholl KS, Sterling KM, et al. Utility of cone-beam CT imaging in prostatic artery embolization. *J Vasc Interv Radiol.* 2013;24:1603–7.
7. Chiaradia M, Radaelli A, Campeggi A, Bouanane M, De La Taille A, Koberer H. Automatic three-dimensional detection of prostatic arteries using cone-beam CT during prostatic arterial embolization. *J Vasc Interv Radiol.* 2015;26:413–7.
8. Bilhim T, Pisco J, Pereira JA, et al. Predictors of Clinical Outcome after Prostate Artery Embolization with Spherical and Nonspherical Polyvinyl Alcohol Particles in Patients with Benign Prostatic Hyperplasia. *Radiology.* 2016 Oct;281(1):289–300.
9. Abt D, Müllhaupt G, Mordasini L, Güsewell S, Markart S, Zumstein V, Kessler TM, Schmid HP, Engeler DS, Hechelhammer L. Outcome prediction of prostatic artery embolization: post hoc analysis of a randomized, open-label, non-inferiority trial. *BJU Int.* 2018 Nov 30. doi: 10.1111/bju.14632.
10. de Assis AM, Maciel MS, Moreira AM, et al. Prostate Zonal Volumetry as a Predictor of Clinical Outcomes for Prostate Artery Embolization. *Cardiovasc Intervent Radiol.* 2017 Feb;40(2):245–251.
11. Little MW, Boardman P, Macdonald AC, et al. Adenomatous-Dominant Benign Prostatic Hyperplasia (AdBPH) as a Predictor for Clinical Success Following Prostate Artery Embolization: An Age-Matched Case-Control Study. *Cardiovasc Intervent Radiol.* 2017 May;40(5):682–689.

12. Franiel T, Aschenbach R, Trupp S, et al. Prostatic Artery Embolization with 250- μ m Spherical Polyzene-Coated Hydrogel Microspheres for Lower Urinary Tract Symptoms with Follow-up MR Imaging. *J Vasc Interv Radiol*. 2018 Aug;29(8):1127-1137.
13. Interventional Urology. Chapter 15. Selective Arterial Prostatic Embolization (SAPE): BPH Embolization. Tiago Bilhim, João Pisco. Springer 2016.
14. Zhang JL, Wang MQ, Shen YG, et al. Effectiveness of Contrast-enhanced MR Angiography for Visualization of the Prostatic Artery prior to Prostatic Arterial Embolization. *Radiology*. 2019 Feb 26;181524. doi: 10.1148/radiol.2019181524.
15. Kim AY, Field DH, DeMulder D, Spies J, Krishnan P. Utility of MR Angiography in the Identification of Prostatic Artery Origin Prior to Prostatic Artery Embolization. *J Vasc Interv Radiol*. 2018 Mar;29(3):307-310.e1.

605.3

Patient selection for PAE: good and bad candidates

J.M. Da Motta Leal Filho

Radiology, Hospital das Clinicas, University of Sao Paulo Medical School, São Paulo, BR

No abstract available.

605.4

Embolisation technique

T.J. Bryant

Radiology, University Hospital Southampton, Southampton, UK

A review of embolisation technique, tips and tricks of Prostate artery embolisation. This will include: tips on prostate artery access including variable and difficult arterial anatomy, identification and management of non-target vessels, optimising embolisation success including details of more advanced techniques such as proximal embolisation first then embolise distally (PerFecTED), details of how to reduce radiation exposure and a discussion of modern equipment and technology.

605.5

Results and trials

M.R. Sapoval

Vascular and Oncological and Interventional Radiology, Hôpital Européen Georges Pompidou, Paris, FR

No abstract available.

605.6

The surgeon's view

G. Siena

Department of Urology, University of Florence, Careggi Hospital, Florence, IT

The role of surgery in the treatment of male lower urinary tract symptoms (LUTS) due to benign prostatic obstruction (BPO) is reserved to patients, fit to surgery, who have not obtained adequate relief from LUTS using conservative or medical treatments and in those with recurrent or refractory urinary retention, overflow incontinence, recurrent UTIs, bladder stones or diverticula and dilatation of the upper urinary tract due to BPO, with or without renal insufficiency (defined as absolute indications to surgery). Although in last decade several treatments have been proposed for the treatment of moderate to severe LUTS secondary to BPO, transurethral resection of the prostate (TURP) still represents the standard of treatment in men with the prostate size of 30-80 mL and can be performed both as

bipolar and monopolar resection. Transurethral incision of the prostate (TUIP), instead, is recommended in case of prostate size <30mL without a middle lobe. In case of larger prostates (80-100 mL), open prostatectomy represents an effective procedure with acceptable and durable functional outcomes while endoscopic enucleation techniques (such as holmium laser enucleation -HoLEP-, Tm:YAG laser assisted anatomical enucleation -ThuLEP- are emerging as safe and minimally-invasive alternatives together with laser vaporisation techniques (also known as "GreenLight" laser vaporisation of the prostate) especially in patients receiving anticoagulant or antiplatelet therapy. Minimally invasive prostatectomy (performed as laparoscopic simple prostatectomy and robot-assisted simple prostatectomy) has been proposed as an alternative to open prostatectomy. Perioperative outcomes and functional results are acceptable, although long term series and randomized clinical trials are not available. Conversely, in men unfit to surgery, the placement of prostatic stents has been proposed as an alternative to an indwelling catheter but they actually have a limited role due to an high frequency of local side effects including the migration of the stent itself. The placement of prostatic urethral lift (commonly known as UroLift) represents a novel technique that allows to obtain an opening of prostatic urethra by retracting the obstructing lateral lobes. Their use is primarily indicated in patients interested in preserving ejaculatory function, with prostates < 70 mL and no middle lobe. Other treatments for BPO are represented by Transurethral microwave therapy (TUMT) and Transurethral needle ablation of the prostate (TUNA). Compared to TURP, these procedures show a decrease morbidity but a lower efficacy and durability with a higher re-treatment rate.

In the recent years, several minimally invasive treatments for lower urinary tract symptoms secondary to BPO have been proposed and in this scenario prostate artery embolization (PAE) is emerging as a viable, minimally invasive alternative to surgery. In the first instance, PAE can be indicated in patients unfit for surgery and severe LUTS. Indeed, this technique can have a role in those patients intended to preserve their fertility, often compromised by surgical approaches, or in patients with large median lobe that does not allow other minimally invasive treatment such as UroLift.

Moreover, transurethral prostate convective water vapor thermal energy (Rezüm system) has been proposed as a minimally invasive procedure that can be performed under local anesthesia in an office setting with a good safety profile and with reported favorable 4-year outcomes. However, large comparative series with longer follow-up are awaited. Finally, Aquablation represents a novel minimally invasive water ablation therapy which combines image guidance and robotics (PROCEPT BioRobotics) for the removal of prostatic tissue. The procedure is usually performed under general anesthesia and is mostly automated. When compared to TURP, Aquablation seems to provide non-inferior symptom relief and a lower risk of sexual dysfunction (in particular, anejaculation) for the treatment of both small and large (up to 150mL) prostates. However, larger series and longer follow-up are available.

In conclusion, the surgical therapy for BPO is an extended and constantly updated field. To date, several techniques have been proposed. In this scenario, strong evidences are needed to draw conclusions on safety and long-term outcomes of the different techniques. Meanwhile, the choice should be driven by surgeon's experience/preference, patient's wishes and expectations and patient's features that may make a technique more appropriate than others.

Focus Session

Collecting and evaluating evidence in IR

606.1

How to collect high-quality data in peripheral arterial disease

G. Chatellier

Unité de Recherche Clinique, European Georges Pompidou Hospital, Paris, FR

Learning Objectives

1. To learn about the methodologies for studying peripheral artery disease
2. To learn about the pros and cons of specific end-points for studying peripheral artery disease
3. To learn how to conduct trials for studying peripheral artery disease

No abstract available.

606.2

How to collect high-quality data in interventional oncology

J. Ricke

Klinik und Poliklinik für Radiologie, Klinikum der Universität München, Munich, DE

Learning Objectives

1. To learn about the methodologies for studying oncological treatments
 2. To learn about the pros and cons of specific end-points for studying oncological treatments
 3. To learn how to conduct trials for studying oncological treatments
- Creating robust evidence is crucial for successful implementation of new treatments in medicine. Specifically in the Oncology arena, in light of the substantial efforts by the pharmaceutical industry, standards of data quality are very high, and so is the competition of the best available treatment options for individual patient situations. In this lecture, the systematics of implementing and performing clinical trials, as well as the according infrastructure including legal requirements are discussed in detail.

606.3

How to perform high-quality meta-analysis and systematic reviews in IR

S. Sharma¹, N. Pandey²

¹Cardiac Radiology, All India Institute of Medical Sciences, Delhi, IN, ²Cardiovascular Radiology & Endovascular Interventions, All India Institute of Medical Sciences, New Delhi, IN

Learning Objectives

1. To learn about the differences between meta-analyses and systematic reviews
2. To learn how to design high-quality meta-analyses and systematic reviews
3. To learn how to conduct high-quality meta-analyses and systematic reviews

The task of reviewing literature has become increasingly intricate as well as time- and labor-intensive due to the exponentially expanding research landscape. Clinical decisions are often guided by multiple relevant studies. However, these studies are variable in terms of their design, study population and also to an extent the intervention, diagnostic test, or condition considered. A reliable high-quality systematic review, summarizing and critically evaluating all relevant literature pertaining to a specific clinical question can address this complexity and form a basis for making sense of the enormous amount of scientific information. It can also provide a

relevance to the factors influencing the differences in the magnitude of effect under investigation across the studies.

Systematic review is a review of a clearly formulated question that uses systematic and explicit methods to identify, select and critically appraise relevant research; and to collect and analyze data from the studies that are included in the review (1). Meta-analysis refers to the use of statistical techniques to synthesize results across multiple primary studies (2). A systematic review with meta-analysis can provide appraisal of existing literature with recognition of associations as well as inconsistencies while investigating the possible explanations for the same, can help formulate new theories as well as assess prevailing theories in an attempt to explain how and why individual studies fit together, can stipulate clinical policy and delineate directions for forthcoming research (3-6).

The first, and often crucial, step in conducting a systematic review is defining the objective of the review and formulating a focused clinical question. This question often stems from equipoise in the available literature regarding choosing one diagnostic strategy or intervention over another. After the question is conceived, it should be transmuted into a systematic and succinct question centered on Patients, Interventions, Comparators, and Outcomes (PICO) criteria, following which a comprehensive systematic review protocol should be outlined. This protocol should clearly delineate inclusion and exclusion criteria, the reproducible search strategy employed, detailing the search terms, time frames and the databases to be included in the search, a priori-planned hypothesis with proposed subgroup and sensitivity analyses to identify possible sources of heterogeneity, data coding elements, approach to risk-of-bias appraisal, and the statistical methods to be employed. The inclusion and exclusion criteria, explicitly defining the boundaries of the systematic review, should be enlisted in detail. These criteria broadly concern the study characteristics, including the topic and scope of research, research design, characteristics of the study population and data provided in the study, and the publication characteristics including the time frame of research, publication status, language of publication and type of publication.

To ensure a methodical and exhaustive literature search, multiple relevant electronic reference databases should be searched. The search should extend to journal indexes, reference lists of reviews and research articles on the same topic and the online websites of journals most likely to publish articles concerning the topic, to recognize published-ahead-of-print studies. After selecting the relevant databases, a search for appropriate keywords is performed. It is imperative to include a comprehensive list of keywords related to each component of PICO to be able to identify all relevant trials pertaining to the topic. An optimal search strategy balances sensitivity, where a high fraction of relevant articles are retrieved, with specificity, where a low fraction of irrelevant articles are retrieved. After the systematic literature search is completed and a comprehensive list of references has been retrieved, the duplicate versions of the same work retrieved via multiple search strategies should be recognized and deleted. The title and/or abstract of all the remaining studies should be then screened to identify potential studies of interest that meet the pre-specified eligibility criteria. Full-text versions of the retained studies should be assessed and studies fulfilling the eligibility criteria are included in the systematic review. Ideally, the results of each step of study selection should be documented in the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) flow diagram (7). After selecting the primary studies, all the relevant data needs to be cautiously and methodically extracted. The data extracted predominantly relates to study characteristics, publication characteristics and data for statistical computations (effect sizes). Inter-rater reliability should be assessed even at this step by calculating the degree of chance-adjusted agreement (Cohen's kappa) by comparing the agreements and disagreements between investigators vis-a-vis data extraction.

The quality of the systematic review and meta-analysis is directly dependent on the quality of evidence in the studies included within the review. Since study quality can be characterized differently across various research designs and disciplines, it is important to decide on the best assessment tool, as using different tools in the same set of studies can lead to

different conclusions (8). The Grading of Recommendations, Assessment, Development and Evaluation system evaluates the quality of evidence and determines the strength of recommendations based upon study limitations, inaccuracies, incompleteness of outcome data, indirectness of evidence, and risk of publication bias (9,10). The study limitations are evaluated using the 'risk-of-bias' method based on the presence or absence of the following processes, viz. random sequence generation, allocation concealment, blinding of participants/ investigators, incomplete outcome data, selective reporting, and other biases (9,11).

It is crucial to evaluate the direction of effect, effect size and homogeneity across the studies incorporated in the review, along with the strength of evidence and subsequently the data are reviewed qualitatively and quantitatively (12). Amalgamating data from continuous variables utilizes mean difference and standardized mean difference, while combining data from dichotomous variables utilizes odds ratio, risk ratio or risk difference. Robustness of the analysis can be checked by observing the change in effect size on excluding one study at a time. If the effect size shows no substantial change on excluding any individual study, it indicates the strength of results (8). After having calculated the overall effect size, presence/ absence and amount of heterogeneity across studies is calculated using the Cochrane's Q test and Higgins I² statistics (13). While the overall effect size focuses on the research question, the moderator analyses, including subgroup analysis and meta-regression, focus on deciphering the factors that can explain the discrepancy in reporting of differences across the studies (8, 14). It is prudent to evaluate the publication bias as conclusion derived from systematic reviews and meta-analysis based on biased literature is deemed to be less reliable. Publication bias can be assessed by graphic tools like the funnel plot or statistical tools like the Egger's linear regression method and the Begg & Mazumdar's rank correlation method (15-17).

While writing a systematic review with meta-analysis, the entire research methodology and statistical approach should be illustrated in detail. A flowchart depicting the study selection process, a tabulated account of the relevant characteristics of all the studies included in the study and information pertaining to the quality of evidence along with the results of statistical analysis in the form of a forest plot and a funnel plot should always be included.

Combining data from a number of well-designed primary studies enables a more precise estimate of the underlying "true effect" than any individual study (18). Thus, a well-conducted systematic review and meta-analysis addressing a focused and pertinent clinical question, with a comprehensive review of literature, can generate powerful results, appraise clinical guidelines and provide level 1A evidence for prognostic and therapeutic studies (19).

The reliability of a systematic review and meta-analysis is directly dependant on the quality of the design and conduct of the primary studies included within the review. Inherent biases within the studies, such as publication bias, are also not overcome by simply conducting a systematic review and meta-analysis and may result in overestimation of benefits. Inclusion of heterogeneous studies, with respect to their design, quality of methods, interventions performed, and the study population, within the ambit of the review may result in inappropriate estimates of precision (20). Undiscerning acceptance of the results of these systematic reviews can be hazardous and hence, results should be critically appraised on the basis of an accurate understanding of the methodological steps of conducting the systematic review and meta-analysis. Well designed and structured systematic reviews and meta-analysis addressing a focused clinical question can go a long way in establishing appropriate evidence-based clinical practice guidelines.

References

- Higgins, J. P. T., & Green, S. (Eds.). (2011). *Cochrane handbook for systematic reviews of interventions*, Version 5.1.0 [updated March 2011]. The Cochrane Collaboration. Retrieved from www.cochrane-handbook.org
- Hunt, M. (1997). *How science takes stock: The story of meta-analysis*. New York, NY: Russell Sage Foundation.

- Baumeister RF. 2013. Writing a literature review. In *The Portable Mentor: Expert Guide to a Successful Career in Psychology*, ed. MJ Prinstein, MD Patterson, pp. 119–32. New York: Springer. 2nd ed.
- Baumeister RF, Leary MR. 1997. Writing narrative literature reviews. *Rev. Gen. Psychol.* 3:311–20
- Bem DJ. 1995. Writing a review article for *Psychological Bulletin*. *Psychol. Bull.* 118:172–77
- Cooper HM. 2003. Editorial. *Psychol. Bull.* 129:3–9
- Moher D, Liberati A, Tetzlaff J, Altman DG; PRISMA Group. Preferred reporting items for systematic reviews and meta-analyses: the PRISMA statement. *PLoS Med.* 2009 Jul 21;6(7):e1000097.
- Croce E. Systematic Reviews With Meta-Analysis: Why, When, and How? *Emerging Adulthood*. 2016;4(1):3-18.
- Ahn E, Kang H. Introduction to systematic review and meta-analysis. *Korean J Anesthesiol.* 2018 Apr;71(2):103-112.
- Dijkers M. Introducing GRADE: a systematic approach to rating evidence in systematic reviews and to guideline development. *Knowl Translat Update* 2013; 1: 1-9.
- Higgins JP, Altman DG, Sterne JA. Chapter 8: Assessing the risk of bias in included studies. In: *Cochrane Handbook for Systematic Reviews of Interventions: The Cochrane Collaboration* 2011; Available from <http://handbook.cochrane.org>.
- Higgins JP, Altman DG, Sterne JA. Chapter 9: Assessing the risk of bias in included studies. In: *Cochrane Handbook for Systematic Reviews of Interventions: The Cochrane Collaboration* 2011; updated 2017 Jun. cited 2017 Dec 13. Available from <http://handbook.cochrane.org>.
- Higgins JP, Thompson SG, Deeks JJ, Altman DG. Measuring inconsistency in meta-analyses. *BMJ* 2003; 327: 557-60.
- Borenstein, M., Hedges, L. V., Higgins, J. P. T., & Rothstein, H. R. (2009). *Introduction to meta-analysis*. Chichester, England: John Wiley.
- Light, R. J., & Pillemer, D. B. (1984). *Summing up: The science of reviewing research*. Cambridge, MA: Harvard University Press.
- Egger, M., Davey Smith, G., Schneider, M., & Minder, C. (1997). Bias in meta-analysis detected by a simple, graphical test. *British Medical Journal*, 315, 629–634.
- Begg, C. B., & Mazumdar, M. (1994). Operating characteristics of a rank correlation test for publication bias. *Biometrics*, 50, 1088–1101.
- Pogue J, Yusuf S: Overcoming the limitations of current meta-analysis of randomised controlled trials. *Lancet* 351: 47–52, 1998
- Burns PB, Rohrich RJ, Chung KC. The levels of evidence and their role in evidence-based medicine. *Plast Reconstr Surg.* 2011 Jul;128(1):305-10.
- Garg AX, Hackam D, Tonelli M. Systematic review and meta-analysis: when one study is just not enough. *Clin J Am Soc Nephrol.* 2008 Jan;3(1):253-60.

606.4

How to interpret scientific articles in IR

K.A. Hausegger

Radiology, General Hospital Klagenfurt, Klagenfurt, AT

Learning Objectives

- To learn about different study types and their levels of evidence
 - To learn how to understand terminology used for presenting results in scientific articles (including odds ratio's, relative risk ratio's, etc.)
 - To learn how to critically assess the scientific merit of IR articles
- Several points should be observed in interpreting scientific articles. The reader may apply a simple check-list to quickly find out, whether it is worth to spend more time on a scientific article by reading the whole paper. Is the topic relevant? The relevance of the topic is defined by the clinical needs. It has to be questioned whether the addressed topic may have any influence on clinical practice, and / or represents a significant contribution to the already existing body of knowledge in the field of interest. Both

the novelty and the educational character of the study play an important role. However, all these parameters cannot be measured by objective means. Thus, the relevance of a study depends on the individual interests of the reader the decision whether an article is relevant or not, is quite subjective and an individual decision of the reader.

Is the aim of the study well defined? The aim of the study should be easy to comprehend and should be as clear and concise as possible. Only clear questions can get clear answers. If the authors provide a complex explanation of the aim of their study typically the answers will be complex and less understandable.

With which type of study is the reader confronted? The type of study defines which is presented in a scientific paper defines the structure of the article. In addition specific types of study can answer specific questions. The majority of clinical investigations are **Observational studies**. These studies may be cross sectional studies, prospective or retrospective cohort studies or case control studies. Typically observational studies do not have a predefined study protocol. However, it is essential the inclusion/exclusion criteria, the intervention (in this case any action is meant), the patient groups which are analyzed or compared, the control group and the outcome measurement are clearly defined. **Case reports and case series** (series of more than 5 cases) report events/techniques/observations in a descriptive way. **Clinical trials** have a clear defined study protocol and follow a predefined study flow chart until predefined primary and secondary endpoints are reached.

The structure of each article is determined by the study type. Reporting standards for each specific study type have been well defined and are available on-line under <https://www.equator-network/reporting> Did the authors apply the right statistical method to evaluate /prove their results? It may be difficult to be sure about this question because many different statistical tests and methods are available. Sometimes applied statistical methods are very complex and have been performed by biostatistical experts. However, in most articles standardized statistical tests are used. The **student's-T test** is applied to compare two nominal parameters (like the mean age of 2 patient groups ect.) and measures the difference between two means. In contrary the **Chi-Square test** is used to test the relationship between qualitative (categorical, not numerically measurable) variables (like sex, symptoms of disease).

Time dependent events, like survival, or patency of vessels, are displayed in **Kaplan-Meier curves**. The difference between the Kaplan-Meier curves is evaluated by the **Log-rank test**. The **Odd ratio** (OR) is used to describe the association between exposure and outcome when two patient groups are compared in retrospective studies. In prospective studies, where the total number of exposed patients is known the OR and **Risk ratio** (RR, relative risk) may be calculated. The **Hazard ratio** refers to an event occurring over the time. All these parameters are related. When the event under evaluation is rare (< 10%) the OR and RR are interchangeable. The **COX proportional-hazard model** is the most commonly used method to assess the association between survival (or patency) of patients with one or more predictor variables.

Sometimes statistical analyses are applied to analyze even small number of patients. However, the smaller the number of patients (events), the less reliable every statistical model will be. The **confidence interval** estimates the precision of various parameters, where a 95% CI determines a high precision. In addition the spectrum of the CI (+/- values) indicates the range of the respective percentage.

Do the results of the study confirm the conclusion? It can be seen quite often, that authors express their personal opinion in the conclusion, rather than facts, which are in accordance with the results of this study. In conclusion – a well written abstract should be able to catch the reader's interest. A clear structure makes a scientific article easy to follow, where the introduction leads to the aim of the study. The method section should clearly explain, how the authors want to answer the question they raised in the introduction, followed by a concise outline of the results, which are the basis for their answer. The discussion may discuss opinion/results for other scholars and reflects on the own results.

Focus Session

Management of real-world critical limb ischaemia

701.1

Foot perfusion assessment: the emerging role of imaging

J.A. Reekers

Department of Radiology, Academic Medical Centre, Amsterdam, NL

Learning Objectives

1. To learn about perfusion technology
2. To understand the advantages of perfusion imaging
3. To learn how to do perfusion imaging

No abstract available.

701.2

Angiosome re-interpretation: which vessel to open, when to insist and when to stop

S. Kum

Vascular Service, Department of Surgery, Changi General Hospital, Singapore, SG

Learning Objectives

1. To learn about the angiosome concept
2. To learn when to stop
3. To learn which vessels to open

No abstract available.

701.3

The resurgence of DCB in BTK

J.H. Rundback

Interventional Institute, Holy Name Medical Center, Teaneck, NJ, US

Learning Objectives

1. To review the results of DCB in the below-the-knee region
 2. To learn about the new generation drug-coated balloons
 3. To understand when to use DCB in below-the-knee lesions
- The OLIVE Registry has suggested that up to 1/3 of patients undergoing angioplasty will need repeated intervention, and this remains the Achilles heel of PTA. Can this be improved? Recent data from DCB, biomimetic stents, and endovascular tack placement suggests that "optimized angioplasty" may be the key element to improved long term patency with these technologies, suggesting a role for improving the method by which PTA is performed to enhance long term patency. Key elements to this include:
1. Vessel sizing -- IVUS is useful. Diameter of the SFA is often underestimated.
 2. Slow increment long length balloon inflations -- possibly with sequential balloons. Inflate balloons with 1-2 atm increases until nominal diameters are reached over 3-5 minutes. Long balloons provide inherent scaffolding to reduce vessel tears.
 3. Focal force balloons -- switch to shorter, high pressure balloons to treat areas of resistant stenosis to avoid overstretch and dissection at other levels
 4. Dissection repair -- early data suggests that focal "tack" repair of flow limiting dissections may improve long term patency

References

1. Circ Cardiovasc Interv 2013; 6:68
2. Catheter Cardiovasc Interv. 2018 Jul;92(1):96-105
3. Catheter Cardiovasc Interv. 2017 Jun 1;89(7):1259-1267
4. J Endovasc Ther. 2019 Apr 1:1526602819839044. doi: 10.1177/1526602819839044

701.4

Indications and prerequisites for intervening below the ankle

M.G. Manzi

Interventional Radiology Unit, Policlinico Abano Terme, Abano Terme, IT

Learning Objectives

1. To learn the technique of below-the-ankle revascularisation
2. To understand the complications of below-the-ankle revascularisation
3. To learn about the most appropriate devices

No abstract available.

701.5

Managing the “desert foot”: new options for no-option patients?

R. Ferraresi

Peripheral Interventional Unit, Humanitas Gavazzeni, Bergamo, IT

Learning Objectives

1. To understand the concept of “desert foot”
2. To learn the treatment options
3. To understand the technical aspects of venous arterialisation

No abstract available.

701.6

Beyond drug-eluting devices

A. Holden

Radiology, Auckland City Hospital, Auckland, NZ

Learning Objectives

1. To learn about new technologies for below-the-knee vessels
2. To learn how to select the most appropriate device
3. To learn about the results of the new technologies

There has been a recent global increase in critical limb ischemic patients referred for endovascular revascularization. These patients typically have tibial and pedal arterial occlusive disease which is characterized by long stenoses and occlusions, multiple vessels involved and a high prevalence of calcification (particularly medial calcification). Endovascular revascularization is based on plain balloon angioplasty. However, angioplasty is associated a high incidence of arterial dissection, late recoil and restenosis. Recently, a number of “vessel preparation” technologies have been evaluated in tibial arteries. These technologies aim to improve acute angioplasty outcomes, reduce the incidence of significant dissection and recoil and facilitate anti-restenotic therapies.

The most common below-the-knee (BTK) vessel preparation devices include specialty balloons and atherectomy. Specialty balloons include cutting and scoring balloons as well as the Chocolate balloon. Trials with these devices in BTK arteries have shown a low incidence of significant recoil and flow limiting dissection. The major atherectomy techniques used in BTK arteries use laser and rotational atherectomy devices and have improved acute procedural outcomes, particularly in long and heavily disease. A new approach to calcified tibial arterial disease is intravascular lithotripsy (IVL) with ShockwaveTM. This has the advantage of producing compliance change in both intimal and medial calcification. Undated results for the DISRUPT PAD 3 Observational Registry will be presented. A new and interesting approach is a temporary spur stent technology from Reflow Medical which potentially provides successful angioplasty with a low incidence of late recoil and improved drug delivery. The device has the additional advantage of being agnostic to the choice of anti-restenotic drug.

When treating complex arterial disease, an incidence of residual stenosis and dissection requiring scaffolding is expected. This is certainly the case in tibial arteries where short coronary drug-eluting stents have been extensively used. An alternative is BTK tacks from Intact Vascular. These

devices provide a very focal scaffold, minimizing the amount of metal and maintaining normal vessel physiology. The results of the TOBA BTK Trials will be presented.

Clinical Evaluation Course

Diabetic foot

902.1

Diabetic patient management

G. Clerici

Diabetic Foot Unit, Amputation Prevention Centre - Humanitas Gavazzeni Hospital, Bergamo, IT

No abstract available.

902.2

Clinical evaluation of the lower limbs

W.A. Gray

Division of Cardiovascular Diseases, Lankenau Heart Institute, Philadelphia, PA, US

No abstract available.

902.3

Pre-treatment vascular imaging

O. Mironov

Dept of Diagnostic Imaging, St. Joseph's Healthcare Hamilton, Hamilton, ON, CA

Learning Objectives

1. To become familiar with the standard imaging modalities in the context of evaluating a suspected ischemic diabetic foot
 2. To understand the tradeoffs between imaging modalities
 3. To optimize imaging choice based on clinical circumstances
- Diabetes vasculopathy differs significantly from atherosclerotic vasculopathy in its distribution. However, diabetes can also coexist with traditional atherosclerotic risk factors such as hyperlipidemia and smoking. Patients with diabetic foot ulcers should have a focused history and physical exam to determine the presence, extent and distribution of arterial occlusive disease. In particular evaluation of the femoral pulses can guide selection of subsequent imaging.

Vascular doppler ultrasound is recommended as the initial imaging modality for evaluation of patients with suspected peripheral vascular disease. This is a minimally invasive method for assessing the levels, extent and severity of arterial occlusive disease. Simultaneously, the saphenous vein can be assessed if venous bypass is contemplated. A standard drawback of this approach is the often limited ability to evaluate the iliacs for presence and extent of disease. An additional limitation specific to diabetics is the presence of calcium within vessel walls which can prevent sound wave penetration completely.

In the presence of unequal femoral pulses and suspicion of iliac disease, CT angiography (CTA) provides high quality evaluation of the iliacs. A significant additional benefit over ultrasound is the ability to obtain planning measurements for iliac intervention. A CTA with bilateral lower extremity runoff will assess the entirety of the lower extremity arteries. CTAs do have some drawbacks. These include higher cost or in some places delay in workup due to limitations in availability. The technique also requires contrast which places patients at risk for kidney injury and contrast reactions. Finally, wall calcium causes blooming artifact and can cause CTAs to overestimate the degree of stenosis. This is also an issue

with the evaluation of tibial arteries which are often densely calcified in diabetics, especially those on dialysis.

Similar to CTA, MR angiography (MRA) permits high quality evaluation of the iliacs without the use of radiation. There are multiple methods available for MRA and the technique has improved over time. The drawbacks are similar to CTA. MR time is often limited, which can delay evaluation often more so than CTA. Contrast significantly improves MRA quality, but may not always be an option in diabetic patients with impaired renal function due to concerns of nephrogenic systemic fibrosis. MRA is a longer exam and more sensitive to motion, thus it requires a higher degree of patient cooperation. This can be a challenge in diabetic patients with neuropathic and vasculopathic pain. Finally, although it is less susceptible to calcium artifacts, it is not completely immune. This can result in over and under estimation of stenoses. Similarly implanted stents and surgical clips can cause significant artifacts. A related issue is the limited resolution of MRI with larger fields of view which can be an issue with tibial vessels. There are additional safety issues with regards to the high strength magnets related to the presence of metals in the body such as pacemakers, older aneurysm clips, etc which require careful screening.

There is an important caveat with regards to evaluation of the iliac and common femoral segments. These are routinely seen on contrast enhanced CTs and occasionally MRIs obtained for other reasons. With modern multi detector CT the iliacs can be well evaluated even if the study is not a true CTA. Routine review of prior imaging can obviate the need for CTA, especially if there was clearly no iliac disease on prior imaging. Conventional arteriography provides the highest resolution evaluation of the arteries. It is not impacted by the presence of wall calcium and is particularly useful in assessing calcified tibial vessels as well as smaller vessels of the foot. Angiography is now usually employed with an intent to intervene. As such, an important decision needs to be made with regards to the direction of puncture. Thus a prerequisite to arteriography should be knowing the extent of involvement of the iliacs, common femoral and preferably proximal SFA. Arteriography is however an invasive exam and requires arterial puncture which places the patient at multiple additional risks related to the access site. The use of contrast can impact renal function. This can be mitigated with CO2 angiography at the price of image quality. Finally it is a two dimensional imaging modality and so can miss significant eccentric stenoses unless repeated in two projections (with the price of additional contrast load).

In conclusion, vascular doppler ultrasound is recommended as the initial imaging modality for evaluating the presence and extent of vascular disease in a diabetic patient with critical limb ischemia. CT or MR angiography is very helpful in evaluating the iliac segment and can be obtained directly if the level of suspicion for iliac disease is high on the basis of unequal femoral pulses. A significant caveat is that the pelvic arteries are routinely seen on contrast enhanced CTs and occasionally MRIs obtained for other reasons which can obviate the need for repeat imaging. Conventional arteriography is usually performed with an intent to intervene and can provide excellent evaluation of the infrageniculate arteries which may not be well assessed by the other modalities. However, it requires careful planning, in particular to the direction of puncture.

References

1. Diabetic foot problems: prevention and management NICE guideline [NG19] Published date: August 2015 Last updated: January 2016
2. Peripheral arterial disease: diagnosis and management Clinical guideline [CG147] Published date: August 2012 Last updated: February 2018
3. Rutherford's Vascular Surgery And Endovascular Therapy, Ninth Edition. ISBN: 978-0-323-42791-3. Elsevier, 2019.
4. Expert Panel on Vascular Imaging; Ahmed O, Hanley M, Bennett SJ, Chandra A, Desjardins B, Gage KL, Gerhard-Herman MD, Ginsburg M, Gornik HL, Oliva IB, Steigner ML, Strax R, Verma N, Rybicki FJ, Dill KE. ACR Appropriateness Criteria® Vascular Claudication-Assessment for Revascularization. J Am Coll Radiol. 2017 May;14(5S):S372-S379. doi: 10.1016/j.jacr.2017.02.037. Review. PubMed PMID: 28473094.

902.4

Percutaneous revascularisation

M. Palena

San Pio X, 36, Policlinico Abano Terme, Abano Terme, IT

No abstract available.

902.5

Bypass and amputation

C.P. Twine

Vascular Surgery, North Bristol NHS Trust, Bristol, UK

Bypass surgery is usually recommended in diabetic patients for critical ischaemia as part of a multidisciplinary process.¹ Diabetic patients will have a greater proportion of tibial disease than the general vascular population. The choice between bypass surgery or angioplasty is a grey area depending on the local endovascular and surgical set up. In some units, patients with suitable vein, an outflow vessel and adequate medical fitness will be offered bypass first with an endovascular first approach for patients with a compromise on one of those factors. In other units, all patients may be offered an endovascular first approach with bypass reserved for failed endovascular intervention. There is some evidence that the latter approach may have worse outcomes after bypass,^{2,3} however this area of practice is grey enough for a randomised trial comparing endovascular first with surgical first approaches for distal bypass to currently be recruiting.⁴ Vein is always the preferred conduit due to superiority both in terms of patency and infection over prosthetic conduit.⁵ Amputation can be performed primarily, usually for sepsis or the foot with no revascularisation option, or secondarily after failed intervention.⁶ There is a lack of data on quality of life to guide amputation, but generally quality of life is severely diminished after amputation as well as length of life. Patients with below knee amputation are more likely to walk with a prosthesis than those with above knee amputation. Care of the remaining limb becomes extremely important following amputation in diabetes as changes in pressure distribution will increase the risk of ulceration.

References

1. Antoniou GA, Georgiadis GS, Antoniou SA, Makar RR, Smout JD, Torella F. Bypass surgery for chronic lower limb ischaemia. Cochrane Database Syst Rev. 2017 Apr 3;4:CD002000. doi: 10.1002/14651858.CD002000.pub3. Review. PubMed PMID: 28368090.
2. Hossain S, Leblanc D, Farber A, Power AH, DeRose G, Duncan A, Dubois L. Infrainguinal Bypass Following Failed Endovascular Intervention Compared With Primary Bypass: A Systematic Review and Meta-Analysis. Eur J Vasc Endovasc Surg. 2018 Nov 2. pii: S1078-5884(18)30703-2. doi: 10.1016/j.ejvs.2018.09.025. [Epub ahead of print] Review. PubMed PMID: 30393063.
3. Twine CP. "Endovascular first" Strategies are not for Every Patient. Eur J Vasc Endovasc Surg. 2018 Oct 28. pii: S1078-5884(18)30737-8. doi: 10.1016/j.ejvs.2018.10.007. [Epub ahead of print] PubMed PMID: 30377033.
4. Popplewell MA, Davies H, Jarrett H, Bate G, Grant M, Patel S, Mehta S, Andronis L, Roberts T, Deeks J, Bradbury A; BASIL-2 Trial Investigators. Bypass versus angioplasty in severe ischaemia of the leg - 2 (BASIL-2) trial: study protocol for a randomised controlled trial. Trials. 2016 Jan 6;17:11. doi: 10.1186/s13063-015-1114-2. PubMed PMID: 26739146; PubMed Central PMCID: PMC4704263.
5. Ambler GK, Twine CP. Graft type for femoro-popliteal bypass surgery. Cochrane Database Syst Rev. 2018 Feb 11;2:CD001487. doi: 10.1002/14651858.CD001487.pub3. Review. PubMed PMID: 29429146.

6. Shin JY, Roh SG, Sharaf B, Lee NH. Risk of major limb amputation in diabetic foot ulcer and accompanying disease: A meta-analysis. *J Plast Reconstr Aesthet Surg*. 2017 Dec;70(12):1681-1688. doi: 10.1016/j.bjps.2017.07.015. Epub 2017 Aug 5. Review. PubMed PMID: 28865989.

902.6

Aftercare and rehabilitation

M. Monami

Geriatric Cardiology, Careggi University Hospital, Florence, IT

Diabetes is a chronic condition that can lead to several complications resulting in diabetic foot ulcers, infections, osteomyelitis, and amputations. About 15-20% of patients with diabetes develop an ulcer in the course of their lifetime and more than 80% of major amputations in diabetes mellitus are preceded by an ulcer. The main risk factors of ulceration are neuropathy, arteriopathy and limited joint mobility. In last decades, several breakthroughs in the treatment and management of peripheral artery disease and (even if to a less extent) neuropathy have been developed, whereas bio-mechanical factors are more often neglected. In fact, altered bio-mechanics due to the deformities secondary to neuropathy and limited joint mobility leads to focal points of increased pressure, which increases the risk of incident ulcers and of recurrence. Ulcer management, in fact, must not only address the healing of ulcers but also should correct the altered bio-mechanics to reduce the focal pressure points and prevent recurrence. Moreover, rehabilitation after ulcer healing, as well as after major amputation, is a crucial point to prevent ulcer recurrence. However, despite there is some published literature on the value of physical therapy and rehabilitation methods for diabetic foot ulcers, no Cochrane Database of Systematic Reviews, National Guidelines or consensus declarations have been published so far. In fact, the available literature on the effectiveness of current treatments, including superficial and deep heaters, electro-therapy procedures, prophylactic methods, exercise and shoe modifications, is far from being conclusive and there are controversies on what should be the best rehabilitative approach after ulcer healing or amputations.

References

1. Ronnema T, Hamalainen H, Toikka T, Liukkonen I. Evaluation of the impact of podiatrist care in the primary prevention of foot problems in diabetic subjects. *Diabetes Care*. 1997; 20: 1833-7.
2. Dargis V, Pantelejeva O, Jonushaite A, Vileikyte L, Boulton AJM. Benefits of a multidisciplinary approach in the management of recurrent diabetic foot ulceration in Lithuania. *Diabetes Care*. 1999; 22: 1428-31.
3. Monami M, Longo R, Desideri CM, Masotti G, Marchionni N, Mannucci E. The diabetic person beyond a foot ulcer: healing, recurrence, and depressive symptoms. *J Am Podiatr Med Assoc*. 2008 Mar-Apr;98(2):130-6.
4. Monami M, Zannoni S, Gaias M, Nreu B, Marchionni N, Mannucci E. Effects of a Short Educational Program for the Prevention of Foot Ulcers in High-Risk Patients: A Randomized Controlled Trial. *Int J Endocrinol*. 2015

Fundamental Course

Pain management

904.1

Interventional radiology techniques for sports athletes

L.M. Sconfienza

Radiology, IRCCS Istituto Ortopedico Galeazzi, Milan, IT

Learning Objectives

1. To become familiar with the most common indications for injections in the athletes
2. To know about technical considerations when performing MSK injections
3. To know how to choose an injectable

Athletes are frequently affected by a number of pathologies of the musculoskeletal system, being overuse and trauma the most common conditions. In this setting, several therapeutic options are available. Many patients are treated conservatively, with rest, ice application, oral NSAIDs or external shockwave therapy. However, recently more innovative treatments are available. In this setting, interventional radiology plays a crucial role, as most of these new treatments need to be injected exactly in the desired anatomical area, thus imaging-guided procedures have become extremely important. In this lecture, the most common procedures, indications and injectables to use in athletes will be thoroughly revised and discussed.

References

1. Albano D, Messina C, Uselli FG, De Girolamo L, Grassi M, Maccario C, Bignotti B, Tagliafico A, Sconfienza LM. Magnetic resonance and ultrasound in achilles tendinopathy: Predictive role and response assessment to platelet-rich plasma and adipose-derived stromal vascular fraction injection. *Eur J Radiol*. 2017 Oct;95:130-135. doi: 10.1016/j.ejrad.2017.08.006
2. Orlandi D, Corazza A, Arcidiacono A, Messina C, Serafini G, Sconfienza LM, Silvestri E. Ultrasound-guided procedures to treat sport-related muscle injuries. *Br J Radiol*. 2016;89(1057):20150484. doi: 10.1259/bjr.20150484
3. Ferrero G, Fabbro E, Orlandi D, Martini C, Lacelli F, Serafini G, Silvestri E, Sconfienza LM. Ultrasound-guided injection of platelet-rich plasma in chronic Achilles and patellar tendinopathy. *J Ultrasound*. 2012 Oct 8;15(4):260-6. doi: 10.1016/j.jus.2012.09.006

904.2

Pulsed radiofrequency stimulation for pain syndromes

S. Masala

Diagnostic Imaging, Interventional Radiology, Molecular Imaging and Radiation Therapy, Policlinico Tor Vergata, Rome, IT

Learning Objectives

1. To know about biophysics behind pulsed RF
2. To become familiar with the most common indications
3. To know about technical considerations when performing pulsed RF

Radiofrequency procedures have been used for treating various chronic pain conditions for decades.

These minimally invasive percutaneous treatments employ an alternating electrical current with oscillating radiofrequency wavelengths to eliminate or alter pain signals from the targeted site.

The aim of the continuous radiofrequency procedure is to increase the temperature sufficiently to create an irreversible thermal lesion on nerve fibres and thus permanently interrupt pain signals.

The pulsed radiofrequency procedure utilises short pulses of radiofrequency current with intervals of longer pauses to avert a temperature increase to the level of permanent tissue damage.

The goal of these pulses is to alter the processing of pain signals, but to avoid relevant structural damage to nerve fibres, as seen in the continuous radiofrequency procedure.

The pulse-dose radiofrequency procedure is a technical improvement of the pulsed radiofrequency technique in which the delivery mode of the current is adapted.

During the pulse-dose radiofrequency procedure thermal damage is avoided. In addition, the amplitude and width of the consecutive pulses are kept the same.

The method ensures that each delivered pulse keeps the same characteristics and therefore the dose is similar between patients.

We will try to describe its applications in painful degenerative spine, joint and neoplastic pathology.

References

1. Pulse-dose radiofrequency treatment in pain management-initial experience. Ojango C, Raguso M, Fiori R, **Masala S**. *Skeletal Radiol*. 2018 May;47(5):609-618. doi: 10.1007/s00256-017-2854-8. Epub 2017 Dec 23.
2. Pulse-Dose Radiofrequency in Athletic Pubalgia: Preliminary Results. **Masala S**, Fiori R, Raguso M, Ojango C, Morini M, Cuzzolino A, Calabria E, Simonetti G. *J Sport Rehabil*. 2017 May;26(3):227-233. doi: 10.1123/jsr.2015-0149.
3. Pulse-dose radiofrequency can reduce chronic pain in trapezio-metacarpal osteoarthritis: A mini-invasive therapeutic approach. **Masala S**, Fiori R, Raguso M, Calabria E, Cuzzolino A, Fusco A, Simonetti G. *Int J Rheum Dis*. 2017 Mar;20(3):309-316. doi: 10.1111/1756-185X.12635.
4. Pulse-dose radiofrequency for knee osteoarthritis. **Masala S**, Fiori R, Raguso M, Morini M, Calabria E, Simonetti G. *Cardiovasc Intervent Radiol*. 2014 Apr;37(2):482-7. doi: 10.1007/s00270-013-0694-z. Epub 2013 Aug 14

904.3

Neurolysis for benign pain

C.S. Georgiades

Vascular & Interventional Radiology, Johns Hopkins University, Baltimore, US

Learning Objectives

1. To become familiar with the most common indications
 2. To understand about different neurolytic techniques
 3. To know about the evidence-based practice of neurolysis
- Neurolysis is an option that can provide significant analgesic effect and improvement to a patient's quality of life. Though complications of neurolysis for malignant pain are mitigated by end of life issues, those of neurolysis for benign pain are not. Careful patient history, physical examination and intimate knowledge of relevant anatomy is crucial to ensure an acceptable risk-benefit ratio. The physiology and anatomy of the targeted nerve must also be considered. For example, in cases where a motor-sensory nerve is involved, or other critical non-target structures are at-risk, a reversible, test-ablation may be considered. In addition, basic knowledge of available pain medications, their pharmacology and how they can be combined to maximize analgesia is also important. Finally, it should be emphasized that nowhere is a multidisciplinary approach more critical, lest the patient receives less than optimum care. There are many modalities that are used to abolish nerve conduction or destroy nerves including alcohol, phenol, cryoablation, radiofrequency ablation, microwave ablation etc. The choice is not arbitrary, rather dependent on location, type of nerve targeted and analgesic objective (temporary vs permanent, long- vs short term). The physics of each modality will be reviewed with a focus on neurolysis applications. There is a multitude of neurolysis procedures including for trigeminal neuralgia, CRPS, spinal interventions, chronic pelvic pain, Morton's neuroma, ganglion impar neurolysis etc. Instructive cases will be presented inclusive of patient work-up, intervention and follow up.

Analgesic outcomes as presented in the literature vary widely. Efficacy of interventions for pain control is high, with reported complete response rates between 50-90% of patients. Other outcome factors include duration of analgesia and percent of patients with partial response. However, it should be noted that these studies are dogged by inconsistencies in patient selection, objective pain quantification, differences in technique and validation of outcomes.

In summary, a multidisciplinary and collaborative pain service with full access to all available interventions/neurolysis modalities and the proficiency to apply them effectively and safely is a humane necessity for all medical centers.

904.4

Neurolysis for malignant pain

M. Pantel

Anesthesiology/interventional pain therapy, Haga Ziekenhuis, The Hague, NL

Learning Objectives

1. To become familiar with the most common indications
 2. To understand about different neurolytic techniques
 3. To know about the evidence-based practice of neurolysis
- Treatment for pain in malignancy is usually based on drug-therapy. Invasive procedures can be a valuable addition or even alternative in selected cases. While in the past neurolytic techniques have been mostly used as a last resort recent publications have recommended the use of some interventional techniques in earlier stages.

The scope of this lecture is to describe several established invasive pain-procedures for cancer pain.

Clear and honest communication with patients about achievable results and possible side-effects is paramount, because all described procedures are more or less neuro-destructive. There are two main groups of interventional pain management techniques:

Targeted neurolytic nerve block: coeliac block, nervus splanchnicus block, hypogastric block, ganglion impar block, cervical cordotomy, and lower end block.

Intrathecal/epidural drug administration and, in selected, cases neuromodulation.

This lecture will focus on targeted neurolytic nerve blocks, possible techniques, achievable results, and possible side-effects, following the guidelines of the Dutch Society of Anesthesiology (NVA), the Dutch Cancer Society (KWF), and the recommendations of the World Institute of Pain (WIP). Intrathecal/epidural drug administration and neuromodulation will not be subject of this lecture.

Focus Session

Pre-operative portal vein embolisation

905.1

Indications and patient selection

B. Guin

Department of Radiology, St-Eloi University Hospital – Montpellier School of Medicine, Montpellier, FR

Learning Objectives

1. To learn when to perform PVE and when not
2. To describe techniques of measuring volume and functional volume of liver remnant
3. To discuss if there are restrictions or contra-indications

No abstract available.

905.2

Technique and materials

D.C. Madoff

Department of Radiology and Biomedical Imaging, Yale School of Medicine, New Haven, CT, US

Learning Objectives

1. To describe different techniques
2. To describe the (dis)advantages of different techniques
3. To discuss the literature excluding follow-up and complications

Portal vein embolisation (PVE) is usually performed percutaneously and there are several approaches to accessing the portal vein. The most common approach to the portal vein is through a transhepatic route; either through the FLR (contralateral approach) or through the liver to be resected (ipsilateral approach). These approaches are chosen based on operator preference, type of hepatic resection planned, extent of embolization and type of embolic agent used. PVE is typically performed in the setting of right hepatic resection as these often result in an inadequate FLR volumes such that PVE is needed.

In the transhepatic contralateral approach, a left portal vein branch (usually segment 3) is accessed, and the catheter is advanced into the right portal venous system for embolization (1,2). The main advantage of this approach is that catheterization of the desired right portal vein branches is more direct via the left system than via the right, making the procedure technically easier. However, the major disadvantage of this technique is the risk of injury to the left portal vein and the FLR parenchyma.

In the transhepatic ipsilateral approach, a peripheral portal vein branch in the liver to be resected is accessed, through which the embolic material is administered (3,4). The key advantage of the ipsilateral approach is that the anticipated FLR is not instrumented. The ipsilateral approach also allows operators to more readily perform segment 4 embolisation without the sharp angulations encountered when trying to cannulate segment 4 from the contralateral approach. When two stage or extended right hepatectomy is planned, RPVE may be extended to segment 4 (RPVE + 4) (5). When RPVE + 4 is needed, segment 4 embolisation should be performed first so as to not manipulate catheters through previously embolised segments. Disadvantages of this approach exist and include the following: 1) catheterization of the right portal vein branches may be more difficult because of severe angulations between right portal branches, necessitating the use of reverse-curved catheters and 2) some embolic material could be displaced upon catheter removal leading to the potential for non-target embolization (6).

When comparing the contralateral and ipsilateral approaches, the complication rates are relatively similar. Di Stefano et al (7) reported on 188 patients who underwent contralateral approach PVE and found a 12.8% adverse event rate and only one major complication (e.g., complete portal vein thrombosis) directly attributed to the contralateral approach that precluded surgery. With regards to the ipsilateral approach, Ribero et al (8) reported on 112 patients and found an 8.9% adverse event rate²¹. Accounting for the fact that Di Stefano et al (7) included clinically occult CT findings in their complications, the rates are comparable between the two studies. In addition, Kodama et al (9) compared complication rates between contralateral ($n = 11$) and ipsilateral approaches ($n = 36$) in a series of 47 who underwent PVE. In their study, the contralateral approach was associated with an 18.1% complication rate as compared to 13.9% for ipsilateral PVE. Though the difference did not reach statistical significance, the authors recommended the ipsilateral approach due to the potential for injury to the FLR during contralateral approach.

Additional percutaneous approaches have been utilized. Given the extensive experience with TIPS creation, PVE using a transjugular approach has been reported in a series of 15 patients (10). In this approach, a right or left portal branch was punctured from a right, middle, or left hepatic vein and a catheter placed near the portal bifurcation through which embolization was performed. FLR hypertrophy was adequate, and right hepatectomy was performed in 12/15 patients with no PVE-related complications. Another approach to access the portal venous system is the transsplenic

approach. Despite the perceived risk of increased bleeding due to the spleen's vascularity, the major advantage is that it avoids transhepatic puncture. In a study by Ko et al (11), 27 transsplenic PVEs were performed in 26 patients of which 16 had tumors which precluded ipsilateral access. Transsplenic PVE was successful in 24 (88.9%) patients and there were 3 failures (e.g., SV dissection ($n=1$), failed SV puncture ($n=2$)). Planned liver resection was ultimately performed in 24 of 26 patients.

A variety of materials exist for embolization and some of these have been adapted for the portal system. Commonly reported agents include polyvinyl alcohol (PVA), gelfoam, fibrin glue, NBCA, polidocanol foam, microspheres, ethiodized oil, coils, vascular plugs and many others (5, 12). An ideal material will provide permanent portal venous embolization that is safe and well tolerated by the patient. The two agents most commonly discussed currently are NBCA and microspheres in combination with coils. NBCA induces an inflammatory reaction resulting in peribiliary fibrosis and rates of liver regeneration are believed to be as good as or better than other embolic agents. In early studies, NBCA was shown to induce greater FLR hypertrophy when compared coils and gelatin sponge and produce durable occlusion of more than four weeks (13,14). Recently, Jaber et al (15) showed increased hypertrophy with NBCA and vascular plug as compared to PVA and coils in their single institution retrospective study. However, plugs and coils were used earlier in the institution's experience, and overall surgical outcomes and complications were similar for both groups. Jaber et al (15) also found decreased contrast utilization and fluoroscopy time in the NBCA and vascular plug group as compared to PVA and coils. However, preparation and administration of NBCA requires expertise (13) and great care must be taken to prevent embolization of NBCA to non-target areas. As such, NBCA is routinely administered through a contralateral approach, and embolization is not routinely extended to segment 4 when using this agent. NBCA requires delivery through an end hole angiographic catheter from second or third order portal branches to prevent non-target embolization. In addition, many groups advocate for the deployment of an vascular plug to prevent NBCA backflow (16). Many studies have also shown the safety and effectiveness of small particle PVE with both PVA particles and microspheres (4, 5, 17). After catheterization of the portal system, embolization of distal small veins is performed with 100–300 micron particles. More proximal veins are embolized with larger particles with a goal of near stasis of flow or stasis. Coils are placed behind particles to prevent later particle dislodgement and recanalization, improving hypertrophy of the FLR. A study by Geisel et al (18) demonstrated superior FLR hypertrophy with reported percentage volume gain of (53.3 ± 34.5)% with the use of coils and plugs in combination with particles vs. (30.9 ± 28.8)% particles alone ($P = 0.002$).

References

1. Kinoshita H, Sakai K, Hirohashi K, Igawa S, Yamasaki O, Kubo S. Preoperative portal vein embolization for hepatocellular carcinoma. *World J Surg*. 1986 Oct; 10(5):803-8.
2. de Baere T, Roche A, Vavasseur D, et al. Portal vein embolization: utility for inducing left hepatic lobe hypertrophy before surgery. *Radiology* 1993; 188:73-77.
3. Nagino M, Nimura Y, Kamiya J, Kondo S, Kanai M. Selective percutaneous transhepatic embolization of the portal vein in preparation for extensive liver resection: the ipsilateral approach. *Radiology* 1996; 200:559-63.
4. Madoff DC, Hicks ME, Abdalla EK, Morris JS, Vauthey JN. Portal vein embolization with polyvinyl alcohol particles and coils in preparation for major liver resection for hepatobiliary malignancy: safety and effectiveness--study in 26 patients. *Radiology* 2003; 227:251-260.
5. Madoff DC, Abdalla EK, Gupta S, et al. Transhepatic ipsilateral right portal vein embolization extended to segment IV: improving hypertrophy and resection outcomes with spherical particles and coils. *J Vasc Interv Radiol* 2005; 16:215-225.
6. Madoff DC, Abdalla EK, Vauthey JN. Portal vein embolization in preparation for major hepatic resection: evolution of a new standard of care. *J Vasc Interv Radiol* 2005; 16:779-790.

7. Di Stefano DR, de Baere T, Denys A, et al. Preoperative percutaneous portal vein embolization: evaluation of adverse events in 188 patients. *Radiology* 2005; 234:625-630.
8. Ribero D, Abdalla EK, Madoff DC, Donadon M, Loyer EM, Vauthey JN. Portal vein embolization before major hepatectomy and its effects on regeneration, resectability and outcome. *Br J Surg*. 2007 Nov; 94:1386-1394.
9. Kodama Y, Shimizu T, Endo H, Miyamoto N, Miyasaka K. Complications of percutaneous transhepatic portal vein embolization. *J Vasc Interv Radiol* 2002; 13:1233-1237.
10. Perarnau JM, Daradkeh S, Johann M, Deneuville M, Weinling P, Coniel C. Transjugular preoperative portal embolization (TJPE) a pilot study. *Hepatogastroenterology* 2003; 50:610-613.
11. Ko HK, Ko GY, Sung KB, Gwon DI, Yoon HK. Portal vein embolization via percutaneous transsplenic access prior to major hepatectomy for patients with insufficient future liver remnant. *J Vasc Interv Radiol* 2016; 27:981-986.
12. Madoff DC. Portal vein embolization: the continued search for the ideal embolic agent. *J Vasc Interv Radiol* 2014; 25:1053-1055.
13. de Baere T, Roche A, Elias D, Lasser P, Lagrange C, Bousson V. Preoperative portal vein embolization for extension of hepatectomy indications. *Hepatology* 1996; 24:1386-1391.
14. Matsuoka T, Nakatsuka H, Nakamura K, et al. Long-term embolization of the portal vein with isobutyl-2-cyanoacrylate in hepatoma. *Nihon Igaku Hoshasen Gakkai Zasshi*. 1986;46:72-74.
15. Jaber A, Toor SS, Rajan DK, et al. Comparison of clinical outcomes following glue versus polyvinyl alcohol portal vein embolization for hypertrophy of the future liver remnant prior to right hepatectomy. *J Vasc Interv Radiol*. 2016
16. Bent CL, Low D, Matson MB, Renfrew I, Fotheringham T. Portal vein embolization using a nitinol plug (Amplatzer vascular plug) in combination with histoacryl glue and iodized oil: adequate hypertrophy with a reduced risk of nontarget embolization. *Cardiovasc Interv Radiol* 2009; 32:471-477.
17. Cazejust J, Bessoud B, Le Bail M, Menu Y. Preoperative portal vein embolization with a combination of trisacryl microspheres, gelfoam and coils. *Diagn Interv Imaging* 2015; 96:57-64.
18. Geisel D, Malinowski M, Powerski MJ, et al. Improved hypertrophy of future remnant liver after portal vein embolization with plugs, coils and particles. *Cardiovasc Interv Radiol* 2014; 37:1251-1258.

905.3

Augmented portal vein embolisation techniques

A. Lunardi

Diagnostic and Interventional Radiology, University of Pisa, Pisa, IT

Learning Objectives

1. To describe the technique of additional arterial/venous embolisation
2. To give an overview of the literature
3. To discuss results compared to traditional PVE

Surgical resection is a potential curative option for primary liver tumours or selected hepatic metastases. In large tumour or diffuse liver involvement, major liver resections are frequently mandatory to achieve tumour-free surgical margins. In these circumstances, the volume and functional reserve of the future liver remnant (FLR) are essential, because post-hepatectomy liver failure (PHLF) is an important cause of morbidity and mortality after extensive liver resection [1]. In a pre-operative healthy liver setting, FLR-to-body weight ratio (FLR/BW) higher than 0.5% is generally regarded as sufficient to maintain adequate post-operative liver function. The critical minimum FLR has been estimated to be approximately 20% of total functioning liver volume (TFLV) in normal livers, and 40% in cirrhotic livers [2]. In the setting of chemotherapy-related injury or cirrhosis, patients would require a FLR/BW $\geq 0.8\%$ in order to avoid PHLF [3]. Portal vein embolization (PVE) still represent the mainstay of radiological techniques for liver hypertrophy and can increase the volume of the FLR by up

to 40-45% within 3 to 8 weeks [4,5]. In healthy livers, hypertrophy after PVE typically occurs within 2-4 weeks, whereas regeneration in patients with cirrhosis can take ≥ 4 weeks [5]. However, PVE alone do not always induce sufficient hypertrophy in very small FLR and obese patients [6, 7]. The pathophysiological situation following PVE alone still remains unclear. On one hand, the main mechanisms of hepatic regeneration appear to be driven by hepatic hypoxia (involving the hepatic arterial buffer response), an increased portal blood flow inducing shear stress and the involvement of several mediators (inflammatory cytokines, vasoregulators, growth factors, eicosanoids and several hormones). On the other hand, several factors are associated with impaired liver regeneration, such as biliary obstruction, malnutrition, diabetes mellitus, male gender, age, ethanol and viral infection. All these mechanisms may explain the varying degrees of hypertrophy observed following a surgical or radiological procedure promoting hypertrophy the FLR [8].

In 2007, for the first time by chance, Hans Schlitt from Regensburg, Germany made a new procedure, called liver bi-partition to perform an extended right hepatectomy in a patient with hilar cholangiocarcinoma. On the 8th postoperative day was performed a CT scan and observed a huge hypertrophy of the remnant liver. Afterwards have been conceived and developed a new two stage surgical procedure called Associating Liver Partition and Portal vein Ligation for Staged hepatectomy (ALPPS) to induce a greater and faster hypertrophy of the FLR, thereby increasing the likelihood of resectability [9,10,11]. Data reported from the International ALPPS Registry underline the high rate of major morbidity and mortality associated to ALPPS procedure, respectively 31%-59% and 8%-29% [9]. Later, another surgical technique for liver hypertrophy was reported: the association of portal embolization and arterial ligation (APEAL). The APEAL technique resulted in rapid and extensive FLR hypertrophy more than 100% at 1 week, with no death by 90 days but 60% morbidity after the first procedure and 30% severe complications after the second-Stage [12]. Moreover during the last five years have been proposed two radiological procedures for Augmented Portal Vein Embolization (aPVE): the Extended Liver Venous Deprivation (eLVD) and the Percutaneous Intrahepatic Split by Ablation (PISA). The PVE associated to these percutaneous procedures was conducted using a mixture of acrylic glue (Glubran II, GEM, Italy) and iodized oil (Lipiodol® Ultra-Fluid; Guerbet, Aulnay-sous-bois, France). After PVE in the eLVD the hepatic veins of the tumour-bearing lobe were embolised percutaneously using oversized Amplatzer Vascular Plugs II (St-Jude Medical, Plymouth, MN) whereas their distal branches and potential collaterals were embolised using glue mixture [13].

Instead, in the PISA technique, 1 week after the PVE the liver parenchyma along the main portal fissure was ablated using a microwave system under real-time US guidance. The aim was to create a necrotic plane realized by a series of partially overlapped elongated ablation areas disrupting sinusoids communications between the two lobes as it happens in liver transection of stage-1 ALPPS [14]. The eLVD and PISA techniques cause a portal overflow to FLR parenchyma by decreasing the portal shunt from FLR to the tumour-bearing lobe. Both techniques, associated to PVE, induce a FLR daily growth significantly higher than PVE alone. The FLR-Volume increase after eLVD and PISA were respectively 25 ± 8 cc/day and 17.0 ± 3 cc/day, compared with 3 cc/day after PV ligation [15], 4.4 cc/day after PVE alone [16], 9.3 cc/day after LVD [17] and 25.4-32.7 cc/day after ALPPS [16,18].

These two percutaneous techniques have been proposed as an alternative option to the Stage-1 ALPPS to induce higher hypertrophy rate than PVE alone. As shown by the Literature, ALPPS morbidity mostly depends on the surgical burden of Stage-1 procedure [11,19,20] therefore the introduction of a radiological Stage-1 ALPPS offers the opportunity to reduce the overall morbidity and mortality rate of liver extended resections.

The aPVE techniques allow reach significantly higher overall hypertrophy rates than PVE alone. Combined PVE + eLVD bi-embolization has achieved an increase in the FLR of between 53% and 63% at three weeks [13]. Combined PVE + PISA has achieved an 83% average increase of FLR volume ranging from 68.1% to 109.3% at 3 weeks [14]. This results are comparable to surgical techniques although needs about two more weeks to be completed [13,14]. Unlike radiological procedures, a surgical

approach seems to be associated with faster FLR hypertrophy. Indeed, the increase in FLR volume achieved with ALPPS can exceed 75% at one week after the first stage, while the APEAL procedure can obtain a higher rate of FLR hypertrophy, with a 104% increase in the FLR at one week post-procedure. These data support that FLR volume increase is not entirely caused by hypertrophy and they are coherent with Truant's study. In his study, Truant reported that the volumetric evaluation of the FLR might not truly reveal its functional reserve assessed by hepatobiliary scintigraphy (HBS) in patients who underwent stage-1 ALPPS [21, 22]. Some authors highlighted the mismatch between high volume increase of FLR after the stage-1 ALPPS and the low increase of function assessed by HBS with 99mTc-labelled mebrofenin [23]. Moreover one Japan study, comparing histological features of FLR after ALPPS and PVE, confirmed that FLR hepatocytes in ALPPS were more immature than in PVE underlying the importance to evaluate functional increase in FLR during ALPPS [24]. However correlation between volume and function is difficult not only in ALPPS but for all extended liver resections. Functional tests after the first stage seems to be more useful than volumetric studies. Mitsunari Maruyama in 2018 reported data supporting the superiority of future liver remnant plasma clearance rate of indocyanine green (ICGK-F) for predicting post-hepatectomy liver failure (PHLF). ICGK-F was significantly higher in the grade A PHLF group than in the non-grade A PHLF group (grades B and C), and ICGK-F was more useful for predicting PHLF than FLR increase of volume [25].

The longer periods to reach the maximum hypertrophy by aPVE techniques in comparison to ALPPS and APEAL can increase the risk of tumour progression with a lower completion rate of the second stage ranging from 70% to 90% in comparison of the 88-100% of the stage-2 ALPPS [8]. However radiological techniques, alternative to stage-1 ALPPS, offers a lower periprocedural morbidity and mortality rate and in the event of failed completion to stage-2 have limited consequences on patient safety and little impact on feasibility of additional medical treatments. Moreover the patients who completed stage-2 had a shorter period of hospitalization than patients in ALPPS series, showing no 90-day mortality [13,14]. The radiological aPVE series are based on small population samples and further evaluation in a larger patient population is necessary in order to better define safety and efficacy of new liver hypertrophy techniques and to propose them as the alternative procedures to the surgical stage-1 ALPPS. Though the published series are small one, still the results are encouraging because of the high hypertrophy percentage obtained in a short time period, the brief hospitalization time and the reduction of morbidity and mortality in comparison to ALPPS procedure.

References

- Bertens KA, Hawel J, Lung K, et al. ALPPS: challenging the concept of unresectability - a systematic review. *Int J Surg*. 2015;13:280-7.
- J.N. Vauthey, A. Chaoui, K.A. Do, et al. Standardized measurement of the future liver remnant prior to extended liver resection: Methodology and clinical associations. *Surgery*, 127 (2000), pp. 512-519.
- Clavien PA, Petrowsky H, DeOliveira ML, et al. Strategies for safer liver surgery and partial liver transplantation. *N Engl J Med*. 2007;356(15):1545-59.
- Abulkhir A, Limongelli P, Healey AJ, et al. Preoperative portal vein embolization for major liver resection: a meta-analysis. *Ann Surg*. 2008;247(1):49-57.
- May BJ, Madoff DC. Portal vein embolization: rationale, technique, and current application. *Semin Intervent Radiol*. 2012;29(2):81-9.
- Garcea G, Ong SL, Maddern GJ. Predicting liver failure following major hepatectomy. *Dig Liver Dis*. 2009;41(11):798-806.
- Tanaka K, Shimada H, Matsuo K, et al. Remnant liver regeneration after two-stage hepatectomy for multiple bilobar colorectal metastases. *Eur J Surg Oncol*. 2007;33(3):329-35.
- Le Roy B, Dupré A, Gallon A et al. Liver hypertrophy: Underlying mechanisms and promoting procedures before major hepatectomy. *J Visc Surg*; 2018;155(5):393-401.
- Schnitzbauer AA, Lang SA, Goessmann H, et al. Right portal vein ligation combined with in situ splitting induces rapid left lateral liver lobe hypertrophy enabling 2-staged extended right hepatic resection in small-for-size settings. *Ann Surg*. 2012;255(3):405-14.
- De Santibañes E, Clavien PA. Playing Play-Doh to prevent postoperative liver failure: the "ALPPS" approach. *Ann Surg*. 2012;255(3):415-7.
- Schadde E, Ardiles V, Robles-Campos R, et al. Early survival and safety of ALPPS: first report of the International ALPPS Registry. *Ann Surg*. 2014;260(5):829-36.
- Dupré A, Hitier M, Peyrat P, et al. Associating portal embolization and artery ligation to induce rapid liver regeneration in staged hepatectomy. *British Journal of Surgery*; 2015;102(12): 1541-1550.
- Guiu B, Chevallier P, Denys A, et al. Simultaneous trans-hepatic portal and hepatic vein embolization before major hepatectomy: the liver venous deprivation technique. *Eur Radiol*. 2016;26:4259-67.
- Lunardi A, Cervelli R, Volterrani D et al. Feasibility of Percutaneous Intrahepatic Split by Microwave Ablation (PISA) After Portal Vein Embolization for Hypertrophy of Future Liver Remnant: The Radiological Stage-1 ALPPS. *Cardiovasc Intervent Radiol*. 2018;41(5):789-798.
- Schadde E, Ardiles V, Slankamenac K et al. ALPPS offers a better chance of complete resection in patients with primarily unresectable liver tumors compared with conventional staged hepatectomies: results of a multicenter analysis. *World J Surg*. 2014; 38:1510-1519
- Croome KP, Hernandez-Alejandro R, Parker M et al. Is the liver kinetic growth rate in ALPPS unprecedented when compared with PVE and living donor liver transplant? A multicentre analysis. *HPB (Oxford)*. 2015; 17:477-484
- Guiu B, Chevallier P, Denys A et al Simultaneous trans- hepatic portal and hepatic vein embolization before major hepatectomy: the liver venous deprivation technique. *Eur Radiol*. 2016; doi:10.1007/s00330-016-4291-9
- Truant S, Scatton O, Dokmak S et al (2015) Associating liver partition and portal vein ligation for staged hepatectomy (ALPPS): impact of the inter-stages course on morbi-mortality and implications for management. *Eur J Surg Oncol* 41:674-682
- Dokmak S, Belghiti J. Which limits to the "ALPPS" approach? *Ann Surg*. 2012;256:e6.
- de Santibañes M, Boccalatte L, de Santibañes E. A literature review of associating liver partition and portal vein ligation for staged hepatectomy (ALPPS): so far, so good. *Updates Surg*. 2017;69(1):9-19.
- Olthof PB, Tomassini F, Huespe PE, et al. Hepatobiliary scintigraphy to evaluate liver function in associating liver partition and portal vein ligation for staged hepatectomy: liver volume overestimates liver function. *Surgery*. 2017;162(4):775-83.
- Truant S, Baillet C, Deshorgue AC, et al. Drop of total liver function in the interstages of the new associating liver partition and portal vein ligation for staged hepatectomy technique: analysis of the "auxiliary liver" by HIDA scintigraphy. *Ann Surg*. 2016;263(3):e33-4.
- Olthof PB, Tomassini F, Huespe PE, et al. Hepatobiliary scintigraphy to evaluate liver function in associating liver partition and portal vein ligation for staged hepatectomy: liver volume overestimates liver function. *Surgery*. 2017;162(4):775-83.
- Matsuo K, Murakami T, Kawaguchi D. et al. Histologic features after surgery associating liver partition and portal vein ligation for staged hepatectomy versus those after hepatectomy with portal vein embolization. *Surgery*. 2016 May;159(5):1289-98
- Maruyama M, Yoshizako T, Araki H et al. Future Liver Remnant Indocyanine Green Plasma Clearance Rate as a Predictor of Post-hepatectomy Liver Failure After Portal Vein Embolization. *Cardiovasc Intervent Radiol*. 2018 Dec;41(12):1877-1884.

905.4

Follow-up and complications

B. Gebauer

Klinik für Strahlenheilkunde, Charité Universitätsmedizin Berlin, Berlin, DE

Learning Objectives

1. To learn about the management of patient after PVE
2. To learn about results and complications
3. To give an overview of the literature

Portal vein embolization (PVE) is in experienced hands a very save technique to increase future liver remnant (FLR). Like other embolization techniques non-target embolization, coil misplacement or migration, thrombosis and bleeding could complicate the procedure. Rare portovenous shunts could result in pulmonary non-target embolization.

Special complications of PVE are the bile leakage in to the peritoneum or into a bilioma formation, recanalization or portal vein or the insufficient increase of future liver remnant (FLR).

If more advanced techniques like hepatic vein embolization (HVE) are added complications like pulmonary non-target embolisation or embolization of middle hepatic vein instead of right hepatic vein could occur.

But in general PVE is very well tolerated by the patient. Usual procedure follow-up in our clinic is abdominal ultrasound the following day and computed tomography after 2-3 weeks to measure the increase of FLR.

Fundamental Course

Update on drug-eluting technologies

1002.1

Different drugs and mechanisms of action

S. Spiliopoulos

2nd Department of Radiology, Interventional Radiology Unit, ATTIKON University General Hospital, Athens, GR

Learning Objectives

1. To understand the basic principles and mechanisms of action to inhibit restenosis
 2. To understand the challenges of drug dose control
 3. To understand limitations and potential complications
- Restenosis leading to clinical relapse is a major drawback of endovascular treatment of peripheral arterial disease. [1] The pathophysiology of restenosis is complex and includes inflammatory and proliferative processes as a response of the vessel wall to trauma, leading to the formation of neointimal hyperplasia (NIH) within the first 6 months post-treatment. [2, 3] NIH is principally a result of smooth muscle cells (MSC) activation, proliferation, and migration to the site of injured endothelium. [2] Endovascular drug-eluting technologies, such as drug-eluting stents (DES) and drug-coated balloons (DCBs), aim in reducing NIH by inhibiting inflammation and MSC proliferation. [4] The two main classes of drugs utilized in peripheral endovascular devices are immunosuppressant agents with antiproliferative action and cytotoxic agents. Paclitaxel is the main agent used in DCBs technology. It is a natural antiproliferative agent, widely used for cancer chemotherapy. Its mechanism of action is based in the depolymerization and stabilization of microtubules by binding to their beta-tubulin subunit. In low doses, paclitaxel exerts a cytostatic action by interfering in the transition between G0 and G1 and between G1 and S mitotic phases. In high doses paclitaxel is cytotoxic as it blocks the transition between G2 and M and between M and G1 phase, leading to cell death. [5] In DES technology the main pharmaceutical agent used is Sirolimus (rapamycin) or analogs such as Everolimus, Tacrolimus, Pimecrolimus, Zotarolimus, Amphilimus, Biolimus A9, etc. [6] Sirolimus is a natural macrocyclic lipophilic lactone with immunosuppressive and anti-inflammatory properties which arrests the progression of the cell cycle from the G1 to the S phase. Specifically, rapamycin binds to the 12-kDa FK506-binding protein (FKBP12) forming a complex which inhibits

the mammalian TOR complex 1 (mTOR1) inciting an antiproliferative and anti-migratory effect in SMC. [7, 8] Drug dose remains one of the most important issues in drug-eluting technology, as the optimal dosage should balance between efficiently inhibiting neointimal hyperplasia while at the same time avoiding systemic adverse events and local vascular damage. Currently, commercially available DCBs use paclitaxel dosages ranging between 2 and 3.5 µg/mm², while in DES the variability of drug dose is wider. [5, 6] Complications of drug-eluting technologies include local adverse events, such as late stent thrombosis, particulate embolization, vessel-wall necrosis and aneurysm formation, as well as potential systemic effects such as myelosuppression, systemic and hematologic toxicity probably due to oxidative stress, while concerns have been raised regarding the safety of paclitaxel-eluting technologies for the treatment of femoropopliteal disease. [9-12]

References

1. Hirsch AT, Haskal ZJ, Hertzer NR, et al ACC/AHA Guidelines for the Management of Patients with Peripheral Arterial Disease (lower extremity, renal, mesenteric, and abdominal aortic): a collaborative report from the American Associations for Vascular Surgery/Society for Vascular Surgery, Society for Cardiovascular Angiography and Interventions, Society for Vascular Medicine and Biology, Society of Interventional Radiology, and the ACC/AHA Task Force on Practice Guidelines (writing committee to develop guidelines for the management of patients with peripheral arterial disease)--summary of recommendations. *J Vasc Interv Radiol.* 2006;17(9):1383-97; quiz 1398.
2. Weintraub WS. The Pathophysiology and Burden of Restenosis. *Am J Cardiol* 2007; 100[suppl]:3K-9K.
3. Nikol S, Huehns TY, Hofling B. Molecular biology and post-angioplasty restenosis. *Atherosclerosis* 1996; 123:17-31.
4. Pastromas G, Katsanos K, Krokidis M, Karnabatidis D, Spiliopoulos S. Emerging stent and balloon technologies in the femoropopliteal arteries. *Scientific World Journal.* 2014;2014:695402.
5. Moreno R. Drug-eluting stents and other anti-restenosis devices. *Rev Esp Cardiol.* 2005;58(7):842-62.
6. Karnabatidis D, Spiliopoulos S, Katsanos K, Siablis D. Below-the-knee drug-eluting stents and drug-coated balloons. *Expert Rev Med Devices.* 2012;9(1):85-94.
7. Marx SO, Marks AR. Bench to bedside: the development of rapamycin and its application in-stent restenosis. *Circulation* 2001;104:852-5.
8. Li J, Kim SG, Blenis J. Rapamycin: one drug, many effects. *Cell Metab.* 2014;19(3):373-9.
9. Diamantopoulos A, Gupta Y, Zayed H, Katsanos K. Paclitaxel-coated balloons and aneurysm formation in peripheral vessels. *J Vasc Surg.* 2015;62(5):1320-2.
10. Limeres J, Lip GYH, Del Blanco BG, et al. Safety of drug-eluting stents compared to bare metal stents in patients with an indication for long-term oral anticoagulation: A propensity score matched analysis. *Thromb Res.* 2019;177:180-186.
11. Campos FC, Victorino VJ, Martins-Pinge MC, Cecchini AL, Panis C, Cecchini R. Systemic toxicity induced by paclitaxel in vivo is associated with the solvent cremophor EL through oxidative stress-driven mechanisms. *Food Chem Toxicol.* 2014;68:78-86.
12. Katsanos K, Spiliopoulos S, Kitrou P, Krokidis M, Karnabatidis D. Risk of Death Following Application of Paclitaxel-Coated Balloons and Stents in the Femoropopliteal Artery of the Leg: A Systematic Review and Meta-Analysis of Randomized Controlled Trials. *J Am Heart Assoc.* 2018;7(24):e011245.

1002.2

Drug-coated balloons: are there any differences?

G. Tepe

Diagnostic and Interventional Radiology, Medical Centre of Rosenheim, Rosenheim, DE

Learning Objectives

1. To understand the differences in balloon coating technologies
2. To understand the differences in trial design
3. To understand differences in terms of outcome and how this was achieved

No abstract available.

1002.3

Drug-eluting stents: are there any differences?

S. Müller-Hülsbeck

Department of Diagnostic and Interventional Radiology / Neuroradiology, Ev.-Luth. Diakonissenanstalt zu Flensburg, Flensburg, DE

Learning Objectives

1. To understand the differences in stent coating technologies
2. To understand the differences in trial design
3. To understand differences in terms of outcome and how this was achieved

The first trial comparing a self-expanding Nitinol stent with a drug-eluting stent (DES) was done by Duda et al (1). The stent platform was combined with a Polymer and Sirolimus (Sirocco trial). The expectation were not met with this concept and therefor stopped. A second trial dealing with an Everolimus eluting self-expanding Nitinol stent combined with a polymer failed also, because the outcome was disappointing (2). Both attempts never reached marked approval and the worse outcome was related to some thrombogenicity and incompatibility of the Polymers used. This was probably the reason why the ZilverPTX Paclitaxel eluting stent was released to the market and approved without any Polymer. The results are promising and long-term data are already available. Boston Scientific tried in a first in man trial the concept of a DES combined with a Polymer established in cardiology for sustained drug release (4). Preliminary results were that promising that a multicenter trial comparing these two DES philosophies in randomized IMPERIAL trial (5). The 1-year-data were in terms of primary patency and TLR in favor for the Eluvia stent. Parallel other DES concepts, again with Sirolimus elution were developed and tested. This is with respect to Katsano's meta-analysis of drug-based technologies (Paclitaxel) used for femoropopliteal PAD treatment showed an increased mortality of patients receiving Paclitaxel.

Latest developments, including Sirolimus DES as potential alternatives, and findings with regard to DES for femoropopliteal implantation will be covered and rated with respect to latest findings, especially with regard to signals of mortality and DES use.

References

1. Duda SH, Bosiers M, Lammer J, Scheinert D, Zeller T, Oliva V, Tielbeek A, Anderson J, Wiesinger B, Tepe G, Lansky A, Jaff MR, Mudde C, Tielemans H, Beregi JP. Drug-eluting and bare nitinol stents for the treatment of atherosclerotic lesions in the superficial femoral artery: long-term results from the SIROCCO trial. *J Endovasc Ther.* 2006 Dec;13(6):701-10.
2. Lammer J, Bosiers M, Zeller T, Schillinger M, Boone E, Zaugg MJ, Verta P, Peng L, Gao X, Schwartz LB. First clinical trial of nitinol self-expanding everolimus-eluting stent implantation for peripheral arterial occlusive disease. *J Vasc Surg.* 2011 Aug;54(2):394-401.
3. Dake MD, Ansel GM, Jaff MR, Ohki T, Saxon RR, Smouse HB, Machan LS, Snyder SA, O'Leary EE, Ragheb AO, Zeller T; Zilver PTX Investigators. Durable Clinical Effectiveness With Paclitaxel-Eluting Stents in the Femoropopliteal Artery: 5-Year Results of the Zilver PTX Randomized Trial. *Circulation.* 2016 Apr 12;133(15):1472-83.

4. Müller-Hülsbeck S, Keirse K, Zeller T, Schroë H, Diaz-Cartelle J. Twelve-Month Results From the MAJESTIC Trial of the Eluvia Paclitaxel-Eluting Stent for Treatment of Obstructive Femoropopliteal Disease. *J Endovasc Ther.* 2016 Oct;23(5):701-7.
5. Gray WA, Keirse K, Soga Y, Benko A, Babaev A, Yokoi Y, Schroeder H, Prem JT, Holden A, Popma J, Jaff MR, Diaz-Cartelle J, Müller-Hülsbeck S; IMPERIAL investigators. A polymer-coated, paclitaxel-eluting stent (Eluvia) versus a polymer-free, paclitaxel-coated stent (Zilver PTX) for endovascular femoropopliteal intervention (IMPERIAL): a randomised, non-inferiority trial. *Lancet.* 2018 Oct 27;392(10157):1541-1551.

1002.4

Adjunctive therapies to enhance drug-eluting efficacy

A. Holden

Radiology, Auckland City Hospital, Auckland, NZ

Learning Objectives

1. To understand the limitations of current drug-eluting concepts
2. To understand the importance of vessel preparation
3. To know attempts how to potentially enhance effectiveness of current drug-eluting technologies

In the era of drug delivery to reduce re-stenosis, vessel preparation has expanded to not only include an optimized angioplasty result (with minimal residual stenosis and flow-limiting dissection) but also improve drug delivery and retention in the vessel wall. By improving drug delivery to the deeper layers of the vessel wall these layers, vessel preparation devices may enhance the anti-restenotic effect, possibly for longer periods and at lower doses.

The most common vessel preparation devices include specialty balloons and atherectomy. Specialty balloons include cutting and scoring balloons as well as the Chocolate balloon. The drug-coated Chocolate drug-coated balloon (DCB) combines vessel preparation with drug delivery and has been successfully evaluated in the ENDURE Trial. The device is currently being evaluated in a prospective multicenter randomized controlled trial. Atherectomy has been shown to enhance the effect of drug-elution. This was demonstrated in the DEFINITIVE AR study where long and calcified lesions showed a significantly better patency if pre-treated by directional atherectomy followed by DCB rather than DCB alone. The REALITY Trial provides updated data on this technique.

An alternative approach in calcified arterial disease is intra-vascular lithotripsy (IVL) with Shockwave.TM This angioplasty balloon-based therapy has been shown in the DISRUPT PAD I&II Trials to effectively treat calcified femoro-popliteal stenoses with an excellent acute luminal gain and a very low incidence of stenting. However, re-stenosis was significant in this patient cohort and the DISRUPT PAD III Trial (comparing IVL followed by DCB to plain balloon angioplasty followed by DCB) is currently enrolling. An update of this important trial will be provided as well as lessons from the Observational Registry which includes a large "real world" cohort of patients.

Several other dedicated vessel preparation devices will be discussed. These include the Cagent Serranator device, evaluated in the Prelude study. An interesting approach is a temporary spur stent technology from Reflow Medical which potentially provides successful angioplasty with a low incidence of late recoil and improved drug delivery. The device has the additional advantage of being agnostic to the choice of anti-restenotic drug. Finally, treating complex arterial disease, an incidence of residual stenosis and dissection requiring scaffolding is expected. An alternative to conventional stents is tacks from Intact Vascular. These devices provide a very focal scaffold, minimizing the amount of metal and maintaining normal vessel physiology. These have been extensively studied and evaluated in the TOBA II trial and results will be presented.

Focus Session Update on pelvic embolisation

1005.1

Pelvic congestion syndrome

J. Egge

Department of Radiology, Haugesund Sjukehus, Haugesund, NO

Learning Objectives

1. To understand the pathophysiology behind the disease
2. To learn about the typical symptoms
3. To learn about the evidence for treatment

Introduction

Pelvic congestion syndrome (PCS) is a poorly understood condition affecting a high proportion of the female population. It is defined by the presence of pelvic varicoceles and ovarian vein reflux, as a result of pelvic venous incompetence, with an increased incidence in the postpartum cohort (1).

It is believed that the hormonal changes and weight gain, along with the anatomic changes in the pelvic structures during pregnancy, can cause increased pressure within the ovarian veins and weaken the vein wall, leading to dilatation (the condition of being stretched beyond normal dimensions). Furthermore Estrogen has been identified as a factor that weakens the vein walls, thus predisposing women to PCS (2).

In normal veins, blood flows from the pelvis up toward the heart in the ovarian vein, and is prevented from flowing backwards by valves within the vein. In dilated ovarian veins, the valves do not close properly, resulting in backwards flow of blood, reflux (3).

Consequently, there is pooling of blood within the pelvis that leads to pelvic varicose veins and clinical symptoms of pain and the sensation of heaviness. Although the underlying pathophysiology of pelvic congestion syndrome is unclear, it probably results from a combination of (1) dysfunctional or absent venous valves, (2) kinking from uterine malposition, (3) retrograde blood flow, (4) venous hypertension and (5) dilatation (3, 4, 5, 6, 7).

Asymptomatic women may also have pelvic varicosities, making pelvic congestion syndrome difficult to diagnose (6, 8, 9, 10).

As the condition can present with non-specific symptoms, the exclusion of other gynaecological disorders such as pelvic inflammatory disease, endometriosis, adenomyosis and uterine fibroids is essential (11).

There is also an increasing incidence of pelvic varicosities in patients with recurrence of lower limb varicose veins (12).

Symptoms

The prevalence of Chronic pelvic pain is 15% in females aged 18 to 50 years in the United States and up to 43.4% worldwide. 30 to 40% of chronic pelvic pain (CPP) cases are associated with PCS (13).

The American College of Obstetricians and Gynecologists defines Chronic pelvic pain as pain lasting for 6 months or more, localized to the pelvis, the anterior abdominal wall at or below the umbilicus, the lumbosacral back, or the buttocks, that is of sufficient severity to cause functional disability or lead to medical care (14).

Pelvic congestion syndrome is associated with pelvic varicosities that result in chronic pelvic pain and are consistently reported as chronic, noncyclic pelvic pain or heaviness which is commonly exacerbated by prolonged standing and often occurring in association with dysmenorrhea, dyspareunia, urinary urgency, and perineal or lower extremity varices (3, 4, 5, 7, 15, 16, 17, 18, 19).

Evidence

Studies show promising results for percutaneous management of PCS. A systematic review by Candace L. Brown et al. of the MEDLINE database was conducted using PubMed, Ovid SP, and Google Scholar search engines (20). The methodological framework followed PRISMA guidelines. Search parameters (29 total) included full text articles published between 1974 and February 2015 using key words "pelvic congestion syndrome" "pelvic congestion", "pelvic varices", and "ovarian vein embolotherapy". Articles

were manually reviewed for treatment of PCS, yielding 25 relevant studies. Fourteen studies of percutaneous treatment for PCS yielded a total of 828 patients and 994 unique percutaneous interventions:

- 979 for initial sclerosis or embolization of ovarian or internal iliac veins (accounting for staged procedures) (6, 12, 19, 21-31).

- 14 repeated interventions for recurrent symptoms (12, 24, 30, 31) and - one repeat intervention for technical failure at initial intervention (31).

Indication for intervention required symptom(s) of PCS in combination with signs of pelvic venous incompetence on catheter-based venography (6, 12, 19, 21-31).

The average patient age was 40 years (range: 16–72 years) (6, 12, 19, 21-31). The average follow-up interval was 36.1 months (range: 1–288 months) (6, 12, 19, 21-31). The post-procedure length of stay ranged from 4 to 24 hours with procedures occurring in the outpatient setting (12, 22, 23, 25, 30, 31) or overnight observation (6, 19, 27, 30).

Reported complications ranged from 0.85 to 10% (M: 4.95, IQRQ3–Q1: 5.4) and were minor without sequelae: 6 cases of vessel perforation, 20 cases of nontarget embolization, 6 groin hematomas, 1 arrhythmias, 1 internal iliac venous thrombus, and 2 contrast reactions among 944 unique procedures (6, 19, 21, 22, 24-31). There were no significant differences in outcomes between parous and nulliparous subpopulations.

From a total of 266 patients, 75.2% reported improvement of dysmenorrhea (19, 27).

From a total of 210 patients, 85.2% reported improvement of dyspareunia (12, 19, 22, 23, 24, 27, 31).

From a total of 149 patients, 98.7% reported improvement of urinary urgency (19, 22, 23, 27).

Clinical improvement following coil embolization ranged from 82.1 to 100% (M: 95.8, IQRQ3–Q1: 6.1) in 473 patients. (19, 20, 24, 25, 27, 28, 29).

Clinical improvement following embolization with glue and lipidized oil ranged from 68.3 to 73.7% (M: 71, IQRQ3–Q1: 5.4) in 60 patients (12, 22). Clinical success involving mixed percutaneous methods, including sclerosant with coil and/or Gelfoam embolization, ranged from 83 to 100% (M: 94.9, IQRQ3–Q1: 17.1) in 196 patients (6, 26, 30, 31).

Percutaneous embolization for PCS was an effective method of treatment with a high percentage of symptom improvement (reported in 697 of 762 patients). Procedural complications in percutaneous treatment of PCS were minor and uncommon, reported in 36 of 944 procedures (6, 19, 20, 22, 25-31). Reports of worsening symptoms after percutaneous treatment for PCS were rare, reported in just 6 of 710 patients (6, 21). No additional treatment-related sequelae were identified.

Conclusion:

PCS is a prevalent and treatable condition for which percutaneous treatment is safe and effective. Thorough clinical and imaging evaluation by a provider who is familiar with the associated diagnostic pitfalls is imperative, as the indication for treatment of PCS requires both clinical symptom(s) and associated venous incompetence.

Catheter-directed venography, compared with noninvasive imaging, demonstrates improved sensitivity in detecting venous insufficiency, as well as providing the benefits of simultaneous diagnosis and treatment, and a high rate of success in improving clinical symptoms.

References

1. Champaneria R, Shah L, Moss J, et al. The relationship between pelvic vein incompetence and chronic pelvic pain in women: systematic reviews of diagnosis and treatment effectiveness. *Health Technol Assess* 2016;20(5)
2. Foong LC, Gamble J, Sutherland IA, et al. Altered peripheral vascular response of women with and without pelvic pain due to congestion. *Br J Obstet Gynaecol* 2000;107:157–64.
3. Phillips D, Deipolyi AR, Hesketh RL, et al. Pelvic congestion syndrome: etiology of pain, diagnosis, and clinical management. *J Vasc Interv Radiol* 2014;25(05):725–733.
4. Ganesan A, Upponi S, Hon LQ, et al. Chronic pelvic pain due to pelvic congestion syndrome: the role of diagnostic and interventional radiology. *Cardiovasc Intervent Radiol* 2007;30(06):1105–1111.
5. Durham JD, Machan L. Pelvic congestion syndrome. *Semin Intervent Radiol* 2013;30(04):372–380.

6. Kim HS, Malhotra AD, Rowe PC, et al. Embolotherapy for pelvic congestion syndrome: long-term results. *J Vasc Interv Radiol* 2006;17(2, Pt 1):289–297.
7. Ignacio EA, Dua R, Sarin S, et al. Pelvic congestion syndrome: diagnosis and treatment. *Semin Intervent Radiol* 2008;25(04):361–368.
8. Dos Santos SJ, Holdstock JM, Harrison CC, et al. Ovarian vein diameter cannot be used as an indicator of ovarian venous reflux. *Eur J Vasc Endovasc Surg* 2015;49(01):90–94.
9. Nascimento AB, Mitchell DG, Holland G. Ovarian veins: magnetic resonance imaging findings in an asymptomatic population. *J Magn Reson Imaging* 2002;15(05):551–556.
10. Rozenblit AM, Ricci ZJ, Tuvia J, Amis ES Jr. Incompetent and dilated ovarian veins: a common CT finding in asymptomatic parous women. *AJR Am J Roentgenol* 2001;176(01):119–122.
11. Latthe P, Mignini L, Gray R, et al. Factors predisposing women to chronic pelvic pain: systematic review. *BMJ* 2006;332(7544):749–755.
12. Meneses L, Fava M, Diaz P, et al. Embolization of incompetent pelvic veins for the treatment of recurrent varicose veins in lower limbs and pelvic congestion syndrome. *Cardiovasc Intervent Radiol* 2013;36(01):128–132.
13. Mathias SD, Kuppermann M, Liberman RF, et al. Chronic pelvic pain: prevalence, health related quality of life, and economic correlates. *Obstet Gynecol*. 1996;87(03):321–327.
14. ACOG Practice Bulletin No. 51. Chronic pelvic pain. ACOG Committee on Practice Bulletins--Gynecology. *Obstet Gynecol*. 2004 Mar;103(3):589–605.
15. Beard RW, Reginald PW, Wadsworth J. Clinical features of women with chronic lower abdominal pain and pelvic congestion. *Br J Obstet Gynaecol* 1988;95(02):153–161.
16. Latthe P, Latthe M, Say L, Gülmezoglu M, Khan KS. WHO systematic review of prevalence of chronic pelvic pain: a neglected reproductive health morbidity. *BMC Public Health* 2006;6:177–183.
17. Zondervan KT, Yudkin PL, Vessey MP, et al. The community prevalence of chronic pelvic pain in women and associated illness behaviour. *Br J Gen Pract* 2001;51(468):541–547.
18. Koo S, Fan CM. Pelvic congestion syndrome and pelvic varicosities. *Tech Vasc Interv Radiol* 2014;17(02):90–95.
19. Laborda A, Medrano J, de Blas I, et al. Endovascular treatment of pelvic congestion syndrome: visual analog scale (VAS) long-term follow-up clinical evaluation in 202 patients. *Cardiovasc Intervent Radiol* 2013;36(04):1006–1014.
20. Brown CL, MA, Rizer M, Alexander R, et al. Pelvic Congestion Syndrome: Systematic Review of Treatment Success. *Semin Intervent Radiol* 2018;35:35–40.
21. Capasso P, Simons C, Trotteur G, Dondelinger RF et al. Treatment of symptomatic pelvic varices by ovarian vein embolization. *Cardiovasc Intervent Radiol* 1997;20(02):107–111.
22. Maleux G, Stockx L, Wilms G, Marchal G. Ovarian vein embolization for the treatment of pelvic congestion syndrome: long-term technical and clinical results. *J Vasc Interv Radiol* 2000;11(07):859–864.
23. Venbrux AC, Chang AH, Kim HS, et al. Pelvic congestion syndrome (pelvic venous incompetence): impact of ovarian and internal iliac vein embolotherapy on menstrual cycle and chronic pelvic pain. *J Vasc Interv Radiol* 2002;13(2, Pt 1):171–178.
24. Pieri S, Agresti P, Morucci M, de' Medici L. Percutaneous treatment of pelvic Congestion syndrome. *Radiol Med (Torino)* 2003;105(1-2):76–82.
25. Chung MH, Huh CY. Comparison of treatments for pelvic congestion syndrome. *Tohoku J Exp Med* 2003;201(03):131–138.
26. Kwon SH, Oh JH, Ko KR, et al. Transcatheter ovarian vein embolization using coils for the treatment of pelvic congestion syndrome. *Cardiovasc Intervent Radiol* 2007;30(04): 655–661.
27. Creton D, Hennequin L, Kohler F, et al. Embolisation of symptomatic pelvic veins in women presenting with non-saphenous varicose veins of pelvic origin - three-year follow-up. *Eur J Vasc Endovasc Surg* 2007;34(01):112–117.
28. Asciutto G, Asciutto KC, Mumme A, et al. Pelvic venous incompetence: reflux patterns and treatment results. *Eur J Vasc Endovasc Surg* 2009;38(03):381–386.
29. Hocquet A, Le Bras Y, Balian E, et al. Evaluation of the efficacy of endovascular treatment of pelvic congestion syndrome. *Diagn Interv Imaging* 2014;95(03):301–306.
30. Nemark AI, Shelkovich NV. Endovascular treatment of persistent dysuria and chronic pelvic pain in women with pelvic varicose veins [in Russian]. *Urologia* 2012;4(04):20–24.
31. Nasser F, Cavalcante RN, Affonso BB, et al. Safety, efficacy, and prognostic factors in endovascular treatment of pelvic congestion syndrome. *Int J Gynaecol Obstet* 2014;125(01):65–68.

1005.2

Complicated pelvic vein embolisation

A.C. Roberts

Radiology, UCSD Medical Center, Thornton Hospital, La Jolla, CA, US

Learning Objectives

1. To learn about challenging cases
2. To understand the technical tools in treating complicated cases
3. To learn about the limitations of treatment

No abstract available.

1005.3

Varicocele

M. Citone

Interventional Radiology, Careggi University Hospital, Florence, IT

Learning Objectives

1. To understand the pathophysiology behind the disease
2. To get to know the technique step-by-step
3. To learn about the success rate and alternative treatments

Varicocele is defined as a dilation of veins within the pampiniform plexus and represent one amongst the more common conditions among male population being reported in up to 20% of general male population and in up to 40% of infertile population. (1)

The etiology of primary varicocele is still unclear but believed to be multifactorial. Various theories have been proposed, including anatomical variations, congenital valvular absence or valvular incompetence, and venous obstruction. These anatomical variations result in longer blood column and greater hydrostatic pressure in the spermatic veins. Congenital valvular absence / incompetence is also believed to facilitate venous reflux in the pampiniform plexus. Secondary varicocele can result from compression or obstruction of the venous drainage by pelvic, abdominal, or renal tumors. Due to anatomic causes left sided varicocele is 10 times more common than right sided, being bilateral condition reported in 10% cases and isolated right sided varicocele in 1%. (2,3)

Indications for the treatment of varicoceles include infertility, orchalgia and testicular atrophy in the pediatric/adolescent population. Additional indications include young men with a palpable varicocele, regardless of semen parameters, and adult men with varicoceles and altered semen parameters, regardless of whether they are currently attempting to conceive. Literature data show evidence indicating that varicocele is associated with abnormal semen parameters, testicular atrophy, and Leydig cell dysfunction. Leading theories for the development of these symptoms include elevated scrotal temperature, hypoxia secondary to venous stasis, and reflux of renal and adrenal metabolites. (4,5)

Diagnosis of varicocele is grounded on physical examination and confirmed by ultrasound examination with Eco-Color-Doppler (ECD) analysis

usually demonstrating dilated peritesticular veins coupled with reflux into the pampiniform plexus during the Valsalva manoeuvre. (6) Several different surgical procedure have been described for the treatment of varicocele. Open surgical varicocelectomy can be performed according to Palomo technique (high retroperitoneal ligation of spermatic vessels), or with inguinal or subinguinal incision. More recently also laparoscopic approach has been reported. Those techniques require general anaesthesia. Common complications are hydrocele, inadvertent arterial ligation, testicular atrophy, vas deference occlusion, and epidymitis. The recurrence rate of traditional surgical procedures ranges between 0 and 37% (7) Initial report of percutaneous treatment of varicocele date back in 1978. Since then, many works have published reporting favourable results with endovascular approach. Usually retrograde varicocele embolisation is performed on outpatient basis with local anaesthesia /mild sedation. Most commonly employed access are the right common femoral or brachial vein. The latter being increasingly used, especially in right sided varicocele. Before retrograde sclerotherapy, diagnostic phlebography study of the spermatic vein is performed. Advantages of percutaneous varicocele embolization include precise anatomic delineation of the complex venous collaterals. Subsequently a catheterisation of the more distal part of the SV is performed with gentle advancement of hydrophilic wire or with micro-catheter for extremely tortuous vessel. Than in order to achieve venous occlusion a variety of embolic agents could be employed. Amongst most frequently used there are mechanical agents, mostly coils, sclerosant agents (polidocanol) or glue (n-butyl cyanoacrylate). It is also described the use of combination of coils with sclerosant agent as well as some variation in the technique of injection of sclerosant agent through an inflated balloon occlusion catheter. (8,9) Overall reported technical success in achieving spermatic vein occlusion is more than 90% regardless of the embolic employed. Technical procedural failure is mainly due to inability to perform spermatic vein catheterisation and is more frequently reported for right sided varicocele. Overall embolization-related complications were reported in less than 2% and mainly concern coil migration, venous dissection/perforation, liquid embolic agent migration in the pulmonary circulation or phlebitis of the peritesticular plexus and pain. Recurrence rate is reported to be lower than in the surgical series and has been found to range from 3% to 11% in the published literature. Recurrent and persistent varicocele may occur after surgical and radiological treatment. Percutaneous embolization has proven to be successful in the management of recurrent varicocele and it is considered the treatment of choice after surgical recurrence/failure. (10,11,12, 13)

Outcomes of varicocele treatment in terms of fertility rate remain debate matter. Although some authors report unclear correlation between treatment of varicocele and improved fertility, recent literature data have demonstrated clear association between varicocele treatment, including embolization, and significant improvement in semen parameters as well as increased spontaneous pregnancy rates compared with non-intervention. Spontaneous pregnancy rate are reported in up to 33% of the treated patients and semen parameters resulted in a 15% improvement in sperm count and in sperm motility after embolisation. (14, 15)

In conclusion percutaneous embolization represents a valuable option in the management of varicocele. Regardless of the employed embolic agent the technical success is high and the complication rate is low. Controversy still exist on the correlation between treatment of varicocele and improved fertility although recent data seem to support an increased pregnancy rate after varicocele treatment.

References

- Masson P, Brannigan RE. The varicocele. *Urol Clin North Am* 2014; 41(1):129–144
- Gat Y, Zukerman Z, Chakraborty J, Gornish M. Varicocele, hypoxia and male infertility. Fluid mechanics analysis of the impaired testicular venous drainage system. *Hum Rep.* 2005;20:2614–9.
- Grieme B, Akman A, Albayati A, Timmreck EJ, Tanski EM, Venbrux AC. Management of male varicocele. In: Mauro MA, Murphy KP, Thomson KR, Venbrux AC, Morgan RA, eds. *Image-Guided Interventions*. 2nd ed. Philadelphia, PA: Saunders; 2014:559–562
- Practice Committee of American Society for Reproductive Medicine. Report on varicocele and infertility. *Fertil Steril* 2008;90 (5, Suppl):S247–S249
- Schlegel P, Goldstein M. Alternate indications for varicocele repair: non-obstructive azoospermia, pain, androgen deficiency and progressive testicular dysfunction. *Fert Steril.* 2011;96:1288–93.
- Dogra V, Gottlieb R, Oka M, Rubens D. Sonography of the scrotum. *Radiology* 2003;227:18–36.
- Feber KM, Kass EJ (2008) Varicocelectomy in adolescent boys: long-term experience with the Palomo procedure. *J Urol* 180(4 Suppl):1657–1659 discussion 1659–1660
- No Kwak & David Siegel Imaging and Interventional Therapy for Varicoceles *Curr Urol Rep* (2014) 15:399
- Basile A et al, Left spermatic vein retrograde sclerosis: comparison between sclerosant agent injection through a diagnostic catheter versus through an occluding balloon catheter. *Radiol Med.* 2015 May;120(5):483–8
- Flacke S, Schuster M, Kovacs A, von Falkenhausen M, Strunk HM, Haidl G, Schild HH. Embolization of varicoceles: pretreatment sperm motility predicts later pregnancy in partners of infertile men. *Radiology* 2008;248:540–9.
- Granata C, Oddone M, Toma P, Mattioli G. Retrograde percutaneous sclerotherapy of left idiopathic varicocele in children: results and follow-up. *Pediatr Surg Int* 2008;24:583–7.
- Makris GC, Efthymiou E, Little M, Boardman P, Anthony S, Uberoi R, Tapping C. Safety and effectiveness of the different types of embolic materials for the treatment of testicular varicoceles: a systematic review. *Br J Radiol.* 2018 Jul;91
- Iaccarino V, Venetucci P. Interventional Radiology of Male Varicocele: Current Status *Cardiovasc Intervent Radiol* (2012) 35:1263–1280
- Cayan S, Shavakhov S, Kadioğlu A. Treatment of palpable varicocele in infertile men: a meta-analysis to define the best technique. *J Androl.* 2009;30:33–40.
- Ficarra V, Crestani A, Novara G, Mirone V. Varicocele repair for infertility: what is the evidence? *Curr Opin Urol* 2012;22:489–94.

1005.4

Haemorrhoids

V. Vidal

Service de Radiologie, Hôpital Timone Adultes, Marseille, FR

Learning Objectives

- To learn about the current evidence for embolisation of haemorrhoids
- To get to know the technique step-by-step
- To learn about the success rate and possible complications

Haemorrhoids are a common anorectal disease. They affect millions of people worldwide and are a major medical and socioeconomic problem. Internal hemorrhoids are composed of a dense anastomotic arteriovenous network, the corpus cavernosum recti (CCR). The CCR is dependent on the influx of arterial blood from the branches of the inferior mesenteric artery: the superior rectal arteries. Replacement of muscle tissue by connective tissue causes an expansion of this vascular network of the anorectal submucosa, initiating a negative vicious circle of progressive vascular dilation and venous insufficiency leading to haemorrhoidal hyperplasia. This hyperplasia causes an increase in arterial inflow in the CCR and leads to symptoms (1-5).

Chronic bleeding is the main symptom of internal hemorrhoids and could be associated with hemorrhoidal prolapse. It is widely accepted that it is difficult for patients to assess bleeding themselves and such assessment is even more difficult in this context, due to the intermittent nature of haemorrhoidal bleeding.

The severity of bleeding symptoms is now assessed according to the French bleeding score, ranging from 0 (no bleeding) to 9 (daily bleeding with anemia requiring blood transfusions) (6).

The Goligher's classification assessed the degree of internal hemorrhoid prolapse from I (no prolapse) to IV (irreducible prolapse).

The lower part of the rectum and the anal canal are supplied with blood by the inferior and middle rectal arteries, both of which have origins from the internal iliac artery.

Hemorrhoidal pathology treatment usually involves hygiene-dietetic measures, oral venotonic treatments and non-surgical minimally invasive therapies such as rubber band ligation, infrared photocoagulation, and sclerosing injection. However, 10% of patients will still require surgical treatment consisting of excision of the hemorrhoidal cushions and ligation of the vascular pedicles. Hemorrhoidectomy, as well as stapled hemorrhoidopexy, are validated and effective surgical techniques but are associated with long, painful postoperative courses with a significant complication rate [7,8]. Improvements in anatomical understanding and the need to develop minimally invasive approaches have led to the development of the Doppler-Guided Haemorrhoidal Artery Ligation procedure (DG HAL). It was developed a decade ago following the anatomical work of Aigner et al [9], which confirmed the vascular theory of hemorrhoids and the arterial supply of the CCR by the superior rectal artery branches. DG HAL involves the identification of the terminal superior rectal artery branches at the upper part of the anal canal through an anoscope and their ligation, to decrease the flow of arterial blood to the CCR. This intervention is carried out via a transanal approach under anaesthesia. This technique is significantly less painful and less susceptible to complications than open surgery, allowing patients to return to work more rapidly (10). Following the same principle, we proposed in 2014 to perform hemorrhoidal artery embolization, termed Emborrhoid (11). This technique involves endovascular coil occlusion of the distal branches of the superior rectal artery arising from the inferior mesenteric artery. This technique has several advantages: it leaves the haemorrhoidal tissue in place, preserves anal continence and does not involve the creation of rectal wounds (no local care required).

The goal of the embolisation is not to « kill » the CCR, but to reduce the blood flow in the CCR.

The embolization is performed under local anesthesia via a femoral arterial approach. The inferior mesenteric artery is cannulated with a 4 French catheter type Simmons or Sidewinder.

Angiography is performed to identify all superior rectal artery branches supplying the corpus cavernosum recti. Each superior rectal artery branch is catheterized using a microcatheter. The branches supplying the internal hemorrhoids are embolized with 2mm or 3mm diameter microcoils. Patients returned home on the same day of their treatment.

Technical success is defined as the ability to occlude all target branches from the superior rectal artery. If a large anastomotic middle rectal artery is seen on angiogram, an internal iliac artery catheterization is performed in order to confirm its involvement with the hemorrhoidal vascularization. Embolization of this middle rectal artery is performed with coils.

The clinical success is evaluated with the improvement of the symptoms by the 3rd and 12th month examination (reduction in the French bleeding score and amelioration of the quality of life).

Results of emborrhoid had been reported by French and European teams in publications and meeting (6,11-13). The mean technical success is around 95 %. Catheterization of superior rectal arteries is not challenging. The mean number of superior rectal artery branches embolized per patient vary from 3 to 6. The average number of coils used is 6 (±3). The average procedure time is one hour.

At follow-up, the patient satisfaction rate (75 %) and quality of life are correlated with improvements in the bleeding score (2 to 3 points).

No minor or major complications according to the Clavien-Dindo and the Society of Interventional Radiology classifications has been notified. No cases of anorectal ischemia, anal incontinence, hemorrhoidal thrombosis, or complications related to the femoral arterial puncture occurred. 25 % of patients describe not enough significantly improved symptoms at one year despite some of them had undergone a second embolization. Among these patients, some could be considered as relative clinical failures: bleeding recurrence under anticoagulation.

However, embolization did not decrease bleeding in some patients, probably due to the presence of unrecognized anatomical variations and the effects of coagulation disorders.

Technical failure can occur if the access to the inferior mesenteric artery is impossible (atherosclerosis). In one case, superior rectal artery posterior trunk had a vasospasm during catheterization. In this case, the embolization of the posterior hemorrhoidal branches could not be achieved. One limitation of embolization is its possible lack of effect on prolapse (stage IV), which might still require conventional surgical treatment. Hemorrhoidal artery coil embolization is a painless technique and can be performed as an outpatient procedure because there is no direct anorectal trauma. Among the non-surgical minimally invasive techniques available for the treatment of hemorrhoids, the rubber band ligation (RBL) offers the best one year-results with an estimated 50 -70% success rate [14]. DGHAL is the least invasive surgical technique [15], based on the same physiopathological concept as embolization and is the most comparable technique. A recent meta-analysis of 28 studies evaluating DGHAL showed a pooled clinical success rate of 82.5% [10]. A large randomized study comparing DGHAL and RBL, showed a 30% recurrence rate at one year after DGHAL [16].

There is no report of major or minor complications for emborrhoid treatment. This is related to a distal superselective embolization of the superior rectal artery hemorrhoidal branches. Preservation of the upper branches feeding the anorectal wall and anastomoses prevents the occurrence of any ischemic complications.

The complication rate reported with DGHAL ranges from 7-15% [10]. It is approximately and less than 5% with RBL [14]. These complications include pain, bleeding, and urinary retention. While these complications are generally benign and common for the transanal route, they may prolong the length of hospitalization and delay a return to normal activities (7). Emborrhoid technique is a painless technique and can be performed as an outpatient procedure because there is no direct anorectal trauma: it leaves the haemorrhoidal tissue in place, preserves anal continence and does not involve the creation of rectal wounds (no local care required). Emborrhoid is also indicated in patients who require compassionate care and have surgical contraindications.

For this different reasons, Emborrhoid technique is promote. There is now a clear need for a randomized controlled study, which would be the best way to confirm the real benefits of this technique.

References

1. Thompson HF, The nature of hemorrhoids. *Br J Surg* 1975; 62: 542-552.
2. Schuurman JP, Go PM, Bleys RL. Anatomical branches of the superior rectal artery in the distal rectum. *Colorectal Dis* 2009; 11: 967-971.
3. Stelzner F. The corpus cavernosum recti. *Dis Colon Rectum*. 1964; 7: 398-399.
4. Chung YC, Hou YC, Pan AC. Endoglin (CD105) expression in the development of haemorrhoids. *Eur J Clin Invest*. 2004; 34: 107-112
5. Aigner F, Bodner G, Gruber H et al. The vascular nature of hemorrhoids. *J Gastrointest Surg* 2006; 10: 1044-1050
6. Moussa N, Sielezneff I, Sapoval M et al. Embolization of the superior rectal arteries for chronic bleeding due to hemorrhoidal disease. *Colorectal Dis*. 2017; 19: 194-199
7. Simillis C, Thoukididou SN, Slessor AAP, Rasheed S, Tan E, Tekkis PP. Systematic review and network meta-analysis comparing clinical outcomes and effectiveness of surgical treatments for haemorrhoids. *Br J Surg* 2015; 102: 1603-1618
8. Watson AJ, Hudson J, Wood J et al. Comparison of stapled haemorrhoidopexy with traditional excisional surgery for haemorrhoidal disease (eTHoS): a pragmatic, multicentre, randomised controlled trial. *Lancet* 2016; 388: 2375-2385
9. Aigner F, Bodner G, Conrad F, Mbaka G, Kreczy A, Fritsch H. The superior rectal artery and its branching pattern with regard to its clinical influence on ligation techniques for internal hemorrhoids. *Am J Surg* 2004;187: 102-108

10. Pucher PH, Sodergren MH, Lord AC, Darzi A, Ziprin P. Clinical outcome following Doppler-guided haemorrhoidal artery ligation: a systematic review. *Colorectal Dis* 2013; 15: 284-294
11. Vidal V, Louis G, Bartoli JM, Sielezneff Y et al. Embolization of the hemorrhoidal arteries (the emborrhoid technique): a new concept and challenge for interventional radiology. *Diagn Interv Imaging* 2014; 95: 307-315
12. Vidal V, Sapoval M, Sielezneff Y et al. Emborrhoid: a new concept for the treatment of hemorrhoids with arterial embolization: the first 14 cases. *Cardiovasc Intervent Radiol*. 2015; 38: 72-78
13. Zakharchenko, Y. Kaitoukov, Y. Vinnik. Safety and efficacy of superior rectal artery embolization with particles and metallic coils for the treatment of hemorrhoids (Emborrhoid technique). *Diagn Interv Imaging* 2016; 97: 1079-1084
14. Brown SR, Tiernan JP, Watson AJM, et al. Haemorrhoidal artery ligation versus rubber band ligation for the management of symptomatic second-degree and third-degree haemorrhoids (HubBLE): a multicentre, open-label, randomised controlled trial. *Lancet* 2016; 388: 356-364
15. Zagryadskiy E, Gorelov S. Transanal Doppler-guided Hemorrhoidal Artery Ligation and Recto Anal Repair vs Closed Hemorrhoidectomy for treatment of grade III-IV hemorrhoids. A randomized trial *Pelviperrineology* 2011; 30: 107-112
16. Brown SR, Tiernan JP, Watson AJM, et al. Haemorrhoidal artery ligation versus rubber band ligation for the management of symptomatic second-degree and third-degree haemorrhoids (HubBLE): a multicentre, open-label, randomised controlled trial. *Lancet* 2016; 388: 356-364

Controversy Session

Carotid artery disease

1101.1

Carotid artery stenting for asymptomatic patients

D. Vorwerk

Zentrum für Radiologie und Neuroradiologie, Klinikum Ingolstadt, Ingolstadt, DE

Learning Objectives

1. To understand the rationale of carotid artery stenting for asymptomatic patients
2. To understand the importance of patient selection for treatment of asymptomatic patients
3. To know challenges for treatment of asymptomatic patients

For decades, vascular surgery has been performed on asymptomatic patients with high-grade carotid artery stenosis and was based on the results of older trials. Actually, asymptomatic patients presented the majority of patients for carotid artery surgery. There is now a growing reservation against treatment of asymptomatic patients in general and most guidelines limit carotid artery stenting to symptomatic patients only while surgery is not.

Intellectually, this is difficult to swallow, as stenting and surgery have gained similar long-term results with regard to permanent neurological deficits but a tendency for minor strokes without permanent sequelae in stenting. This was found both for asymptomatic and symptomatic patients.

Moreover, there are several individual constellations where stenting has technical advantages over surgery also in asymptomatic patients. Therefore, we need to define which asymptomatic patients should undergo treatment in general but not to primarily exclude asymptomatic patients from stenting.

1101.2

Carotid artery stenting is just for symptomatic patients

T.J. Cleveland

Radiology, Sheffield Vascular Institute; Northern General Hospital, Sheffield, UK

Learning Objectives

1. To understand the rationale of carotid artery stenting for symptomatic patients
 2. To understand the importance of patient selection for treatment of symptomatic patients
 3. To know challenges for treatment of symptomatic patients
- "Medicine's much hailed ability to help the sick is fast being challenged by its propensity to harm the healthy" – Moynihan 2012¹

INTRODUCTION

Carotid artery stenting (CAS) is an established way of treating carotid artery stenosis.

It has recently had an extension to its indication, in the acute phase of stroke, where a stenosis has either been responsible for an acute embolic event, or presents an obstruction to access for mechanical thrombectomy. In such patients a stent may be placed as a part of the thrombectomy procedure, but by definition, these patients are symptomatic.

For the remainder of carotid stenting practice, the procedure is for stroke prevention, as indeed is the case for endarterectomy.

There are therefore two sets of circumstances, which we need to consider: A carotid artery stenosis that has been identified, but which has not caused a neurological event which might have been considered to be as a consequence of the stenosis

An otherwise asymptomatic carotid stenosis, which presents a high risk of stroke should the patient undergo a high-risk procedure, such as coronary artery or cardiac surgery.

WHAT IS AN ASYMPTOMATIC CAROTID STENOSIS?

Asymptomatic carotid atherosclerotic disease refers to the presence of atherosclerotic narrowing of the extracranial internal carotid artery in individuals without a history of recent ipsilateral carotid territory ischemic stroke or transient ischemic attack (TIA). An asymptomatic carotid stenosis carries with it a significantly lower risk of stroke than one which has been recently symptomatic.

It is generally recognised, and accepted, that if symptoms arise from a carotid stenosis, then the risk of recurrent events is high, and particularly so in the days and weeks following the symptomatic event. Whilst males and females show differing patterns, with women's risk of recurrent stroke dropping more rapidly than men, it is generally accepted that if a carotid stenosis has been symptomatic, once three months have passed without symptoms the overall risk has returned to that seen for carotid stenoses that have never been symptomatic.

Therefore an asymptomatic carotid stenosis is one that has never been symptomatic, or has not been symptomatic for more than three months. It should be remembered that a patient with an asymptomatic carotid stenosis not only has a risk of stroke, but is also at high risk of myocardial infarction, which will benefit from the similar intensive medical therapies which can be used to reduce the stroke risk. Indeed the risk of myocardial infarction in patients with asymptomatic carotid stenosis is higher than their risk of stroke. In the Veteran's Administration Trial of asymptomatic carotid stenosis, patients with no prior history of coronary disease had a 33% 4-year risk of myocardial infarction². Therefore all patients who have asymptomatic carotid stenosis should receive, and practice, intensive medical therapy.

WHAT IS INTENSIVE MEDICAL THERAPY?

This is a combination of lifestyle choices and modifications, along with drug therapy³.

Lifestyle – The US Health Professional Study identified 5 healthy lifestyle choices (not smoking, moderate alcohol intake, BMI <25, 30 minutes of daily exercise, healthy diet score), which if all five were adopted reduced the risk of stroke by 80%. In Sweden, healthy lifestyles reduced the risk of stroke by 60% in women.

Smoking cessation – smoking is thought to raise the risk of stroke six-fold, and even second hand smoke doubles the cardiovascular risk. It seems likely that smoking cessation is the single most effective measure for stroke prevention.

Diet – Some of the best diet evidence for vascular disease prevention comes from studies on the Cretan Mediterranean diet⁴. This is a diet which is mainly vegetarian which is high in olive oil, canola oil, vegetables, lentils, beans, chickpeas, nuts and whole grains. In secondary prevention, this type of diet can reduce the risk of stroke and recurrent myocardial infarction by 60%, and in primary prevention reduce stroke by nearly 50%. Blood pressure control – this will include compliance with treatment/drugs, avoidance of substances which patients may consume which may increase blood pressure, and identifying any underlying cause of hypertension.

Antiplatelet therapy – patients with asymptomatic carotid stenosis are at high risk of coronary events, and so should all be considered for antiplatelet therapy.

Lipid lowering drugs – these are again indicated to reduce the risk of coronary events, and should be combined with dietary advice on lipid lowering.

(B vitamin therapy) – here there is contradictory evidence.

WHAT IS THE STROKE RISK ASSOCIATED WITH AN ASYMPTOMATIC STENOSIS?

There is a widespread practice of intervention for asymptomatic carotid stenosis, be that carotid endarterectomy or stenting. This varies widely around the world (90% in the USA, around 60% in Germany and Italy, 15% in Canada and Australia and 0 in Denmark).

Such a disparity of itself indicates uncertainty as to the benefit.

So what is the justification? This comes from the comparison of the risks of modern techniques of intervention, compared with the historical risks seen in the medical arms of older trials, before the intensive medical treatment outlined above were instituted or known to be effective. It was generally accepted that the yearly risk of stroke from a high grade (greater than 70% lumen loss) asymptomatic stenosis of the carotid artery was in the region of 1% per year. Lesser degrees of stenosis were seen to carry lower risk levels.

With modern medical therapy this risk is much reduced, the annual risk of ipsilateral stroke from an asymptomatic stenosis is only in the region of 0.5%^{5, 6, 7}.

WHAT ARE THE RISKS OF CAS IN ASYMPTOMATIC STENOSIS?

Two recent studies indicated that, after the perioperative risks of CAS and CEA were deducted, the annual stroke risk associated with the treated segment was in the region of 0.5%^{8,9}.

This is similar, therefore, to the yearly risks for an asymptomatic carotid stenosis treated with optimal non-interventional methods.

However, this does not take into account the procedural risks of the intervention.

In the ACT-1 trial the 30 day risk of stroke or death for CAS was 2.9%.

In the CREST Trial, the 30 day risk of stroke or death in the asymptomatic group of patients was 2.5% for stenting.

The risk of myocardial events are higher in CEA than CAS, but these too are higher in patients who undergo intervention, than those who embrace intensive medical therapy and lifestyle changes.

IS ROUTINE CAS IN ASYMPTOMATIC CAROTID STENOSIS JUSTIFIED?

Modern methods of reducing stroke in asymptomatic carotid stenosis reduces the yearly risk to 0.5%, and that carotid stenting will carry approximately the same yearly risk following successful treatment, there is no justification for the additional procedure. Indeed the procedure carries with it an additional, unnecessary risk of stroke, which exceeds that of optimal medical therapy (which should be instigated in all patients due to the reduction in myocardial events).

The answer to the question is therefore – no.

IS THERE A HIGH RISK GROUP WHO MAY BENEFIT FROM INTERVENTION?

The main theoretical concern related to non-interventional treatment of asymptomatic carotid stenosis is that the appearances of ulcerated high grade plaque leads many to worry that these may result in the

formation of thrombus and subsequent embolus. It is less related to the concern of internal carotid artery occlusion (much less likely to happen with intensive medical therapy).

The best-validated method of trying to assess a clinically asymptomatic patient, with a stenosis, for their risk of an embolic stroke, is to perform trans cranial Doppler (TCD). In 2005, Spence et al¹⁰ reported that patients with asymptomatic carotid stenosis and 2 or more micro emboli in 1 hour of TCD monitoring, had a 15% 1 year risk of stroke (considerably higher than the risk of intervention). Other approaches to identifying high risk patients include:

cerebrovascular reserve

intra-plaque haemorrhage on MRI

ulceration on 3D ultrasound

inflammatory plaque on PET/CT

These have yet to be proven to be useful clinically, and are not in general routine clinical practice.

WHAT ABOUT ASYMPTOMATIC CAS PRIOR TO CABG?

There has long been controversy in relation to the risks and benefits of treatment for patients with concomitant carotid and coronary artery disease.

There seems little debate that patients who have been recently symptomatic from carotid stenosis, who also warrant coronary artery (and/or aortic, mitral or combination) surgery benefit from treatment of their carotid arteries. The uncertainty lies in the arena of patients with asymptomatic carotid stenosis.

In patients who are being considered for coronary artery bypass grafting (CABG), the existence of carotid artery disease is thought to represent an increased risk of stroke at the time of CABG. The rationale for treating carotid artery disease, either before or synchronously, with CABG is that this will reduce the risk of post-CABG stroke. However, the aetiology of stroke post CABG is multifactorial and there remains debate as to what proportion of these strokes might be attributable to embolisation or haemodynamic failure secondary to the carotid artery disease. This is particularly so in patients who have previously been neurologically asymptomatic.

In 2017, Paraskevas et al published an updated systematic review and meta-analysis of carotid stenting prior to coronary artery bypass surgery¹¹. They came to the conclusion that the majority (80%) of CAS and CABG procedures were done in asymptomatic patients with unilateral carotid stenosis with a 30-day death and stroke rate of 6.7% and death/stroke and MI rate of 8.5%. They found that CAS and CABG done on the same day was not associated with a significant increase in procedural risks. Interestingly they found that there were 5 different strategies in relation to antiplatelet medications, and that whilst there was too much heterogeneity to make statistic conclusions, the highest (16%) stroke/death/MI rate was when dual antiplatelet therapy was started pre-CAS and not stopped pre-CABG. The highest risk of bleeding complications was seen when a single antiplatelet was started pre-CAS and continued through CABG, and boosted to dual after CABG. The lowest was when dual antiplatelets were started pre-CAS and then both agents were stopped prior to CABG. There were broadly similar outcomes when CEA and CAS were combined with CABG, and they considered that CAS is a reasonable alternative to CEA in such patients.

Data analysis of patients undergoing CABG with an asymptomatic unilateral carotid stenosis (50-99%), show that the prevalence of stroke is only 2%. In terms of patients with bilateral severe stenoses who underwent a unilateral CEA and CABG, the rate of stroke in the hemisphere on the non-operate side is only 3.8%, which would suggest that the carotid disease is unimportant as a cause of post-CABG stroke.

On the basis that the vast majority of CAS and CABG performed for asymptomatic patients are done for unilateral carotid stenosis, and that the risk of death/stroke and death/stroke/MI still exceeds the risk of death/stroke in patients undergoing isolated CABG, prophylactic CAS probably does not confer any additional safety advantage over isolated CABG in this type of patient.

Those with bilateral high grade carotid stenosis, may accrue benefit, as their procedural risk of stroke at CABG is higher¹².

CONCLUSIONS

The evidence from the literature clearly shows that whilst CAS can be undertaken in patients with asymptomatic carotid disease with low risk, this is a procedure performed to reduce the risk of future stroke. The risk of stroke occurring with intensive medical therapy and lifestyle modification in a patient with an asymptomatic carotid stenosis matches that for patients who have undergone CAS (or CEA). However, those that have undergone the intervention have taken an additional risk to achieve the same long-term risk. This is not justified, on the basis of currently available literature. Despite this large numbers of asymptomatic carotid artery stenoses are treated around the world outside clinical trials, with differing levels of enthusiasm.

In the context of concomitant carotid and coronary artery disease, the widespread practice of CAS in unilateral carotid artery disease does not appear to confer an additional benefit. In patients with bilateral high-grade carotid stenoses, there may be justification, but there remains controversy, and if the intervention carries a higher than "normal" risk, then it too may not be beneficial.

References

1. R. Moynihan, J. Doust, D. Henry Preventing overdiagnosis: how to stop harming the healthy *Brit Med J*, 344 (2012), p. e3502
2. Chimowitz MI, Weiss DG, Cohen SL, et al. Cardiac prognosis of patients with carotid stenosis and no history of coronary artery disease. Veterans Affairs Cooperative Study Group 167. *Stroke* 1994;25:759–65
3. Spence JD, Song H and Cheng D. Appropriate management of asymptomatic carotid stenosis. *Stroke and vascular Neurology*. 2016;1:e00016
4. Keys A. Mediterranean diet and public health: personal reflections. *Am J Clin Nutr* 1995;61(6 Suppl):1321S–3S
5. Spence JD, Coates V, Li H, et al. Effects of intensive medical therapy on microemboli and cardiovascular risk in asymptomatic carotid stenosis. *Arch Neurol* 2010;67:180–6.
6. Marquardt L, Geraghty OC, Mehta Z, et al. Low risk of ipsilateral stroke in patients with asymptomatic carotid stenosis on best medical treatment: a prospective, population-based study. *Stroke* 2010;41:e11–17
7. Naylor AR. Time to rethink management strategies in asymptomatic carotid artery disease. *Nat Rev Cardiol* 2012;9:116–24
8. Rosenfield K, Matsumura JS, Chaturvedi S, et al. Randomized trial of stent versus surgery for asymptomatic carotid stenosis. *N Engl J Med* 2016;374:1011–20.
9. Brott TG, Howard G, Roubin GS, et al. Long-term results of stenting versus endarterectomy for carotid-artery stenosis. *N Engl J Med* 2016;74:1021–31.
10. Spence JD, Tamayo A, Lownie SP, et al. Absence of microemboli on transcranial Doppler identifies low-risk patients with asymptomatic carotid stenosis. *Stroke* 2005;36:2373–8
11. Parakevas KI, Nduwayo S, Saratzis AN and Naylor AR. Carotid Stenting Prior to Coronary Bypass Surgery: An Updated Systematic Review and Meta-analysis. *Eur J Vasc Endovasc Surg*. 2017;53:309–319.
12. Naylor AR, Mehta Z, Rothwell PM, Bell PR. Carotid artery disease and stroke during coronary artery bypass: a critical review of the literature. *Eur J Vasc Endovasc Surg*. 2002 Apr; 23(4):283–94.

1101.3

Single-layer technology is still valid

R. Sachar

North Carolina Heart & Vascular, UNC Health Care, Raleigh, NC, US

Learning Objectives

1. To know design differences in single-layer technology
2. To know potential advantages and disadvantages of single-layer technology
3. To know the clinical outcome with single-layer technology

No abstract available.

1101.4

Multi-layer technology can improve outcomes

E. Stabile

Division of Cardiology, Department of Advanced Biomedical Sciences, University of Naples Federico II, Naples, IT

Learning Objectives

1. To know design differences in multi-layer technology
 2. To know potential advantages and disadvantages of multi-layer technology
 3. To know the clinical outcome with multi-layer technology
- Procedural and post procedural cerebral ischemic events still represent the Achilles heel of a carotid artery stenting (CAS). While the occurrence of periprocedural events has almost been annealed by the use of embolic protection device (EPDs), tailored to specific anatomic and clinical characteristics (1). Large-scale clinical data showed that adverse neurological events in the post-procedural period still account for a significant proportion of all CAS-related neurological events. The average risk of post procedural ipsilateral stroke is still quite robust, (i.e., 0.4% per year) (2, 3) and this phenomenon could be related to plaque protrusion through stent struts, which occurs in up to two thirds of the cases and is related to plaque morphology/symptomatic status and stent type (4). Recently, the risk of post-procedural adverse cerebral event has been definitively linked to the size of the carotid stent free cell area indicating a robust impact of the carotid stent design on CAS outcome (5). The need for an increase plaque coverage and decrease the risk of debris dislodgement through the stent struts has brought to the design of a new generation of dual layered carotid stents (DLS). These devices basically consist of novel thin strut nitinol stent combined with mesh covering (which can be made of nitinol or of polyethylene terephthalate -PET). The smallest cell size in the mesh can have a free cell area that goes down to less than 500 μm^2 (i.e. nitinol) or even to 165 μm^2 (i.e. PET). This feature allows the device to trap and exclude thrombus and plaque debris so to prevent acute and late embolic events from the target lesion. The firsts clinical study evaluating these devices (6, 7, 8) demonstrated devices safety, but they were not sufficiently powered for device related and clinical endpoints. A recently published patient level based meta-analysis suggested that DLS can be safely used for the guideline-based treatment of symptomatic or asymptomatic extracranial carotid artery stenosis, allowing a low rate of peri-procedural complications and of post procedural adverse events by 30 days. According to the pooled available data there are no clinical, anatomical or procedural characteristics that could be identified in relation to an increased risk of peri- or post-procedural adverse events; this includes lack of the effect of symptomatic status on the peri- or post-procedural adverse event risk (9). Finally, recent evaluation of stent malapposition (SM) to the vessel wall and residual plaque prolapse (PP), indicate that the a similar rate of SM with the available mesh covered stents and a higher risk of residual PP with the double metallic layer device (10).

The reproducibility and the clinical value of these findings should be further investigated.

References

1. Stabile E, Garg P, Cremonesi A, Bosiers M, Reimers B, Setacci C, Cao P, Schmidt A, Sievert H, Peeters P, Nikas D, Werner M, de Donato G, Parlani G, Castriota F, Hornung M, Mauri L, Rubino P. European Registry of Carotid Artery Stenting: results from a prospective registry of eight high volume EUROPEAN institutions. *Catheter Cardiovasc Interv*. 2012 Aug 1;80(2):329-34
2. Brott TG, Howard G, Roubin GS, Meschia JF, Mackey A, Brooks W, Moore WS, Hill MD, Mantese VA, Clark WM, Timaran CH, Heck D, Leimgruber PP, Sheffet AJ, Howard VJ, Chaturvedi S, Lal BK, Voeks JH, Hobson RW 2nd; CREST Investigators. Long-Term Results of Stenting versus Endarterectomy for Carotid-Artery Stenosis. *N Engl J Med*. 2016 Mar 17;374(11):1021-31
3. Rosenfield K, Matsumura JS, Chaturvedi S, Riles T, Ansel GM, Metzger DC, Wechsler L, Jaff MR, Gray W; ACT I Investigators. Randomized Trial of Stent versus Surgery for Asymptomatic Carotid Stenosis. *N Engl J Med*. 2016 Mar 17;374(11):1011-20.
4. Leal I, Orgaz A, Flores Á, Gil J, Rodríguez R, Peinado J, Criado E, Doblas M. A diffusion-weighted magnetic resonance imaging-based study of transcervical carotid stenting with flow reversal versus transfemoral filter protection. *J Vasc Surg* 2012;56:1585-90.
5. Stabile E, Giugliano G, Cremonesi A, Bosiers M, Reimers B, Setacci C, Cao P, Schmidt A, Sievert H, Peeters P, Nikas D, Sannino A, de Donato G, Parlani G, Castriota F, Hornung M, Rubino P, Esposito G, Tesorio T. Impact on outcome of different types of carotid stent: results from the European Registry of Carotid Artery Stenting. *EuroIntervention*. 2016 Jun 12;12(2):e265-70.
6. Musialek P, Mazurek A, Trystula M, Boratynska A, Lesniak-Sobelga A, Urbanczyk M, Banys RP, Brzychczy A, Zajdel W, Partyka L, Zmudka K, Podolec P. Novel PARADIGM in carotid revascularisation: Prospective evaluation of All-corer perCutaneous cArotiD revascularisation in symptomatic and Increased-risk asymptomatic carotid artery stenosis using CGuard™ MicroNet-covered embolic prevention stent system. *EuroIntervention*. 2016 Aug 5;12(5):e658-70.
7. Nerla R, Castriota F, Micari A, Sbarzaglia P, Secco GG, Ruffino MA, de Donato G, Setacci C, Cremonesi A. Carotid artery stenting with a new-generation double-mesh stent in three high-volume Italian centres: clinical results of a multidisciplinary approach. *EuroIntervention*. 2016 Aug 5;12(5):e677-83
8. Bosiers M, Deloose K, Torsello G, Scheinert D, Maene L, Peeters P, Müller-Hülsbeck S, Sievert H, Langhoff R, Bosiers M, Setacci C. The CLEAR-ROAD study: evaluation of a new dual layer micromesh stent system for the carotid artery. *EuroIntervention*. 2016 Aug 5;12(5):e671-6.
9. Stabile E, de Donato G, Musialek P, De Loose K, Nerla R, Sirignano P, Chianese S, Mazurek A, Tesorio T, Bosiers M, Setacci C, Speciale F, Micari A, Esposito G. Use of Dual-Layered Stents in Endovascular Treatment of Extracranial Stenosis of the Internal Carotid Artery: Results of a Patient-Based Meta-Analysis of 4 Clinical Studies. *JACC Cardiovasc Interv*. 2018 Dec 10;11(23):2405-2411
10. Umemoto T, de Donato G, Pacchioni A, Reimers B, Ferrante G, Isobe M, Setacci C. Optical coherence tomography assessment of newgeneration mesh-covered stents after carotid stenting. *EuroIntervention*. 2017 Dec 20;13(11):1347-1354.

1101.5

Stenting is the first option

W.A. Gray

Division of Cardiovascular Diseases, Lankenau Heart Institute, Philadelphia, PA, US

Learning Objectives

1. To understand the importance of patient selection
2. To know about patient preparation
3. To achieve knowledge why endovascular first might be an adequate treatment option

No abstract available.

1101.6

Surgery in all patients

S. Michelagnoli

Vascular and Endovascular Surgery Unit, San Giovanni di Dio Hospital, Florence, IT

Learning Objectives

1. To understand the interdisciplinary decision making process for treatment options
2. To understand potential advantages and disadvantages of surgery
3. To know developments in vascular surgery/hybrid procedures

No abstract available.

Honorary Lecture

Andreas Gruentzig Lecture

1301.1

25 years of endovascular therapy of abdominal aortic aneurysms: where do we stand now?

W. Jaschke

Universitätsklinik für Radiologie, Medizinische Universität, Innsbruck, AT

We performed the first endovascular aneurysm repair in December 1994. Since then, more than 1000 EVAR procedures were carried out. In 1994, EVAR was an experimental procedure, suitable only for a small group of patients. In 2019, more than 60% of all abdominal aortic aneurysms are treated endovascularly.

From the beginning, late aneurysm rupture was a major concern for EVAR. First generation devices suffered from lack of stable proximal fixation, long term stability of graft materials and limitations regarding graft sizes. Endoleaks type I and III proved to be the major cause of late rupture. But even with current devices, late rupture may occur in 0.9-2.4% of patients. Especially, patients with large aneurysmal necks (>30mm) are at risk for neck related adverse events (<https://doi.org/10.1177/1526602816673325>). In a recent paper published by Zacharias et al (<http://dx.doi.org/10.1016/j.jvs.2016.04.048>), 64% of all patients presenting with delayed rupture were treated outside of the instructions for use (IFU). This population of patients also had a higher rate of type Ia endoleak history (44% vs 6%; P = .001). Thus, aggressive use of EVAR in AAAs with hostile necks in the elective setting may contribute to delayed rupture and poor outcomes. Compliance with IFU is, therefore, an important factor for long term outcome.

Besides concerns regarding adequacy of EVAR for life long prevention of aneurysm related morbidity and mortality, radiation exposure of the patient and operator is a major concern. A high number of EVAR procedures are carried out by non-radiologists who are not trained in radiation protection. In addition, more complex procedures (FEVAR/BEVAR/ side branch EVAR etc) are carried out with increasing frequency. Also, the number of procedure/operator is increasing. All of these factors including

lack of adequate radiation protection measures and training may result in excessive doses to the operator and the patient. Regarding the operator, dose to the eye lens is critical. Regarding the patient, dose to the skin is of major concern. Thus, interventionalists have to be trained how to measure occupational dose, dose to the eye lens and dose to the skin of the patient. Tissue reactions in the eye lens are prevented by staying within the dose limits published in the 2014 edition of the International Basic Safety Standards. The maximum dose to the eye lens should not exceed 20mSv/a (over 5 consecutive years) and not more than 50mSv in a single year.

Hot Topic Symposium

Does ATTRACT change our DVT management practice?

1302.1

What is ATTRACT?

W.E.A. Saad

Senior (Professor) Staff Clinician, National Institute of Health (NIH), Washington, DC, US

ATTRACT (Acute venous Thrombosis: Thrombus Removal with Adjunctive Catheter-directed Thrombolysis) was a National Institutes of Health (NIH)-sponsored, phase III, multicenter trial that was designed to determine if the use of pharmacomechanical catheter-directed fibrinolysis (thrombolysis) had additional benefit to standard care for above-knee (proximal) deep vein thrombosis in preventing post-thrombotic syndrome from developing over a two year period. The primary outcome was the cumulative occurrence of post-thrombotic syndrome 6 to 24 months after randomization, as measured by the Villalta scale. Secondary outcomes include safety, general and venous disease-specific quality of life, relief of early pain and swelling, post-thrombotic syndrome severity and cost-effectiveness.

692 patients with acute proximal deep vein thrombosis involving the femoral, common femoral, and/or iliac vein were enrolled into the ATTRACT study at 56 centers. The patients were randomised as follows: 337 catheter-directed thrombolysis and anticoagulation ("interventional arm") and 355 to anticoagulation alone ("conventional arm"). The ATTRACT results show no difference in the development of post-thrombotic syndrome in the two groups (anticoagulation alone vs. anticoagulation + thrombus removal), there was a suggestion that removal of the thrombus was associated with early reduction of DVT symptoms and possibly a reduction in severity of post-thrombotic syndrome (but not its prevalence) in the long-term. In addition, there was increased risk of bleeding in the "interventional arm" (anticoagulation + thrombus removal) compared to the "conventional arm" (anticoagulation alone) which was valued at $p=0.049$.

The written and spoken opinions of the author and presenter (Wael Saad) are his alone and do not necessarily represent the opinions of the National Institutes of Health (NIH).

1302.2

What is wrong with ATTRACT?

G.J. O'Sullivan

Interventional Radiology, U.C.H. Galway, Galway, IE

The ATTRACT trial (Acute Venous Thrombosis Thrombus Removal with Adjunctive Catheter-directed Thrombolysis) (Vedantham et al. in N Engl J Med 377:2240–2252, 2017) concluded that the addition of catheter-directed thrombolysis to standard therapy with anticoagulation and compression stockings offers no significant clinical benefit over standard therapy in terms of reduction in the rate of post-thrombotic syndrome (PTS) at 2 years. It is the largest, prospective,

multi-centre, randomised controlled trial on acute deep vein thrombosis and represents the culmination of more than a decade of planning, execution and analysis. In this 8 minutes I hope to give you a snapshot as to why I feel it had serious limitations.

Despite employing the most experienced physicians and statisticians in the design and execution of this trial, with the benefit of 10–15 years of further venous experience, it does suffer from several major methodological issues.

Briefly, these can be summarised as follows:

- 1- the use of the Villalta scale. Never published; heavily weighted towards ulcers and skin changes- does not measure claudication at all
- 2- slow recruitment initially led to inclusion of femoro-popliteal DVTs. This meant the ilio-femoral arm was seriously under-powered
- 3- Selection bias. They screened 27,000 patients and recruited 700 for the trial. 1 in 50!! Screen failure was ascribed to be due to either old age or significant comorbidities in patients and not "selection bias". This is not my experience- I believe patients with IF DVT were being treated with PCDT in the enrolling centres at the time of the trial- but they were not included in the trial.
- 4- Lack of dedicated imaging, both pre- and post-intervention- no requirement for pre op CTV/MRV; no requirement for intra-operative IVUS; and no requirement for post op day 1 colour Doppler Ultrasound.
- 5- Low rate of stent deployment- 30% (meaning only 60% of patients with IF DVT had a stent placed- not remotely close to the rate typically used in major European centres (80–95%))
- 6- In analysis the **binary** results for Villalta indicate no benefit; however, the analysis of Villalta and VCSS for **continuous** data shows a significant difference at every time point in favour of intervention (P values of .01). This indicates that patients were significantly more likely to be symptomatically better if they received lysis than if treated medically. Few if any studies of medical intervention in the literature evaluate patients on the basis of binary rather than continuous outcome.

References

1. Cohen AT, Agnelli G, Anderson FA, Arcelus JJ, Bergqvist D, Brecht JG, Greer IA, Heit JA, Hutchinson JL, Kakkar AK, Mottier D, Oger E, Samama MM, Spannagl M, VTE Impact Assessment Group in Europe (VITAE). Venous thromboembolism (VTE) in Europe. The number of VTE events and associated morbidity and mortality. *Thromb Haemost.* 2007;98:756–64.
2. Be'lohla'vek J, Dytrych V, Linhart A. Pulmonary embolism, part I: epidemiology, risk factors and risk stratification, pathophysiology, clinical presentation, diagnosis and nonthrombotic pulmonary embolism. *Exp Clin Cardiol.* 2013;18(2):129–38.
3. Vedantham S, Goldhaber SA, Julian JA, et al. Pharmacomechanical catheter-directed thrombolysis for deep-vein thrombosis. *N Engl J Med.* 2017;377:2240–52.
4. Barritt DW, Jordan SC. Anticoagulant drugs in the treatment of pulmonary embolism, a controlled trial. *Lancet.* 1960;1(7138):1309–12.
5. Kernohan RJ, Todd C. Heparin therapy in thromboembolic disease. *Lancet.* 1966;1(7438):621–3.
6. O'Donnell TF, Browse NL, Burnand KG, Thomas ML. The socioeconomic effects of an iliofemoral venous thrombosis. *J Surg Res.* 1977;22:483–8.
7. Goldhaber SZ, Buring JE, Lipnick RJ, Hennekens CH. Pooled analyses of randomized trials of streptokinase and heparin in phlebographically documented acute deep venous thrombosis. *Am J Med.* 1984;76:393–7.
8. Gusto Investigators. An international randomized trial comparing four thrombolytic strategies for acute myocardial infarction. *N Engl J Med.* 1993;329(26):673–82.
9. Semba CP, Dake MD. Iliofemoral deep venous thrombosis: aggressive therapy with catheter-directed thrombolysis. *Radiology.* 1994;191(2):487–94.
10. Mewissen MW, et al. Catheter-directed thrombolysis for lower extremity deep venous thrombosis: report of a national multi-center registry 1. *Radiology.* 1999;211(1):39–49.

11. Watson L, Armon MP. Thrombolysis for acute deep vein thrombosis. *Cochrane Database Syst Rev*. 2004. <https://doi.org/10.1002/14651858.cd002783.pub2>.
12. O'Meara JJ, McNutt RA, Evans AT, Moore SW, Downs SM. A decision analysis of streptokinase plus heparin as compared with heparin alone for deep-vein thrombosis. *N Engl J Med*. 1994;330:1864–9.
13. Enden T, Haig Y, Klow NE, Slagsvold CE, Sandvik L, Ghanima W, Hafsahl G, Holme PA, Holmen LO, Njaastad AM, Sandbaek G, Sandset PM. Long-term outcome after additional catheter-directed thrombolysis versus standard treatment for acute iliofemoral deep vein thrombosis (the CaVenT study): a randomised controlled trial. *Lancet*. 2012;379:31–8.
14. Haig Y, Enden T, Grotta O, Klow NE, Slagsvold CE, Ghanima W, Sandvik L, Hafsahl G, Holme PA, Holmen LO, Njaastad AM, Sandbaek G, Sandset PM, CaVen TSG. Post-thrombotic syndrome after catheter-directed thrombolysis for deep vein thrombosis (CaVenT): 5-year follow-up results of an open-label, randomised controlled trial. *Lancet Haematol*. 2016;3:e64–71.
15. Lattimer CR, Kalodiki E, Azzam M, Geoulakos G. Validation of the Villalta scale in assessing post-thrombotic syndrome using clinical, duplex, and hemodynamic comparators. *J Vasc Surg Venous Lymphat Disord*. 2014;2(1):8–14. <https://doi.org/10.1016/j.jvs.2013.06.003> Epub 2013 Oct 2.
16. Engelberger RP, Spirk D, Willenberg T, Alatri A, Do DD, Baumgartner I, Kucher N. Ultrasound-assisted versus conventional catheter-directed thrombolysis for acute iliofemoral deep vein thrombosis. *Circ Cardiovasc Interv*. 2015;8(1):e002027.
17. Engelberger RP, Fahrni J, Willenberg T, Baumann F, Spirk D, Diehm N, Do DD, Baumgartner I, Kucher N. Fixed low-dose ultrasound-assisted catheter-directed thrombolysis followed by routine stenting of residual stenosis for acute ilio-femoral deep vein thrombosis. *Thromb Haemost*. 2014;111:1153–60.
18. Baekgaard N, Broholm R, Just S, Jorgensen M, Jensen LP. Longterm results using catheter-directed thrombolysis in 103 lower limbs with acute iliofemoral venous thrombosis. *Eur J Vasc Endovasc Surg*. 2010;39:112–7.
19. O'Sullivan GJ. The role of interventional radiology in the management of deep venous thrombosis: advanced therapy. *Cardiovasc Interv Radiol*. 2011;34(3):445–61. <https://doi.org/10.1007/s00270-010-9977-9> (Epub 2010 Oct 7).
20. Wang JY, et al. Ambulatory venous thrombectomy for acute deep venous thrombosis. *J Vasc Surg*. 2012;55(6):1025.
21. Comerota AJ, et al. Catheter-directed thrombolysis for iliofemoral deep venous thrombosis improves health-related quality of life. *J Vasc Surg*. 2000;32(1):130–7.
22. O'Sullivan GJ, de Graaf R, Black SA. Just How Attractive is the ATTRACT Trial? *Cardiovasc Interv Radiol*. 2018 Sep;41(9):1313–1317. doi: 10.1007/s00270-018-2016-y. Epub 2018 Jun 26.
23. Comerota AJ, Kearaon C, Gu CS et al.. Endovascular Thrombus Removal for Acute Iliofemoral Deep Vein Thrombosis. Analysis From a Stratified Multicenter Randomized Trial. *Circulation*. 2018;139:1162–1173

1302.3

Has ATTRACT affected my practice?

R. de Graaf

Diagnostic and Interventional Radiology, Clinic of Friedrichshafen, Friedrichshafen, DE

I have been treating DVT patients by endovascular thrombus removal for more than 10 years. From the beginning we knew that patients with iliofemoral thrombosis not older than 14 days were the best candidates for catheter directed thrombectomy. Nevertheless, I acquired quite some additional knowledge over the years: maximum thrombus removal is eminent and is best monitored with intravascular ultrasound while the identification of an underlying cause of the DVT and adequate treatment

further improves results. We and others experienced favorable results with this strategy. Therefore, I was very surprised when the results of ATTRACT came out, that is, in the form of headlines. Once I actually read the article it was very obvious why ATTRACT was not successful to show the benefit of thrombus removal to prevent PTS. Because the study protocol was conceived so many years ago, ATTRACT was not able to benefit from the significant knowledge we acquired over the years. Moreover, the analysis of the clean ATTRACT data showed an entire different picture compared to the primary publication and suggest that catheter-directed thrombolysis may have a benefit in patients who have acute iliofemoral deep vein thrombosis. Catheter-directed thrombolysis significantly reduced early leg symptoms and, over 24 months, reduced PTS severity scores, reduced the proportion of patients who developed moderate-or-severe PTS, and resulted in greater improvement in venous disease-specific quality of life.

Patients should likely be excluded in the following situations: recent major surgery, trauma, pregnancy, intracranial lesions or recent active bleeding. Patients with severe acute complaints like pain and swelling however should be considered for endovascular treatment. Mostly, these patients suffer from iliofemoral DVT, in contrast to popliteal or calf DVT which is less likely to cause significant symptomatic.

In conclusion, the young patient with an acute iliofemoral DVT with severe symptoms and a low risk of bleeding will most likely benefit in terms of reduction of acute deep venous thrombosis symptoms and post-thrombotic syndrome severity and thus be a good candidate for PCDT. The older than 65 year old immobile patient with an isolated popliteal DVT with only marginal complaints may be found at the other side of the spectrum and should not be offered endovascular treatment.

So, has ATTRACT changed my DVT practice? No, it did not, however it might change yours and hopefully in your patient's best interest when you decide to treat Ilio-femoral DVT only, monitor thrombus removal accurately and stent the underlying outflow obstruction.

References

1. Vedantham S., Goldhaber, S.A., Julian, J.A. et al. Pharmacomechanical Catheter-Directed Thrombolysis for Deep-Vein Thrombosis. *N Engl J Med* 2017; 377:2240–2252.
2. ATTRACT Trial Investigators. Endovascular Thrombus Removal for Acute Iliofemoral Deep Vein Thrombosis. *Circulation*. 2019 Feb 26;139(9):1162–1173.
3. Mewissen, Mark W., et al. "Catheter-Directed Thrombolysis for Lower Extremity Deep Venous Thrombosis: Report of a National Multicenter Registry 1." *Radiology* 211.1 (1999): 39–49.
4. Enden T, Haig Y, Klow NE, Slagsvold CE, Sandvik L, Ghanima W, Hafsahl G, Holme PA, Holmen LO, Njaastad AM, Sandbaek G, Sandset PM. Long-term outcome after additional catheter-directed thrombolysis versus standard treatment for acute iliofemoral deep vein thrombosis (the CaVenT study): a randomised controlled trial. *Lancet*. 2012; 379: 31–8.
5. Haig Y, Enden T, Grotta O, Klow NE, Slagsvold CE, Ghanima W, Sandvik L, Hafsahl G, Holme PA, Holmen LO, Njaastad AM, Sandbaek G, Sandset PM, CaVen TSG. Post-thrombotic syndrome after catheter-directed thrombolysis for deep vein thrombosis (CaVenT): 5-year follow-up results of an open-label, randomised controlled trial. *Lancet Haematol*. 2016; 3: e64–71.
6. Engelberger RP, Spirk D, Willenberg T, Alatri A, Do DD, Baumgartner I, Kucher N. Ultrasound-assisted versus conventional catheter-directed thrombolysis for acute iliofemoral deep vein thrombosis. *Circ Cardiovasc Interv*. 2015; 8.
7. Engelberger RP, Fahrni J, Willenberg T, Baumann F, Spirk D, Diehm N, Do DD, Baumgartner I, Kucher N. Fixed low-dose ultrasound-assisted catheter-directed thrombolysis followed by routine stenting of residual stenosis for acute ilio-femoral deep-vein thrombosis. *Thromb Haemost*. 2014; 111: 1153–60.
8. Baekgaard N, Broholm R, Just S, Jorgensen M, Jensen LP. Long-term results using catheter-directed thrombolysis in 103 lower limbs with acute iliofemoral venous thrombosis. *Eur J Vasc Endovasc Surg*. 2010; 39: 112–7.

9. O'Sullivan GJ. The role of interventional radiology in the management of deep venous thrombosis: advanced therapy. *Cardiovasc Intervent Radiol*. 2011 Jun;34(3):445-61. doi: 10.1007/s00270-010-9977-9. Epub 2010 Oct 7.
10. Wang, Jeffrey Y. et al. Ambulatory Venous Thrombectomy for Acute Deep Venous Thrombosis. *Journal of Vascular Surgery*, Volume 55, Issue 6, 1025
11. Comerota, Anthony J. et al. Catheter-directed thrombolysis for iliofemoral deep venous thrombosis improves health-related quality of life. *Journal of Vascular Surgery*, Volume 32, Issue 1, 130 – 137.

1302.4

Where will we be in five years' time?

S. Black

Vascular Surgery, Guys and St Thomas' Hospital, London, UK

No abstract available.

Focus Session

Endovascular masterclass: intermittent claudication

1702.1

Supervised exercise therapy and lifestyle

B.S. Tan

Department of Vascular and Interventional Radiology, Singapore General Hospital, Singapore, SG

Learning Objectives

1. To understand the importance of lifestyle
2. To learn about exercise therapy
3. To learn the results in the literature

Claudication is a symptom of peripheral arterial disease (PAD), defined as fatigue, discomfort, cramping, or pain of vascular origin in the muscles of the lower extremities that is consistently induced by exercise and consistently relieved by rest¹. PAD refers to atherosclerotic disease of the lower extremity arteries and includes disease of the aortoiliac, femoropopliteal, and infrapopliteal arterial segments.

A series of risk factors have been shown to affect and accelerate the progress of atherosclerosis, in particular smoking. The other factors include diabetes mellitus, hypertension, hyperlipidemia, age, gender, inactivity and obesity². Modification of lifestyle to address these risk factors is critical in the management of PAD.

A healthy diet that emphasizes the intake of vegetables, fruits, nuts, whole grains, lean vegetable or animal protein, and fish and minimizes the intake of *trans* fats, processed meats, refined carbohydrates, and sweetened beverages is recommended³. For adults who are overweight, counselling and caloric restriction are recommended for achieving and maintaining weight loss.

Smoking cessation is a vital component of care for patients with PAD who continue to smoke¹. In one study, more than one third of patients with claudication consulting a PAD provider were active smokers and few received evidence-based cessation interventions⁴. It was noted that patients appear to be most likely to quit smoking early in their treatment course, but many quickly relapsed and 72% of all patients smoking at baseline were still smoking at 12 months. Therefore continuous smoking cessation support is a critical component in the management of claudication.

Exercise therapy for claudication is a very well studied strategy of management, with multiple prospective randomised published⁵. Supervised treadmill exercise (SET) has been shown to significantly improve treadmill performance in patients with claudication, compared to no exercise⁵. More recent evidence suggests that home-based exercise is also effective,

as SET is not as accessible. Home-based walking preferentially improves over-ground walking, which is more representative of daily life⁶.

More recently, there have been several studies comparing SET with revascularisation in various combinations^{7,8}. Taken together, the results of these studies suggest that both SET and revascularization improve functional outcomes in patients with aortoiliac and femoropopliteal arterial occlusive disease and claudication and that their effects appear to be additive.

There is also evidence that shows that modalities other than SET and home-based exercise, including arm ergometry, leg cycling, and perhaps resistance training, can also improve walking performance⁸.

Lifestyle modification and exercise therapy are therefore key components in the management of the patient who presents with claudication from PAD.

References

1. Gerhard-Herman MD, Gornik HL, Barrett C, Barshes NR, Corriere MA, Drachman DE, Fleisher LA, Fowkes FG, Hamburg NM, Kinlay S, Lookstein R, Misra S, Mureebe L, Olin JW, Patel RA, Regensteiner JG, Schanzer A, Shishehbor MH, Stewart KJ, Treat-Jacobson D, Walsh ME. 2016 AHA/ACC Guideline on the Management of Patients With Lower Extremity Peripheral Artery Disease: Executive Summary: A Report of the American College of Cardiology/American Heart Association Task Force on Clinical Practice Guidelines. *Circulation*. 2017 Mar 21;135(12):e686-e725. doi: 10.1161/CIR.0000000000000470. Epub 2016 Nov 13.
2. Swedish Council on Health Technology Assessment. Peripheral Arterial Disease – Diagnosis and Treatment: A Systematic Review. Stockholm: Swedish Council on Health Technology Assessment (SBU); 2008 Nov. SBU Yellow Report No. 187. [Internet].
3. Arnett DK, Blumenthal RS, Albert MA, Buroker AB, Goldberger ZD, Hahn EJ, Himmelfarb CD, Khera A, Lloyd-Jones D, McEvoy JW, Michos ED, Miedema MD, Muñoz D, Smith SC Jr, Virani SS, Williams KA Sr, Yeboah J, Ziaeian B. 2019 ACC/AHA Guideline on the Primary Prevention of Cardiovascular Disease. *Circulation*. 2019 Mar 17;CIR0000000000000678. doi:10.1161/CIR.0000000000000678 [Epub ahead of print]
4. Patel KK, Jones PG, Ellerbeck EF, Buchanan DM, Chan PS, Pacheco CM, Moneta G, Spertus JA, Smolderen KG. Underutilization of Evidence Based Smoking Cessation Support Strategies Despite High Smoking Addiction Burden in Peripheral Artery Disease Specialty Care: Insights from the International PORTRAIT Registry. *J Am Heart Assoc*. 2018 Oct 16;7(20):e010076. doi: 10.1161/JAHA.118.010076
5. Lane R, Harwood A, Watson L, Leng GC. Exercise for intermittent claudication. *Cochrane Database Syst Rev*. 2017 Dec 26;12:CD000990. doi: 10.1002/14651858.CD000990.pub4.
6. McDermott MM. Exercise training for intermittent claudication. *J Vasc Surg*. 2017 Nov;66(5):1612-1620. doi: 10.1016/j.jvs.2017.05.111. Epub 2017 Sep 2.
7. Pandey A, Banerjee S, Ngo C, Mody P, Marso SP, Brilakis ES, Armstrong EJ, Giri J, Bonaca MP, Pradhan A, Bavry AA, Kumbhani DJ. Comparative Efficacy of Endovascular Revascularization Versus Supervised Exercise Training in Patients With Intermittent Claudication: Meta-Analysis of Randomized Controlled Trials. *JACC Cardiovasc Interv*. 2017 Apr 10;10(7):712-724. doi: 10.1016/j.jcin.2017.01.027.
8. Treat-Jacobson D, McDermott MM, Bronas UG, Campia U, Collins TC, Criqui MH, Gardner AW, Hiatt WR, Regensteiner JG, Rich K; American Heart Association Council on Peripheral Vascular Disease; Council on Quality of Care and Outcomes Research; and Council on Cardiovascular and Stroke Nursing. Optimal Exercise Programs for Patients With Peripheral Artery Disease: A Scientific Statement From the American Heart Association. *Circulation*. 2019 Jan 22;139(4):e10-e33. doi: 10.1161/CIR.0000000000000623.

1702.2

Guidewire and crossing techniques

C.S. Pena

Interventional Radiology, Miami Cardiac and Vascular Institute, Miami, FL, US

Learning Objectives

1. To learn the differences between available guidewires
 2. To understand how to select the most appropriate guidewire
 3. To learn about the different techniques for recanalisation
- Femoral Popliteal Disease in Claudication: Guidewire and Crossing techniques?

The decision to perform endovascular revascularization has been made. What are the next steps? How do we cross the lesion in preparation for the therapeutic intervention to the vessel? The importance of successfully crossing a stenosis or occlusion is critical. Without crossing, there can be no therapy.

The initial assessment of a patient prior to revascularization should include the decision of how and where to begin. What is the best access site for the particular patient? This requires some understanding of the location and extent of the lesion or lesions. The patient's body habitus as well as the state of the iliac vessels along with the common femoral artery will be important to determine whether an antegrade puncture should and can be performed. The decision to perform a radial puncture may be made in patients with favorable height and the existence of sufficiently long devices. This technique relies on significant lesion planning and assessment of current inventory. Nontraditional or secondary access sites are reserved for situations when primary access sites have been limited or unsuccessful. Additionally, the morphology of a particular occlusion may call for a retrograde approach from the popliteal, tibial or pedal vessel puncture. How common and successful are these retrograde punctures? This may be related to the shape (morphology) of the occlusion as defined by the CTOP trial.

Once the initial lesion approach has been selected and the access has safely been secured; how does the guidewire cross the lesion? When there is a high-grade stenosis or short occlusion, the use of a hydrophilic wire along with a catheter may be helpful. The wire should be rotated to avoid collaterals or plaques. The catheter is used to back-up the wire crossing and allow for confirmation the wire has crossed and is in the vessel lumen on the other side of the lesion. When there is an occlusion; there are a number of important factors that should be considered. These include: occlusion length, occlusion calcification, vessel diameter, previous stents. These factors may increase the chances of an unsuccessful crossing.

The initial approach for a Femoral popliteal occlusion most likely utilizes a catheter and wire. The wire system is usually 0.035/8 inch and a standard or crossing catheter. Our initial wire is usually a straight Long Length Taper (LLT) wire (0.035in). This wire will buckle or deflect before perforating a vessel wall in most cases. The wire tip may be strengthened by the use of a support catheter as it is advanced through an occlusion. Another common technique is the use of hydrophilic a wire along with a support catheter. The hydrophilic catheter is maybe more likely to select a subintimal path. The sub-intimal path may not change the ultimate efficacy of the treatment. However, once crossing an occlusion it is critical to be in the true lumen proximally and distally. A catheter and a wire can be used to attempt to re-enter the lumen or re-entry devices can be used. These re-entry devices include the Outback and the Pioneer among others. The use of smaller caliber wires such as 0.018in or 0.014in wires can be used to recanalize an occlusion but requires enough backup support to allow for the wire to be advanced through an occlusion.

The use of crossing devices may be used to help to cross. These devices must be used before the initial crossing as once a path has been established many of these devices are not as effective. These devices are divided into crossing wires and crossing devices. These devices carry a significant cost but can be justified in difficult cases if they are successful and save on overall cost and procedure time.

The importance of successful lesion and occlusion crossing is critical to allow for subsequent therapy.

1702.3

Drug-eluting technology: randomised trials and real-world practice

K. Rocha-Singh

Interventional Cardiology, Vascular and Endovascular Medicine, Prairie Heart Institute, St. John's Hospital, Springfield, IL, US

Learning Objectives

1. To learn about the literature data
2. To understand the difference between real-world data and randomised trials
3. To understand the safety issues correlated with drug-eluting technologies

Recent epidemiologic studies identify peripheral arterial disease (PAD) as a significant disease process effecting over 200 million adults worldwide in 2010. The global prevalence of PAD has increased substantially in the past two decades, particularly in low-income patients and those with multiple co-morbidities (i.e., tobacco use and diabetes). The timely diagnosis and medical management of PAD are critical to the management of these patients; left untreated PAD contributes substantial cost to healthcare systems. The percutaneous approach to PAD patients with femoropopliteal and infrapopliteal atherosclerosis, spanning the disease spectrum from intermittent claudication to limb threatening ischemia, has been the focus of many prospective medical and device investigations. When revascularization is required, an endovascular-first approach, given its lower associated of peri-procedural complications compared to open surgery, is generally pursued, when applicable. As such, endovascular therapies for patients with appropriate lesion sub-types have now been integrated into the latest European Society of Cardiology guidelines. Use of drug eluting devices, both drug-coated balloons (DCBs) and drug-eluting stents (DES), in femoropopliteal lesions is a Class IIb indication. Of note, the in US, the IN.PACT™ Admiral™ DCB is approved for use in de novo, restenotic and in-stent restenotic lesions up to 36 cm as of April 2018 (https://www.accessdata.fda.gov/cdrh_docs/pdf14/P140010S037a.pdf). Current publications and presentations of large randomized controlled trials of the IN.PACT™ Admiral™ compared to balloon angioplasty have established the overall reduction in clinically-driven target lesion revascularization (CD-TLR) through 5-years. The Philips Stellarex paclitaxel coated balloon has demonstrated effectiveness when compared to balloon angioplasty reported through 2 years follow-up. In a similar manner, polymer free paclitaxel coated nitinol stents (Zilver PTX, Cook Medical) has reported 5 year maintenance of reduction in CD-TLR rates through 5 years when compared to bare metal stents. In summary, U.S. and European based regulatory trials have presented a robust data set substantiating the use of paclitaxel eluting technologies compared to previous standards of care.

While these regulatory trials randomized patients between drug eluting technologies versus previous standards of care, it must be acknowledged that these trials do not capture the typical "real world" patient who may present with more complex disease, high degrees of calcium burden and other co-morbidities not included in regulatory trials. In this regard, several CEC adjudicated registries, including the IN.PACT™ Global Registry, have established the utility of Admiral™ drug eluting balloon in "all comers" studies. Additionally, the IN.PACT™ Admiral™ drug-eluting balloon has established its effectiveness in highly calcified lesions, although the requirement for the use of bare metal stents to treat suboptimal acute results has been observed. The real world IN.PACT™ Admiral™ dataset have been used in regulatory submissions in the United States for their use in the treatment of in-stent restenosis and long lesions extending up to 36 cm. Taken together, both the randomized controlled trials and CEC adjudicated registries provide a dataset to help guide the use of this device in appropriate patients.

Given the evolution of drug eluting devices as the new “standard of care” versus plain balloon angioplasty, recent second-generation stent and balloon technologies have pursued head-to-head randomized comparisons. In this regard, the polymer-coated drug eluting Eluvia stent has shown superiority at 1 year in reducing clinically driven TLR rates when compared to a polymer free paclitaxel stent (Zilver PTX, Cook Medical). Similarly, the ongoing SurModics Surveil™ DCB in the TRANSCEND Study will compare this second-generation drug-eluting balloon against the IN.PACT™ SFA Admiral balloon. This 1:1 trial is ongoing in the United States.

SAFETY ISSUES

Paclitaxel eluting stents (DES) and drug eluting balloons (DCBs) became commercially available for the treatment of intermittent claudication in 2012 and 2015, respectively. As noted, both devices demonstrated superiority in the reduction of clinically-driven TLRs when compared to control non-paclitaxel containing devices. As such, there has been a gradual but clear adoption of DCB technologies in clinical practice. Paclitaxel is a potent anti-microtubular agent, which induces abnormal conformation of microtubules forming stable dysfunctional microtubules that disrupt the cellular mitotic process. Paclitaxel inhibits important cellular processes and has substantial residence time which is proportional to the injury provided to allow the penetration of the drug into the cellular matrix. Because of variable amounts of paclitaxel on drug-coated balloons, the delivery mode of balloon angioplasty has a higher rate of potential distal embolization and, in pre-clinical studies, evidence of muscle deposition has been noted months later. However, tissue reservoirs are not readily amenable to drug elution into the systemic circulation. To date, there are no adverse effects related to distal paclitaxel embolization that have been reported.

Despite these pre-clinical observations, in December 2018, Katsanos and colleagues, in a systematic review and literature summary meta-analysis, reported a late all cause mortality signal for patients in the DCB and DES arms of randomized clinical trials. This summary level meta-analysis concluded: “There is increased risk of death following application of paclitaxel coated balloons and stents in the femoropopliteal artery of lower limbs. Further investigations are urgently warranted.” This study comprised 28 published and presented randomized controlled trials (n = 4,663) of paclitaxel drug eluting balloons and stents. While there was no difference in mortality at 1 year, at 2 years, mortality was 7.2% in the paclitaxel versus 3.8% in the controls (risk ratio 1.68). Furthermore at 5 years, 3 trials (n = 863) noted a mortality rate of 14.7% in the paclitaxel and 8.1% in the controls (risk ratio 1.93). Eight-nine percent of the trial participants in this summary suffered from intermittent claudication. As a result of this meta-analysis, considerable attention has been drawn to the execution and follow-up of the large randomized controlled trials. This has resulted in a substantial concern in the medical community and among regulatory agencies. In March 2019, the U.S. Federal Drug Administration issued a Health Advisory Letter suggesting the consideration of alternative therapies for the treatment of patients with claudication until additional data review is undertaken.

On March 1-2 2019, VIVA Physicians conducted a 1.5-day Vascular Leaders Forum comprised of global content experts, basic scientists, statistician and regulatory officials (oral presentations can be viewed online at www.VIVA-Physicians.org/vlf on YouTube). At this forum, the FDA disclosed its preliminary review of regulatory data suggesting a “early signal” of an increased mortality rate in patients receiving paclitaxel containing devices. As a consequence of these findings, VIVA Physicians have engaged industry partners and expert statisticians to performance of a PRISMA-IPD meta-analysis. At the time of this writing, the FDA has announced a panel date of June 19-20, at which industry and societal representatives will present their perspectives on the current data. The FDA and VIVA Physicians will present their findings as part of the PRISMA-IPD process.

JAHA META-ANALYSIS IN CONTEXT

The Katsanos JAHA meta-analysis of summary level data assumed a random distribution model in its statistics but did not make adjustments for potentially skewed distribution. If adjustments are made, the mortality rate difference between paclitaxel and control patients is not significant at 1 and 2 years. Importantly, all trials were powered to 1-year patency

endpoint and not long-term mortality. Therefore, in order to avoid committing a type 1 error in the assessment of mortality, a prospective study would have to enroll thousands of patients. Moreover, adverse events are better understood with an “as treated” rather than an “intention to treat” analysis. Additionally, there is a selection bias due to a lack of complete follow-up; only 3 trials followed patients to 5 years. The IN.PACT™ Admiral™ trial was randomized in a 2:1 fashion and the control group was small at 5 year follow-up. Additionally, the control group of IN.PACT™ SFA had the lowest ever reported mortality in a device trial at 1, 2 and 3 years (0, 0.9% and 1.9%). Of note, the THUNDER trial was a 24 month trial that later sought to follow patients to 5 years; by 5 years, 40% of patients were lost to follow-up. In the Zilver PTX trial, 30% of the control group crossed over to be treated by a paclitaxel eluting stent as a pre-planned secondary procedure and this information was not available to Katsanos, et al. As such, as many as 15% of the control group patients may have been exposed to paclitaxel either in the index extremity or the contralateral extremity during follow-up.

In order to further elucidate the potential mortality signal, VIVA Physicians in collaboration with the industry members, have assembled a 5 member content expert Steering Committee and engaged expert statisticians in PRISMA IPD analysis. Data will also include lost to follow-up patients that were not included in the regulatory trials. This presentation will elucidate and define the findings of the PRISMA IPD meta-analysis as a continuation of the Katsanos summary meta-analysis and propose improvements of design and execution of randomized controlled trials and adjudicated registries in order to improve our understanding of the safety and efficacy of these important endovascular technologies.

References

1. Giacoppo D, Cassese S, Harada Y, et al. Drug-coated balloons versus plain balloon angioplasty for the treatment of femoropopliteal disease: An updated systematic review and meta-analysis of randomized controlled trials. *JACC Cardiovasc Interv* 2016; 9: 1731-42.
2. Kayssi A, Al-Atassi T, Oreopoulos G, et. al. Drug-eluting balloon angioplasty vs. uncoated balloon angioplasty for peripheral arterial disease in the lower limbs (review). *Cochrane database of systematic reviews*. 2016; doi: 10.1002/14651858.CD01119.pub2
3. Dake MD, Ansel GM, Jaff MR, et al. Durable clinical effectiveness with paclitaxel-eluting stents in the femoropopliteal artery: 5-year results of the Zilver PTX randomized trial. *Circulation*. 2016; 133(15): 1472-1483.
4. Krishnan P, Faries P, Niazi K, et al. Stellarex drug-coated balloon for treatment of femoropopliteal disease: twelve-month outcomes from the randomized ILLUMENATE pivotal and pharmacokinetic studies. *Circulation* 2017; 136(12): 1102-1113.
5. Rosenfield K, Jaff MR, White CJ, et al. Trial of a paclitaxel-coated balloon for femoropopliteal artery disease. *N Engl J Med*. 2015; 373(2): 145-153.
6. Schneider PA, Laird JR, Tepe G, et al. Treatment effect of drug-coated balloons is durable to 3 years in the femoropopliteal arteries: long-term results of the IN.PACT SFA randomized trial. *Circ Cardiovasc Interv*. 2018; 11(1): e005891.
7. Torii S, Kolodgie F, Vermani r, et al. IN.PACT Admiral drug-coated balloons in peripheral artery disease: current perspectives. *Medical Devices: Evidence and Research* 2019; 12:53-64.
8. Katsanos K, Spiliopoulos S, Kitrou P, et al. Risk of death following application of paclitaxel-coated balloons and stents in the femoropopliteal artery of the leg: A systematic review and meta-analysis of randomized controlled trials. *J of Am Heart Assoc*. 2018; doi: 10.1161/JAHA.118.011245.
9. Schneider PA, Laird JR, Doros G, et. al. Mortality not correlated with paclitaxel exposure: An independent patient-level meta-analysis. *J Am Coll Cardiol*. 2019; doi: 10.1016/j.jacc.2019.01.013.
10. Schneider PA, Laird JR, Doros G, et. al. Mortality not correlated with paclitaxel exposure: An independent patient-level meta-analysis. Correction. *J Am Coll Cardiol*. 2019; doi: 10.1016/j.jacc.2019.02.029.

11. FDA UPDATE: Treatment of peripheral arterial disease with paclitaxel-coated balloons and paclitaxel-eluting stents potentially associated with increased mortality - Letter to Health Care Providers. March 2019.
12. Secemsky EA, Kundi H, Weinberg I, et. al. Association of survival with femoropopliteal artery revascularization with drug-coated devices. *JAMA Cardiol.* 2019; 10.11001./jahacardio.2019.0325.
13. Secemsky EA, Kundi H, Weinberg I, et. al. Drug-eluting stent implantation and long-term survival following peripheral artery revascularization. *J Am Coll Card.* 2019; 259-72.
14. Gray W, Keirse K, Soga Y, et al. A polymer-coated, paclitaxel-eluting stent (Eluvia) versus a polymer-free, paclitaxel-free stent (Zilver PTX) for endovascular femoropopliteal intervention (IMPERIAL): A randomized non-inferiority trial. *Lancet* 2018; 392:1541-1551.
15. Giri J. Assessing the long-term safety of endovascular therapies: The case for peripheral paclitaxel-coated devices. *JAMA Cardio* 2019; doi: 10.1001/jahacardio.0339.

1702.4

Plaque modification vs. debulking

E. Blessing

Abteilung Innere Medizin und Angiologie, SRH Klinikum Karlsbad-Langensteinbach gGmbH, Karlsbad, DE

Learning Objectives

1. To learn about plaque modifications
2. To learn how to select the most appropriate technique
3. To learn the potential complications

Plaque modification and lesion debulking gained increasing recognition in recent years. Despite major advances in endovascular treatment of peripheral arterial disease, mainly driven through drug based technologies, there are still several limitations: first, drug coated balloons do not work well in presence of circumferential calcium. Second, treatment of long lesions are plagued by a high bail-out stent rate. Thirdly, preparation of calcified lesions is mandatory even in the case of subsequent stenting to avoid poor stent expansion or stent elongation, in case of the use of intervoven vascular implants (Supera). The term plaque modification is not clearly defined and includes the following: prolonged inflations with standard or high-pressure balloons, use of specialty balloons (e.g. cutting balloons, focal force balloons) or intravascular lithotripsy. Debulking refers basically to plaque removal (as a stand-alone therapy or prior delivering adjunctive therapies). Current debulking techniques achieve plaque removal mainly via directional, rotational or orbital atherectomy. Again, debulking can be used as a stand-alone therapy but is often followed by antirestenotic therapy (drug coated balloons). Whereas clinical data are limited in regard of plaque modification therapies (specialty balloons etc.), there is rather robust data in respect of directional atherectomy (Definitive LE study). Overall patency was 78% in the claudicant cohort (core lab adjudicated duplex ultrasound) after 12 month with a low complication rate and a bail-out stent rate of only 3,2%. However, data were generated without the use of drug coated balloons. The pilot Definitive AR study generated the hypothesis that directional atherectomy followed by anti-restenotic therapy might be superior to drug coated balloons only, in particular in longer and calcified lesions. The later is currently evaluated in the ongoing VIVA reality trial. In summary, lesion preparation clearly has its role to improve outcome in complex lesions. However, data from randomized controlled trials are needed to clarify the role of specialty balloons or debulking therapies, since they clearly add cost and complexity to the procedure.

Focus Session Everything you wanted to know about immunotherapy in IR

1703.1

Immunotherapy: big business vs. evidence

D.Y. Sze

Interventional Radiology, Stanford University, Stanford, CA, US

Learning Objectives

1. To learn about the current developments and concepts
2. To understand clinical indications and contraindications
3. To learn about current evidence and potential adverse events

Decades of study on the immune system and its role in suppressing malignancy have finally yielded effective pharmaceuticals prescribed to treat cancer. The idea of manipulating a patient's immune system to promote its recognition and attack of that patient's cancer is extremely compelling, and the introduction of these agents into the commercial market were met with very rapid adoption. These new immunotherapy agents include checkpoint inhibitors, a type of agent that boosts anti-tumor immunity by reducing some of the restraints on immune cells, CAR-T cells, tailored human T lymphocytes that are taught to recognize and attack a cancer, and oncolytic viruses, engineered to selectively infect cancer cells and trigger antitumor immunity. These new agents have been proven in large clinical trials to be efficacious against a wide variety of malignancies, with improvement of survival and tolerable toxicity rates. It is particularly exciting that a subset of treated patients have very durable responses for many years, suggesting that even in late stages, some malignancies may be permanently cured.

The 2018 Nobel Prize in Physiology or Medicine was shared by two researchers, James Allison and Tasuku Honjo, who discovered costimulatory checkpoints that are now the targets of most of the available immunotherapy drugs. The American Society of Clinical Oncology (ASCO), the American Association for Cancer Research (AACR), the European Organisation for Research and Treatment of Cancer (EORTC), the European Society for Medical Oncology (ESMO), and virtually every cancer organization worldwide have celebrated the emergence of this new class of drug as the greatest advance of the year(s). IO is finally recognized as a new pillar in the treatment of cancer, but IO is immuno-oncology, not interventional oncology. Pharmaceutical companies market directly to the public, and many patients make appointments with their oncologists specifically to ask for immunotherapy.

The two top-selling checkpoint inhibitors, pembrolizumab and nivolumab, are each responsible for approximately €6 billion in sales annually – the sales of these two drugs alone are equivalent to the annual total healthcare expenditure of the Czech Republic with a population of over 10 million people. Per gram, these drugs cost approximately 5000 times the price of gold, and treatment of a typical American patient costs about €130,000 per year. CAR-T cells are even more costly, approximately €400,000 per patient. The mean total cost of management of malignant melanoma was €1,634 per patient in 2004, and had escalated to €269,682 in 2017. A study in 2019 showed the addition of the oncolytic virus talimogene laherparepvec increased the cost further to €439,060. This represented an incremental cost-utility ratio of €2,007,065 per progression-free survival quality-adjusted life year (PFS QALY) gained.

Certainly, immunotherapy is revolutionizing the way we treat cancer, with particular benefit to the 15-20% of patients with durable, long-term responses. It is problematic to assign a cost to human life. The financial burden of immunotherapy, however, is threatening already stretched medical systems, and is not sustainable. Pharmaceutical companies deserve a return on their investments in research and development, but eligible patients deserve treatment without falling into bankruptcy. Even beyond the science, we will need to devise new ways to apply immunotherapy in rational, fair, and sustainable algorithms.

References

1. Cancer **Immunotherapy**: A Simple Guide for Interventional Radiologists of New Therapeutic Approaches. Digkila A, Duran R, Homicsko K, Kandalaf LE, Hocquelet A, Orcuto A, Coukos G, Denys A. **Cardiovasc Intervent Radiol**. 2018 Sep 12. doi: 10.1007/s00270-018-2074-1. [Epub ahead of print] PMID: 30209564
2. A systematic review of the **cost** and **cost-effectiveness** studies of immune checkpoint inhibitors. Verma V, Sprave T, Haque W, Simone CB 2nd, Chang JY, Welsh JW, Thomas CR Jr. **J Immunother Cancer**. 2018 Nov 23;6(1):128. doi: 10.1186/s40425-018-0442-7. Review. PMID: 30470252
3. Update of survival and **cost** of metastatic **melanoma** with new drugs: Estimations from the MelBase cohort. Kandel M, Allayous C, Dalle S, Mortier L, Dalac S, Dutriaux C, Leccia MT, Guillot B, Saïag P, Lacour JP, Legoupil D, Lesimple T, Aubin F, Beylot-Barry M, Brunet-Possenti F, Arnault JP, Granel-Brocard F, Stoeber PE, Dupuy A, Maubec E, Grob JJ, Dreno B, Rotolo F, Ballon A, Michiels S, Lebbe C, Borget I. **Eur J Cancer**. 2018 Dec;105:33-40. doi: 10.1016/j.ejca.2018.09.026. Epub 2018 Oct 29. PMID: 30384014
4. Economic Evaluation of **Talimogene** Laherparepvec Plus Ipilimumab Combination Therapy vs Ipilimumab Monotherapy in Patients With Advanced Unresectable Melanoma. Almutairi AR, Alkhatib NS, Oh M, Curiel-Lewandowski C, Babiker HM, Cranmer LD, McBride A, Abraham I. **JAMA Dermatol**. 2019 Jan 1;155(1):22-28. doi: 10.1001/jamadermatol.2018.3958. PMID: 30477000

1703.2

Ablative therapies as a primer for immunotherapies and vice versa

R. Lencioni

Department of Radiology, University of Pisa, School of Medicine, Pisa, IT

Learning Objectives

1. To understand immune-modulatory effects
2. To understand the potential of ablation prior to immuno-therapy
3. To understand the potential of ablation after immuno-therapy

No abstract available.

1703.3

Transarterial delivery of immunotherapy: how could it work – does it make sense?

B.J. Wood

Department of Radiology, NIH Clinical Center / NCI, Bethesda, MD, US

Learning Objectives

1. To understand humoral effects in IT
2. To learn about potential techniques
3. To learn about initial evidence and potential adverse events

No abstract available.

1703.4

Imagining the ideal minimally invasive treatment concept

D. Arnold

Onkologie und Hämatologie, Asklepios Klinik Altona, Hamburg, DE

Learning Objectives

1. To understand the potential of combined therapies
2. To understand which oncological situations might benefit from combined treatment concepts
3. To learn about current evidence and potential adverse events

No abstract available.

Fundamental Course Porto-mesenteric vein thrombosis

1704.1

Background in pathophysiology and imaging

A.J. Wigham

Interventional Radiology, Oxford University Hospitals NHS Trust, Oxford, UK

Learning Objectives

1. To understand the causes of mesenteric ischemia
 2. To understand the pathophysiology of mesenteric ischemia
 3. To learn about the imaging findings of mesenteric ischemia
- Historically mesenteric venous thrombosis (MVT) was thought to be responsible for only a small proportion of cases of gastrointestinal ischemia, often only being recognised at surgery or post-partum. The advent of highly sensitive imaging modalities has enabled earlier diagnosis before intestinal infarction occurs. The mortality of acute MVT has fallen due to earlier diagnosis and treatment; including anticoagulation, endovascular therapies and surgery.

MVT occurs in acute, sub-acute and chronic subtypes. Acute MVT is defined as symptomatic thrombosis of the SMV or its branches with no evidence of collateral formation and can lead to intestinal infarction. Chronic MVT patients may be asymptomatic or present with portal hypertensive bleeding.

Virchow's triad describes three principal causes of thrombosis - blood flow anomalies, hypercoagulable states and vascular injury. Local pathologies such as pancreatitis are associated with thrombus formation in the large veins. Systemic hypercoagulable states lead to thrombosis in the intra-mural venules, vasa recta and venous arcades. Patients in whom the thrombosis starts in the small veins are at greatest risk of immediate bowel infarction, whereas those where the thrombosis starts in larger veins and propagates peripherally may take a number of days for infarction to develop.

Aetiological factors can be broadly divided into three groups:

Hereditary thrombophilia

Acquired thrombophilias and hypercoagulable states, including malignancy.

Intra-abdominal causes, including; cirrhosis, intra-abdominal infection, pancreatitis.

CT is the imaging modality of choice and is highly sensitive and specific. Vascular assessment can be more challenging when only small mesenteric vessels are affected. Typical vascular appearances of acute mesenteric vein thrombus on CT include a thin enhancing venous wall with absent luminal opacification and vessel expansion. The bowel appearances include wall thickening, abnormal enhancement patterns, luminal distension and ascites. In the early stages of acute MVT arterial in-flow is preserved and there may be hyperaemia in the mucosa and sub-mucosa. A homogenous enhancement pattern with reduced density compared with normal bowel is >90% sensitive for transmural infarction.

References

1. Tilsed JV, Casamassima A, Kurihara H, et al. ESTES guidelines: acute mesenteric ischaemia. **Eur J Trauma Emerg Surg** 2016; 42:253.
2. Harnik IG, Brandt LJ. Mesenteric venous thrombosis. **Vasc Med** 2010; 15:407.
3. Acosta S, Alhadad A, Svensson P, Ekberg O. Epidemiology, risk and prognostic factors in mesenteric venous thrombosis. **Br J Surg** 2008; 95:1245.

1704.2

When to intervene

E. Velasco Sánchez

Departamento de Cirugía General, Sección de Cirugía Hepatobiliar y Transplante Hepático, Hospital Universitario Gregorio Marañón, Madrid, ES

Learning Objectives

1. To learn about the indications for interventional treatment
 2. To learn about the contraindications for intervention
 3. To become familiar with the typical scenario for an intervention
- Porto-mesenteric vein ischemia is a rare but catastrophic condition with high mortality rates. The thrombotic venous event usually leads to a mesenteric ischemia that may conclude in bowel infarction and eventually perforation and peritonitis.

A delay in the treatment is life threatening and an early diagnose is mandatory. After the clinical suspicion and laboratory findings, a contrast enhanced CT scan is the gold standard for the diagnose. It provides information of the localization and extension of the thrombus, but also is able to assess the compromise of the bowel which will be crucial in the decision of surgery.

There are no well established treatment guidelines, but the cornerstone of treatment is systemic anticoagulation. Considered classically as the gold standard of the therapy for porto-mesenteric thrombosis, surgery is nowadays less used once the endovascular approach and thrombolysis have achieved promising results.

The surgical treatment is indicated in two circumstances: first, patients who present suspicion of bowel infarction in whom is mandatory to evaluate the viability of the bowel. The presence of pneumoperitoneum and perforation of the bowel is an indication for emergent surgery and will lead to a bowel resection and eventually to an open thrombectomy. And second, patients in whom thrombolytic therapy may be contraindicated as those who has a recent major surgery or history of cirrhosis. The bleeding events and recurrent thrombosis are complications that determine the outcomes of the treatment of porto-mesenteric thrombosis, always considering that an early diagnose and immediate treatment are life-saving.

1704.3

How to intervene

S. Kee

Interventional Radiology, UCLA Medical Center, Los Angeles, CA, US

Learning Objectives

1. To learn about the ways of access for an intervention
2. To learn about the materials necessary for an intervention
3. To learn step-by-step how to perform an intervention

The mainstay of therapy is anticoagulation (without substantial supportive evidence), this should be initiated early and maintained throughout more aggressive therapy if indicated.

Decisions as to when and how to intervene depend on a number of factors: 1) degree of acuity, 2) presence of hemorrhage (variceal or other), 3) concerns for (pending) mesenteric ischemia/infarction, 4) coexisting cirrhosis

In chronic cases in general anticoagulation is often all that is required, duration at least 1 year, possibly lifetime. Intervention should be reserved for symptomatic patients with pending mesenteric ischemia (post-prandial pain).

If non-cirrhotic, acute, pending ischemia, recommendation is for early aggressive intervention. Portal Vein access can be achieved in one of 3 ways 1) direct PV puncture (preferred), 2) TIPS approach (with or without a stent), 3) trans-splenic puncture (not recommended especially if lysis likely). In our experience direct Ultrasound guided PV puncture through the right liver is associated with low incidence of complications, can

always be converted to TIPS later if the Portal Vein pressures are found to be elevated (unsuspected cirrhosis).

Once in position debulk the clot using a combination of pharmacomechanical thrombolysis (Angiojet and t-PA, or variant). Remove as much clot as possible early, then lysis in ICU for 24-48 hours (1mg/hr t-PA, continued therapeutic anticoagulation).

In presence of hemorrhage (non-cirrhotic) a higher percentage of mechanical lysis should be performed, but still use some t-PA if possible, with transfusion to manage.

Following lysis measure porto-systemic pressure gradient (PSPG) should be measured, if elevated consider TIPS to increase mesenteric vein outflow. If PSPG is normal, perform maneuvers to optimize flow from gut to liver, venoplasty, more mechanical lysis, stents.

In cirrhotics the situation becomes more complicated, evaluate MELD, is patient a transplant candidate, are esophageal varices documented, are they bleeding? If not actively hemorrhaging anticoagulation is often all that is required, uncommon to have mesenteric ischemia, however, if cirrhotic (MELD 20), acute, and pending mesenteric ischemia prognosis is limited. Perform TIPS, access the thrombosed PV (difficult, consider IVUS guided TIPS), perform mechanical and pharmacological lysis as tolerated. In cirrhotic with non-acute (unknown timeframe) PV occlusion, these patients are often asymptomatic, being considered for transplant, can consider recanalization of the occluded PV from a trans-splenic approach, with creation of a short TIPS.

References

1. Condat et al. Recent portal or mesenteric venous thrombosis: increased recognition and frequent recanalization on anticoagulant therapy. *Hepatology* 2000;32:466
2. Pannach et al. Successful treatment of acute portal vein thrombosis with rivaroxiban. *Thromb Haemost* 2013;110:626
3. Plessier et al. Acute portal vein thrombosis unrelated to cirrhosis: a prospective multicenter follow-up study. *Hepatology* 2010;51:210
4. Blum et al. Noncavernomatous portal vein thrombosis in hepatic cirrhosis: treatment with transjugular intrahepatic portosystemic shunt and local thrombolysis. *Radiology* 1995;195:153
5. Hollinghead et al. Transcatheter thrombolytic therapy for acute mesenteric and portal vein thrombosis. *J Vasc Inter Radiol* 2005;16:651
6. Kumar et al. Mesenteric venous thrombosis. *N Engl J Med* 2001;345:1683
7. Thornburg et al. Pretransplantation Portal Vein Recanalization and Transjugular Intrahepatic Portosystemic Shunt Creation for Chronic Portal Vein Thrombosis: Final Analysis of a 61-patient Cohort. *J Vasc Inter Radiol* 2017;28:1714

1704.4

The role of surgery

D. Seehofer

Department of Visceral, Vascular, Thoracic and Transplant Surgery, University Hospital Leipzig, Leipzig, DE

Learning Objectives

1. To become familiar with surgical approaches to treat porto-mesenteric interventions
2. To learn about the advantages and disadvantages of a surgical intervention
3. To learn about combined procedures

Acute porto-mesenteric thrombosis is a rare cause of acute abdominal pain. In contrast, chronic porto-mesenteric vein thrombosis is mainly seen in patients with liver cirrhosis or chronic pancreatitis. It often manifests with formation of portal collaterals leading to oesophageal varices or portal cholangiopathy. Chronic occlusion does not result in mesenteric ischemia and therefore surgical treatment is normally not required.

The most common symptoms of acute porto-mesenteric thrombosis are abdominal distension, pain and diarrhoea. An early diagnosis by multiphasic CT or MRI and immediate initiation of anticoagulation are essential

to avoid the need for surgical intervention. Medical therapy results in complete or partial recanalization in most cases. The main treatment goal of therapy is the recanalization and the prevention of intestinal infarction. In the long term, portal hypertension and recurrent thrombosis are to be prevented. During medical or interventional treatment, repeated physical, laboratory (CRP, leukocytes, lactate) and if required repeated imaging are essential for further clinical decision making.

It is general consent, that surgical intervention is indicated in the subset of patients with clinical signs of peritonitis, bowel gangrene or bowel perforation. In these circumstances, a prompt surgical exploration should be initiated, to assess bowel viability. Bowel infarction is mainly seen in cases with involvement of the venous arcades and the vasa recta. During the operation necrotic bowel segments are to be resected. In practice, it is often difficult to differentiate between viable and irreversibly damaged segments, even by the use of intraoperative imaging modalities like Doppler ultrasound, ICG-imaging or angiography. However, these techniques have not been proven to be superior to clinical judgement. Since it is a major goal, to avoid short bowel syndrome, it is essential to conserve as much bowel as possible.

Since mesenteric vein thrombosis is a high risk situation for surgical anastomosis due to bowel edema and critical tissue perfusion many centers nowadays prefer a damage-control concept at initial surgery. This implies the resection of necrotic bowel but no attempts of reconstruction. The abdomen is often left open by using an abdominal vacuum-dressing system, since a short termed second look is indicated in most cases. This enables a sparse initial bowel resection and a close re-evaluation of the viability of the precarious segments. Bowel anastomosis is postponed until this or even later re-laparotomies. Short bowel syndrome occurs in patients with extensive resection and should be avoided by preserving as much of the bowel as possible.

References

1. Singal AK, Kamath PS, Tefferi A. Mesenteric venous thrombosis. *Mayo Clin Proc.* 2013 Mar;88(3):285-94.
2. Björck M, Koelemay M, Acosta S, Bastos Goncalves F, Kölbel T, Kolkman JJ, Lees T, Lefevre JH, Menyhei G, Oderich G, Esvs Guidelines Committee, Kolh P, de Borst GJ, Chakfe N, Debus S, Hinchliffe R, Kakkos S, Koncar I, Sanddal Lindholt J, Vega de Ceniga M, Vermassen F, Verzini F, Document Reviewers, Geelkerken B, Gloviczki P, Huber T, Naylor R. Editor's Choice - Management of the Diseases of Mesenteric Arteries and Veins: Clinical Practice Guidelines of the European Society of Vascular Surgery (ESVS). *Eur J Vasc Endovasc Surg.* 2017 Apr;53(4):460-510
3. Shatzel JJ, O'Donnell M, Olson SR, Kearney MR, Daugherty MM, Hum J, Nguyen KP, DeLoughery TG. Venous thrombosis in unusual sites: A practical review for the hematologist. *Eur J Haematol.* 2019 Jan;102(1):53-62
4. Bala M, Kashuk J, Moore EE, Kluger Y, Biffi W, Gomes CA, Ben-Ishay O, Rubinstein C, Balogh ZJ, Civil I, Coccolini F, Leppaniemi A, Peitzman A, Ansaloni L, Sugrue M, Sartelli M, Di Saverio S, Fraga GP, Catena F. Acute mesenteric ischemia: guidelines of the World Society of Emergency Surgery. *World J Emerg Surg.* 2017 Aug 7;12:38. doi: 10.1186/s13017-017-0150-5

Clinical Evaluation Course Trauma

1705.1

Work-up of the polytraumatised patient in the trauma team

C. Dödt

Emergency Centre, Kliniken Bogenhausen, Munich, DE

No abstract available.

1705.2

Imaging algorithms

V. Miele

Department of Radiology, Careggi University Hospital, Florence, IT

In Emergency Department it is crucial to choose the correct imaging approach or technique modality when evaluating a trauma patient on the basis of mechanism and severity of trauma itself. An ultrasound evaluation (integrated also with contrast media utilization – CEUS) may be adequate in case of minor blunt trauma.

However, this modality is not appropriate when evaluating a severe penetrating/non-penetrating trauma or even a polytrauma patient with a major mechanism of injury. Also clinical parameters must be considered, especially arterial pressure: in case of hemodynamically unstable patient, a radiological diagnostic bed-side approach is the first step, using the FAST protocol extended to the thorax (E-FAST). In particular cases, also chest and pelvic radiographs should be performed during the primary survey, as the ATLS protocols have affirmed.

In the secondary survey, and only after having stabilized the patient's hemodynamic state, thus in hemodynamically stable patient, multi-detector CT is actually the modality of choice, accompanied by appropriate exam's protocols in order to avoid missed injuries and to correctly detect all post-traumatic damages. Moreover, due to the shift from a more operative management to a conservative one (even in polytrauma patients with comorbidities, older age and higher number of injuries), imaging plays an essential role in the treatment choice: surgery, conservative or endovascular treatment.

1705.3

Chest trauma

T. Kratimenos

Interventional Radiology, Evangelismos General Hospital of Athens, Athens, GR

Thoracic trauma accounts for approximately 25% of total trauma-associated mortality in the United States and can be classified as chest wall, pulmonary, or cardiovascular injury.

For blunt thoracic trauma with a high-energy mechanism, CT angiography or contrast-enhanced chest CT should be always performed.

The chest wall trauma this is mainly associated with ribs fracture which can be connected with severe vascular injury and less commonly with sternum, vertebral or clavicle fractures. Because of their location in the costal groove along the inferior aspect of the rib, the intercostal arteries and veins are particularly susceptible to injury in the context of concomitant rib fracture. Active arterial or venous hemorrhage may lead to hemothorax or extrapleural hematoma. Rib fracture predisposes to the development of traumatic pseudoaneurysm of the intercostal arteries that can rupture, leading to significant hemorrhage.

High-velocity thoracic trauma in the upper thorax zone may be associated with aortic arch or aortic isthmus injury, but also subclavian and brachial arteries damage.

In the middle chest zone, rib fractures are more likely to be lateral or posterior and usually are associated with pulmonary laceration, contusion, hemothorax, and pneumothorax. In the lower chest zone, rib fractures has long been considered a marker of liver and splenic injuries.

There is widespread agreement that transcatheter arterial embolization is an important therapeutic modality representing a reliable therapeutic alternative to surgery to stop intrathoracic arterial hemorrhage. Various embolic agents can be used with most popular being the PVA particles and metallic coils (pushable or detachable).

Spinal cord ischemia is a serious possible complication related to embolization of intercostal arteries and is mainly associated with the older times practice to perform embolization from the artery's orifice with potential displacement of embolic agents into the radicular arteries. and from there to the spinal cord arteries.

Recent advances in technology such as steerable guide wires and micro-catheters allow a superselective embolization crossing distally from the orifice of the radicular arteries thus minimizing the risk of spinal cord complications.

Regarding the pulmonary sequelae post chest trauma the most often pathology is lung contusion. This type of injury leads to reduced gas exchange, because there is damage of the pulmonary parenchyma that leads to oedema or alveolar haematoma and loss of physiological structure and function of the lung. In severely injured patients, the inflammatory response may result in ARDS. Extremely rare are the vascular injuries in pulmonary artery branches such as pseudoaneurysms as a result of chest trauma. In these cases again transcatheter superselective embolization can be a very effective and safe method to resolve such pathologic condition. The cardiovascular injuries post thoracic trauma mostly refer to the blunt traumatic thoracic aortic injury (TAI) which most often occurs after sudden deceleration, usually in high speed motor vehicle accidents or falls from great heights. CT angiography or contrast enhanced thoracic CT is the gold standard method for this condition diagnosis.

There are 4 grades of TAI, (grade I: intimal tear, grade II: intramural hematoma, grade III: pseudoaneurysm and grade IV: laceration and rupture) and only grade II-IV requires intervention. Regarding the type of intervention there is no doubt that thoracic endovascular aortic repair (TEVAR) is the method of choice as most scientific societies included it in their guidelines as basic method.

Interventional radiologists as part of a multidisciplinary aortic team play a crucial role in the choice of the appropriate device according to the patient's anatomical characteristics respect to the CT results and can perform the stent graft implantation in order to secure exclude the traumatized aortic wall.

Both TAE and TEVAR are a minimally invasive, safe and reliable methods in patients with active intrathoracic hemorrhage or aortic injury due to chest trauma. Yet, there are possible complications and should be performed by experienced interventional radiologists who are familiar with the techniques, in dedicated angiosuites and disponibility of modern materials.

1705.4

Solid organ injury (liver, spleen, kidney)

I. Robertson

Interventional Radiology Unit, Gartnavel General Hospital, Glasgow, UK

Introduction

Solid organ injury of the liver, spleen or kidney accounts for over 50% of injuries visualised on abdominal CT after blunt trauma. Patients are selected for CT most commonly on haemodynamic instability, mechanism of injury and physical signs on examination such as abdominal tenderness. The increased use of CT in evaluation of trauma has meant that many more low grade solid organ injuries are identified and it is vital to have an understanding of treatment options. Arterial complications including extravasation and pseudo aneurysm are visualised with a high degree of accuracy with dual phase CT and solid organ injuries are usually graded dependent upon the extent and depth of laceration and/or haematoma. Most studies and centres continue to use the AAST grading system to report and guide management. Haemodynamically unstable patients will often proceed to urgent operative intervention. However, increasingly some patients with correctable haemodynamic instability will have treatment with non-operative management (NOM) supplemented by interventional radiology techniques.

Spleen

The spleen is the most commonly injured organ in the upper abdomen and up to 45% of patients with blunt upper abdominal trauma will have a splenic injury. The management of splenic injuries has changed in recent years with guidelines now favouring an approach of non-operative management (NOM) as this will preserve splenic immune function. NOM may vary from completely conservative approaches to endovascular intervention. Intervention is most frequently indicated for extracapsular or the site of splenic laceration or pseudoaneurysm. The most commonly

used IR technique is embolisation; proximal occlusion for more diffuse injuries (coils/ plugs) and distal occlusion for focal bleeding or pseudoaneurysm. Proximal splenic artery injuries are rarer but have the potential to be treated by stent graft placement. Major complications post embolisation; abscess formation, splenic infarction, cyst formation, contrast nephropathy and rebleeding occur in 14-29% of cases. Minor complications such as pyrexia, left pleural effusion and coil migration occur in 34-62% of cases.

Liver

The liver is the second most commonly injured organ. NOM is the favoured approach with even severe Grade V injuries achieving good outcomes. Notably, even in cases initially managed with surgical intervention due to haemodynamic instability a significant proportion will require IR techniques for vascular injury. IR techniques are used for extravasation in the acute scenario or pseudoaneurysm which is typically detected on follow up scans of NOM. Embolisation in the acute setting is very valuable as the alternative surgical procedure; perihepatic packing may not be effective and partial hepatectomy is associated with higher peri-operative mortality. Embolisation is usually performed with selective segmental catheterisation and microcoils though proximal occlusion may be undertaken for diffuse injury. The liver has sufficient potential for collateral supply that embolisation should be undertaken across (proximal/distal) any arterial injury when possible. Evaluation of the portal venous circulation should be made as embolisation in an area of portal venous occlusion will result in hepatic infarction. This is particularly important in trauma patients as there seem to be higher rates of ischaemic injury presumably secondary to generally compromised portal venous flow. Complications post embolisation include hepatic infarction, gallbladder infarction, hepatic abscess and recurrent haemorrhage.

Kidney

In blunt abdominal trauma, the incidence of injury to the kidney is 5-7%. The majority of kidney injuries are managed with NOM. Patients with Grade V injuries will usually undergo surgical intervention. IR techniques are used to treat acute extravasation, pseudoaneurysm, arteriovenous fistula and haematuria. Renal artery branching is end-organ without significant collateral circulation and embolisation close to the injury will result in segmental infarction of the occluded territory and maximum preservation of renal function. Coil embolisation is the most frequently used technique often utilising micro-catheters to achieve distal cannulation and occlusion. Technical success rates in most series exceed 90% with rebleeding rates relatively low due to the relatively limited risk of collateral circulation.

References

1. Chakraverty S, Flood K, Kessel D, McPherson S, Nicholson T, Ray CE, et al. CIRSE Guidelines: Quality Improvement Guidelines for Endovascular Treatment of Traumatic Hemorrhage. *CardioVascular and Interventional Radiology*. 2012 Jun;35(3):472–82.
2. Hildebrand DR, Ben-sassi A, Ross NP, Macvicar R, Frizelle FA, Watson AJM. Modern management of splenic trauma. *BMJ*. 2014 Apr 2;348(apr02 3):g1864–g1864.
3. Zealley Ian A, Chakraverty Sam. The role of interventional radiology in trauma *BMJ* 2010; 340 :c497
4. Ierardi AM, Duka E, Lucchina N, Floridi C, De Martino A, Donat D, et al. The role of interventional radiology in abdominopelvic trauma. *The British Journal of Radiology*. 2016 May;89(1061):20150866.

1705.5

Pelvic fracture

O. Pellerin

Interventional Radiology, Hôpital Européen Georges Pompidou, Paris, FR

No abstract available.

1705.6**Damage-control surgery****K.J. Ponsen***Department of Surgery, NoordWestZiekenhuisgroep, Alkmaar, NL*

Damage control surgery is an essential part of the coordinated team effort to treat seriously injured, often polytraumatised patients.

These patients are often hemodynamically unstable, with sometimes external and often 'invisible' internal bleeding, where life- and limb-saving procedures are urgently necessitated to keep the patient alive and to grab the chance to work on (full) recovery of the injured in future.

An early start of this lifesaving mode for these very sick traumapatient is crucial, starting in the prehospital phase with interventions such as applying a pelvic binder and administering tranexamin acid intravenously in suspected significant (internal) haemorrhage, is crucial.

Early decisionmaking in the Emergency Room, sometimes with no time for indepth diagnostics, and early interventions such as an ER thoracotomy, can make the difference between life and death.

Damage control surgery has a prominent role in these algorhythms, is location and trauma system dependent, but needs to be considered in every patient on the brink of death due to trauma ('non-responders') in case other life saving options are less effective, more timeconsuming, or not straight at hand.

However, it is important to realise that this type of surgery is just one of the important steps in the cascade of interventions and decisions often needed to save life and limbs of the most seriously injured patients.

Time and timing is of utmost importance and needs to be very critically followed and respected in all steps of the treatment along these algorhythms. Preparedness in the ER (emergency room) as well as in the OR (operating room) (ref1) is crucial.

In this brief overview the specific aspects, pro's and con's of each pathway, and the role of surgery versus IR (interventional radiology) within the treatment algorhythms will be highlighted, especially focussing on short procedures and the cooperation and coordination with other specialists and their treatment modalities.

References

1. Facilitating damage control surgery with a dedicated DCS equipment trolley. J.C.Goslings, R.Haverlag, K.J.Ponsen, J.S.K.Luitse. Injury, may 2006, vol 37, Issue 5, Pages 466–467

Focus Session**Medical therapy to improve outcomes of PAD interventions****1802.1****The role of statins****T.W.I. Clark***Department of Interventional Radiology, Penn Presbyterian Medical Center, Philadelphia, PA, US***Learning Objectives**

1. To understand the development of atherosclerosis
2. To understand the action of statins
3. To gain knowledge about scientific data supporting statins role

No abstract available.

1802.2**Single vs. double antiplatelet therapy: any evidence?****N.D. Ptohis***Interventional Radiology, General Hospital of Athens, Athens, GR***Learning Objectives**

1. To understand the basics of coagulation and how to inhibit
2. To gain knowledge about scientific data supporting antiplatelets role
3. To understand when to use single, double or event triple anticoagulation

Definition and incidence of PAD

Regarding the latest Guidelines by the European Society of Cardiology (ESC) the term "peripheral artery disease" (PAD) should not be restricted to lower extremity artery disease (LEAD), as this also includes the carotid and vertebral, upper extremities, mesenteric and renal arteries (1). PAD is estimated to affect more than 200 million people worldwide (incidence 3%-12%) and has high morbidity and mortality rates (2).

Comorbidities

Patients with PAD are at increased risk for major adverse cardiac events (MACE) [myocardial infarction (MI), ischemic stroke, and cardiovascular (CV) death] and major adverse limb events (MALE) (major amputation and acute limb ischemia). In spectrum of symptomatic PAD, annual rates of MACE are 4% to 5%, and rates of MALE are 1% to 2% (3).

Indications for individualization of therapy

It is well established that platelet activation and aggregation is associated with these adverse events, setting antiplatelet therapy as a cornerstone in the treatment of patients with PAD. Additionally, evidence suggest individualization of antiplatelet therapy relatively to clinical presentation (3). Multiple antiplatelet agents have been studied in the PAD population, including aspirin, the combination of aspirin and dipyridamole, clopidogrel, ticagrelor, cilostazol and vorapaxar (3).

Stratification of LEAD patients

In accordance with individualization of antiplatelet therapy relatively to clinical presentation, four groups of LEAD patients are formed.

The **first group** consists of LEAD patients with a low ankle brachial index (ABI) (i.e. $ABI \leq 0.90$) or other noninvasive testing consistent with PAD but no symptoms of PAD and no clinically manifest coronary or cerebrovascular disease. To be noted, PAD-related symptoms are defined as exertional ischemic leg symptoms, including typical intermittent claudication (exertional calf pain that resolves within 10 minutes of rest and does not begin at rest), and atypical forms, ischemic rest pain, ischemic ulcers, or history of lower extremity revascularization. In this group, clinical trial evidence does not support use of aspirin despite increased CV risk and guideline recommendations of American College of Cardiology/American Heart Association 2016 (3).

The **second group**, consisting of patients with asymptomatic PAD but with a history of clinically manifest coronary or cerebrovascular disease, should receive antithrombotic therapy such as aspirin, P2Y12 inhibitors (e.g. clopidogrel), or both according to current guidelines for treating acute ischemic event (within the past 12 months) or stable coronary artery or cerebrovascular disease (3).

For the **third group**, including symptomatic PAD patients who do not have clinically manifest coronary or cerebrovascular disease, the practice guidelines recommend aspirin or clopidogrel to reduce MACE, despite a lack of evidence for aspirin in this setting (3). On the contrary, antiplatelet agents other than aspirin (P2Y12 inhibitors or picotamide) including clopidogrel monotherapy (4), reduce MACE in this population (MALE not studied). Given the similar efficacy of ticagrelor and clopidogrel in preventing MACE (EUCLID trial), ticagrelor can be considered an effective alternative to poor clopidogrel metabolizers, who often demonstrate risk factors for PAD (including diabetes mellitus, smoking, chronic kidney disease). Doubling the dose of clopidogrel in these patients has proven ineffective whereas more potent P2Y12 inhibitor such as prasugrel or ticagrelor should be considered as a solution (Spiliopoulos et al).

In the **last group**, consisting of patients with symptomatic PAD and clinically manifest coronary or cerebrovascular disease, should be treated with antithrombotic treatment of acute CV events within the past 12 months respectively to guidelines. For symptomatic PAD patients with stable coronary artery or cerebrovascular disease, the benefit of monotherapy with aspirin or clopidogrel to reduce MACE risks is well established (2,4). Treatment with dual antiplatelet therapy with clopidogrel and aspirin is not more effective than aspirin alone and causes more major bleeding (6). Patients with symptomatic PAD who are at increased risk for ischemic limb events (e.g., prior history of acute limb ischemia or ABI < 0.60) should be treated with aspirin combined with vorapaxar to reduce MALE, whereas aspirin plus ticagrelor or aspirin plus low-dose rivaroxaban alone reduces MACE and MALE in patients with PAD and clinically manifest coronary artery disease (3). Adding antithrombotic therapies to aspirin is associated with increased risk of major bleeding, necessitating consideration of the net clinical benefit of combination therapies (number of MACE and MALE events avoided relative to major bleeding events caused) (6). The optimal antithrombotic therapy for patients with critical leg ischemia remains unclear and is currently under investigation for patients undergoing lower extremity revascularization.

Percutaneous transluminal angioplasty in LEAD

The high rate of re-occlusion and target lesion stenosis after percutaneous transluminal angioplasty is a major limitation for favorable outcomes. Vascular inflammation as well as platelet activation and aggregation have a key role in these complications. However, the optimal type and time of antiplatelet regimen has not been well validated in clinical trials. The combination of aspirin and dipyridamole had a slightly superior impact on patency after femoro-popliteal angioplasty compared with vitamin K antagonists at 3, 6, and 12 months (7). The combination of clopidogrel and aspirin showed higher inhibition of platelets before and after angioplasty in patients undergoing endovascular intervention for claudication, improved the patency of treated lesions and decreased the need for revascularization (8). Regarding a survey by Allemang et al, dual antiplatelet therapy is often used in patients undergoing infra-inguinal angioplasty and stenting, which revealed that the most common antiplatelet therapy after lower extremity endo-luminal therapy was a combination of aspirin and clopidogrel. Duration of therapy also varied, with 1 to 3 months as the most common time frame. Therapy use increased with distal endovascular treatment and with the placement of stents and there was no consensus over the duration of therapy. However, there is no sufficient data to support such practice.

Surgical treatment of LEAD

Lower extremity bypass is another important treatment for patients with symptomatic PAD when less-invasive endovascular procedures are impractical due to anatomic or technical considerations. Type of graft material, site of anastomosis, rate of stenosis, type of antiplatelet used postprocedural and duration of the regimen are contributing factors in the graft success or failure. Prosthetic grafts with anastomosis to the tibial arteries seem to have highest rate of failures. Critical seem to be the first two years as then the majority of graft stenosis occur. Antiplatelet therapy with aspirin improves graft patency and limb salvage. Administration of antiplatelet therapy were of greater benefit to prosthetic grafts rather than to venous grafts (9). The risk of graft occlusion while on single antiplatelet therapy (typically aspirin) reported to be 15% per year when a vein is used and 20% with synthetic material (polytetrafluoroethylene) rising to 45% and 75%, respectively, for below-knee grafts (9). In the CASPAR trial, combination of aspirin and clopidogrel showed statistically significant decrease in prosthetic graft failure with decreasing rate of occlusion and amputation to levels similar to those seen with venous grafts.

Antiplatelet therapy in asymptomatic carotid stenosis or previous TIA

Asymptomatic patients with evidence of atherosclerotic carotid stenosis as well as patients with previous transient ischemic attack (TIA) or stroke can benefit from antiplatelet therapy. The Antiplatelet Trialists' Collaboration reported that antiplatelet monotherapy (aspirin, or other antiplatelet agent), reduces the risk of stroke, in high-risk patients. In particular, non-fatal stroke was reduced by 25%. Aspirin was the most widely studied antiplatelet drug. It was clearly demonstrated that a low dose of aspirin

(75–150 mg daily) is at least as effective as higher daily doses. In addition, the meta-analysis showed that addition of dipyridamole to aspirin produced no significant further reduction in vascular events compared with aspirin alone (4).

Primary prevention of stroke or TIA

In primary prevention of stroke or TIA, evidences supporting the use of antiplatelet therapy are indirectly obtained in different trials evaluating the benefit of these drugs in primary prevention of all CV events, in particular in the "high-risk" population. Patients with significant carotid stenosis (>50%), even if asymptomatic for TIA or stroke, are at twice the risk of MI (14). According to a meta-analysis, low-dose aspirin therapy is beneficial in terms of CV events, including stroke, if the annual baseline risk of MI exceeds 1.5% per year (15). If the risk of CV events is high, the benefit observed in terms of reduction of ischemic events, balances the risk of bleeding and hemorrhagic stroke associated to the daily use of aspirin (14). Antiplatelet agents, other than aspirin, have still no evidence of benefit in asymptomatic patients with carotid stenosis (14). The CHARISMA study demonstrated that DAPT did not reduce the primary endpoint of MI, stroke or CV death, but was associated with an increased risk of bleeding rates (12). Therefore, there is currently no evidence to support the use of DAPT in patients with asymptomatic carotid stenosis.

Secondary prevention of stroke

About secondary prevention, a systematic review of literature suggested that aspirin alone, combination of aspirin and dipyridamole, clopidogrel, and triflusal, could reduce the relative risk of stroke after a first event. In particular, the combination of aspirin and extended-release dipyridamole reduces the relative odds of stroke, MI, or vascular death by about 18% (OR 0.82, 95% CI: 0.74–0.91) compared with aspirin alone, without causing more bleeding events (10). Early administration of aspirin in the acute phase of stroke or TIA was also shown to be safe and effective (10). In the same meta-analysis, also cilostazol was proven to be effective in reduction of major vascular events when compared to placebo [4.2% vs. 6.8% (placebo); RR 0.61, 95% CI: 0.41–0.91]. In the CARESS trial, the efficacy of DAPT (aspirin plus clopidogrel) was compared to aspirin alone, in reducing asymptomatic embolization in patients with recently symptomatic carotid stenosis, measured with microembolic signals (MES) detected by transcranial Doppler ultrasound. Patients treated with DAPT had lower MESs (RR 39.8%, 95% CI, 13.8–58.0, $P=0.0046$), fewer MESs per hour (95% CI: 31.6–78.2, $P=0.0013$), and fewer strokes compared to patients treated with aspirin alone in the first week after stroke (11).

Acute treatment of TIA or minor stroke

The CHANCE trial, enrolling in patients with TIA or minor stroke treated within 24 hours after the onset of symptoms, showed that DAPT was better than aspirin alone in reducing the risk of stroke in the first 90 days (8.2% vs. 11.7%; HR 0.68, 95% CI: 0.57–0.81, $P<0.001$) and did not increase the risk of hemorrhage (0.3% vs. 0.3%, $P=0.73$). There was no difference in incidence of moderate to severe hemorrhage in patients treated with aspirin monotherapy versus DAPT (13).

Carotid artery stenting

About optimal antiplatelet therapy before and after carotid artery stenting (CAS) there are few data and management of antiplatelet therapy derives from experience in coronary angioplasty. The use of DAPT prior to and after CAS is suggested by current practice, but its optimal duration post CAS remains unknown. Two small randomized trials comparing aspirin alone with DAPT for CAS demonstrated a higher rate of neurological events in the aspirin-alone group at 30 days (14). In addition, data about loading dose of clopidogrel before CAS are not univocal (14). A little randomized study demonstrated in patients undergoing CAS that a strategy using a 600-mg clopidogrel load before stenting protects against early ischemic cerebral events (18% vs. 35.9%, $P=0.019$) (16).

Carotid endarterectomy

Antiplatelet therapy seems to be of great importance in carotid endarterectomy (CEA) as 5% to 7% of patients could present a perioperative ischemic stroke and 2–3% of patients could be affected of postoperative thromboembolic stroke (14). Aspirin administration in patients undergoing CEA has been shown to reduce the risk of postoperative stroke and of periprocedural MI (14). A low dose of aspirin appears to be more effective

than higher doses in reducing the composite of CV death, MI and stroke at 30 days (5.4 vs. 7.0%, $P=0.07$) and at 3 months (6.2 vs. 8.4%, $P=0.03$) (17). Payne et al. showed that in patients undergoing CEA, pretreatment with aspirin and clopidogrel before surgery reduced postoperative embolization detected by transcranial Doppler (OR 10.23, 95% CI: 1.3–83.3, $P=0.01$), without increase in bleeding complications. Nevertheless, DAPT was associated with a major risk of bleeding in subsequent trials, despite its benefit in neurological events postoperative (18).

Conclusions

Despite an abundance of data demonstrating efficacy of antiplatelet therapy in coronary artery disease and cerebrovascular disease, there is a paucity of clinical information, clinical guidelines and randomized controlled studies in the PAD population. Hence, data on antiplatelet therapy in coronary interventions is frequently extrapolated to peripheral interventions. Another challenge, that necessitates further trials specifically focused on different subsets of populations, is related to the extreme variability of PADs scenarios: stable and unstable conditions, different treatment options (medical, endovascular and surgical), variable extension and localization of artery disease.

References

1. Aboyans V, Ricco JB, Bartelink MEL, et al. 2017 ESC Guidelines on the Diagnosis and Treatment of Peripheral Arterial Diseases, in collaboration with the European Society for Vascular Surgery (ESVS): Document covering atherosclerotic disease of extra-cranial carotid and vertebral, mesenteric, renal, upper and lower extremity arteries Endorsed by: the European Stroke Organization (ESO) The Task Force for the Diagnosis and Treatment of Peripheral Arterial Diseases of the European Society of Cardiology (ESC) and of the European Society for Vascular Surgery (ESVS). *Eur Heart J* 2018;39:763-816.
2. Gerhard-Herman MD, Gornik HL, Barrett C, et al. 2016 AHA/ACC guideline on the management of patients with lower extremity peripheral artery disease. *Circulation*. 2017;135(12):e686-e725.
3. Connie N. Hess, MD, MHS; William R. Hiatt, MD. Antithrombotic Therapy for Peripheral Artery Disease in 2018. *JAMA* June 12, 2018 Volume 319, Number 22, p2329-p2330. Antithrombotic Trialists' Collaboration Collaborative meta-analysis of randomised trials of antiplatelet therapy for prevention of death, myocardial infarction, and stroke in high risk patients. *BMJ*. 2002;324(7329):71-86.
4. Hiatt WR, Fowkes FG, Heizer G, et al. Ticagrelor versus clopidogrel in symptomatic peripheral artery disease. *N Engl J Med*. 2017;376(1):32-40.
5. Bhatt DL, Fox KA, Hacke W, et al. Clopidogrel and aspirin versus aspirin alone for the prevention of atherothrombotic events. *N Engl J Med*. 2006;354(16):1706-1717.
6. Dörffler-Melly J, Koopman MM, Prins MH, Büller HR. Antiplatelet and anticoagulant drugs for prevention of restenosis/reocclusion following peripheral endovascular treatment. *Cochrane Database Syst Rev* 2005; (1): CD002071 [PMID: 15674891 DOI: 10.1002/14651858.CD002071.pub2]
7. Cassar K, Ford I, Greaves M, Bachoo P, Brittenden J. Randomized clinical trial of the antiplatelet effects of aspirin-clopidogrel combination versus aspirin alone after lower limb angioplasty. *Br J Surg* 2005; 92: 159-165 [PMID: 15609386 DOI: 10.1002/bjs.4810]
8. Pahul Singh, Yenai Harper, Carrie S Oliphant, Mohamed Morsy, Michelle Skelton, Raza Askari, Rami N Khouzam Peripheral interventions and antiplatelet therapy: Role in current practice *World J Cardiol* 2017 July 26; 9(7): 583-593
9. O'Donnell MJ, Hankey GJ, Eikelboom JW. Antiplatelet therapy for secondary prevention of non cardioembolic ischemic stroke: a critical review. *Stroke* 2008;39:1638-46.
10. Markus HS, Groste DW, Kaps M, et al. Dual antiplatelet therapy with clopidogrel and aspirin in symptomatic carotid stenosis evaluated using doppler embolic signal detection: the Clopidogrel and Aspirin for Reduction of Emboli in Symptomatic Carotid Stenosis (CARESS) trial. *Circulation* 2005;111:2233-40.
11. Bhatt DL, Flather MD, Hacke W, et al. Patients with prior myocardial infarction, stroke, or symptomatic peripheral arterial disease in the CHARISMA trial. *J Am Coll Cardiol* 2007;49:1982-8.
12. Wang Y, Wang Y, Zhao X, et al. Clopidogrel with aspirin in acute minor stroke or transient ischemic attack. *N Engl J Med* 2013;369:11-9.
13. Rosetta Melfi, Elisabetta Riccittini Antiplatelet therapy for peripheral artery disease *Cardiovasc Diagn Ther* 2018;8(5):663-677. doi:10.21037/cdt.2018.07.02
14. Patrono C, Garcia Rodriguez LA, et al. Low-dose aspirin for the prevention of atherothrombosis. *N Engl J Med* 2005;353:2373-83.
15. Patti G, Tomai F, Melfi R, et al. Strategies of clopidogrel load and atorvastatin reload to prevent ischemic cerebral events in patients undergoing protected carotid stenting. Results of the randomized ARMYDA-9 CAROTID (Clopidogrel and Atorvastatin Treatment During Carotid Artery Stenting) study. *J Am Coll Cardiol* 2013;61:1379-87.
16. Taylor DW, Barnett HJM, Haynes RB, et al. Low-dose and high-dose acetylsalicylic acid for patients undergoing carotid endarterectomy: a randomised controlled trial. *ASA and Carotid Endarterectomy (ACE) Trial Collaborators. Lancet* 1999;353:2179-84.
17. McKinsey JF. Symptomatic carotid stenosis: endarterectomy, stenting, or best medical management? *Semin Vasc Surg* 2008;21:108-14.

1802.3

A new generation of anticoagulation

A. Cannavale¹, M. Bezzi¹, M. Corona¹, M. Santoni², C. Catalano³, F. Fanelli⁴

¹Vascular and Interventional Unit, Policlinico Umberto I, Rome, IT,

²Department of Radiological Sciences, "Sapienza" University of Rome,

Rome, IT, ³Radiological, Pathological and Oncological Sciences, Sapienza

- University of Rome, Rome, IT, ⁴Vascular and Interventional Radiology Department, "Careggi" University hospital, Florence, IT

Learning Objectives

1. To understand the working principles of advanced new generation anticoagulation
 2. To gain knowledge about scientific data supporting the new generation of anticoagulation and its role
 3. To understand when to use the new generation anticoagulation
- Direct oral anticoagulants (DOACs) were introduced in 2008 and now are currently used for multiple thromboembolic disorders and provide advantages over existing agents. They are also known as non-vitamin K antagonist OACs (NOACs) and offer reliable levels of anticoagulation and lower rates of intracranial hemorrhage and life-threatening or fatal bleeding compared with vitamin K antagonists. In particular they are alternatives to low molecular weight heparin (LMWH) in a peri-operative setting for venous thromboembolism (VTE) prophylaxis and therapy and to vitamin K antagonists (VKAs) for longer term therapy. Because the DOACs have predictable pharmacokinetic/pharmacodynamic effects, routine coagulation monitoring for titration and maintenance is not required.

The drawbacks of these agents are the lack of a reversal agent and the risk of major bleeding. Most DOACs are direct inhibitors of Factor Xa (i.e. Rivaroxaban) or thrombin (Dabigatran) that are responsible of the coagulation cascade, otherwise the new antiplatelets agents (ticagrelor and voraxapar) directly act on specific platelet receptors (i.e. P2Y₁₂), inhibiting the platelets aggregation. Anyway acting on different pathways, all those agents aim to reduce the risk of thrombus formation. In patients with stable peripheral artery disease (PAD) these new antithrombotic agents may reduce the risk of emboli, atherothrombosis and acute limb ischaemia on a background of stable chronic atherosclerotic disease. Recently several randomised controlled trials (RCT) were carried out to test the safety and efficacy of these new antithrombotic agents, against or combined with the old ones (i.e. aspirin, clopidogrel). In particular

those trials evaluated the capacity to reduce the risk of cardiovascular and possibly limb events in patients with PAD. In example the EUCLID (Examining Use of Ticagrelor in Peripheral Artery Disease) trial randomized 13,885 symptomatic patients with PAD to ticagrelor vs clopidogrel. After a 30 month follow-up, there was no difference between the 2 groups in terms of the primary composite endpoint of CV death, MI, or stroke. Both major bleeding (1.6% vs. 1.6%; $p=0.49$) and hospitalization for acute limb ischemia (1.7% vs. 1.7%; $p=0.85$) were also similar between treatment groups.

Otherwise the vorapaxar was mainly investigated in the TRA 2P-TIMI 50 Trial (Thrombin Receptor Antagonist in Secondary Prevention of Atherothrombotic Ischemic Events–Thrombolysis in Myocardial Infarction 50) that randomized 26,449 patients with histories of myocardial infarction, stroke, or symptomatic PAD to vorapaxar or placebo on a background of antiplatelet (88% aspirin alone). A subanalysis of patients with symptomatic PAD, who underwent revascularization (including secondary revascularization - 70% endovascular), showed a significant reduction of the risk of peripheral revascularization by 18% at 3 years in the treatment group (19.3% for placebo, 15.4% for vorapaxar; hazard ratio [HR], 0.82; 95% confidence interval [CI]: 0.72 to 0.93; $p=0.003$). On the basis of this evidence, some Authors would recommend this new agent with aspirin in patients at higher risk of ischaemic limb events to reduce the incidence of major adverse limb events (i.e. acute limb ischaemia).

Regarding the new anticoagulants, the COMPASS (Cardiovascular Outcomes for People Using Anticoagulation Strategies) trial enrolled a total of 27,395 patients with stable atherosclerotic vascular disease (CAD, PAD, or both), who were randomized to 3 arms (aspirin 100 mg daily vs. rivaroxaban 5 mg twice daily vs. aspirin 100 mg daily+ rivaroxaban 2.5 mg twice daily) at 602 centers worldwide. In a sub-cohort of 7,470 patients affected by PAD (55.2% symptomatic limbs, 19.1% with low ankle-brachial index (ABI) and the rest with carotid disease), rivaroxaban 2.5 mg twice daily plus aspirin compared with aspirin alone reduced Major Adverse Cardiovascular Events (5.1% vs 6.9%; $P=.005$), Major Adverse Limb Events (MALE, 0.9% vs 2.4%; $P=.004$), MALE components of acute limb ischemia (0.8% vs 1.4%; $P=.04$), and major amputation (0.2% vs 0.7%; $P=.01$). The combination of rivaroxaban plus aspirin increased bleeding compared with aspirin alone. Bleeding was mainly gastrointestinal (1.6% vs 0.7%; $P=.03$) with few intracranial (0.2% vs 0.4%) or fatal hemorrhages (0.2% vs 0.1%). Contrary the WAVE (Warfarin Antiplatelet Vascular Evaluation) trial did not show any benefit for full-dose anticoagulation with warfarin in addition to antiplatelet (aspirin, clopidogrel or ticlopidine) vs antiplatelet alone. Therefore Rivaroxaban 2.5 mg bid co-administered with ASA should be considered for the prevention of atherothrombotic events only in adult patients with CAD or symptomatic PAD at high risk of ischaemic events. Another recent RCT (ePAD) investigated the safety and efficacy of Edoxaban to prevent loss of patency following endovascular treatment. This trial compared the use of Edoxaban plus aspirin vs conventional treatment with dual anti-platelet therapy (DAPT - clopidogrel and aspirin) in 275 symptomatic patients (29% claudicant). Location of lesions was mainly in the SFA and stents were used in about 54% of patients in each group. There were no major or life-threatening bleeding events in the edoxaban group, while there were 2 major and 2 life-threatening bleeding events in the clopidogrel group. Following 6 months of observation, there was a lower incidence of restenosis/reocclusion with edoxaban compared with clopidogrel, although not statistically significant (30.9% vs 34.7%; RR 0.89, 95% CI 0.59 to 1.34, $p=0.643$).

Despite there is evidence of a real advantage of edoxaban over clopidogrel, the Authors concluded that larger and longer term trials should confirm those findings.

Currently other trials are ongoing, as the VOYAGER PAD (Efficacy and Safety of Rivaroxaban in Reducing the Risk of Major Thrombotic Vascular Events in Subjects with Symptomatic Peripheral Artery Disease Undergoing Peripheral Revascularization Procedures of the Lower Extremity), that is comparing rivaroxaban 2.5 mg twice daily or placebo on a background of aspirin 100 mg daily after peripheral surgical and/or endovascular revascularization and the BEST-CLI (Best Endovascular Versus Best Surgical Therapy in Patients With Critical Limb Ischemia).

As shown by the overmentioned trials, a new era of antithrombotic therapy is emerging for patients with peripheral artery disease; several agents among direct anticoagulant and new antiplatelets have demonstrated promising results in multicentre randomized trials and should be considered for the prevention of acute limb events and amputation in patients with PAD including those who had previous revascularization. However platelet inhibition with or without low-dose anticoagulation will be decided by the ability to balance ischaemic and bleeding risks when selecting the type, dose, and intensity of antithrombotic therapies for individual patients with peripheral artery disease.

References

1. Jones WS, Patel MR. Antithrombotic Therapy in Peripheral Artery Disease: Generating and Translating Evidence Into Practice. *J Am Coll Cardiol*. 2018 Jan 23;71(3):352-362. doi: 10.1016/j.jacc.2017.11.021.
2. Anand SS, Bosch J, Eikelboom JW, Connolly SJ, Diaz R, Widimsky P, Aboyans V, Alings M, Kakkar AK, Keltai K, Maggioni AP, Lewis BS, Störk S, Zhu J, Lopez-Jaramillo P, O'Donnell M, Commerford PJ, Vinereanu D, Pogossova N, Ryden L, Fox KAA, Bhatt DL, Misselwitz F, Varigos JD, Vanassche T, Avezum AA, Chen E, Branch K, Leong DP, Bangdiwala SI, Hart RG, Yusuf S; COMPASS Investigators. Rivaroxaban with or without aspirin in patients with stable peripheral or carotid artery disease: an international, randomised, double-blind, placebo-controlled trial. *Lancet*. 2018 Jan 20;391(10117):219-229. doi: 10.1016/S0140-6736(17)32409-1.
3. Amer MR, Chaturvedula ST, Joshi S, Ingrassia J. Antithrombotic Therapy After Revascularization in Patients With Peripheral Arterial Disease: What Is Here, What Is Next. *Vasc Endovascular Surg*. 2019 May;53(4):325-336. doi: 10.1177/1538574419836316.
4. Bonaca MP, Creager MA, Olin J, Scirica BM, Gilchrist IC Jr, Murphy SA, Goodrich EL, Braunwald E, Morrow DA. Peripheral Revascularization in Patients With Peripheral Artery Disease With Vorapaxar: Insights From the TRA 2°P-TIMI 50 Trial. *JACC Cardiovasc Interv*. 2016 Oct 24;9(20):2157-2164. doi: 10.1016/j.jcin.2016.07.034.
5. Moll F, Baumgartner I, Jaff M, Nwachuku C, Tangelder M, Ansel G, Adams G, Zeller T, Rundback J, Grosso M, Lin M, Mercur MF, Minar E; ePAD Investigators. Edoxaban Plus Aspirin vs Dual Antiplatelet Therapy in Endovascular Treatment of Patients With Peripheral Artery Disease: Results of the ePAD Trial. *J Endovasc Ther*. 2018 Apr;25(2):158-168. doi: 10.1177/1526602818760488.

1802.4

Risk stratifications for strong anticoagulation regimens

M. Burbelko

Department of Radiology, Klinikum Am Urban, Berlin, DE

Learning Objectives

1. To understand the differences in anticoagulation regimens
2. To gain knowledge about scientific data supporting a strong anticoagulation regimen
3. To gain knowledge about risks and contraindications for a strong anticoagulation regimen

No abstract available.

Focus Session Dialysis masterclass

1804.1

Failing arteriovenous fistulas and grafts: epidemiology and pathobiology

B. Dolmatch

Interventional Radiology, The Palo Alto Medical Foundation, Mountain View, CA, US

Learning Objectives

1. To learn the mechanism of fistula occlusions
2. To learn how to prevent AV fistulas failure
3. To review the literature data

The incidence of end-stage renal disease in the United States increases by approximately 5% per year, largely due to the growing prevalence of hypertension and diabetes. Currently in the US over 661,000 individuals have been diagnosed with ESRD, and of these, approximately 468,000 are receiving hemodialysis. The average cost of dialysis is \$89,000 per patient, per year, for a total cost to the US medical system of approximately \$42 billion annually, of which \$34 billion is absorbed by Medicare, our national payor. Approximately 1% of the Medicare population undergoes chronic dialysis, but accounts for 7% of the Medicare budget (1).

Vascular access for hemodialysis is achieved via an arteriovenous fistula (AVF), arteriovenous graft (AVG) or central venous catheter. The National Kidney Foundation Kidney Disease Outcomes Quality Initiatives (2) recommends that an AVF (direct surgical connection of artery to vein) be considered as the first choice for vascular access due to longer period of patency, improved durability, and low infection rates. AVF site location in order of preference, is wrist (radiocephalic), upper arm (brachiocephalic), and upper arm (brachiocephalic) (3). An access in the wrist area is considered the gold standard since it is relatively simple to create, has a low incidence of complications, and if abandonment becomes necessary, it allows for more proximal future access (4). AVFs must be planned a minimum of a month in advance, and may take 3 months or longer to mature, or an AVF may never mature at all. In a large US multicenter prospective study, approximately 60% of newly created AVFs were considered immature, of which half were abandoned without any intervention (5).

Once an AVF reaches maturity and has been successfully cannulated and used for hemodialysis, it may lose patency due to the development of stenosis anywhere in the circuit. All AVFs are at risk for the development of juxta-anastomotic stenosis, while brachiocephalic AVFs often develop stenosis in the cephalic arch (6,7). Brachiocephalic AVFs are prone to stenosis at the "swing point," where the superficialized basilic vein arcs down to its deeper undisturbed location.

Development of AVF stenosis is complex and poorly understood, and many mechanisms have been proposed (8). More perplexing is that some AVFs never develop stenosis, some undergo dilation rather than stenosis, while others are prone to develop multifocal and recurrent stenosis. In any one patient, it is impossible to predict the ultimate patency of an AVF, whether the AVF will develop stenosis, and where it may occur.

There is good reason to believe that juxta-anastomotic stenoses develop, in part, due to a non-anatomic end-to-side configuration that induces turbulent blood flow and wall shear forces. There is probably some contribution from adventitial disruption at the time of surgery, as well as deformity (twisting or kinking) of the vein at the time of surgical creation of the adjacent arteriovenous anastomosis. There are many other possible explanations for the development of a juxta-anastomotic stenosis, too. In the end, we have a long list of possible causes of juxta-anastomotic and swing point stenosis but are still not sure why this happens.

Cephalic arch stenosis and brachiocephalic swing point stenosis may be caused by turbulence and shear forces of high flow pressurized blood passing through curved venous segments. However, other factors may contribute. For example, in the cephalic vein arch there are valves that may produce high flow jets inducing wall shear stress, and also valves leaflets

that may become hyperplastic and cause stenosis. Extrinsic compression of the cephalic vein arch as it passes through the deltopectoral groove is another factor that may lead to stenosis.

One additional thought is that we tend to see all AVF stenoses as luminal narrowings and therefore consider them similar. "Luminology," however, doesn't reveal the nature of the stenotic tissue. AVF stenoses may be fibrotic, hyperplastic, or a mixture of both (9).

Arteriovenous grafts (AVGs) consist of an interposed conduit bridging an artery and a vein. AVGs may be used when autogenous AVF options have been exhausted, as a first line choice in patients whose superficial veins are deep in subcutaneous tissue, or those with extreme vascular fragility who must start hemodialysis and cannot wait for an AVF to mature (3). While most AVGs will be ready for cannulation within a month or two, stenosis at the venous anastomosis often develops (10). In a large prospective multicenter trial, about 75% of newly created AVGs lost primary patency by one year, largely due to the development of stenosis at the venous anastomosis of the graft (11).

To summarize our understanding of failing AVFs and AVGs, the development of stenosis underlies most failures. The development of an AVF stenosis is unpredictable, though juxta-anastomotic, cephalic vein arch, and basilic vein swing points are the most frequent locations. AVGs are particularly prone to develop venous anastomotic stenosis. There is no easy answer as to "why" arteriovenous access circuit stenoses develop, though current thinking is that flow dynamics and biologic responses are closely related, and that surgical factors may also play an important role. We know relatively little about the cellular components of any particular stenosis, and therefore we are at an impasse regarding personalization of treatment. Characterization of the tissue that causes AVF and AVG stenotic lesions could lead to selection of the optimal treatment, but we have not developed reliable and easily applied methods or tools for this. Without a clear understanding of why stenoses occur, it is not possible to prevent them. There are many unanswered questions regarding AVF and AVG stenoses - important clinical problems ripe for study and innovation.

References

1. USRDS 2015, US Renal Data System, Annual Data Report: Epidemiology of kidney disease in the United States. National Institutes of Health, National Institute of Diabetes, Digestive and Kidney Diseases, Bethesda, MD.
2. NKF-KDOQI Clinical Practice Guidelines: American Journal of Kidney Diseases, Vol 48, No 1, Suppl 1 (July), 2006: Clinical Practice Guidelines for Vascular Access.
3. Santoro D, Benedetto F, Mondello P, et al. Vascular access for hemodialysis: current perspectives. *Internat J Nephro and Renovasc Dis* 2014; 7:281-294.
4. Vascular Access 2006 Work Group (VAWG). Clinical practice guidelines for vascular access. *Am J Kidney Dis* 2006; 48 (suppl 1): s176-s247.
5. Dember LA, Beck GJ, Allon M, et al. Effect of Clopidogrel on early failure of arteriovenous fistulas for hemodialysis: A randomized controlled trial. *JAMA*. 2008; 299(18): 2164-2171.
6. Rajan DK, MD, Clark TWI, Patel NK, Stavropoulos SW, Simons ME: Prevalence and Treatment of Cephalic Arch Stenosis in Dysfunctional Autogenous Hemodialysis Fistulas. *J Vasc Interv Radiol* 2003; 14:567-573.
7. Quencer KB, Arici M. Arteriovenous fistulas and their characteristic sites of stenosis. *Am J Radiology*. 2015;205(4): 726-734.
8. Hammes M. Hemodynamic and Biologic Determinates of Arteriovenous Fistula Outcomes in Renal Failure Patients. *BioMed Research International*. 2015;2015:171674.
9. Yamamoto Y, Nakamura J, Nakayama Y, Hino H, Kobayashi H, Sugiura T. Relationship between the outcomes of stent placement and the properties of arteriovenous graft outflow vein stenotic lesions. *J Vasc Access*. 2012 Oct-Dec;13(4):426-31.
10. Zozof R, Kats M, Barker J, Allon M. Time to symptomatic vascular stenosis at different locations in patients with arteriovenous grafts. *Seminars in Dialysis*. 2008;21(3):285-289.

11. Dixon BS, Beck GJ, Vazquez MA, Greenberg A, et al. Effect of Dipyridamole plus Aspirin on Hemodialysis Graft Patency. *N Engl J Med* 2009; 360:2191-2201.

1804.2

Haemodialysis access: randomised trials of drug-coated balloons and covered stents

S.O. Trerotola

Interventional Radiology, University of Pennsylvania Medical Center, Philadelphia, PA, US

Learning Objectives

1. To learn about the published data on drug-coated balloons and covered stents
2. To understand the results of drug-coated balloons
3. To understand the results of covered stents

The area of hemodialysis access (HD) interventions is experiencing an era of unprecedented evidentiary support. In sharp contrast to many other fields in medicine and IR, management of arteriovenous grafts and fistulae used for hemodialysis can be guided on a daily basis by multiple randomized trials. The volume of such studies has reached the point where systematic reviews will be forthcoming which can further inform our practice of evidence based medicine in this space. That said, there remain many areas of HD interventions where evidentiary support is either weak or nonexistent, thus it is essential for the practicing IR physician to be familiar with both the strengths of the evidence and the gaps.

Stent Grafts

The 2010 publication of the FLAIR trial changed HD intervention with the first ever publication of high level evidence showing a device or technique could significantly improve outcomes in such interventions (1). This randomized clinical trial (RCT), as well as the subsequent RENOVA (2) and REVISE (3) RCTs, cemented the role of stent-grafts (SG) in HD interventions by proving beyond any reasonable doubt that stent grafts are better than angioplasty *at the venous anastomosis of grafts*. These were large, well powered, multicenter trials which for the most part explored restenotic lesions. While the original FLAIR trial reported only 6 month data, with both superior 6 month target lesion primary patency (TLPP) and access circuit primary patency (ACPP) for the SG compared with PTA control, the subsequent two trials reported 2 year results for which the same pattern held up. Unlike FLAIR and RENOVA, the REVISE trial included both clotted and patent grafts, and it is important to note that the SG benefit was not seen in either subgroup, only in the aggregate (3). Of note, as would be expected in this area of medicine, the 2 year results were relatively poor for both SG and control in both long term studies. In the RESCUE trial, bare metal in-stent restenosis was found to be better treated with stent grafts compared to angioplasty as measured by both TLPP and ACPP at 2 years (4). This study notably included fistulas and central veins as well as grafts, and again it is worth noting that the 2 year patency data are bleak in both groups: this underscores just how poorly bare metal stents (BMS) fare in access circuits and reminds us that no less than 3 RCT of BMS vs PTA failed to show any benefit for BMS (5-7). Also notably absent from RCT of SG in synthetic HD grafts are systematic comparisons in in-graft locations or central veins.

As strong as the data are for grafts, they are far weaker for arteriovenous fistulae (AVF). In terms of published data, only small single center RCT have compared stent grafts to BMS (8) or PTA (9) and only in the cephalic arch. Both of these small studies found in favor of SG, however there are many limitations of SG in fistulae and especially in the terminal arch of the cephalic vein, where even a perfectly positioned SG often leads to axillary vein stenosis and a poorly positioned one can be disastrous, compromising the entire arm for future access. A recently enrolled multicenter RCT compared SG to PTA in multiple locations throughout AVF (though excluding cannulation zones and central veins) and preliminary data reported at national and international meetings have shown favorable 6 month TLPP compared to PTA control (10). This study, called AVeNEW, is ongoing to 2 years. At present, based on published evidence, it is difficult to make

a strong evidence based recommendation for SG in AVF. Hopefully, as more evidence is gathered, this situation will become clearer.

Drug Coated Balloons

In contrast to stent grafts, where large multicenter trials dominate the published evidence, there is to date only one published large multicenter RCT of drug coated balloons (DCB) in AV access (11), and also in contrast to SG, that study is in AVF, not AVG. The Lutonix AV RCT showed benefit in terms of TLPP but not ACPP (likely due to study design) in mostly restenotic lesions throughout failing arm AVF. To date only the 6 month results have been published, though final 2 year data have been presented at international meetings (12) and show sustained benefit as well. This benefit can be measured in terms of prolonged TLPP, fewer interventions to maintain target lesion patency, and longer time to reintervention for those requiring one. In addition, multiple small single center trials in both AVG and AVF (13-16) have shown benefit in terms of TLPP and/or ACPP, including at the vein-graft anastomosis as well as in the central veins (16). Of note, not every RCT has shown benefit; there are at least 2 published studies showing no benefit (17-18) of DCB in AVF; curiously, the experimental design and devices used in at least one of these (18) were virtually identical to a prior RCT which showed benefit. Also of note, the roles of DCB in immature fistulae and clotted fistulae have not been specifically studied, nor have large studies addressed specific locations such as the cephalic arch. Additional large multicenter RCT are underway and/or fully enrolled and additional data should be forthcoming shortly, and these additional studies will help determine the relative role of DCB in AVG and AVF compared to PTA. Finally, there is no United States FDA approval for DCB in AVG at this time.

Stent Grafts vs Drug Coated Balloons

In contrast to SG, DCB can be used anywhere in the AV circuit including cannulation zones and they do not have the drawbacks of stent fracture, skin penetration, potential jailing of usable access sites and infection that are associated with SG. As no RCT comparing DCB to SG has yet been done, direct comparisons of patency cannot be made at this time; these studies will surely come in time. Looking at the relative advantages of SG in the setting of elastic recoil, these devices may have an edge for this application, and as noted above the vein-graft anastomosis. Conversely when the problem is restenosis without elastic recoil (far more common in AV access than recoil), DCBs likely have an edge due to the fact they leave nothing behind.

In summary, a growing body of evidence in the form of RCT supports use of SG and DCB in various applications in AV access. The available RCT evidence suggests that BMS have no role at all in AV access and should be abandoned altogether in this field. Future studies will inform the relative roles of SG vs DCB in AVG vs AVF.

References

1. Haskal ZJ, Trerotola S, Dolmatch B, et al. Stent graft versus balloon angioplasty for failing dialysis-access grafts. *N Engl J Med* 2010; 362:494-503.
2. Haskal ZJ, Saad TF, Hoggard JG et al. Prospective, randomized, concurrently- controlled study of a stent graft versus balloon angioplasty for treatment of arteriovenous access graft stenosis: 2-Year results of the RENOVA study. *JVIR* 2016;27:1105-1114
3. Vesely T, DaVanzo W, Behrend T, Dwyer A, Aruny J. Balloon angioplasty versus Viabahn stent graft for treatment of failing or thrombosed prosthetic hemodialysis grafts, *JVS* 2016; 64:1400-1410
4. Falk A, Maya ID, Yevzlin AS et al. A prospective, randomized study of an expanded polytetrafluoroethylene stent graft versus balloon angioplasty for in-stent restenosis in arteriovenous grafts and fistulae: Two-year results of the RESCUE study. *JVIR* 2016;27:1465-1776.
5. Quinn SF, Schuman ES, Demlow TA, et al. Percutaneous transluminal angioplasty versus endovascular stent placement in the treatment of venous stenoses in patients undergoing hemodialysis: intermediate results. *JVIR* 1995; 6:851-855.
6. Beathard GA. Gianturco self-expanding stent in the treatment of stenosis in dialysis access grafts. *Kidney Int* 1993; 43:872-877.

7. Hoffer EK, Sultan S, Herskowitz MM, Daniels ID, Sclafani SJ. Prospective randomized trial of a metallic intravascular stent in hemodialysis graft maintenance. *JVIR* 1997; 8:965-973.
8. Shemesh D, Goldin I, Zaghal I, Berlowitz D, Raveh D, Olsha O. Angioplasty with stent graft versus bare stent for recurrent cephalic arch stenosis in autogenous arteriovenous access for hemodialysis: a prospective randomized clinical trial. *J Vasc Surg* 2008; 48:1524-1531.
9. Rajan DK and Falk A. A Randomized Prospective Study Comparing Outcomes of Angioplasty versus VIABAHN Stent-Graft Placement for Cephalic Arch Stenosis in Dysfunctional Hemodialysis Accesses, *JVIR* 2015;26:1355-1361
10. Dolmatch, B, *Controversies in Dialysis Access* 2018, Washington, DC, November 2018
11. Trerotola SO, Lawson J, Roy-Chaudhury P, Saad TF, Drug Coated Balloon Angioplasty in Failing AV Fistulas: A Randomized Controlled Trial, *CJASN* 2018;13:1215-1224
12. Trerotola SO, Leipzig Interventional Course, January 2019, Leipzig, GE
13. Kitrou PM, Katsanos K, Spiliopoulos S, Karnabatidis D, Siablis D. Drug-eluting versus plain balloon angioplasty for the treatment of failing dialysis access: final results and cost-effectiveness analysis from a prospective randomized controlled trial *Eur J Radiol* 2015;84:418-23
14. Kitrou PM, Spiliopoulos S, Katsanos K, Papachristou E, Siablis D, Karnabatidis D. Paclitaxel-coated versus plain balloon angioplasty for dysfunctional arteriovenous fistulae: one-year results of a prospective randomized controlled trial. *J Vasc Interv Radiol* 2015;26:348-54.
15. Katsanos K, Karnabatidis D, Kitrou P, Spiliopoulos S, Christeas N, Siablis D Paclitaxel-coated balloon angioplasty vs. plain balloon dilation for the treatment of failing dialysis access: 6-month interim results from a prospective randomized controlled trial. *J Endovasc Ther* 2012;19(2):263-72.
16. Kitrou PM, Papadimitos P, Spiliopoulos S, Katsanos K, Christeas N, Broutzos E, Karnabatidis D: Paclitaxel-Coated Balloons for the Treatment of Symptomatic Central Venous Stenosis in Dialysis Access: Results from a Randomized Controlled Trial. *JVIR* 2017; 28: 811-817
17. Bjorkmann P, Weselius E-M, Kokkonen T, Rauta V, Alback A, Venermo M. Drug-Coated Versus Plain Balloon Angioplasty In Arteriovenous Fistulas: A Randomized, Controlled Study With 1-Year Follow-Up (The Drecorest li-Study), *Scand J Surgery* 2018, 1-6
18. Maleux G, Vander Mijnsbrugge W, Henroteaux D et al. Multicenter, Randomized Trial of Conventional Balloon Angioplasty versus Paclitaxel-Coated Balloon Angioplasty for the Treatment of Dysfunctioning Autologous Dialysis Fistulae, *JVIR* 2018; 29:470-475

1804.3

Balloon angioplasty of the central outflow venous system: indications and results

P.M. Kitrou

Department of Interventional Radiology, University Hospital of Patras, Patras, GR

Learning Objectives

1. To understand when intervention is required
 2. To learn about the potential complications
 3. To learn the results of angioplasty in central venous
- By definition central veins of the upper part of the body are considered the veins distal to the junction of the axillary vein with the cephalic arch i.e. subclavian vein, brachiocephalic vein and superior vena cava. Although an incidental finding in many cases, central venous stenosis (CVS) could become symptomatic resulting not only in inadequate dialysis performance but also in several other clinical findings including, but

not limited to ipsilateral neck, arm or breast swelling (1). Prior insertion of foreign materials, mainly central venous catheters, accompanied by actual use of the access circuit for dialysis, are the main reasons leading to stenosis of central veins in dialysis patients (2). Symptom occurrence constitutes the absolute reason for treating a central venous stenosis. Treatment of concomitant stenosis within the circuit may result in symptomatic central venous stenosis unmasking as described by Ehrie et al. (3). Standard of practice for interventional procedures is conventional angioplasty with patency rates as low as 28.9% at six months and 25% at 1 year; doubling when high pressure balloons are utilized (60% at six months) (4). Immediate elastic recoil is another possible problem in central vein treatment, however, a recent publication by Rajan et al concluded that elastic recoil, although a common finding (as high as 16%, fifteen minutes following intervention) does not significantly affect primary patency (5). Drug-coated balloons (DCB) have been proposed as a tool to decelerate the process of restenosis and hence increase primary patency. In a proof-of-concept randomized controlled trial by Kitrou et al. a significant difference was observed in favor of DCB angioplasty when compared with plain balloon angioplasty in intervention-free period (6). Bare metal stenting (BMS) is proposed as a bail-out option were restenosis occurs in less than 3 months after CBA with assisted patency rates between 33-56% at 1 year. SIR guidelines published in 2016 however, give a benefit on the use of covered stents over BMS in central veins (7). In the particular session an overview of the available guidelines regarding balloon angioplasty will be described together with an update of the most important studies available. Special emphasis will be given in the symptoms, the different treatment options while the complications will also be discussed.

References

1. Agarwal, A.K., Central vein stenosis. *Am J Kidney Dis*, 2013. 61(6): p. 1001-15.
2. Kundu, S., Review of central venous disease in hemodialysis patients. *J Vasc Interv Radiol*, 2010. 21(7): p. 963-8.
3. Ehrie JM, Unmasking of Previously Asymptomatic Central Venous Stenosis following Percutaneous Transluminal Angioplasty of Hemodialysis Access. *J Vasc Interv Radiol*. 2017 28(10): p. 1409-1414
4. Beathard, G.A., The treatment of vascular access graft dysfunction: a nephrologist's view and experience. *Adv Ren Replace Ther*, 1994. 1(2): p. 131-47.
5. Rajan, D.K., et al., Elastic Recoil after Balloon Angioplasty in Hemodialysis Accesses: Does It Actually Occur and Is It Clinically Relevant? *Radiology*, 2016. 279(3): p. 961-7.
6. Kitrou PM, Paclitaxel-Coated Balloons for the Treatment of Symptomatic Central Venous Stenosis in Dialysis Access: Results from a Randomized Controlled Trial. *J Vasc Interv Radiol*. 2017 28(6): p. 811-817

1804.4

Percutaneous creation of haemodialysis arteriovenous fistulas: technique and early results

D.K. Rajan

Dept of Medical Imaging, Toronto General Hospital, Toronto, ON, CA

Learning Objectives

1. To understand the rationale behind it
2. To learn the percutaneous technique
3. To understand the potential complications

Since the original description of the Brescia Cimino fistula over 50 years ago there has been little improvement or change in the surgical creation of autogenous fistulas. In a meta-analysis of 46 publications which included over 12000 patients, the primary and secondary patency rates were 60 and 71% at one year. Furthermore, 20-60% of surgically created fistulas fail to mature [1]. Percutaneous creation of an AVF represents a dramatic departure from surgery with early results demonstrating significantly better outcomes.

There are two devices approved both within Europe and the United States for percutaneous creation of autogenous hemodialysis fistulas. With both systems, no sealing material, suture or device is left at the fistula site. The first is the Ellipsys device by Avenue Medical and the second is the WaveLinQ device by Becton Dickinson. The Ellipsys device is a single 6Fr catheter system that cauterizes a fistula between the radial artery and a deep venous perforator in the proximal forearm. The WavelinQ device is a 4Fr dual catheter system that creates a fistula using RF (radiofrequency) energy between the ulnar vein/ulnar artery or between the radial vein/radial artery for most cases in the proximal forearm.

The Ellipsys procedure primarily uses ultrasound guidance where a needle is used to puncture the skin, into a superficial vein, down the perforator and then to puncture into the radial artery. Over a wire a 6Fr sheath is advanced into the radial artery. The device is then passed through the sheath into the artery and deployed with a mechanism that catches the arterial wall on one side and the venous wall on the other side which are then apposed and cauterized thereby creating the fistula. After fistula creation, the venous perforator is dilated with an angioplasty balloon to enhance flow.

There are three published studies. The first, included 26 patients and had a technical success rate of 88% with 60% of patients receiving dialysis at 12 months. 87% of AVFs had an additional procedure to facilitate maturation with no major complications [3]. The second was a prospective single arm study conducted within the United States with 107 patients. Technical success was 95% with cumulative or secondary patency of 87% at one year. Maturation procedures including balloon dilation, embolization, vein ligation and surgical transposition were required in 72% of patients. No major adverse events occurred [4]. The third is a single center study from France where in 34 patients and endoAVF was attempted with 97% success. Patency of the pAVF was 94% with all fistulas have been used or were ready for dialysis at 6 weeks. In contrast to the prior two studies, only one patient required superficialization of the upper arm cephalic vein by lipectomy with no additional interventions [6].

The WavelinQ device originally consisted of two 6Fr catheters but with evolution of the device it now consists of two 4Fr catheters that contain rare earth magnets within the shaft of each catheter. One catheter is advanced transvenous and contains the RF element. The second arterial catheter also has rare earth magnets and a ceramic endplate to capture the RF element from the other catheter. Both catheters contain rotational markers, and together with the magnets, allow for proper alignment of the catheters and pull the vessels together. RF energy is delivered for 0.7 seconds and the catheters are then removed. In most cases, one of the outflow brachial veins is embolized to promote flow from the deep venous system to the superficial system to promote maturation for dialysis. The procedure is a combination of ultrasound guided puncture of the vein and artery with subsequent fluoroscopic guidance. Unlike the Ellipsys device multiple access site combinations for both the arterial and venous catheters are possible.

There are five published studies on the 6 Fr EverLinQ system which is now the WavelinQ 6 Fr system with one additional study on the initial results of the 4Fr system completed in follow-up and a second post market approval European Union study of 100 patients that included use of the 6Fr and 4Fr systems. These later two studies are completing follow-up or are in manuscript preparation. Of the five published studies, three are clinical studies and two are economic studies.

The feasibility or pilot study which represented first in human was published in 2015 and included 33 patients. Technical success was 97% with cumulative patency of 96% at six months. Maturation time for dialysis use was 58 days with one serious device related complication [8]. The NEAT study (Novel Endovascular Access Trial) was an open label study consisting of 20 roll-in patients and 60 study patients enrolled within Canada, New Zealand and Australia. EndoAVFs were created in 98% of participants with 87% considered physiologically suitable for dialysis within three months. The 12-month primary and secondary patencies were 69% and 84% respectively. An 8% serious complication rate was observed which was primarily related to closure devices used for the brachial artery puncture. This study was published within the American

Journal of Kidney Diseases in 2017 [5]. A third, real world single center experience was published in 2018 where in 8 patients they observed a 100% technical success rate, and dialysis initiation and maintenance in 7/8 patients within 60 days with one patient lost to follow-up. No major complications occurred [7].

The remained two papers examined via case matching between Medicare and USRDS (US data) data to NEAT study patients, intervention rates and associated costs post surgical or endoAVF creation. Both papers identified at least a 6-fold reduction of interventions (0.6 interventions with the WavelinQ endoAVF vs 3.4 for a surgical AVF) within the endoAVF group in contrast to the surgical comparator. This translated into a minimal cost savings of 11000 USD per patient year [2; 9].

While there are fundamental differences with both systems and techniques, no surgical anastomosis is created and no prosthetic material is placed. The advantages which are now published with the BD WavelinQ system are reduced post creation costs and interventions but both systems have improved patency and lower infection rates than surgically created fistulas. Future studies will solidify the endoAVF as a valuable access option for hemodialysis patients.

References

1. Al-Jaishi AA, Oliver MJ, Thomas SM, et al. (2014) Patency rates of the arteriovenous fistula for hemodialysis: a systematic review and meta-analysis. *Am J Kidney Dis*, 63(3):464-478
2. Arnold RJG, Han Y, Balakrishnan R, et al. (2018) Comparison between Surgical and Endovascular Hemodialysis Arteriovenous Fistula Interventions and Associated Costs. *J Vasc Interv Radiol*, 29(11):1558-1566 e1552
3. Hull JE, Elizondo-Riojas G, Bishop W, Voneida-Reyna YL (2017) Thermal Resistance Anastomosis Device for the Percutaneous Creation of Arteriovenous Fistulae for Hemodialysis. *J Vasc Interv Radiol*, 28(3):380-387
4. Hull JE, Jennings WC, Cooper RI, Waheed U, Schaefer ME, Narayan R (2018) The Pivotal Multicenter Trial of Ultrasound-Guided Percutaneous Arteriovenous Fistula Creation for Hemodialysis Access. *J Vasc Interv Radiol*, 29(2):149-158.e145
5. Lok CE, Rajan DK, Clement J, et al. (2017) Endovascular Proximal Forearm Arteriovenous Fistula for Hemodialysis Access: Results of the Prospective, Multicenter Novel Endovascular Access Trial (NEAT). *Am J Kidney Dis*, 70(4):486-497
6. Mallios A, Jennings WC, Boura B, Costanzo A, Bourquelot P, Combes M (2018) Early results of percutaneous arteriovenous fistula creation with the Ellipsys Vascular Access System. *J Vasc Surg*, 68(4):1150-1156
7. Radosa CG, Radosa JC, Weiss N, et al. (2017) Endovascular Creation of an Arteriovenous Fistula (endoAVF) for Hemodialysis Access: First Results. *Cardiovasc Intervent Radiol*, 40(10):1545-1551
8. Rajan DK, Ebner A, Desai SB, Rios JM, Cohn WE (2015) Percutaneous creation of an arteriovenous fistula for hemodialysis access. *J Vasc Interv Radiol*, 26(4):484-490
9. Yang S, Lok C, Arnold R, Rajan D, Glickman M (2017) Comparison of post-creation procedures and costs between surgical and an endovascular approach to arteriovenous fistula creation. *J Vasc Access*, 18(Suppl. 2):8-14

Fundamental Course

Peripheral arteriovenous malformations

1805.1

Arteriovenous malformations

L.J. Schultze Kool

Radiology, Radboud University Nijmegen Medical Centre, Nijmegen, NL

Learning Objectives

1. To learn how to manage an arteriovenous malformation
 2. To understand the technical aspects
 3. To learn the potential complications and how to manage them
- Treatment of vascular malformations and especially arteriovenous malformations should preferably be done by expertise centers. Treatments can be highly complex and if an incorrect approach is chosen both complications can be high and the options for further treatment and cure can be limited.

Clinical symptoms are classified according to the schobinger staging. (schobinger I = quiescence; II = expansion; III = destruction; IV = cardiac failure).

The nidus of the avm, which can be variable in architecture is the focus for a treatment plan. In this presentation, the approach to these lesions (both the diagnostic (CTA, 4D CTA, MRA, duplex US) and the interventional), the classification (yakes and Do types), the different subtypes and the subsequent implications of this for the treatment will be further discussed. The results obtained in expert centers show that if the assessment is done properly, a high change of cure is present. Different examples of the subtypes and the options for treatment will be illustrated.

Within the European Reference Networks for rare and complex diseases, started by the EU in March 2017, exists a vascular malformation network. (VASCA). The goal of the EU with these ERN's is to spread knowledge and support and to advice centers outside the network in order to make optimal healthcare available across Europe. 8 vascular malformation expert centers in Europe, after being recognized by the governments at a national level, have joined forces in this network. More information about the network, the centers involved and how to get into contact with them can be found on www.vascern.eu

References

1. Congenital vascular malformations. book Springer ,14 Oktober 2017, Young-Wook Kim, Byung-Boong Lee, Wayne F. Yakes, Young Soo Do

1805.2

Venous malformations

L. Ratnam

Department of Radiology, St. James's Wing, St. George's Hospital, London, UK

Learning Objectives

1. To learn the pathophysiology or venous malformation
 2. To learn the endovascular technique
 3. To learn the potential complications and how to manage them
- Venous malformations consist of communications between normal veins and abnormally developed blood vessels that contain low flowing venous blood within. The lesions are made up of a matrix of tissue with abnormal vascular lakes. The low flowing venous blood in the lesions can clot and calcify, resulting in phleboliths.
- Low flow venous malformations can occur anywhere in the body and are usually present from birth although may not become symptomatic or apparant until later in life. Symptoms can become exacerbated by hormonal changes during puberty or pregnancy, as well as by trauma and surgery. They can also worsen with activity, extremes of temperature and in dependent positions.

On examination, the lesions are usually soft, compressible and non-pulsatile. They demonstrate filling on dependency and the larger lesions may have palpable phleboliths within. Superficial lesions can cause a bluish discoloration of the skin. They are usually best assessed with MRI scans to define the anatomical involvement of the lesion and its relationship to adjacent structures. Ultrasound is very useful to assess suitability for percutaneous sclerotherapy.

The indications for treating venous malformations are usually symptoms of pain or dull aching, swelling, bleeding or functional symptoms. Sometimes treatment can be carried out for cosmetic reasons as some malformations in prominent places can cause significant distress to patients and have a serious impact on their quality of life. Various agents have been described in the treatment of vascular and lymphatic malformations by percutaneous sclerotherapy. The most common agent used to treat venous malformations with sclerotherapy is Sodium Tetradecyl Sulphate (Fibrovein). Potential complications of the treatment are pain, swelling, infection, bleeding and skin ulceration.

It is important that the management of venous malformations are carried out in a multidisciplinary team setting. Malformations that have no symptoms should not be treated. In many cases, establishing the diagnosis, providing advice on the natural history of the lesion and observation is all that is required. Conservative management with clinical follow up either during symptomatic episodes or routine monitoring is sufficient in many patients with the use of compression garments to manage symptoms. Sclerotherapy cannot cure venous malformations but can provide good symptom relief and reduce the size of the malformations. It is usually carried out as a day case procedure and requires multiple sessions of treatment to achieve results.

References

1. Mulliken JB, Glowacki J. Hemangiomas and vascular malformations in infants and children: a classification based on endothelial characteristics. *Plast Reconstr Surg* 1982;69:412-20.
2. McCafferty I.J, Jones R.G. Imaging and management of vascular malformations. *Clinical Radiology*, 66 (2011), 1208-1218.
3. Flors L, Leiva-Salinas C, Maged IM, Norton PT, Matsumoto AH, Angle JF, Hugo Bonatti M, Park AW, Ahmad EA, Bozlar U, Housseini AM, Huerta TE, Hagspiel KD. MR imaging of soft-tissue vascular malformations: diagnosis, classification and therapy follow-up. *Radiographics*. 2011, Sep-Oct;31(5):1321-40.

1805.3

Arteriovenous fistula

W.S. Rilling

Vascular and Interventional Radiology, Medical College of Wisconsin, Milwaukee, WI, US

Learning Objectives

1. To learn the pathophysiology of arteriovenous fistulas
 2. To learn the role of interventional radiology
 3. To learn the endovascular technique
- Arteriovenous fistulas are anomalous connections between arteries and veins which can be congenital or acquired. A direct connection between high pressure and low pressure structures is the hallmark of this type of vascular malformation. This A-V connection creates a cycle of high flow and vascular hypertrophy which occurs, resulting in progressive increased flow. The increased flow may result in aneurysm formation, stealing of flow from normal tissues, pain, edema, and other local symptoms. In extreme cases, cardiac complications may arise from high output cardiac failure. Acquired A-V fistulas typically arise from penetrating or iatrogenic trauma. The incidence of A-V fistula following therapeutic coronary interventions is in the range of 0.5- 1 %. Patients may present with symptoms of lower extremity ischemia, edema from venous hypertension, or both. Penetrating trauma can cause A-V fistulas in a wide range of locations and presenting symptoms. Endovascular embolization and/or repair with covered endografts are often the preferred method of management.

Congenital AV fistulas are rare lesions that have a wide range of presenting symptoms. Patients with dural A-V fistulas may present with a bruit, tinnitus, headache, visual symptoms, seizures, or other mental status changes if hemorrhage occurs. Endovascular embolization, surgery, or combined approaches are most commonly used to treat these complex patients. Peripheral AV fistulas arise in a wide range of vessels and organ systems. Patients with arterio-portal fistulas have a fistula between the hepatic artery and portal vein and often present with signs and symptoms of portal hypertension such as variceal bleeding and ascites. Embolization therapy is the treatment of choice for most peripheral AV fistulas. Pulmonary AVMs, present in about 11-40% of patients with HHT, are architecturally A-V fistulas. Due to their unique position in the lungs, they represent a "bypass circuit" of the pulmonary capillary bed filtering mechanism and therefore can cause stroke and brain abscess. Prophylactic embolization is recommended for lesions with a feeding artery diameter of 2-3 mm or greater.

1805.4

Vascular malformation in children

A.M. Barnacle

Radiology, Great Ormond St Hospital for Children, London, UK

Learning Objectives

1. To understand the differences between adults and children
2. To learn the technical aspects
3. To understand the potential complications

The majority of vascular malformations have the same clinical presentation and treatment options in childhood as they do in adults. However, there are some conditions that present in childhood but are very rarely encountered in adult populations, as well as complex syndromes that require intensive multi-disciplinary input in childhood to ensure as normal as possible physical and psychological development of the child. The study of vascular malformations associated with overgrowth is rapidly evolving and the genetic basis of many conditions previously labelled as 'syndromes' is now far better understood. It is now clear that almost all of these malformations are related to underlying somatic mutations in growth genes. The most common mutation currently recognised lies in the PIK3CA gene, giving rise to abnormal PIK3-AKT-mTOR pathway activations. This suggests that medical therapies can be used to target overgrowth at a cellular level, and it hopefully encourages a more simplistic and methodical approach to treatment, recognising that the condition as a whole cannot be cured by any one surgical or IR intervention. Much has been made of the use of sirolimus (rapamycin) to treat what is now increasingly commonly labelled as 'PIK3CA-related overgrowth spectrum' or PROS but it is clear that such medical therapies are still in their infancy. Vascular tumours feature much more in childhood than in adults. The majority are entirely benign and need not concern us. However, kaposiform haemangioendotheliomas (KHE) and tufted angiomas are associated with severe coagulopathies and require early diagnosis and active treatment. Rapidly-involuting congenital haemangiomas (RICH) are, oddly, self-limiting but may require embolisation in the first few days of life if their hypervascularity is causing high output cardiac failure. Finally, it is worth mentioning fibro-adipose vascular anomaly (FAVA), a recently recognised disease. It presents most commonly in primary school age children but has been documented in adults. It comprises a dense fibrofatty infiltrative lesion affecting one or more muscle groups within an extremity, most commonly the forearm or calf. There is associated phlebectasia and patients are often initially labelled as having a venous anomaly. Many are diagnosed after repeated sclerotherapy attempts that give little symptomatic relief. The striking features are pain and contractures that would be out of proportion to the size of the lesion if it were a venous malformation. Sclerotherapy appears to have no role to play. Surgical resection or debulking is possible in smaller lesions, though recurrence rates are as yet unknown.

References

1. Overgrowth syndromes with vascular malformations. Hagen SL, Hook KP. *Semin Cutan Med Surg.* 2016 Sep;35(3):161-9
2. Oral sildenafil as a treatment option for lymphatic malformations in PIK3CA-related tissue overgrowth syndromes. Horbach SE, Jolink F, van der Horst CM. *Dermatol Ther.* 2016 Nov;29(6):466-469
3. CLOVES syndrome: review of a PIK3CA-related overgrowth spectrum (PROS). Martinez-Lopez A, Blasco-Morente G, Perez-Lopez I, et al. *Clin Genet.* 2017 Jan;91(1):14-21
4. Cryoablation in fibro-adipose vascular anomaly (FAVA): a minimally invasive treatment option. Shaikh R, Alomari AI, Kerr CL, Miller P, Spencer SA. *Pediatr Radiol.* 2016 Jul;46(8):1179-86

Hot Topic Symposium

Is renal tumour ablation ready for prime time?

2102.1

Latest guidelines

A. Veltri

Department of Oncology, Diagnostic and Interventional Radiology Unit, University of Turin, Orbassano, IT

A presentation of latest guidelines (GL) on renal tumour ablation (RTA), about if it is ready for prime time, should eventually look at the mainstream in tumour managing, i.e. the agreement between the multidisciplinary tumour board (MTB) and the patient. Radiological and urological updates are thus illustrated, but it is highlighted that the GL suggest patient counselling.

Being RTA mostly for small renal masses (SRM), last GL by CIRSE for small RCC (2016/17)¹ recommend not to undermine confidence in the results of surgery, as the gold standard, despite percutaneous RTA represents a valid treatment of T1a RCCs with excellent long-term technical and functional outcomes and a very low complication rate. Waiting for randomized comparison of RTA with partial nephrectomy (PN), it is still recommended for patients that are not fit or are not willing to undergo PN (after a visit at an outpatient clinic), not differing from ESMO² and EAU³ GLs. The latter are updated every year (latest 2019), without news on RTA recommendation (lacking high quality studies on outcomes, offer non-surgical management only to elderly and/or comorbid patients with SRM).

A more "open" approach comes from the American associations, after AUA updated its GL on Renal Mass and Localized Kidney Cancer in 2017⁴, with the participation of representatives from many "allied fields", including SIR. The new has been that, recognizing great variance in patient/oncologic/functional characteristics, the panel recommended individualized counselling/management (deleting the previous "index patients"), increasing emphasis on importance of functional outcomes for survivorship for most patients with localized RCC. Therefore, the MTB should be involved in the counselling process when necessary and RTA can be offered as an alternate approach for the management of cT1a renal masses <3 cm in size. For patients who elect TA, a percutaneous technique is preferred over a surgical approach whenever feasible to minimize morbidity. Both radiofrequency ablation and cryoablation are options for patients who elect thermal ablation. Counselling about RTA should include information regarding an increased likelihood of tumor persistence or local recurrence after primary RTA relative to surgical extirpation, which may be addressed with repeat ablation if further intervention is elected. Therefore, looking at the NCCN GL for Patients, Kidney Cancer⁵, RTA is presented as a "primary treatment option" for Stage I (T1a, <= 4cm) tumors and it is described as causing very little damage to nearby tissues and much less invasive and with fewer side effects than surgery.

References

1. Krokidis ME, Orsi F, Katsanos K, Helmberger T, Adam A. CIRSE Guidelines on Percutaneous Ablation of Small Renal Cell Carcinoma. *Cardiovasc Intervent Radiol.* 2017 Feb;40(2):177-191. doi: 10.1007/s00270-016-1531-y. Epub 2016 Dec 16.

2. Renal Cell Carcinoma: ESMO Clinical Practice Guidelines | ESMO <https://www.esmo.org/Guidelines/...Cancers/Renal-Cell-Carcinoma>
Renal cell carcinoma: ESMO Clinical Practice Guidelines for diagnosis, treatment and follow-up. Bernard Escudier, Camillo Porta, Manuela Schmidinger, Nathalie Rioux-Leclercq, Axel Bex, Vincent Khoo, Viktor Grünwald, Silke Gillessen, Alan Horwich
Annals of Oncology, mdz056, <https://doi.org/10.1093/annonc/mdz056> Published: 21 February 2019
3. Renal Cell Carcinoma | Uroweb <https://uroweb.org/guideline/renal-cell-carcinoma/> B. Ljungberg (Chair), L. Albiges, K. Bensalah, A. Bex (Vice-chair), R.H. Giles (Patient Advocate), M. Hora, M.A. Kuczyk, T. Lam, L. Marconi, A.S. Merseburger, T. Powles, M. Staehler, A. Volpe Guidelines Associates: Y. Abu-Ghanem, S. Dabestani, S. Fernández-Pello Montes, F. Hofmann, T. Kuusk, R. Tahbaz. EAU Guidelines on Renal Cell Carcinoma 2019.
4. Campbell S, Uzzo RG, Allaf ME, Bass EB, Cadeddu JA, Chang A, Clark PE, Davis BJ, Derweesh IH, Giambarresi L, Gervais DA, Hu SL, Lane BR, Leibovich BC, Pierorazio PM. Renal Mass and Localized Renal Cancer: AUA Guideline. J Urol. 2017 Sep;198(3):520-529. doi: 10.1016/j.juro.2017.04.100. Epub 2017 May 4.
5. NCCN Guidelines for Patients® | Kidney Cancer <https://www.nccn.org/patients/guidelines/kidney/index.html>

2102.2

The urologist's point of view

G. Siena, R. Tellini, A. Minervini

Department of Urology, University of Florence, Careggi Hospital, Florence, IT

According to current guidelines, partial nephrectomy (PN) is the standard treatment for localized renal cell carcinoma (RCC), irrespective of surgical approach, since it achieves equivalent oncologic outcomes compared to radical nephrectomy, with the additional benefit of preservation of healthy renal parenchyma thus avoiding renal function deterioration and its consequences.

In this clinical context, ablative therapies play a significant role since they are indicated in elderly and/or comorbid patients with small renal masses. Currently there is a potential widening of the indication.

Cryoablation (CA) -performed either with percutaneous or laparoscopic approach-, compared to PN, is associated with acceptable perioperative outcomes (8-20% of complications, mostly minor), superimposable functional outcomes and slightly lower RFS and MFS but similar CSS and OS. Radiofrequency ablation (RFA) is associated with a safe perioperative profile and significantly higher local recurrence but functional and survival outcomes are comparable to PN. Nevertheless, only short follow-up and small comparative series are nowadays available.

Some studies have shown the feasibility of other ablative techniques, such as microwave ablation (MWA), thermal ablation technique, laser ablation, and high-intensity focused US ablation. However, these techniques are considered experimental and evidence is still very low.

In conclusion, several alternative treatment options for patients with RCC, especially for those patients who are unfit to undergo an invasive treatment, have been proposed.

All alternative treatment modalities have been described as being safe and effective, based on phase I and II studies. RFA, CA and MWA can be technically limited by the size and location of the tumor, as larger or central lesions undermine local control rates and treatment-related morbidity. To date large multicenter prospective series with an adequate follow-up are required. Indeed, randomized controlled trials (RCTs) comparing PN to ablative treatments have not yet been performed. However, given the strong evidence on NSS, an RCT comparing surgical and ablative treatments could face ethical issues.

Till to that moment, renal tumor ablation techniques should be reserved to well-selected patients unfit or unwilling to surgery and should be treated after a multidisciplinary discussion in highly experienced centres.

2102.3

State-of-the-art of interventional radiology treatment

D.J. Breen

Radiology, Southampton University Hospitals, Southampton, UK

No abstract available.

2102.4

What can we expect in the next five years?

A. Gangi

Imagerie Interventionnelle, NHC, Strasbourg, FR

No abstract available.

Focus Session

New in endovascular thrombectomy

2204.1

What do the DAWN and the DEFUSE-3 trials tell us about stroke imaging?

P. Mordasini

Universitätsinstitut für Diagnostische und Interventionelle Neuroradiologie, Universitätsspital Bern - Inselspital, Bern, CH

Learning Objectives

1. To understand the most important messages from DAWN and DEFUSE trials
2. To understand patient selection in DAWN & DEFUSE trials
3. To learn about the strengthes and weaknesses of CTP and Diffusion MR

The DAWN Trial showed a significant reduction in disability in selected patients with large vessel occlusion (LVO) treated by mechanical thrombectomy (MT) up to 24 hours after last seen well (including wake-up strokes and strokes with unknown symptom onset) with a number needed to treat of 2.8 for functional independence. The imaging inclusion criteria used were based on the concept of **clinical-imaging-mismatch (CIM)**, i. e. including patients with a small core infarct volume depicted by diffusion weighted imaging (DWI), but a large area of brain at risk for ischemia clinically represented by a high NIHSS score. The DEFUSE-3 Trial showed significant better functional outcomes in MT for LVO ischemic stroke 6 to 16 hours after the patient was last seen well than standard therapy alone using **imaging based mismatch criteria** using CT perfusion imaging with a maximum core infarct volume (<70ml), a minimal mismatch volume (≥15ml) and a minimal mismatch ratio (≥ of 1.8). Both trials used DWI or CT perfusion imaging based on an automated software assessment for the estimation of core volume, penumbra volume and mismatch ratio. Consecutively, the most recent treatment guidelines for acute ischemic stroke recommend applying the DAWN and DEFUSE 3 imaging criteria to select patients for MT in unknown or longer time windows. However, the trials included selected patients using restrictive inclusion criteria. Therefore, we have still limited understanding of treatment benefits of late presenting patients with LVO ischemic strokes with larger infarct cores. However, the trials should be seen as proof-of-concept trials. Further studies are needed to establish the prevalence of patients who would be eligible for MT among the entire population of ischemic stroke patients. Because CT perfusion and/or MRI is not routinely performed in all stroke centres, the DAWN and DEFUSE 3 imaging criteria based on core and penumbra volume measurements cannot be assessed and applied everywhere. Therefore, further studies are needed to determine whether MT in late time windows has a benefit when simple, more widely available imaging criteria (ASPECTS, CTA, multiphase CTA for collateral imaging)

in conjunction with simple clinical criteria (good baseline function, significant neurological deficit) are used.

2204.2

What can be learned from the thrombus removal trials?

W.H. van Zwam

Dept. of Radiology, Maastricht University Medical Centre, Maastricht, NL

Learning Objectives

1. To understand the level of evidence from the EVT trials
2. To understand what is proven and what is speculated
3. To understand for which patients EVT is proven

Clinical trials in 2015 have shown convincing evidence that endovascular thrombectomy (EVT) is beneficial for patients with acute ischemic stroke due to an intracranial large vessel occlusion of the anterior circulation. However, many details of the treatment needed further research, like the role of advanced imaging in selecting patients, optimal anesthetic management, best treatment method, treatment effect beyond the recommended time window, etc. Many of these issues have been addressed in studies performed and published since 2015. A short overview of these studies with some critical notes will be given during this lecture.

2204.3

New tips and tricks

J.D. Molina Nuevo

Radiology, Centro Hospitalario Universitario Albacete, Albacete, ES

Learning Objectives

1. To understand how to gain access in difficult cases
2. To understand which devices are proven to be better than others
3. To become familiar with new and handy tools

Recent trials have shown the clinical benefit of endovascular thrombectomy (EVT) in patients who have suffered from an acute ischemic stroke due to large vessel occlusion of the anterior intracranial circulation (1-5). As a result of these evidence-based favorable outcomes, there is an increasing demand to adapt acute stroke management systems in order to make EVT available for as many acute ischemic stroke patients as possible. It's clear that to perform EVT interventional radiologists should have clear knowledge about the pathophysiology of stroke, its management and the appearances of stroke on diagnostic imaging (CT, MR, Angiography). Besides all of that, interventional radiologists should also have wide practical experience of the techniques for carrying out EVT in the context of acute stroke.

A very important point, concerning technical issues, is the vascular access. In the majority of mechanical thrombectomy procedures a transfemoral vascular access is used but radiologist should have present that this is not the only nor the best access possibility. Following the cardiologic tendency the transradial access is becoming more and more used, not only in cases with unfavorable aortic arch configuration but as a first choice technique since it has been shown to decrease morbidity and mortality in comparison with the transfemoral approach (6). The major limitation concerning transradial approach is the radial artery diameter. In the context of a tiny or severe calcified radial artery we must remember other vascular access options as the humeral artery or even the ipsilateral common carotid artery.

Once the vascular access is gained another point of great importance is the choice of the thrombectomy device. Many devices have been used and there are few studies comparing them (7, 8). The efficacy of mechanical thrombectomy with stent retrievers in acute ischemic stroke was demonstrated with the publication of several randomized controlled trials (1-5). This fact caused the stent retrievers to become a first-line treatment in the context of acute ischemic stroke.

Distal aspiration is also used in the management of acute ischemic stroke. The technique is called ADAPT (A Direct Aspiration first Pass Technique), and in this method dedicated large-bore aspiration catheters are used.

Recently ASTER and COMPASS (7, 8) trials showed no inferiority of aspiration, compared with stent retrievers, as a first choice thrombectomy technique in terms of recanalization rate and functional independence. Endovascular mechanical thrombectomy devices achieve recanalization from 70-90% (1-5, 7, 8). Multiple rescue treatments have been attempted when recanalization is not achieved, such as: stent replacement, double stents retrieval, balloon angioplasty, intra-arterial fibrinolysis, and others. In this context, the implantation of an intracranial stent with or without balloon angioplasty could be beneficial as a rescue technique for selected cases (9).

References

1. Berkhemer OA, Fransen PSS, Beumer D, et al. A randomized trial of intraarterial treatment for acute ischemic stroke. *N Engl J Med* 2015; 372: 11-20.
2. Goyal M, Demchuk AM, Menon BK, et al. Randomized assessment of rapid endovascular treatment of ischemic stroke. *N Engl J Med* 2015; 372: 1019-30.
3. Jovin TG, Chamorro A, Cobo E, et al. Thrombectomy within 8 hours after symptom onset in ischemic stroke. *N Engl J Med* 2015; 372: 2296-306.
4. Campbell BCV, Mitchell PJ, Kleinig TJ, et al. Endovascular therapy for ischemic stroke with perfusion-imaging selection. *N Engl J Med* 2015; 372: 1009-18.
5. Goyal M, Menon BK, van Zwam WH, et al. Endovascular thrombectomy after large-vessel ischaemic stroke: a meta-analysis of individual patient data from five randomised trials. *Lancet* 2016; 387: 1723-31.
6. Chen SH, Snelling BM, Sur S, Sha SS, et al. Transradial versus transfemoral access for anterior circulation mechanical thrombectomy: comparison of technical and clinical outcomes. *J Neurointerv Surg* 2019; 0: 1-5.
7. Lapergue B, Blanc R, Gory B, et al. Effect of endovascular contact aspiration vs stent retriever on revascularization in patients with acute ischemic stroke and large vessel occlusion: the ASTER randomized clinical trial. *JAMA* 2017; 318: 443-52.
8. Turk AS 3rd, Siddiqui A, Fifi JT, et al. Aspiration thrombectomy versus stent retriever thrombectomy as first-line approach for large vessel occlusion (COMPASS): a multicentre, randomised, open label, blinded outcome, non-inferiority trial. *Lancet* 2019; 393: 998-1008.
9. Li DD, Huang H, Fang JH, et al. Solitaire stent permanent implantation as an effective rescue treatment for emergency large artery occlusion. *World Neurosurg* 2019; 124: 533-39.

2204.4

Carotid stenting during stroke treatment

L.C. van Dijk¹, K. de Laat², K. Treurniet³, H. van Overhagen¹

¹Department of Radiology, Haga Teaching Hospital, Leyenburg, The Hague, NL, ²Neurology, HAGA Ziekenhuis, The Hague, NL, ³Radiology, HMC, The Hague, NL

Learning Objectives

1. To understand the pros & cons of CAS during EVT
2. To understand which stent is preferentially used during EVT and why
3. To understand why CAS knowledge is mandatory when performing EVT

Carotid Artery Stenting (CAS) can be performed as single therapy in stroke caused by acute occlusion of a stenosed cervical carotid artery, or during EVT in anterior circulation acute ischemic stroke patients who present with a tandem lesion (i.e. an intracranial occlusion combined with an ipsilateral occlusion or high-grade stenosis cervical internal carotid artery (ICA)). Whether and when CAS is appropriate during EVT of tandem lesions is debated since the start of EVT. Arguments in favour of CAS during EVT are the direct treatment of the probable cause of the stroke, facilitation of the intracranial EVT and cerebral flow augmentation.

The main argument against is the assumed increased risk of intracranial haemorrhage due to the necessity of heparin and/or anti-platelet therapy and possible hyperperfusion syndrome.

To our knowledge no randomised controlled trial comparing CAS+ EVT to EVT alone has been performed in patients with stroke and a tandem occlusion, nor is their evidence for acute CAS in patients with an acute stroke due to a solitary cervical ICA occlusion. Further, no optimal technique of CAS during EVT has been established. Which stent should be used? Is there a need for embolic protection? Should we treat the intra- or extracranial occlusion first? Which heparin/anti-platelet regime is optimal? A large recent survey among experts in the US and Canada found that 60% of the therapists performed CAS during EVT whereas 40% never did!¹ They concluded that there seems to be a "clinical equipoise" warranting a clinical trial. A French registry – the TITAN collaboration² – was started to investigate the methods and results of treatment of tandem lesions. In this registration the combination of CAS with EVT in tandem lesions resulted in better reperfusion rates and better clinical outcome compared to other strategies. The addition of pre-interventional IVT, heparin during EVT and antiplatelet therapy necessary for CAS did not result in a significant increase in intracranial haemorrhage. Kim et al³ published results of a large prospective registry of 17 stroke centres. Of a total of 955 patients undergoing acute stroke interventions, 75 presented with a tandem lesion (8%). 75% were treated with CAS and EVT, 25% with EVT alone. Both reperfusion rates and clinical outcomes were significantly better in the CAS+EVT treated patients. Moreover, no significant difference in intracranial haemorrhage was seen. In a systematic review and meta-analysis in which a total number of 1102 patients treated with a tandem lesion were analysed, Wilson et al⁴ concluded that nearly half of the patients treated with a tandem lesion had good clinical outcome. They found no significant differences in outcomes between patients who were stented before or after the intracranial lesion was treated, nor in patients who underwent angioplasty only or stenting.

In acute ischemic stroke caused by acute occlusion of the probably stenosed cervical ICA the treatment of choice usually is Intravenous Therapy (IVT) alone. In a small series of 43 patients with isolated cervical ICA occlusion no statistically significant advantage of CAS over IVT was found (favourable clinical outcome with CAS: 6 of 12 versus without CAS 3 of 10).⁵ CAS was associated with a higher rate of haemorrhage but this did not result in a higher mortality (2 of 12 compared to 2 of 10).

In the presentation at CIRSE 2019 we will show and hopefully discuss the use of CAS in acute ischemic stroke with tandem lesions and isolated cervical ICA occlusion. Theoretical and practical advantages of different stent types and pros and cons of a CAS first versus CAS last approach in patients with tandem lesions will be addressed. Last, usage of CT perfusion to aid treatment decisions in isolated cervical ICA occlusion is discussed. In conclusion we see a trend towards a more liberal use of CAS during treatment of acute ischemic stroke. However, no evidence from randomized clinical trials substantiates this trend, nor is there consensus regarding optimal technique or strategy.

References

1. Jacquin G. et al.: Lack of Consensus Among Stroke Experts on the Optimal Management of Patients With Acute Tandem Occlusion. *Stroke* 2019;50:00-00
2. Zhu F. et al. Impact of Emergent Cervical Carotid Stenting in Tandem Occlusion Strokes Treated by Thrombectomy: A Review of the TITAN Collaboration. *Frontiers in Neurology* 2019;V10:A206:1-6
3. Kim B. et al. Carotid Artery Stenting and Intracranial Thrombectomy for Tandem Cervical and Intracranial Artery Occlusions. *Neurosurgery* 2019;March 8.
4. Wilson M.P. et al. Management of tandem occlusions in acute ischemic stroke – intracranial versus extracranial first and extracranial stenting versus angioplasty alone: a systematic review and meta-analysis. *J Neurointerv Surg*, 2018 Aug;10(8) 721-728
5. Gliem M. et al. Outcome and Treatment Effects in Stroke Associated with Acute Cervical ICA Occlusion. *PLOS ONE* 2017; January 12.

Clinical Evaluation Course Acute mesenteric arterial ischaemia

2502.1

Clinical presentation

M.C. Ferraro

Anestesia e rianimazione, AOUC, Florence, IT

Acute mesenteric ischemia (AMI), secondary to the occlusion of visceral vessels, is a life-threatening condition characterized by bowel ischemia, infarction, and necrosis. Mortality rate is high as 10.6% when AMI is diagnosed and treated within 24 h from onset and raises to 72.9% when delayed. Symptoms, usually non-specific, make the diagnosis frequently challenging. AMI is sustained by one of the four pathophysiologic mechanisms: 1) Arterial embolism; 2) Arterial thrombosis; 3) Non occlusive ischemia (NOMI); 4) Venous thrombosis.

A careful medical history may help the physician to suspect the diagnosis. Emboli can originate from the left atrium, in case of atrial fibrillation, Thrombosis is usually associated with chronic atherosclerotic disease. NOMI is usually the consequence of a vasoconstriction of vessels in shocked patients. Thrombosis is attributed to a hypercoagulability like in inherited diseases (e.g. Factor V Leiden, prothrombin mutation, protein S or C deficiency).

Since patients usually complain nonspecific abdominal pain, early diagnosis is based on the clinical suspect. Additional or alternative symptoms, although infrequent, could be fever, rectal bleeding, vomiting and diarrhea. In the early stage, the reduction of blood flow can lead to intestinal edema and weakened peristalsis. Laboratory findings include elevated leukocyte count and metabolic acidosis with elevated lactate level.

When AMI is suspected, CT scan should be performed. It allows early diagnosis and differentiation between occlusive and non-occlusive causes. If AMI, the CTA findings reflect irreversible ischemia. If CT scan is inconclusive and there is strong clinical suspicion of AMI, angiography is useful to verify the diagnosis

References

1. Bala M, Kashuk J, Moore EE Acute mesenteric ischemia: guidelines of the World Society of Emergency Surgery. *World J Emerg Surg*. 2017 Aug 7;12:38.
2. Liao G, Chen S, Cao H; Wang W; Gao Q Review: Acute superior mesenteric artery embolism: A vascular emergency cannot be ignored by physicians. *Medicine (Baltimore)*. 2019 Feb;98(6):e14446.
3. Stahl K; Busch M; Maschke SK A Retrospective Analysis of Nonocclusive Mesenteric Ischemia in Medical and Surgical ICU Patients: Clinical Data on Demography, Clinical Signs, and Survival. *J Intensive Care Med* 2019 Mar 25;885066619837911
4. Aliosmanoglu I, Gul M, Kapan M, et al. Risk factors effecting mortality in acute mesenteric ischemia and mortality rates: a single center experience. *Int Surg* 2013;98:76–81.

2502.2

Diagnostic imaging

G. Papageorgiou

Interventional Radiology, Metropolitan Hospital, N. Faliro, GR

No abstract available.

2502.3

Guidelines

M. Szczerbo-Trojanowska

Department of Interventional Radiology, Medical University of Lublin, Lublin, PL

An early diagnosis and intervention are essential for improving outcome in patients with acute mesenteric ischaemia (AMI).

At present, according to the guidelines of the World Society of Emergency Surgery published in 2017 and the European Society for Trauma and Emergency Surgery published in 2016 there is no level 1 evidence for the evaluation and treatment of patients with presumed AMI. Recommendations for diagnosis and treatment of AMI are based on the published literature containing institutional reviews, comparative studies, case series and personal recommendation (level II and III evidence). There is a strong evidence that AMI should be suspected in patients with an acute, severe abdominal pain that is disproportionate to minimal findings on physical examination particularly in the elderly with a history of cardiovascular events.

Clinical appearance does not reliably differentiates AMI as mesenteric arterial emboli, mesenteric arterial thrombosis, non-occlusive mesenteric ischaemia or mesenteric venous thrombosis but these aetiological types of AMI have different characteristics and risk factors.

AMI resulting from mesenteric arterial emboli (accounts for approximately 45 % of cases of AMI) has sudden onset of pain and is frequently associated with atrial fibrillation, recent MI, cardiac thrombi, mitral valve disease, left ventricular aneurysm, previous embolic disease, diffuse atherosclerotic disease. It may occur when atheromatous plaques are dislodged during angiography.

Patients with mesenteric arterial thrombosis (accounts for approximately 25 % of cases of AMI) often have a history of chronic postprandial abdominal pain, progressive weight loss, and previous revascularization procedures for mesenteric arterial occlusion. These patients frequently report prodromal symptoms of mesenteric angina.

Non-occlusive mesenteric ischaemia (accounts for approximately 20 % of cases of AMI) most probably is due to a combination of low cardiac output and vasoconstriction. It usually occurs in critically ill patients. They have pain that is more diffuse and episodic. Risk factors include age >50, history of acute myocardial infarction, congestive heart failure, aortic insufficiency, cardiopulmonary bypass.

Venous thrombosis (accounts for approximately 20 % of cases of AMI) occurs in a younger population. Patients often report a previous deep venous thrombosis or pulmonary embolism. Risk factors include hypercoagulability states, abdominal trauma, abdominal infection, acute pancreatitis, malignancy, portal hypertension, cirrhosis, splenomegaly. Oral contraceptives, are a risk factor in young women.

There are no specific laboratory tests that are sufficiently accurate for early detection of AMI. A normal serum lactate level does not exclude AMI although elevated l-lactate, and D-dimer may assist.

Diagnostic imaging procedures should be performed as early as possible for any patient with suspicion for AMI. A plain abdominal radiograph has limited diagnostic value in evaluating AMI particularly in the early stage. A negative radiograph does not exclude mesenteric ischemia. Nonspecific radiographic signs appear when bowel infarction has already occurred. Biphasic multidetector computed tomography (MDCT) with intravenous contrast should be the first line imaging method. It is the most sensitive and specific diagnostic tool for the early diagnosis of AMI. It also allows to exclude other causes of acute abdominal pain. MDCT displaced angiography as the diagnostic study of choice except where non-occlusive mesenteric ischaemia is suspected. Percutaneous angiography for diagnosis of suspected AMI has been replaced by MDCT. No relevant trials supporting the use of angiography for diagnosis can be found in the recent literature.

Biphasic CT includes pre-contrast scans and the arterial and venous phases. Pre-contrast scans reveal vascular calcification, intramural hemorrhage, hyper-attenuating intravascular thrombus. Arterial and venous

phases allows the identification of thrombus in the mesenteric arteries and veins, abnormal enhancement of the bowel wall, the presence of embolism or infarction of other organs. Multi-planar reconstructions are useful in evaluation of the mesenteric artery origin. CTA should be performed even in patients with renal failure. Delayed diagnosis is far more detrimental to the patient than administration of the iodinated contrast agent.

After diagnosing AMI, fluid replacement as well as supplementary oxygen should start promptly but should not delay an intervention. Patients should receive intravenously unfractionated heparin, unless contraindicated. Due to the high risk of infection broad-spectrum antibiotics should be administered early in the course of AMI treatment.

The goal of surgical and endovascular intervention for AMI is to re-establish blood supply to the ischemic bowel. The accepted treatment is an open surgical embolectomy. Currently, an increasing number of patients successfully treated percutaneously have been reported. These methods have been attempted in the very early cases of AMI. The results of endovascular treatment are comparable to the open surgery. However it should be stressed that only patients who did not require open emergent surgery are suitable for endovascular treatment. Peritonitis secondary to bowel necrosis mandates surgery without delay.

Endovascular methods include percutaneous mechanical thrombus aspiration or thrombolysis and permits percutaneous transluminal angioplasty, with or without stenting. If expertise and appropriate resources are available these methods can be offered to the patients with CTA evidence of acute partial or complete occlusion of the main trunk or branch of the SMA.

In patients with acute thrombosis of a superior mesenteric artery endovascular treatment should be considered as soon as possible. The commonest interventions are PTA and stenting. Other endovascular techniques include percutaneous aspiration thrombectomy, local fibrinolysis or intra-arterial drug perfusion with heparin or papaverine.

In the management of non-occlusive mesenteric ischaemia additional treatment may include systemic anticoagulation and the use of catheter-directed infusion of vasodilatory and antispasmodic agents.

There are no randomized controlled trials comparing laparotomy versus endovascular treatment as the first line strategy for the management AMI. In cases of endovascular approach, the use of laparoscopy to assess bowel function may be a reasonable addition.

Treatment performed in the hybrid operating rooms may provide further data supporting the use of endovascular methods.

References

1. Bala M, Kashuk J, Moore EE et al. Acute mesenteric ischemia: guidelines of the World Society of Emergency Surgery. *World J Emerg Surg.* 2017; 12: 38. doi: 10.1186/s13017-017-0150-5
2. Tilsed JVT, Casamassima A, Kurihara H et al. European Journal of Trauma and Emergency Surgery ESTES guidelines: acute mesenteric ischaemia. *Eur J Trauma Emerg Surg.* 2016; 42: 253–270. doi: 10.1007/s00068-016-0634-0
3. Clair DG, Beach JM. Mesenteric Ischemia. *N Engl J Med.* 2016;374:959–968. doi: 10.1056/NEJMr1503884.
4. Mastoraki A, Mastoraki S, Tziava E, Touloumi S, Krinos N, Danias N, Lazaris A, Arkadopoulos N. Mesenteric ischemia: pathogenesis and challenging diagnostic and therapeutic modalities. *World J Gastrointest Pathophysiol.* 2016;7:125–130. doi: 10.4291/wjgp.v7.i1.125.
5. Treskes N, Persoon AM, van Zanten ARH. Diagnostic accuracy of novel serological biomarkers to detect acute mesenteric ischemia: a systematic review and meta-analysis. *Intern Emerg Med.* 2017.
6. Beaulieu RJ, Arnaoutakis KD, Abularrage CJ, Efron DT, Schneider E, Black JH. Comparison of open and endovascular treatment of acute mesenteric ischemia. *J Vasc Surg.* 2014;59:159–164. doi: 10.1016/j.jvs.2013.06.084.
7. Sarac TP. Techniques of endovascular revascularization for acute mesenteric ischemia. In: Oderich G, editor. *Mesenteric Vascular Disease.* New York: Springer; 2015. pp. 241–252.

8. Kim BG, Ohm JY, Bae MN, Kim HN, Kim YJ, Chung MH, Park CS, Ihm SH, Kim HY. Successful percutaneous aspiration thrombectomy for acute mesenteric ischemia in a patient with atrial fibrillation despite optimal anticoagulation therapy. *Can J Cardiol*. 2013;29:1329.e5–1329.e7. doi: 10.1016/j.cjca.2012.12.008.
9. Jia Z, Jiang G, Tian F, Zhao J, Li S, Wang K, Wang Y, Jiang L, Wang W. Early endovascular treatment of superior mesenteric occlusion secondary to thromboemboli. *Eur J Vasc Endovasc Surg*. 2014;47:196–203. doi: 10.1016/j.ejvs.2013.09.025.
10. Björck M. Part one: for the motion. an endovascular first strategy is the optimal approach for treating acute mesenteric ischemia. *Eur J Vasc Endovasc Surg*. 2015;50:273–275. doi: 10.1016/j.ejvs.2015.04.025.

2502.4

The role of interventional radiology

J.A. Kaufman

Dotter Interventional Institute/Interventional Radiology, Oregon Health & Science University Hospital, Portland, OR, US

No abstract available.

2502.5

The role of surgery

C. Pilasi Menichetti

Major Trauma Centre, Kings College Hospital, London, UK

No abstract available.

2502.6

Post-procedural management and follow-up

M. Cejna

Institut fuer Diagnostische und Interventionelle Radiologie, Akademisches Lehrkrankenhaus LKH Feldkirch, Feldkirch, AT

Post-procedural management and follow-up after acute intestinal ischaemia depends on the initial extent of bowel injury on CT, the way of treatment and the cause of acute ischaemia (thrombotic occlusion or dissection or embolic occlusion).

In all patients undergoing mesenteric revascularization, angiographic completion imaging is warranted. After surgical revascularization second look surgery is often (repeatedly) necessary after “restricted or minimal” bowel resection. After endovascular revascularization laparoscopy or laparotomy is necessary to assess bowel viability.

During early follow-up repeated clinical reassessment of bowel viability is necessary, dependent on the initial severity of intestinal ischaemia prior to revascularization, the rate and completeness of revascularization. Patients after stent placement must be followed by duplex ultrasound or CT-Angiography to detect in-stent restenosis, stent thrombosis has a relevant mortality rate. A standard follow-up regime has not been established, CTA prior to discharge, duplex/CTA after 3, 6, 12 months and then yearly can be advocated. After stent placement for thrombotic occlusion or dissection best medical therapy with (at least one) antiplatelet agent, a statin and (if present) smoking cessation should be performed. If the patient was treated for clear embolic occlusion without stent placement a strict f/u regimen may not be indicated. In the case of embolic arterial occlusion oral anticoagulation is indicated.

References

1. Björck M, Koelemay M, Acosta S et al. Management of the Diseases of Mesenteric Arteries and Veins: Clinical Practice Guidelines of the European Society of Vascular Surgery (ESVS). *Eur J Vasc Endovasc Surg*. 2017 Apr;53(4):460-510

Fundamental Course Intra-arterial stroke management

2503.1

For whom should thrombectomy be considered?

P. Mordasini

Universitätsinstitut für Diagnostische und Interventionelle Neuroradiologie, Universitätsspital Bern - Inselspital, Bern, CH

Learning Objectives

1. To understand which patients should be considered for EVT
 2. To understand which diseases can mimic stroke
 3. To understand the time windows for EVT
- Several recent randomised controlled trials have shown superior efficacy and clinical outcome of endovascular thrombectomy in acute ischemic stroke due to proximal vessel occlusion of the anterior cerebral circulation compared to intra-venous thrombolysis (IVT) with rtPA (recombinant tissue-type plasminogen activator) alone. These positive trials have led to the introduction of mechanical thrombectomy (MT) using stent retriever devices in addition to IVT as the recommended treatment for acute ischaemic stroke in patients with large vessel occlusion of the anterior circulation based on class I level A evidence (1,2). However, uncertainties remain about the benefit of MT in patient subgroups which are not represented at all or under-represented in these trials. A meta-analysis of pooled individual patient data from 5 randomised trials (3) showed a treatment benefit over a wide range of patient subgroups, including patients older than 80 years of age, patients ineligible for IVT, patients presenting later than 300 minutes after symptom onset or with a low NIHSS score, large infarct core as well as tandem lesions with an overall number of patients needed to treat to reduce disability by at least one level on the mRS of 2.6. Other single- and multi-centre studies further suggest efficacy of MT in patients with low NIHSS score (4) as well as in selected patients with large infarct core (>50 ml), especially if they are younger and/or present with a large mismatch profile (5,6). The DAWN Trial showed a significant reduction in disability in selected patients with large vessel occlusion treated by MT up to 24 hours after last seen well (including wake-up strokes and strokes with unknown symptom onset) using target mismatch criteria (clinical-imaging mismatch with small core infarct volume, but a large area of brain at risk for ischaemia) with a number needed to treat of 2.8 for functional independence. The results of this study will further expand the patient population eligible for mechanical thrombectomy.

References

1. Powers WJ, Derdeyn CP, Biller J, et al. AHA / ASA Guideline 2015 American Heart Association / American Stroke Association Focused Update of the 2013 Guidelines for the Early Management of Patients With Acute Ischemic Stroke Regarding Endovascular Treatment. <https://doi.org/10.1161/STR.0000000000000074>.
2. Fiehler J, Cognard C, Gallitelli M, et al. European Recommendations on Organisation of Interventional Care in Acute Stroke (EROICAS). 2016;11:701–16.
3. Goyal M, Menon BK, Zwam WH Van, et al. Endovascular thrombectomy after large-vessel ischaemic stroke: a meta-analysis of individual patient data from five randomised trials. [https://doi.org/10.1016/S0140-6736\(16\)00163-X](https://doi.org/10.1016/S0140-6736(16)00163-X).
4. Dargazanli C, Arquizan C, Gory B, et al. Mechanical Thrombectomy for Minor and Mild Stroke Patients Harboring Large Vessel Occlusion in the Anterior Circulation: A Multicenter Cohort Study. *Stroke* <https://doi.org/10.1161/STROKEAHA.117.018113>.
5. Gilgen MD, Klimek D, Liesirova KT, et al. Younger Stroke Patients with Large Pretreatment Diffusion-Weighted Imaging Lesions May Benefit from Endovascular Treatment. *Stroke* 2015;46.

6. Rebello LC, Bouslama M, Haussen DC, et al. Endovascular Treatment for Patients With Acute Stroke Who Have a Large Ischemic Core and Large Mismatch Imaging Profile. *JAMA Neurology* 2017;74:34.

2503.2

Imaging the brain and the clot

T. Struffert

Neuroradiologie, Universitätsklinikum Giessen, Giessen, DE

Learning Objectives

1. To understand which imaging technique is essential for EVT consideration (CT & CTA)
2. To understand strengths and weaknesses of CTP
3. To understand strengths and weaknesses of diffusion MR

No abstract available.

2503.3

Thrombectomy and aspiration

S. Hopf-Jensen

Department of diagnostic/interventional Radiology/Neuroradiology, Diakonissenhospital Flensburg, Flensburg, DE

Learning Objectives

1. To understand thrombectomy techniques
 2. To understand aspiration techniques
 3. To understand pros and cons of thrombectomy vs aspiration
- With mechanical thrombectomy having become the standard of care for large proximal vessel occlusion in ischemic stroke, the focus of research is shifting towards improvements in techniques and different strategies. Stent retriever thrombectomy with or without aspiration assistance was predominantly employed in the 5 randomized controlled clinical trials (MR CLEAN, ESCAPE, REVASCAT, SWIFT PRIME, and EXTEND IA) (1-5) demonstrating the superiority of endovascular thrombectomy to intravenous rt-PA (recombinant tissue-type plasminogen activator) (1, 6). In summary, following techniques can be differentiated a) stent-based thrombectomy using retrievable stents with or without aspiration catheter and b) aspiration thrombectomy using aspiration catheter alone. Furthermore the stent-based thrombectomy can be subclassified into "SOLUMBRA" technique (stent retriever thrombectomy and distal aspiration) (7, 8, 9), with and without proximal flow blockade via BGC (balloon guide catheter) and into different techniques with regard to distal access catheters. Specific techniques have been described involving a combination of distal aspiration and stent retrievers including CAPTIVE (continuous aspiration before intracranial vascular embolectomy) (10), DAT (dual aspiration stent retriever assistant technique) (11), SAVE (stent retriever assisted distal vacuum-locked extraction) (12), ASAP (A Stent-Retrieving into an Aspiration Catheter with Proximal Balloon) (13) or PROTECTPLUS (PROximal balloon Occlusion TOgEther with direCT Thrombus aspiration and a partially inserted stent retriever into a large-bore aspiration catheter) (14). A direct aspiration first-pass technique (ADAPT), or contact aspiration, involves the first-line use of aspiration through a large-bore catheter (15). Several authors demonstrated the feasibility of the ADAPT technique using a large bore aspiration catheters to achieve successful revascularization (16, 17, 6, 18, 19, 20, 21, 22). Primiani et al. performed a systematic analysis to compare ADAPT and primary stent retriever thrombectomy (38 publications and a total of 3028 patients). They found no significant difference in successful recanalization rates (mTICI score=2b or 3) between the ADAPT and stent-based Thrombectomy (23). However the ASTER trial (first-line thrombectomy with contact aspiration compared with stent retriever) failed to show a superiority of aspiration regarding to patients outcome (24).

This lecture gives an overview of different techniques of stent-based thrombectomy and aspiration techniques in ischemic stroke, as well as a review of the current literature.

References

1. Berkhemer OA, Fransen PS, Beumer D, et al. A randomized trial of intraarterial treatment for acute ischemic stroke. *N Engl J Med*. 2015;372:11–20.
2. Goyal M, Demchuk AM, Menon BK, et al. Randomized assessment of rapid endovascular treatment of ischemic stroke. *N Engl J Med*. 2015;372:1019–30.
3. Jovin TG, Chamorro A, Cobo E, et al. Thrombectomy within 8 hours after symptom onset in ischemic stroke. *N Engl J Med*. 2015;372:2296–306.
4. Saver JL, Goyal M, Bonafe A, et al. Stent-retriever thrombectomy after intravenous t-PA vs. t-PA alone in stroke. *N Engl J Med*. 2015;372:2285–95.
5. Campbell BC, Mitchell PJ, Kleinig TJ, et al. Endovascular therapy for ischemic stroke with perfusion-imaging selection. *N Engl J Med*. 2015;372:1009–18.
6. Stapleton CJ, Leslie-Mazwi TM, Torok CM, Hakmelahi R, Hirsch JA, Yoo AJ, Rabinov JD, Patel AB. A direct aspiration first-pass technique vs stentriever thrombectomy in emergent large vessel intracranial occlusions. *J Neurosurg*. 2018 Feb;128(2):567–574.
7. Deshaies EM. Tri-axial system using the Solitaire-FR and Penumbra Aspiration Microcatheter for acute mechanical thrombectomy. *J Clin Neurosci*. 2013 Sep;20(9):1303–5.
8. Humphries W, Hoit D, Doss VT, Eljovich L, Frei D, Loy D, Dooley G, Turk AS, Chaudry I, Turner R, Mocco J, Morone P, Fiorella D, Siddiqui A, Mokin M, Arthur AS. Distal aspiration with retrievable stent assisted thrombectomy for the treatment of acute ischemic stroke. *J Neurointerv Surg*. 2015 Feb;7(2):90–4.
9. Lee JS, Hong JM, Lee SJ, Joo IS, Lim YC, Kim SY. The combined use of mechanical thrombectomy devices is feasible for treating acute carotid terminus occlusion. *Acta Neurochir (Wien)*. 2013 Apr;155(4):635–41.
10. McTaggart RA, Tung EL, Yaghi S, Cutting SM, Hemendinger M, Gale HI, Baird GL, Haas RA, Jayaraman MV. Continuous aspiration prior to intracranial vascular embolectomy (CAPTIVE): a technique which improves outcomes. *J Neurointerv Surg*. 2017 Dec;9(12):1154–1159.
11. Hopf-Jensen S, Preiß M, Marques L, Lehrke S, Schattschneider J, Stolze H, Müller-Hülsbeck S. Impact and Effectiveness of Dual Aspiration Technique in Stent-Assisted Mechanical Thrombectomy: Recent Improvements in Acute Stroke Management. *Cardiovasc Intervent Radiol*. 2016 Nov;39(11):1620–1628.
12. Maus V, Behme D, Kabbasch C, Borggreffe J, Tsogkas I, Nikoubashman O, Wiesmann M, Knauth M, Mpotsaris A, Psychogios MN. Maximizing First-Pass Complete Reperfusion with SAVE. *Clin Neuroradiol*. 2018 Sep;28(3):327–338.
13. Goto S, Ohshima T, Ishikawa K, Yamamoto T, Shimato S, Nishizawa T, Kato K. A Stent-Retrieving into an Aspiration Catheter with Proximal Balloon (ASAP) Technique: A Technique of Mechanical Thrombectomy. *World Neurosurg*. 2018 Jan;109:e468–e475.
14. Maegerlein C, Berndt MT, Mönch S, Kreiser K, Boeckh-Behrens T, Lehm M, Wunderlich S, Zimmer C, Friedrich B. Further Development of Combined Techniques Using Stent Retrievers, Aspiration Catheters and BGC: The PROTECT(PLUS) Technique. *Clin Neuroradiol*. 2018.
15. Turk AS, Spiotta A, Frei D, Mocco J, Baxter B, Fiorella D, Siddiqui A, Mokin M, Dewan M, Woo H, Turner R, Hawk H, Miranpuri A, Chaudry I. Initial clinical experience with the ADAPT technique: a direct aspiration first pass technique for stroke thrombectomy. *J Neurointerv Surg*. 2014 Apr 1;6(3):231–7.
16. Turk AS, Frei D, Fiorella D, Mocco J, Baxter B, Siddiqui A, Spiotta A, Mokin M, Dewan M, Quarfordt S, Battenhouse H, Turner R, Chaudry I. ADAPT FAST study: a direct aspiration first pass technique for acute stroke thrombectomy. *J Neurointerv Surg*. 2018 Jul;10(Suppl 1):i4–i7.

17. Delgado Almandoz JE, Kayan Y, Young ML, Fease JL, Scholz JM, Milner AM, Hehr TH, Roohani P, Mulder M, Tarrel RM. Comparison of clinical outcomes in patients with acute ischemic strokes treated with mechanical thrombectomy using either Solumbra or ADAPT techniques. *J Neurointerv Surg*. 2016 Nov;8(11):1123-1128.
18. Wong JHY, Do HM, Telischak NA, Moraff AM, Dodd RL, Marks MP, Ingle SM, Heit JJ. Initial experience with SOFIA as an intermediate catheter in mechanical thrombectomy for acute ischemic stroke. *J Neurointerv Surg*. 2017 Nov;9(11):1103-1106.
19. Delgado Almandoz JE, Kayan Y, Wallace AN, Tarrel RM, Fease JL, Scholz JM, Milner AM, Roohani P, Mulder M, Young ML. Larger ACE 68 aspiration catheter increases first-pass efficacy of ADAPT technique. *J Neurointerv Surg*. 2019 Feb;11(2):141-146.
20. De Marini P, Nayak S, Zhu F, Bracard S, Anxionnat R, Tonnelet R, Liao L, Richard S, Humbertjean L, Mione G, Lacour JC, Derelle AL, Gory B. A direct aspiration first pass technique with the new ARC catheter for thrombectomy of large vessel occlusion strokes: A multicenter study. *Interv Neuroradiol*. 2019 Apr;25(2):187-193.
21. Almallouhi E, Anadani M, Al Kasab S, Lena JR, Spiotta AM. Initial Experience in Direct Aspiration Thrombectomy Utilizing a Novel 0.071-inch Aspiration Catheter. *World Neurosurg*. 2019 Mar 14.
22. Schramm P, Navia P, Papa R, Zamarro J, Tomasello A, Weber W, Fiehler J, Michel P, Pereira VM, Krings T, Gralla J, Santalucia P, Pierot L, Lo TH. ADAPT technique with ACE68 and ACE64 reperfusion catheters in ischemic stroke treatment: results from the PROMISE study. *J Neurointerv Surg*. 2019 Mar;11(3):226-231.
23. Primiani C, Primiani C et al: Direct aspiration (ADAPT) and primary stent retriever thrombectomy for acute ischemic stroke: A systematic review of radiographic and clinical outcomes in 5441 patients (P4.214).
24. Lapergue B, Blanc R, Gory B, Labreuche J, Duhamel A, Marnat G, Saleme S, Costalat V, Bracard S, Desal H, Mazighi M, Consoli A, Piotin M; ASTER Trial Investigators. Effect of Endovascular Contact Aspiration vs Stent Retriever on Revascularization in Patients With Acute Ischemic Stroke and Large Vessel Occlusion: The ASTER Randomized Clinical Trial. *JAMA*. 2017

2503.4

What do the trials tell us?

E.R. Gizewski

Neuroradiology, University Hospital, Innsbruck, AT

Learning Objectives

1. To understand the levels of evidence for EVT
2. To become familiar with the most important trials in EVT
3. To become familiar with newest important trial results

Since the first 5 randomised trials in 2015 the treatment criteria for mechanical thrombectomy in acute stroke patients changed continuously. In the first studies the inclusion criteria were: large vessel occlusion (internal carotid artery, middle cerebral artery), ASPECT Score 6-10, time onset within 6 hours. The results of these studies lead to a level Ia evidence for thrombectomy in patients presenting with those clinical and imaging characteristics.

Within the last years further studies and sub-group analyses were published and some important aspects will be discussed. Due to matter of time, mainly randomized trials dealing with anterior circulation will be presented and critically discussed according to the Learning Objectives. With increasing evidence for good outcomes also in patients outside the above-mentioned criteria further studies were conducted for selecting patients with a good ASPECT score who present later than 6 hours after the onset of a ischemic stroke. The results of these studies indicate, that patient selection for thrombectomy in acute stroke have to be re-defined according to the significant benefit in up to 24 hours of onset. Patients with a relatively small area of core infarction as shown by CT-perfusion (CTP/ or MRP) or MR diffusion or multiphase CTA and a large artery occlusion

with severe clinical symptoms will most likely benefit from thrombectomy combined with medical treatment, again a level Ia evidence.

As an outlook, some studies now enrolling patients with acute stroke in extended time window and lower ASPECT score will be introduced.

References

1. Albers GW, Marks MP, Kemp S, Christensen S, Tsai JP, Ortega-Gutierrez S, McTaggart RA, Torbey MT, Kim-Tenser M, Leslie-Mazwi T, Sarraj A, Kasner SE, Ansari SA, Yeatts SD, Hamilton S, Mlynash M, Heit JJ, Zaharchuk G, Kim S, Carrozzella J, Palesch YY, Demchuk AM, Bammer R, Lavori PW, Broderick JP, Lansberg MG; DEFUSE 3 Investigators. Thrombectomy for Stroke at 6 to 16 Hours with Selection by Perfusion Imaging. *N Engl J Med*. 2018 Feb 22;378(8):708-718.
2. Barral M, Boudour S, Viprey M, Giroudon C, Aulagner G, Schott AM, Turjman F, Armoiry X, Gory B. Stent retriever thrombectomy for acute ischemic stroke: A systematic review and meta-analysis of randomized controlled trials, including THRACE. *Rev Neurol (Paris)*. 2018 May;174(5):319-326.
3. Bhogal P, Andersson T, Maus V, Mpotsaris A, Yeo L. Mechanical Thrombectomy-A Brief Review of a Revolutionary new Treatment for Thromboembolic Stroke. *Clin Neuroradiol*. 2018 May 9. doi: 10.1007/s00062-018-0692-2.
4. Goyal M, Menon BK, van Zwam WH, Dippel DW, Mitchell PJ, Demchuk AM, Dávalos A, Majoie CB, van der Lugt A, de Miquel MA, Donnan GA, Roos YB, Bonafe A, Jahan R, Diener HC, van den Berg LA, Levy EI, Berkhemer OA, Pereira VM, Rempel J, Millán M, Davis SM, Roy D, Thornton J, Román LS, Ribó M, Beumer D, Stouch B, Brown S, Campbell BC, van Oostenbrugge RJ, Saver JL, Hill MD, Jovin TG; HERMES collaborators. Endovascular thrombectomy after large-vessel ischaemic stroke: a meta-analysis of individual patient data from five randomised trials. *Lancet*. 2016 Apr 23;387(10029):1723-31.
5. Motyer R, Thornton J, Power S, Brennan P, O'Hare A, Looby S, Williams DJ, Moynihan B, Murphy S. Endovascular thrombectomy beyond 12 hours of stroke onset: a stroke network's experience of late intervention. *J Neurointerv Surg*. 2018 Feb 19. pii: neurintsurg-2017-013575. doi: 10.1136/neurintsurg-2017-013575. [Epub ahead of print]
6. Nogueira RG, Jadhav AP, Haussen DC, Bonafe A, Budzik RF, Bhuva P, Yavagal DR, Ribo M, Cognard C, Hanel RA, Sila CA, Hassan AE, Millan M, Levy EI, Mitchell P, Chen M, English JD, Shah QA, Silver FL, Pereira VM, Mehta BP, Baxter BW, Abraham MG, Cardona P, Veznedaroglu E, Hellinger FR, Feng L, Kirmani JF, Lopes DK, Jankowitz BT, Frankel MR, Costalat V, Vora NA, Yoo AJ, Malik AM, Furlan AJ, Rubiera M, Aghaebrahim A, Olivot JM, Tekle WG, Shields R, Graves T, Lewis RJ, Smith WS, Liebeskind DS, Saver JL, Jovin TG; DAWN Trial Investigators. Thrombectomy 6 to 24 Hours after Stroke with a Mismatch between Deficit and Infarct. *N Engl J Med*. 2018 Jan 4;378(1):11-21.

Focus Session

Urinary tract embolisation

2504.1

Iatrogenic bleeding

J. Irurzun

Radiology, Hospital General Universitario de Alicante, Alicante, ES

Learning Objectives

1. To learn the causes of iatrogenic bleeding and how to recognise them
 2. To learn when to treat conservatively and when to intervene
 3. To learn about the treatment alternatives
- Iatrogenic bleeding of the kidney can be due to many causes such as percutaneous renal biopsy, percutaneous nephrolithotomy, nephron-sparing

surgery or even after renal branch artery perforation during an endovascular procedure. It must be suspected if sudden significant anemia and / or hematuria occur. Ultrasound and / or dynamic CT are mandatory to rule out for perirenal haematoma, arterial vessel leaks and arterio-venous or excretory system fistulae. Sometimes selective direct angiography is performed in emergency situation or in renal function impairment. In these cases, if positive findings are found, superselective embolization is considered the best option to stop bleeding. Sometimes, it can be challenging to reach the bleeding point due to overlapping of renal branches and steerable microcatheters can be very helpful. Among different embolization materials, coils are mandatory if fistula is suspected because they give us a permanent and confident occlusion, but liquid embolization material are also very interesting emphasizing in new iodinated liquid embolic agents as they do not make artefacts during follow-up. Sometimes, multiple bleeding points are seen due to vessel fragility and intrarenal hematoma which requires a broader embolization. Iatrogenic main renal artery injury is rare but it has been reported due to percutaneous drainage attempt and it was treated by endovascular stent-graft placement.

References

1. Endovascular management of arterial injuries after blunt or iatrogenic renal trauma. Loffroy R, Chevallier O et al. *Quant Imaging Med Surg.* 2017 aug;7(4):434-442.
2. Superselective renal artery embolization in the treatment of iatrogenic bleeding into the urinary tract. Tomasz Zabkowski, Piotr Piasecki et al. *Med Sci Monit.* 2015; 21:333-337.
3. Endovascular management of iatrogenic renal vascular injuries complicating percutaneous nephrolithotomy: Role of renal angiography and embolization; an analysis of 159 cases. Venkateswarly J, kumar MS et al. *Indian J Radiol Imaging.* 2017 Jul-Sep;27(3):293-297.
4. Iatrogenic main renal artery injury: treatment by endovascular stent-graft placement. Heye S, Vanbeckevoort D, et al. *Cardiovasc Intervent Radiol.* 2005 Jan-Feb;28(1):93-4.

2504.2

Angiomyolipoma

N. Moussa

Radiology, Hôpital Européen Georges Pompidou, Paris, FR

Learning Objectives

1. AML overview and when to intervene
 2. To learn about treatment alternatives
 3. To learn results, complications and follow-up of AML embolisation
- Renal angiomyolipoma (AML) are a benign hamartomatous tumor arising from renal mesenchymal cells, it's the most common solid renal neoplasm. Although benign, the tumors have potential to grow and cause complication including hemorrhage, renal dysfunction, and venous thrombosis, without appropriate management.

Asymptomatic AML <4 cm in non-pregnant patients does not require immediate intervention and may be followed with active surveillance, symptomatic patients or tumors >4 cm are appropriate candidates for primary intervention.

The treatment of renal AML is focused on nephron-sparing modalities such as partial nephrectomies, renal embolization or ablative therapies (cryoablation or radiofrequency ablation)

Renal embolisation is often the first-line of treatment for patient with renal AML, in addition to prevention or management of tumor rupture, embolization is effective at inducing tumor shrinkage

Risks after embolization of renal AML include post-embolization syndrome in the days following the procedure, other rare complications include non-target embolization either of normal renal parenchyma or other organs, abscess formation, and vascular injuries such as renal artery rupture or dissection. Overall, embolization is a well-tolerated procedure. Follow-up is important to monitor for complications or disease recurrence and progression.

2504.3

Pre-operative embolisation

F. Mondaini

Vascular and Interventional Radiology Unit, Careggi University Hospital, Florence, IT

Learning Objectives

1. To learn if there is a role for pre-operative embolisation in kidney tumours
2. To learn pros and cons of different embolic agents
3. To learn about results and complications

Kidney cancer is the most common kidney tumor and the third one by frequency in urology. In the advanced stages therapy of choice is nephrectomy. Preoperative tumor embolization is performed in patients with advanced stage of tumor, infiltration of venous system, tumor rich in collateralize. There are many solid or liquid embolizing agents, each with different characteristics that can allow us to have an optimal embolization. There are many potential operative advantages for patients having renal artery embolisation before surgery, with minimal morbidity. In T3 and T4 tumors with infiltration of renal vein and vena cava inferior, preoperative embolization has the goal to reduce intraoperative bleeding and to reduce the time of surgical procedure. Reasons for blood loss during nephrectomy are: hypervascularisation of tumor, atypical blood vessels and hilar lymph nodes that hamper visibility of blood vessels. Another facilitation of nephrectomy after embolisation is the ease of dissection secondary to the development of oedema in tissue planes. The surgery can be made 24-48 h after the embolization, or it can be made as late nephrectomy after 2-3 weeks. Some percent of patients who were inoperable before the embolization, become operative after the procedure. Complications of renal artery embolization procedure are reported in less than 5.0% of cases and usually involve possible non target embolization (coil migration), incomplete embolization, and groin haematoma. Post embolization syndrome is frequent in the setting of renal ischemia. Is reported in up to 70% of patients and usually is successfully managed with medical therapy.

2504.4

Haematuria

C. Scheurig-Muenkler

Radiology, Universitätsklinikum Augsburg, Augsburg, DE

Learning Objectives

1. To learn how to know the source of haematuria
 2. To learn when to treat conservative and when to intervene
 3. To learn about techniques and results for haematuria treatment
- The invisible microscopic haematuria is distinguished from the more concerning macroscopic haematuria with visible discoloration of the urine, ranging from as little as 1 ml blood in 1000 ml urine up to a massive and possibly life-threatening hemorrhage with urinary tract tamponade. The usually asymptomatic microscopic haematuria has a worldwide prevalence ranging from 2 to 31%, in Europe usually around 5%. However, a high sensitivity of urine dipstick tests not distinguishing between pathologic haematuria and transient physiological erythrocyturia, mild myoglobinuria after physical exercise and bacterial contamination cause a high number of false positives. Thus, up to two thirds of cases of initially diagnosed microscopic haematuria remain unresolved. The remaining cases can usually be assigned to a urinary tract infection (4-22%), a bleeding from the prostate in the setting of a benign prostatic hyperplasia (10-13%), a urinary tract stone (5%), bladder cancer (3%), renal cystic disease (2-3%) or a glomerular nephropathy (2%; e.g. IgA-nephropathy, thin basement membrane nephropathy, Alport-syndrome, postinfectious glomerulonephritis, mesangioproliferative glomerulonephritis). Renal cell cancer and prostate cancer with a prevalence of less than 1% each play a minor role as differential diagnosis in microscopic haematuria. With ultrasound, computed and magnetic resonance tomography as well

as modern fusion imaging techniques diagnostic radiology provides a variety of imaging methods for the elective diagnostic clarification and targeted biopsy. Except for the prostatic artery embolization in the treatment of symptomatic benign prostatic hyperplasia as a possible cause for microscopic as well as macroscopic haematuria, interventional radiologic therapies play a minor role in causal treatment of microscopic haematuria. The differential diagnoses in patients presenting with macroscopic haematuria at first sight differ not too much from those in microscopic haematuria, however, the higher likelihood of malignancy and the possible life-threatening course increase the importance in clinical practice. In up to 50% of cases of macroscopic haematuria diagnosis remains unclear. However, malignancies of the kidney, the urothelium or the prostate are much more likely as in patients with microscopic haematuria and according to the literature are found in up to 19 to 30% of cases and demand thorough clarification. Further causes of macroscopic haematuria are diverse and include benign tumors, such as angiomyolipomas and oncocytomas, urinary tract stones and strictures, infections, renal infarction, renal vein thrombosis, trauma, glomerular nephropathies and iatrogenic causes, e.g. following biopsies, renal preserving surgery, catheterization, radiation therapy or extracorporeal shockwave lithotripsy. Patients under oral anticoagulation within therapeutic range face no higher risk for haematuria as other patients and therefore require the same diagnostic work-up. This starts in a first step after positive urine dipstick with urine microscopy and culture to rule out possible infectious causes of haematuria, which should be treated empirically. An additional urine cytology may show malignant cells with the highest sensitivity for lower urinary tract tumors. However, a normal cytology does not exclude a malignancy, which is why it is usually used as an adjunct to routinely performed cystoscopy only. Computed tomography including low dose non-enhanced acquisitions as well as multi phasic protocols including a late phase urography is given a key role in the process of diagnostic clarification. Regarding the topic of this focus session the following three groups of indications for embolization therapy can be highlighted as the most important ones to be kept in mind. Each group thereby reflects a different endovascular treatment strategy. I) Haematuria following trauma and biopsy. The renal trauma is usually a blunt trauma following motor vehicle accidents and falls. Gunshot and stab wounds causing penetrating trauma of the kidneys are less frequent. Both, blunt and penetrating trauma are currently managed non-operatively when hemodynamically stable with angioembolization in case of active bleeding as an adjunct. Bleeding from the urethra or the prostate after pelvic trauma are rare but can also be addressed by superselective angioembolization in the acute trauma management. Biopsies as well as penetrating trauma of the kidneys may lead to relevant injury of renal vessels with parenchymal pseudoaneurysm, vessel truncations or AV fistulas causing intermittent bleeding and thus haematuria. All these pathologies can safely and effectively be treated by superselective angioembolization, predominantly with the use of microcoils, but also particles or glue. II) Massive haematuria mainly as a late complication after pelvic surgery and pelvic radiation therapy (usually in combination with chronic ureteral stenting). With about 100 cases described in the literature it is not highly frequent, due to the potentially life-threatening magnitude of bleeding it has to be highlighted when talking about haematuria. Fistulas can occur uni- or bilaterally usually along the course of the common iliac arteries close to the iliac bifurcation at the crossover of the ureter. Active bleeding from the arteries into the ureter can hardly ever be documented and also relevant alterations of the vessel walls, like the usual pseudoaneurysm, may be subtle on computed tomography angiography and invasive angiography. For a good technical and durable clinical result it is of great importance to liberally cover the iliac arteries over a long distance with stent grafts, usually after prior embolization of the internal iliac (aka hypogastric) artery using coils or vascular plugs to prevent retrograde filling of presumably excluded pseudoaneurysm. III) Benign and malignant tumors. These include angiomyolipomas and oncocytomas, but also renal cell carcinomas, which may be embolized in palliative intention or preoperatively in large hypervascular tumor burden. A benign prostatic hyperplasia causing lower urinary tract symptoms and concomitant haematuria as well as an

actively bleeding prostatic cancer previously treated with radiotherapy can effectively be addressed with prostatic artery embolization. Tumor embolization is mainly realized with the use of particles and probably glue in certain situations. In conclusion, diagnostic radiology plays a key role in the diagnostic work-up of patients with haematuria, both in microscopic and macroscopic. In addition, interventional radiology can effectively and safely treat various causes of impairing and potentially life-threatening haematuria.

References

1. Sharp VJ, Barnes KT, Erickson BA. Assessment of Asymptomatic Microscopic Hematuria in Adults. 2013;88(11):8.
2. Subiela JD, Balla A, Bollo J, et al. Endovascular Management of Ureteroarterial Fistula: Single Institution Experience and Systematic Literature Review. Vasc Endovascular Surg. 2018;52(4):275–286.
3. Moloney F, Murphy KP, Twomey M, O'Connor OJ, Maher MM. Haematuria: An Imaging Guide. Adv Urol. 2014;2014:1–9.
4. Yeoh M, Lai NK, Anderson D, Appadurai V. Macroscopic haematuria—a urological approach. Aust Fam Physician. 2013;42(3):123–126.
5. Hicks D, Li C-Y. Management of macroscopic haematuria in the emergency department. Postgrad Med J. 2008;84(996):539–544.
6. Kably I, Pereira K, Chong W, Bhatia S. Prostate Artery Embolization (PAE) in the Management of Refractory Hematuria of Prostatic Origin Secondary to Iatrogenic Urological Trauma: A Safe and Effective Technique. Urology. 2016;88:218–221.
7. Erlich T, Kitrey ND. Renal trauma: the current best practice. Ther Adv Urol. 2018;10(10):295–303.
8. Bolenz C, Schröppel B, Eisenhardt A, Schmitz-Dräger BJ, Grimm M-O. The investigation of hematuria. Dtsch Arzteblatt Online. 2018;https://www.aerzteblatt.de/10.3238/arztebl.2018.0801. Accessed April 9, 2019.
9. Turo R, Hadome E, Somov P, et al. Uretero-Arterial Fistula - Not So Rare? Curr Urol. 2018;12(1):54–56.

Focus Session

Standardising planning to achieve optimal ablation

2505.1

Why we need standardisation

M.R. Callstrom

Department of Radiology, Mayo Clinic, Rochester, MN, US

Learning Objectives

1. To explain why we need standardisation
2. To learn about different examples of standardisation in other specialities
3. To review the actual standard

No abstract available.

2505.2

Simulation planning before radiofrequency ablation

M. Reinhardt¹, M. Moche²

¹*Diagnostic and Interventional Radiology, University Hospital Leipzig, Leipzig, DE, ²Interventional Radiology, Helios Park-Klinikum Leipzig, Leipzig, DE*

Learning Objectives

1. To explain why we need simulation and planning before RFA
 2. To describe the planning methods available in RFA
 3. To learn how to use the planning methods in RFA
- Several patient specific parameters influence the result of radiofrequency ablation (RFA): size and perfusion of the tumor, proximity to larger vessels

(heat sink effect), proximity to delicate structures or the liver border, and tissue characteristics like perfusion or fibrosis. The protocols recommended by the manufactures hardly include these variables. As consequence, there is a significant amount of undertreatments with local recurrences, as well as overtreatments with potential life threatening complications (1–4). The amount of experience of the interventional radiologist correlates positively with overall survival after RFA but goes along with a relatively long learning curve (5). Finally, patient specific planning and simulation of the ablation in combination with precise image guidance (Ultrasound, CT or MRI), to adequately place the RFA probe in the target lesion, is demanded to further improve results of RFA, especially for less experienced operators.

General considerations when planning RFA procedures, based on existing imaging studies entail: Access planning, selection of an appropriate protocol by determining the size of the tumor, as well as consideration of tumor proximity to vessels and critical structures. An optimal access path for hepatic RFA avoids interference with the diaphragm, pleural recesses, the falciform ligament and large vascular structures or the bile system. Transfissural access paths should be avoided in pulmonary RFA planning. The lack of possibility of fissural local anaesthesia can lead to a significantly reduced patient compliance. Furthermore the probability of pneumothorax increases with transfissural access paths. When planning RFA in peripherally located lesions sufficient shaft guidance in (subcutaneous) tissue should be ensured for probe stability during probe delivery and ablation. Optimal patient positioning (prone, supine, side) is a crucial part of access path planning.

The selection of an appropriate ablation protocol should be determined based on the size of the tumor under consideration of tumor proximity to vessels and critical structures. Ablations in vicinity of larger vessels can lead to a considerable heat sink effect. As a result, the temperature around the vessel is not sufficient to cause tissue necrosis (1,6). The consequence is a zonal lack of ablation, which leads to residual tumor tissue and/or local tumor relapse.

The different RF-generators can help to achieve the desired ablation result using several techniques. The interventional radiologist should keep these in mind when planning RF-procedures. RF-generators control the release of electrical energy into the tissue through fixed target temperatures, maximum power and/or ablation time. These specifications are provided by the manufacturers for each of their ablation probes based on ablation protocols. Most generators additionally regulate power output individually based on two permanently measured parameters: resistance (impedance) and/or temperature in the tissue. This feature prevents premature carbonization of the tissue and reliably enables the promised ablation size. The pulsed release of high energies (up to 200W) results in a relative cooling of the tissue in the immediate vicinity of the active electrode with reduction of carbonization and simultaneously low temperature loss in the periphery. This technique enables a prolonged application of high energies, which allows the induced heat to penetrate deeper into the tissue. Most manufacturers prescribe ablation protocols with increasing power output in order to ensure slower and therefore more complete heating of the target area by avoiding carbonization. Conventional RFA planning can be done using PACS and most other commercially available viewers and should involve multiplanar reconstruction techniques. Additionally, several software tools (such as Software Assistance for Needle Based Intervention (SAFIR) from MEVIS, iGuide by Siemens, XperGuide ablation by Philips, GoSmart, RFA-Guardian) offer assistance for optimal probe placement, some of these tools additionally offer patient specific ablation simulation.

RFA planning and probe placement can be performed using Ultrasound, CT or MRI. If simulation tools are used to predict and visualize the ablation result co-registration of the preinterventional scan and an intraprocedural scan (with the probe in position) might be required (7). In case of CT-assisted RFA, a helical CT with or without contrast medium is first performed for tumor localization and access planning. Based on these images the pathway is planned by definition of entry- and target points. Critical structures have to be considered in access planning. A navigation system can help with precise probe placement according to the planned

access. Otherwise the probe is guided to the treatment target, either under real-time ultrasound imaging, or using single slice CT imaging. Once the probe is placed, the electrode tips are extended to the desired diameter (depending on the system used). The correct probe position can be confirmed by an additional helical scan. The probes are connected to the RF generator and ablation is initiated according to the manufacturer-specific or modified ablation protocol. Some software tools allow to visualize the expected ablation area according to the predefined ablation size. Other tools can additionally calculate the ablation area based on patient specific parameters like vessel anatomy or tissue perfusion. Depending on the availability of such software tools the standardized protocols of the manufactures can be modified. If large or irregularly shaped tumors are treated, additional probe positions should be included into planning, simulation and the RF-procedure. Additional access paths might become necessary and should be considered during planning.

After the procedure, a CT-scan is usually performed to assess the ablation zone. However, only contrast-enhanced CT or MRI allow a precise 3D-visualization of the ablation zone. Subsequently, the RF probe is retracted with continuous ablation. The purpose of the so called 'track ablation' is to avoid cell proliferation and the resulting vaccination metastases. In addition, bleeding in the access path can be reliably avoided. In contrast-enhanced control imaging with CT or MRI approximately one month after RFA, the ablation zone can usually be very well delineated. It is relatively common to find that the size and shape do not correspond to the specifications of the manufacturer-specific protocols. There are several possible reasons for this, most importantly heat sink. The modulation of the blood flow during ablation is one way to reduce the influence of the heat sink effect. This can be done by mechanically occluding the "cooling" vessels in the hepatic- or portal vein. In hypervascularized tumors, the ablation result may be much smaller than expected, as the removal of heat increases the thermal energy requirement. In these cases prior performance of a transarterial chemoembolization can be considered. In liver tissue with reduced global or regional perfusion, e.g. in cirrhosis (9), decreased heat transfer results in higher efficacy of RFA, potentially leading to over-treatment (3). These challenges underline the importance of RFA-simulation. One approach is to include patient-specific parameters such as proximity to thermally relevant vessels or pre-interventionally determined liver- and tumor perfusion during planning and simulation of the RFA procedure. This may allow a personalized adaptation of the ablation protocol.

To conclude, accurate planning of probe pathway and the ablation procedure, based on individual patient data including in silico simulation, is important to optimize treatment results. This approach is especially relevant for RFA because of its comparably strong dependency on patient specific parameters.

References

1. Lin Z-Y, Li G-L, Chen J, Chen Z-W, Chen Y-P, Lin S-Z. Effect of heat sink on the recurrence of small malignant hepatic tumors after radiofrequency ablation. *J Cancer Res Ther.* 2016 Dec;12(Supplement):C153–8.
2. Zorbas G, Samaras T. A study of the sink effect by blood vessels in radiofrequency ablation. *Comput Biol Med.* 2015 Feb;57:182–6.
3. Liu Z, Ahmed M, Weinstein Y, Yi M, Mahajan RL, Goldberg SN. Characterization of the RF ablation-induced "oven effect": the importance of background tissue thermal conductivity on tissue heating. *Int J Hyperthermia.* 2006 Jun;22(4):327–42.
4. Lu DSK, Raman SS, Limanond P, Aziz D, Economou J, Busuttill R, et al. Influence of large peritumoral vessels on outcome of radiofrequency ablation of liver tumors. *J Vasc Interv Radiol.* 2003 Oct;14(10):1267–74.
5. Hildebrand P, Leibecke T, Kleemann M, Mirow L, Birth M, Bruch HP, et al. Influence of operator experience in radiofrequency ablation of malignant liver tumours on treatment outcome. *Eur J Surg Oncol.* 2006 May;32(4):430–4.

6. Lehmann KS, Poch FGM, Rieder C, Schenk A, Stroux A, Frericks BB, et al. Minimal vascular flows cause strong heat sink effects in hepatic radiofrequency ablation ex vivo. *J Hepatobiliary Pancreat Sci*. 2016 Aug;23(8):508–16.
7. Reinhardt M, Brandmaier P, Seider D, Kolesnik M, Jenniskens S, Sequeiros RB, et al. A prospective development study of software-guided radio-frequency ablation of primary and secondary liver tumors: Clinical intervention modelling, planning and proof for ablation cancer treatment (ClinicIMPACT). *Contemporary Clinical Trials Communications*. 2017 Dec 1;8:25–32.
8. Nakazawa T, Kokubu S, Shibuya A, Ono K, Watanabe M, Hidaka H, et al. Radiofrequency ablation of hepatocellular carcinoma: correlation between local tumor progression after ablation and ablative margin. *AJR Am J Roentgenol*. 2007 Feb;188(2):480–8.
9. Wu D, Tan M, Zhou M, Sun H, Ji Y, Chen L, et al. Liver computed tomographic perfusion in the assessment of microvascular invasion in patients with small hepatocellular carcinoma. *Invest Radiol*. 2015 Apr;50(4):188–94.

2505.3

Simulation planning before cryoablation

C. Essert

ICube, University of Strasbourg, CNRS, Illkirch, FR

Learning Objectives

1. To explain why we need simulation in cryoablation
2. To describe the planning methods available in cryoablation
3. To learn how to use the planning methods in cryoablation

The planning of surgeries based on preoperative images is a widely used process. A number of medical imaging modalities is now available, including X-rays, ultrasound (US), computed tomography (CT) and Magnetic Resonance Imaging (MRI). Using these modalities, the surgeon and the medical team can assess the patient condition, provide a diagnosis, and plan the surgery. However, whatever their quality, the preoperative images can only provide information about the current status of the patient. In that context, computer simulations based on preoperative images allow the surgeon to consider different treatment options, evaluate their feasibility, predict an effect, anticipate possible complications, and in the end optimize the treatment in order to reduce the risk of injury and improve the surgical outcome. Such simulations combined with automatic optimization algorithms are very efficient tools to assist the preoperative planning of surgical interventions.

Computer assistance to preoperative planning has been investigated in the past few years in the field of percutaneous thermal ablations, and more particularly for cryoablation of abdominal tumors. Percutaneous cryoablation consists in inserting several cryoprobes through the skin towards the tumor and causing the localized destruction of the malignant cells using an extreme cold in the form of an iceball produced at the tip of the probes [1,2]. For this type of intervention, the surgeon does not have a direct visualization of the surgical site. Simulation-based treatment planning is crucial to predict the final iceball shape and size, estimate the most optimal position of the cryoprobes, and ensure that a feasible and efficient scenario can be found before surgery. The prediction of the iceball is especially difficult to predict given that it is resulting from the combined action of several cryoprobes, with the possible presence of cooling anatomical structures in the direct vicinity, such as blood vessels for instance. Avoiding damages to critical structures with the iceball or along the path of the cryoprobe is also a very important aspect to preserve the safety. That is why such tools are now an essential part of the computer-assisted decision-making process.

A few groups have investigated approaches to assist the surgeon in planning percutaneous cryoablation surgery. Early models proposed an optimization of the cryoprobes positions, with simplified iceball models, and regardless of the surrounding anatomy [3]. Some other groups focused on the simulation part. Magalov [4] and Ge [5] both proposed simplified models to simulate iceball growth in gels. More recently, Ge [6] applied

the model to human properties, including a simulation of the influence of blood vessels during freezing. Similar models were presented with application to various organs, e.g., the prostate [7] or the lungs [8]. More recently, Golkar [9] proposed a formulation of a realistic propagation of cold in the tissue, and a fast implementation on GPU within a cube of interest that takes only a few seconds to compute. The simulation also takes into account surrounding blood vessels and the presence of dissection water.

The cryoprobes placement planning aspect has also been the subject of works from various groups. The approach usually consists in finding the best compromise between a number of surgical constraints, related to the efficiency of the treatment (providing the best coverage), and the safety of the patient (avoiding damages to sensitive structures). It was first addressed by Keanini [10] using simplex method. Baissalov [11] studied simultaneous optimization of cryoprobe placement and thermal simulation using a gradient descent algorithm called L-BFGSB. A 3D solution based on the cumulative 2D transverse planes is described, with results in 2D on a prostate model. Tanaka and Rubin [12] used a method called bubble-packing in 3D. Giorgi [13] used an approach named Ants Colony to choose the optimal parameter configurations. The study was done on a 2D standard prostate phantom. Jaberzadeh [14] proposed different optimization methods to compute the best placement for multiple cryoprobes and compared their convergence. The optimizations were combined to 3D simulation of heat transfer.

The automatic cryoablation planning methods are still under active development. To the best of our knowledge, to this day there is still no commercial system available that provides both an optimal placement for the cryoprobes and a realistic mathematical prediction of the iceball, but very promising academic works are tending towards this objective, and it is reasonable to think that they will be available soon to be used in clinical routine.

References

1. McGahan JP, van Raalte VA. History of Ablation. *Tumor Ablation*, pp. 3–15, 2005.
2. Weber SM, Lee FT. Cryoablation: history, mechanism of action, and guidance modalities. *Tumor Ablation* pp. 250–265, 2005.
3. Butz T, Warfield SK, Tuncali K, Silverman SG, van Sonnenberg E, Jolesz FA, et al. Pre- and intra-operative planning and simulation of percutaneous tumor ablation. *Lecture Notes in Computer Science*, Springer pp. 317–326, 2000.
4. Magalov Z, Shitzer A, Degani D. Isothermal volume contours generated in a freezing gel by embedded cryo-needles with applications to cryo-surgery. *Cryobiology* 55(2), 127–137 (2007)
5. Ge, M., Chua, K., Shu, C., Yang, W.: Analytical and numerical study of tissue cryofreezing via the immersed boundary method. *International Journal of Heat and Mass Transfer* 83, 1–10 (2015)
6. Ge, M., Shu, C., Yang, W., Chua, K.: Incorporating an immersed boundary method to study thermal effects of vascular systems during tissue cryo-freezing. *Journal of thermal biology* 64, 92–99 (2017)
7. Hossain, S.C., Zhang, X., Haider, Z., Hu, P., Zhao, G.: Optimization of prostatic cryosurgery with multi-cryoprobe based on refrigerant flow. *Journal of thermal biology* 76, 58–67 (2018)
8. Kumar, M., Upadhyay, S., Rai, K.: A study of cryosurgery of lung cancer using modified legendre wavelet galerkin method. *Journal of Thermal Biology* 78, 356 – 366 (2018)
9. Golkar, E., Rao, P.P., Joskowicz, L., Gangi, A., Essert, C.: Fast GPU computation of 3D isothermal volumes in the vicinity of major blood vessels for multiprobe cryoablation simulation. In: *proceedings of MICCAI 2018, LNCS 11073*. pp. 230– 237. Springer (2018)
10. Keanini R. and Rubinsky B.: Optimization of multiprobe cryosurgery. *Heat Transfer* 114(4) (1992) 796–801
11. Baissalov R., Sandison G., Reynolds D. and Muldrew K.: Simultaneous optimization of cryoprobe placement and thermal protocol for cryosurgery. *Physics in medicine and biology* 46(7) (2001) 1799

12. Tanaka D., Shimada K., Rossi M.R. and Rabin Y.: Cryosurgery planning using bubble packing in 3d. *Computer methods in biomechanics and biomedical engineering* 11(2) (2008) 113–121
13. Giorgi G., Avalle L., Brignone M., Piana M. and Caviglia G.: An optimisation approach to multiprobe cryosurgery planning. *Computer Methods in Biomechanics and Biomedical Engineering* (2011) 1–11
14. Jaberzadeh A, Essert C. Pre-operative planning of multiple probes in three dimensions for liver cryosurgery: comparison of different optimization methods. *Math Methods Appl Sci* 39: 4764–4772, 2015.

2505.4

Simulation planning before microwave ablation

J. Chiang

Department of Radiology, UCLA Ronald Reagan Medical Center, Los Angeles, CA, US

Learning Objectives

1. To explain why we need simulation in MWA
2. To describe the planning methods available in MWA
3. To learn how to use the planning methods in MWA

Microwave ablation is a rapidly growing therapeutic modality used for early stage cancers of the liver, kidney, lung and bone. Microwave ablation systems use frequencies in the 915 MHz to 2.45 GHz range and is capable of delivering electromagnetic energy through desiccated and charred tissue. This allows for continuous and rapid volumetric heating that can lead to larger and more homogenous ablation zones compared to radiofrequency or laser ablations. While the thermal conductive effect is similar to that of laser, radiofrequency and high-intensity focused ultrasound, microwave is unique in that it is able to heat tissue to over 150 degrees C.

Modeling plays a critical role in the development and implementation of microwave ablation systems. Computational modeling provides a highly-controlled environment to investigate and understand the effects of changing single or multi-variable inputs. These findings can lead to more focused experimental studies, fewer animal studies, decreased developmental costs and greater efficiency. Much of the pre-clinical modeling research has focused on designing antennas capable of creating various types of ablation zone shapes. In particular, there has been an emphasis on a larger, more spherical ablation pattern inside a vascular organ like the liver. Numerical simulations can also rapidly predict the propagation of electromagnetic waves from antennas of various geometries and evaluate performance metrics. Numerical modeling also allows for calculation of the precise electromagnetic fields, heat generation and temperature dose response models in a variety of tissue conditions.

Common microwave antenna performance metrics include those that describe how efficiently antennas can deliver power into the tissue and the resulting heating pattern. Reflection coefficients can capture antenna efficiency and is described by the ratio of power output to power input. Specific absorption rate (SAR) can be calculated from the electric field and roughly estimates the potential shape of an ablation zone by a given antenna design. Modeling is also useful in analyzing and optimizing antenna arrays for microwave tissue heating. Using multiple antennas produce larger, more homogenous ablation zones compared to single antennas. Computer modeling can analyze zones of constructive and destructive interference within an ablation zones. These interactions not only affect the heating rate but also can help optimize antenna placement guides to produce deeper tissue penetration and improve local tumor control.

Due to microwave-mediated heating to temperatures far greater than 100 degrees C, there is a large amount of water vapor that is created during ablations. Accounting for water vaporization and transport allows for more flexible tissue property definitions in numerical simulations. More specifically, the ability to predict when and where water vaporization occurs during ablation can facilitate the use of tissue models that

decouple temperature and water content dependencies. Furthermore, this would allow for a more complete analysis of the heat transfer process across various microwave ablation devices. Intense heating, in addition to the formation and mass transport of water vapor, also leads to tissue contraction. This is noticeable during microwave ablations when the center of the ablation zone becomes dehydrated first and water droplets are driven outwards from the antenna. As tissue becomes dehydrated, there is an associated contraction effect that occurs. This can become a confounding feature during microwave ablations as the boundaries of the tumor as well as fiducial markers from nearby vasculatures become distorted. Contraction is further complicated by the fact that it is not uniform spatially or temporally: it is usually greatest at the center of the ablation zone and at the beginning of the ablation zone. Current models incorporate temperature and time-dependent tissue contraction models that couple solid mechanics into existing electromagnetic and heat transfer models.

While microwave energy heats tissue at a faster rate and more homogeneously, they are still susceptible to the heat sink effect – although to a lesser degree than radiofrequency ablation devices. Coupling the electromagnetic field propagation with heat transfer and flow can lead to valuable insight into the size and dimensions of the final ablation zone. Doppler ultrasound can provide flow information but is often limited to user expertise, body habitus and overlying bowel gas. Novel methods of characterizing blood flow using 4D flow MRI have been investigated and may potentially play a role in pre-ablation mapping to create more accurate microwave ablation zones. Recognizing the propensity of vessels to remain patent or occlude may allow physicians to create a “heat-sink” map of the liver prior to performing an ablation procedure.

Creating an optimal ablation zone requires a general knowledge of the aforementioned variables listed above, which dictate the extent of the ablation zone. While numerical models for each of these variables exist and can be quantified in a time-dependent manner, it is impractical to pre-operatively perform all of these calculations for each patient. Most microwave ablation systems currently only have simplified charts that tell an operator what the ablation zone dimensions will be at a specific time and power setting. However, these values are generally created in non-perfusion models that are devoid of vasculature. In a clinical setting, relying on these charts can lead to undertreating tumor tissue or overtreating healthy tissue. Modern ablation planning software is only in its infancy, pairing patient specific CT images with predicted ablation zones. Current software packages are able to predict ablation zone sizes and shapes based on a combination of antenna placement, contraction and edge detection. These prediction models can help physicians assess whether or not there is adequate margin to minimize the risk of recurrence. Microwave ablation continues to gain traction worldwide as the dominant therapy for treating early stage cancers. Due to its inherent advantages in heating, there will be an increasing need to better predict the active heating zone and thermal effect in a heterogenous organ environment. While we have a good understanding of the basic physics behind microwave ablation, using computational simulations will create better prediction models for how an ablation zone may look in a patient-specific anatomy. Further research in computational approaches and more importantly, their respective validation studies, will be necessary to continue facilitating clinical translation and further adoption into clinics worldwide. Leveraging computational modeling will lead to better integration of patient-specific microwave models and improve long term clinical outcomes.

References

1. Chiang J, Wang P, Brace CL. Computational modelling of microwave tumour ablations. *Int J Hyperth Off J Eur Soc Hyperthermic Oncol North Am Hyperth Group*. 2013 Jun;29(4):308–17.
2. Chiang J, Birla S, Bedoya M, Jones D, Subbiah J, Brace CL. Modeling and validation of microwave ablations with internal vaporization. *IEEE Trans Biomed Eng*. 2015 Feb;62(2):657–63.
3. Ji Z, Brace CL. Expanded modeling of temperature-dependent dielectric properties for microwave thermal ablation. *Phys Med Biol*. 2011 Aug 21;56(16):5249–64.

4. Brace CL. Radiofrequency and microwave ablation of the liver, lung, kidney, and bone: what are the differences? *Curr Probl Diagn Radiol*. 2009 Jun;38(3):135–43.
5. Lyons GR, Pua BB. Ablation Planning Software for Optimizing Treatment: Challenges, Techniques, and Applications. *Tech Vasc Interv Radiol*. 2019 Mar;22(1):21–5.
6. Ahmed M, Solbiati L, Brace CL, Breen DJ, Callstrom MR, Charboneau JW, et al. Image-guided tumor ablation: standardization of terminology and reporting criteria—a 10-year update. *J Vasc Interv Radiol JVIR*. 2014 Nov;25(11):1691–1705.e4.
7. Wood BJ, Locklin JK, Viswanathan A, Kruecker J, Haemmerich D, Cebal J, et al. Technologies for Guidance of Radiofrequency Ablation in the Multimodality Interventional Suite of the Future. *J Vasc Interv Radiol*. 2007 Jan 1;18(1):9–24.
8. Fallahi H, Prakash P. Antenna Designs for Microwave Tissue Ablation. *Crit Rev Biomed Eng*. 2018;46(6):495–521.
9. Chiang J, Hynes K, Brace CL. Flow-dependent vascular heat transfer during microwave thermal ablation. *Conf Proc Annu Int Conf IEEE Eng Med Biol Soc IEEE Eng Med Biol Soc Conf*. 2012;2012:5582–5.
10. Bedoya M, del Rio AM, Chiang J, Brace CL. Microwave ablation energy delivery: influence of power pulsing on ablation results in an ex vivo and in vivo liver model. *Med Phys*. 2014 Dec;41(12):123301.

Focus Session Gastrointestinal bleeding

2604.1

Imaging work-up

N.L. Kelekis¹, S. Spiliopoulos²

¹2nd Department of Radiology, General University Hospital Attikon, Athens, GR, ²2nd Department of Radiology, Interventional Radiology Unit, General University Hospital Attikon, Athens, GR

Learning Objectives

1. To learn different imaging modalities for GIB assessment
 2. To learn advantages and drawbacks of CT and endoscopy
 3. To learn the current value of diagnostic angiography for GIB
- Gastrointestinal (GI) bleeding is a life-threatening pathology responsible for 375 annual hospital admissions per 100,000 individuals in the US with a mortality rate ranging between 5%-10%. [1] The causes of GI bleeding are numerous and include benign ulcers, malignant disease, vascular ectasias, Dieulafoy's lesions, angiodysplasias, varices, diverticulitis and polyps. Upper GI bleeding (UGIB) is defined as bleeding occurring proximal to the ligament of Treitz (between the oesophagus and the duodenal flexure) while lower GI bleeding (LGIB) is defined as bleeding occurring distal to the ligament of Treitz. According to the American Gastroenterological Association, GI bleeding can be classified as overt (acute, visible bleeding); occult defined as an initial presentation of positive faecal occult blood test result and/or iron-deficiency anaemia without evidence of visible blood loss; and obscure defined as a recurrent bleeding without identified source after upper endoscopy and colonoscopy. Obscure bleeding can be either overt or occult. [2]

The imaging workup of GI bleeding largely depends on the clinical presentation and its suspected location. In order to confirm the diagnosis and localise the site of bleeding, endoscopic, radiological and nuclear scintigraphic modalities can be used. In overt UGI bleeding, endoscopy is the first-line diagnostic and treatment modality. However, in cases in which endoscopy fails and endovascular treatment is the next step, computed tomography angiography (CTA) should be performed in order to confirm the diagnosis of ongoing bleeding and allow optimal pre-procedural planning.

In cases of overt LGI bleeding, both colonoscopy and CTA are indicated. Despite the fact that colonoscopy is the first-line diagnostic and treatment modality, in cases of major acute bleeding its diagnostic sensitivity

decreases significantly (as low as 13% in some series), while successful treatment is obtained in only 21% of the cases, mainly due to inadequate bowel preparation and compromised visibility. [3] Notably, the differential diagnosis between UGA and LGI bleeding can be challenging, as almost 75% of apparently UGI bleeding episodes are actually LGI bleedings. The American College of Radiology recommends colonoscopy to be utilized as the initial diagnostic and treatment modality in hemodynamically stable patients (allowing for adequate bowel preparation) and angiography in hemodynamically unstable patients with massive lower GI bleeding. However, pre-procedural detection of the bleeding site and the assessment of the vascular anatomy using CTA imaging are imperative for the performance of successful transcatheter embolization. According to the literature, CTA is more sensitive in detecting active bleeding compared to digital subtraction angiography (DSA). Specifically, the sensitivity and specificity of CTA in detecting LGI bleeding is 90% and 92%, respectively. [4] Moreover, experimental studies have demonstrated that CTA following intravenous contrast media infusion can detect bleeding rates as low as 0.35 mL/min while intra-arterial selective CTA can demonstrate even lower bleeding rates of 0.05 mL/min. On the other hand, DSA performed via a catheter positioned 10 cm proximal to the bleeding site can detect bleeding rates of 0.96 mL/min. [5] Moreover, pre-procedural CTA offers significant information regarding the pathology of the GI system, such as the presence of perforation requiring surgery, and provides an overall assessment of arterial anatomy and patency, necessary for endovascular treatment. For these reasons, in the vast majority of GI bleeding cases, transcatheter embolization should be performed only after CTA imaging. [6] CTA Imaging protocol for GI bleeding should include a three phases (non-contrast, arterial, portal-venous). Oral contrast should not be administered. [3]

Multiphase CT enterography can also be used in stable patients with negative upper and lower endoscopy, while CTA can be utilized in both stable and unstable patients (stabilized after resuscitation), with a high clinical suspicion of LGI active bleeding. Nuclear scintigraphy using ^{99m}Tc-RBC or ^{99m}Tc-sulfur colloid is a very sensitive imaging modality for the detection of GI bleeding, as it can detect very low bleeding rates of 0.2-0.5 mL/min and 0.05-1 mL/min; respectively. Scintigraphy can be very useful for the investigation of obscure GI bleeding and does not require any specific preparation. However, it cannot provide information regarding the cause of bleeding and is not as accurate in detecting the exact anatomical location of the bleeding site. CT- or MR- enterography can be used to demonstrate both the site and cause of obscure-occult GI bleeding, especially when other modalities such as enteroscopy and video capsule endoscopy are negative. [7]

Conclusively, various imaging modalities are available for the assessment of GI bleeding. Three-phases CTA imaging is essential, especially in the emergent setting, as it is widely available, rapid, non-invasive and provides significant information such as the presence of active bleeding, its anatomical location and its cause contributing to the choice of treatment and optimizing the clinical success of transcatheter embolization.

References

1. Wortman JR, Landman W, Fulwadhva UP, Viscomi SG, Sodickson AD. CT angiography for acute gastrointestinal bleeding: what the radiologist needs to know. *Br J Radiol*. 2017;90(1075):20170076.
2. Raju GS, Gerson L, Das A, Lewis B; American Gastroenterological Association. American Gastroenterological Association (AGA) Institute technical review on obscure gastrointestinal bleeding. *Gastroenterology*. 2007;133(5):1697-717.
3. Artigas JM, Martí M, Soto JA, Esteban H, Pinilla I, Guillén E. Multidetector CT angiography for acute gastrointestinal bleeding: technique and findings. *Radiographics*. 2013;33(5):1453-70.
4. He B, Yang J, Xiao J, et al. Diagnosis of lower gastrointestinal bleeding by multi-slice CT angiography: A meta-analysis. *Eur J Radiol*. 2017;93:40-45.
5. Roy-Choudhury SH, Gallacher DJ, Pilmer J, et al. Relative threshold of detection of active arterial bleeding: in vitro comparison of MDCT and digital subtraction angiography. *AJR Am J Roentgenol*. 2007.

6. Spiliopoulos S, Inchingolo R, Lucatelli P, et al. Transcatheter Arterial Embolization for Bleeding Peptic Ulcers: A Multicenter Study. *Cardiovasc Intervent Radiol*. 2018;41(9):1333-1339.
7. Ilangovan R, Burling D, George A, Gupta A, Marshall M, Taylor SA. CT enterography: review of technique and practical tips. *Br J Radiol*. 2012;85(1015):876-86.

2604.2

The endoscopist's role

G. Braun

III. Medizinische Klinik, Universitätsklinikum Augsburg, Augsburg, DE

Learning Objectives

1. To learn indications and protocols for endoscopic treatment in UGIB and LGIB
2. To learn about efficacy, rebleeding and complication rates of endoscopic treatment
3. To learn what to do if endoscopy fails or if it is not possible
1. There are different types of gastrointestinal bleeding. The most common type is the non variceal upper gastrointestinal bleeding NVUGIB, the therapy strategies are completely different to the management of variceal upper gastrointestinal bleeding. Finally there are bleedings from the lower GI-tract. Obscure-overt and obscure-occult gastrointestinal bleedings (often from the midgut) are not part of the lecture.
2. Management of NVUGIB: In cases of hypovolemic shock an initial resuscitation has to be established. The preendoscopic therapy contains the intravenous admission of a proton pump inhibitor and azithromycin. Bleeding episodes under anticoagulant, antiplatelet therapy or both need a special management of prothrombotic agents. The endoscopy therapy contains the injection of vasoactive agents, through-the-scope-clips, over-the-scope-clips, "hemostatic powders" and thermal therapy strategies. Rebleeding occurs in up to 15%. The mean risk factor is the bleeding posterior bulb ulcer. Rescue strategy in these cases is therapeutic angiography.(1)
3. Management of variceal bleeding episodes: Patients with suspected variceal bleeding are admitted to the intensive care unit. The preendoscopic therapy contains the intravenous admission of a proton pump inhibitor, an antibiotic agent and a vasoactive agent (terlipressin, somatostatin or octreotide). INR and PTT are no useful markers for coagulation management. The endoscopic therapy of esophageal variceal bleeding is band ligation, the endoscopic therapy of gastric variceal bleeding is cyanoacrylate injection. The rebleeding rate depends on liver function. A TIPSS can be established in terms of a rescue strategy or in a secondary prevention setting.(2)
4. In cases of suspected severe or active lower gastrointestinal bleeding episode the UK guidelines recommend a CT-angiogram as first step, in my opinion, an upper-GI-endoscopy and after exclusion of UGIB a colonoscopy have to be done.(3)

References

1. Gotz, M. et al. (2017). [S2k Guideline Gastrointestinal Bleeding - Guideline of the German Society of Gastroenterology DGVS]. doi: 10.1055/s-0043-116856
2. Tripathi, D. et al. (2015). "UK guidelines on the management of variceal haemorrhage in cirrhotic patients." *Gut* 64(11): 1680-1704.
3. Oakland, K. et al. (2019). "Diagnosis and management of acute lower gastrointestinal bleeding: guidelines from the British Society of Gastroenterology." doi:10.1136/gutjnl-2018-317807

2604.3

Upper GI

A. Basile

Radiology, Policlinico Universitario G.Rodolico, Catania, IT

Learning Objectives

1. To learn when embolisation is indicated in UGIB
2. To learn techniques and materials for UGIB embolisation
3. To learn about results, rebleeding and complications after UGIB embolisation

Upper gastrointestinal bleeding is a serious and often life-threatening condition. Bleeding origin is proximal to the ligament of Treitz and is usually divided into two main categories: variceal and non-variceal. The most frequent causes of non-variceal bleeding are: complicated peptic ulcer, benign and malignant tumors, ischemia, gastritis, arterio-venous malformations (Dieulafoy lesions), Mallory-Weiss tears, trauma, and iatrogenic causes (1-2).

MDCT is a rapid, accurate and highly valuable tool in diagnosing GI bleeding as well as planning interventional treatment such as embolization, although it should be borne in mind that active GI bleeding is usually intermittent (3). TAE indication is usually based on a multidisciplinary consensus between the gastroenterologist, radiologist, and surgeon. It is generally indicated for patients with significant acute gastrointestinal bleeding with endoscopically untreatable or unrevealed source of bleeding or with excessive bleeding that obscures the endoscopic view, even in patients with signs of hemodynamic instability (4).

Arterial embolization in the upper GI tract above the ligament of Treitz is generally considered to be very safe because of the rich collateral supply to the stomach and duodenum. This can make successful embolization more challenging; it decreases the incidence of post-embolization ischemia but rises the incidence of rebleeding even if this tendency does not affect the clinical outcome (5). The comparison of mortality rates for surgery and TAE highlights a slight drift toward a lower mortality for patients undergoing TAE. However, interventional radiologists must be aware of technical and clinical factors that may influence the outcome of patients who undergo embolization procedures for upper GI haemorrhage, as this can help avoid pitfalls and complications (6).

References

1. Loffroy R, Favelier S, Pottecher P, Estivalet L, Genson PY, Gehin S, Cercueil JP, Krause D. Transcatheter arterial embolization for acute nonvariceal upper gastrointestinal bleeding: indications, techniques and outcomes. *Diagn Interv Imaging*. 2015; 96:731-44.
2. Ji Hoon Shin. Recent Update of Embolization of Upper Gastrointestinal Tract Bleeding. *Korean J Radiol*. 2012 Jan-Feb; 13(Suppl 1): S31-S39.
3. Vlastimil Valek, Jakub Husty. Quality Improvement Guidelines for Transcatheter Embolization for Acute Gastrointestinal Nonvariceal Hemorrhage. *Cardiovasc Intervent Radiol* (2013) 36:608-612.
4. Laursen SB, Jakobsen M, Nielsen MM, Hovendal C, Schaffalitzky de Muckadell OB. Transcatheter arterial embolization is the first-line therapy of choice in peptic ulcer bleeding not responding to endoscopic therapy. *Scand J Gastroenterol*. 2015; 50:264-271.
5. Tarasconi A, Baiocchi GL, Pattonieri V, Perrone G, Abongwa HK, Molino S, Portolani N, Sartelli M, Di Saverio S, Heyer A, Ansaloni L, Coccolini F, Catena F. Transcatheter arterial embolization versus surgery for refractory non-variceal upper gastrointestinal bleeding: a meta-analysis. *World J Emerg Surg*. 2019; 14: 3.
6. Schenker MP, Duszak Jr R, Soulen MC, et al. Upper gastrointestinal hemorrhage and transcatheter embolotherapy: clinical and technical factors impacting success and survival. *J Vasc Interv Radiol* 2001; 12:1263-71.

2604.4

Lower GI

R. Uberoi

Radiology, John Radcliffe Hospital, Oxford, UK

Learning Objectives

1. To learn when embolisation is indicated in LGIB
2. To learn techniques and materials for LGIB embolisation
3. To learn about results, rebleeding and complications after LGIB embolisation

GI bleeding is serious life threatening emergency. Broadly it is defined as upper GI bleeding if this occurs proximal to the ligament of trietz and lower GI bleeding if from the more distal bowel. Upper GI bleeding presents with haematemesis and or malena and lower GI bleeding with bright red blood in the rectum. Brisk bleeding from any site however can result in bright red blood in the rectum and can be a cause of confusion. Clinically patients are managed differently based on the suspected site of bleeding and clear protocols should be in place to manage these difficult patients. All patients should have a named clinical lead to manage their condition in a dedicated unit and help co-ordinate a multidisciplinary approach to manage these complex patients. There are several risk stratification scoring systems such as the Oakland score which we have recently published, which should be used to guide management of these patients. Patients who are hypotensive may require fluid replacement and this usually in the form of crystalloids. Blood transfusion should be reserved for patients who have a >30% reduction of the Hgb levels or absolute levels of <7g/dL. Similarly platelet replacement should be considered if <50/Mmol. Oral anticoagulants and antiplatelets should be stopped following discussion with relevant teams to assess the risks of continued bleeding and potential coagulations risks i.e. stroke, mechanical valves, stents etc. There are differences in the causes of upper and lower GI bleeding and consequently management strategies.

For lower GI bleeding patients should ideally have direct visualisation of the ano-rectal region and colon, however the later may be difficult endoscopically due to rapid bleeding. Increasing MSCT is utilized to image the patients to confirm the site of bleeding. Even if active extravasation is not seen the cause of the underlying bleed may be seen and direct further imaging and intervention. Embolisation has now very much become the first line strategy in many centres, but in many units is not available and underutilized. However endoscopic treatments remain an important part of treating accessible bleeding site, particularly piles, rectal ulcers and angiodysplasia. Surgery is now rarely utilised to treat these patients. With the development of increasingly more sophisticated technologies, particularly in microcatheter and embolic technologies, virtually every site within the arterial and venous anatomy is accessible to IR treatments. The type of embolics utilized depends on several factors including the site of bleeding, accessibility the local anatomy and operator preferences. For lower GI bleeding, coils are most commonly utilized either microcoils for very small distal lesions and larger standard 0.35 coils for larger vessels. Increasingly other agents such as liquid embolics i.e glue, onxy, squid, particles and plug devices are also being used. In some instances where there is a need to preserve larger vessels, stentgrafts may also be employed. The technical and clinical success is high, but varies on the indications, underlying lesion and the type of embolics. The highest failure or recurrence rate where single agents such as coils or spongistan are used. Combining agents and or liquid embolics may be more effective. Conclusion. Radiological imaging and intervention is at the forefront of managing patients with GI bleeding and all centres should have protocols in place to manage these patients with direct radiological involvement.

References

1. Longstreth GF. Epidemiology and outcome of patients hospitalized with acute lower gastrointestinal hemorrhage: a population based study. *Am J Gastroenterol* 1997; 92:419-24

2. Derivation and validation of a novel risk score for safe discharge after acute lower gastrointestinal bleeding: a modelling study. Oakland K, Jairath V, Uberoi R, Guy R, Ayaru L, Mortensen N, Murphy MF, Collins GS. *Lancet Gastroenterol Hepatol*. 2017 Sep;2(9):635-643.
3. Anthony S, Milburn S, Uberoi R Multi-detector CT: review of its use in acute GI haemorrhage. *Clin Radiol*. 2007 Oct;62(10):938-49
4. NICE- <http://pathways.nice.org.uk/pathways/acute-upper-gastro-intestinal-bleeding> Pathway last updated: 10 February 2017
5. Victoria Chan Donald Tse Shaheen Dixon Vivek Shrivastava Mark Bratby Suzie Anthony Rafiuddin Patel Charles Tapping Raman Uberoi: Outcome Following a Negative CT Angiogram for Gastrointestinal Hemorrhage: *Cardiovasc Intervent Radiol*
6. International Consensus Recommendations on the Management of Patients With Nonvariceal Upper Gastrointestinal Bleeding Alan N. Barkun, MD, MSc (Clinical Epidemiology); et al, for the International Consensus Upper Gastrointestinal Bleeding Conference Group* *Ann Intern Med*. 2010;152:101-113.
7. NCEPOD report 2015-'Time to get Control'
8. Lisa L. Strate, MD, MPH, FACG1 and Ian M. Gralnek, MD, MSHS2ACG Clinical Guideline: Management of Patients With Acute Lower Gastrointestinal Bleeding. *Am J Gastroenterol* advance online publication, 1 March 2016; doi: 10.1038/ajg.2016.41

Clinical Evaluation Course Strategies for T1 renal cell carcinoma

2605.1

State-of-the-art imaging

E. Bertelli

Radiology, Azienda Ospedaliero Universitaria Careggi, Florence, IT

In this lecture we will analyze the diagnostic imaging modalities for the characterization of T1 renal cell carcinomas.

In the last decades there is an increasing detection of small renal masses, due to the widespread use of diagnostic modalities. In the majority of cases these lesions are found incidentally, during US or CT examinations performed for other medical reasons, and are usually consistent with T1a renal cell carcinomas; only a minority of them are aggressive renal cell carcinomas (about 10%). Furthermore the probability of being benign of a small renal mass increases with the decrease of its dimension. So these lesions have better prognosis but create problems about differential diagnosis and patients management.

Small renal masses are challenging for the radiologist because we have to suggest a possible diagnosis for a correct management of the patient. Small renal masses could be divided into two categories: cystic and solid ones. In some cases ultrasound is not capable to distinguish about this two type of lesions, especially if the lesion is small and if the patient is "difficult-to-image" (if, for example, has high BMI or if he has intestinal meteorism or if the lesion is deep).

The most important criterion for the definition of malignancy is the presence of enhancement, for both solid and cystic lesions, so even if ultrasound (US) is usually the first imaging modality in the detection of small renal masses (in Literature is reported that about 83% of them are detected by US), for their characterization we need a contrast-enhanced technique.

For cystic lesions is mandatory to classify them following the Bosniak scheme because this scheme is crucial for the management, dividing them into surgical and non-surgical ones.

As reported in Literature and in the main guidelines the most useful technique for cystic lesions characterization is contrast enhanced magnetic resonance (CEMR): this method is reported to have a slightly higher sensitivity and specificity for small cystic renal masses compared to contrast-enhanced computed tomography (CECT).

Contrast-enhanced ultrasound (CEUS) is a very promising method, reported also in EAU (European Association of Urology) guidelines 2019 and in EFSUMB (European Federation of Societies for Ultrasound in Medicine and Biology) guidelines 2017: this method is based on the use of a not-nephrotoxic contrast medium, made up of microbubbles of an inert gas, that is eliminated through the lungs in about 15 minutes, so it could be used also in patients with impaired renal function. The technique is indicated for its high sensitivity and high specificity in characterization of renal lesions with Level of Evidence 2 in the EAU guidelines 2019. CECT is the gold standard in characterization of solid renal lesion, but it is based on the use of ionizing radiation and is burdened by the risk of contrast-induced nephropathy (CIN). Also in this setting of lesions (small, usually indolent, founded incidentally in most of cases after the 7th decade of life, so in patients with comorbidities) CEUS could be an alternative modality because it's safe, widely available, cost-effective and has no radiation exposure.

With the widespread use of diagnostic imaging modalities is imperative for the radiologist to use methods as safe and non invasive as possible, especially in this setting of usually indolent lesions.

Also the latest EAU guidelines contain this sentence, with a strenght rating strong: "use non-ionising modalities, mainly contrast-enhanced ultrasound, for further characterisation of small renal masses, tumour thrombus, and differentiation of unclear renal masses".

Furthermore CEUS permits not only a qualitative evaluation of the enhancement but also a quantitative one by the elaboration of time/intensity curves. This method is also suitable in a context of follow up or active surveillance of small renal masses, both in young patients (no radiation exposure) and in elderly ones (avoiding nephrotoxicity).

All those imaging modalities are useful not only for lesions staging, but also for follow up and active surveillance, or as biopsy guide.

References

1. European Association of Urology (EAU) Guidelines 2019 <https://uroweb.org/guideline/renal-cell-carcinoma/#5>. Finelli A, Ismaila N, Bro B, et al. Management of Small Renal Masses: American Society of Clinical Oncology Clinical Practice Guideline. *J Clin Oncol* 2017 Feb 20;35(6):668-680.
2. Volpe A. The role of active surveillance of small renal masses. *Int J Surg*. 2016 Dec; 36(Pt C):518-524.
3. Pierorazio PM, Johnson MH, Ball MW, et al. Five-year analysis of a multi-institutional prospective clinical trial of delayed intervention and surveillance for small renal masses: the DISSRM registry. *Eur Urol* 2015 Sep;68(3):408-15.
4. Silverman SG, Israel GM, Herts BR, et al. Management of the incidental renal mass. *Radiology* 2008 Oct;249(1):16-31.
5. Frank I, Blute ML, Cheville JC, et al. Solide renal tumors: an analysis of pathological features related to tumor size. *J Urol* 2003 Dec; 170(6 Pt 1):2217-20.
6. Sidhu PS, Cantisani V, Dietrich CF, et al. The EFSUMB Guidelines and Recommendations for the Clinical Practice of Contrast-Enhanced Ultrasound (CEUS) in Non-Hepatic Applications: Update 2017. *Ultraschall Med* 2018 Apr;39(2):154-180.
7. Rubenthaler J, Negrão de Figueiredo G, Mueller-Peltzer K, et al. Evaluation of renal lesions using contrast-enhanced ultrasound (CEUS): a 10-year retrospective European single-center analysis. *Eur Radiol* 2018 Nov;28(11):4542-4549.
8. Sasaguri K, Takahashi N. CT and MR imaging for solid renal mass characterization. *Eur J Radiol* 2018 Feb;99:40-54.
9. Wang ZJ, Westphalen AC, Zagoria RJ. CT and MRI of small renal masses. *Br J Radiol* 2018 Jul;91(1087):20180131.

2605.2

The role of active surveillance

A. Alcaraz

Urology, Hospital Clinic de Barcelona, Barcelona, ES

As European Urologist I really support the statement on EAU guidelines referent to active surveillance:

Active surveillance is defined as the initial monitoring of tumour size by serial abdominal imaging (US, CT, or MRI) with delayed intervention reserved for tumours showing clinical progression during follow-up [1]. The concept of AS differs from the concept of watchful waiting. Watchful waiting is reserved for patients whose comorbidities contraindicate any subsequent active treatment and do not require follow-up imaging, unless clinically indicated. In the largest reported series of AS the growth of renal tumours was low and progression to metastatic disease was reported in only a limited number of patients [2,3]. A single-institutional comparative study evaluating patients aged > 75 years showed decreased OS for those who underwent surveillance and nephrectomy relative to NSS for clinically T1 renal tumours. However, a multi-variate analysis, management type was not associated with OS after adjusting for age, comorbidity, and other variables [1]. No statistically significant difference in OS and CSS were observed in another study of RN vs. PN vs. AS for T1a renal masses with a follow-up of 34 months [6]. Results from the multi-institutional Delayed Intervention and Surveillance for Small Renal Masses (DISSRM) registry were recently published [7]. This prospective, NRS enrolled 497 patients with solid renal masses < 4 cm in size who selected either AS or primary active intervention. Patients who selected AS were older, had worse ECOG scores, more comorbidities, smaller tumours, and more often had multiple and bilateral lesions. In patients who elected for AS in this study the overall median small renal mass growth rate was 0.09 cm/year with a median follow-up of 1.83 years. The growth rate and variability decreased with longer follow-up. No patients developed metastatic disease or died of RCC [8]. Overall survival for primary intervention and AS was 98% and 96% at two years, and 92% and 75% at five years, respectively (p = 0.06). At five years, CSS was 99% and 100%, respectively (p = 0.3). Active surveillance was not predictive of OS or CSS in regression modelling with relatively short follow up [7]. Overall, both short- and intermediate-term oncological outcomes indicate that in selected patients with advanced age and/or comorbidities, AS is appropriate for initially monitoring small renal masses, followed, if required, by treatment for progression [3-5, 9-12]. A multicentre study assessed QoL of patients undergoing immediate intervention vs. AS. Patients undergoing immediate intervention had higher QoL scores at baseline, specifically for physical health. The perceived benefit in physical health persisted for at least one year following intervention. Mental health, which includes domains of depression and anxiety, was not adversely affected while on AS [13].

Elderly and comorbid patients with incidental small renal masses have a low RCC-specific mortality and significant competing-cause mortality.

References

1. Lane, B.R., et al. Active treatment of localized renal tumors may not impact overall survival in patients aged 75 years or older. *Cancer*, 2010. 116: 3119
2. Hollingsworth, J.M., et al. Five-year survival after surgical treatment for kidney cancer: a populationbased competing risk analysis. *Cancer*, 2007. 109: 1763.
3. Volpe, A., et al. The natural history of incidentally detected small renal masses. *Cancer*, 2004. 100: 738.
4. Jewett, M.A., et al. Active surveillance of small renal masses: progression patterns of early stage kidney cancer. *Eur Urol*, 2011. 60: 39.
5. Smaldone, M.C., et al. Small renal masses progressing to metastases under active surveillance: a systematic review and pooled analysis. *Cancer*, 2012. 118: 997.

6. Patel, N., et al. Active surveillance of small renal masses offers short-term oncological efficacy equivalent to radical and partial nephrectomy. *BJU Int*, 2012. 110: 1270.
7. Pierorazio, P.M., et al. Five-year analysis of a multi-institutional prospective clinical trial of delayed intervention and surveillance for small renal masses: the DISSRM registry. *Eur Urol*, 2015. 68: 408.
8. Uzosike, A.C., et al. Growth Kinetics of Small Renal Masses on Active Surveillance: Variability and Results from the DISSRM Registry. *J Urol*, 2018. 199: 641.
9. Abou Youssif, T., et al. Active surveillance for selected patients with renal masses: updated results with long-term follow-up. *Cancer*, 2007. 110: 1010.
10. Abouassaly, R., et al. Active surveillance of renal masses in elderly patients. *J Urol*, 2008. 180: 505.
11. Crispen, P.L., et al. Natural history, growth kinetics, and outcomes of untreated clinically localized renal tumors under active surveillance. *Cancer*, 2009. 115: 2844.
12. Rosales, J.C., et al. Active surveillance for renal cortical neoplasms. *J Urol*, 2010. 183: 1698.
13. Pierorazio P, et al. Quality of life on active surveillance for small masses versus immediate intervention: interim analysis of the DISSRM (delayed intervention and surveillance for small renal masses) registry. *J Urol*, 2013. 189: e259

2605.3

When to biopsy

R.E. Beasley

Vascular/Interventional Radiology Lab and Evanescence Vein Center,
Mount Sinai Medical Center, Miami Beach, FL, US

Introduction

The extensive use of cross-sectional imaging has increased the detection of renal cell carcinoma (RCC). Luciani, LG et al 's retrospective study (n= 1092 patients) found a progressive increase of incidental tumors from 13.0% in 1982 - 1983 to 59.2% in 1996 - 1997.¹

Incidental renal tumors are most commonly small, asymptomatic masses.² The high frequency of benign pathology on surgical resection and the increasing appeal for non-invasive treatment options created a new path towards tissue diagnosis before intervention.³

Even though nephron-sparing approaches represent the gold standard of treatment for suspected RCCs, they are not free of surgical complications and so the use of ablative therapies is rising.⁴ Marconi et al published a meta-analysis asserting the increasing acceptance of percutaneous renal mass biopsy secondary to the outstanding accuracy with a low rate of complications.⁵ Percutaneous biopsy has the potential of circumventing preventable surgeries, particularly in patients at high surgical risk, confirm histologic success after ablation and supporting the selection of systemic therapy for metastatic RCC. In this presentation, we will discuss the most current data on the role of biopsies for small renal masses.

Tumor size

The size selection for indicating biopsy is not well estimated due the lack of prospective studies, but it is likely to be in the order of 2–6 cm.⁵ The rationale behind the approximation is that very small masses are both unlikely to be treated actively and challenging to target with biopsy, while large tumors would improbably benefit from biopsy if the treatment plan is with curative intent.

Staging Renal Cell Carcinoma

Stage I	T ₁ NoMo	T ₁ is limited to kidney <7 cm
Stage II	T ₂ NoMo	T ₂ is limited to kidney >7 cm
Stage III	T ₃ or any TN ₁ Mo	T ₃ is ingrowth perinephric tissue but not beyond Gerota's fascia or tumor thrombus vein
Stage IV	T ₄ or M ₁	T ₄ involves ipsilateral adrenal gland or invades beyond Gerota's fascia

Types of Biopsy

The biopsies can be ultrasound or CT guided, the choice is personal and varies according to the institution. The most common protocols for each modality are described below.

Fine needle aspiration (FNA)

Using 22-gauge needles, the aspirated material is used for air-dried and alcohol-fixed smear slides and the needle is then rinsed in RPMI solution for cell block. Immunohistochemical stains are performed on needle rinse cell block.⁶ Our institution does not perform FNA as a protocol for kidney biopsies.

Core biopsy (CNB)

Core needle biopsy (CNB) using 16-, 18- or 20-gauge biopsy needles. US-guided biopsies employ 18-gauge core needle biopsies, without the use of a coaxial sheath. CT-guided biopsies use a 16-gauge coaxial sheath. The most frequently reported method is collecting between two and four core samples at their own discretion using the Bard Mission Max-Core, the Cook Quick-Core, or the Argon Full Core devices.⁶ Our institution most frequently uses 18-gauge CNB taking at least three core samples at their own preference using the Bard Mission Max-Core. The material from the CNB is touched on glass slides for imprints, before being fixed in 10% neutral buffered formalin

Discussion

Patel et al. published a survey-based study employing members of the American Urological Association exploring their indications to perform a renal mass biopsy (RMB) for small renal masses (≤4 cm). It was found that 32% of American urologists would "never" perform a biopsy of a small renal mass (SRM). They demonstrated that urologists, predominantly those in private practice, government-based practice or limited exposure (< 5 SRM/year) are less likely to perform RMB, which may account for 6000 additional surgeries. They found of the 1131 urologists that utilized RMB in their small renal mass workups, the majority utilized interventional radiology service to perform the biopsies.⁷

The current data displayed in this abstract demonstrates that the performance of RMB for small masses is creating a new pattern of practice, reflected by the updates in the American Urological Association (AUA) guidelines for management of solid renal masses.⁸ Multiple sources were reviewed and the implementation of percutaneous kidney mass biopsies has recurrently shown a high overall diagnostic rate (92%), with high accuracy 96% for the diagnosis of RCC histologic subtype. It is important to observe that there is an agreement between tumor grade at biopsy and on the final specimen.⁵

Conclusion

Core needle biopsy (CNB) for small kidneys masses has been proven to be a safe procedure with a high diagnostic rate.⁵ In our experience nodules as small as 1.5 cm can be successfully biopsied under CT and Ultrasound guidance. The increasing use of percutaneous kidney mass biopsy can prevent unnecessary surgical excisions, guide systemic therapy and safely indicate ablative candidates, as reflected in the updated AUA guidelines.

References

1. Luciani LG, Cestari R, Tallarigo C. Incidental renal cell carcinoma-age and stage characterization and clinical implications: study of 1092 patients (1982-1997). *Urology*. 2000;56(1):58-62.
2. Volpe A, Panzarella T, Rendon RA, Haider MA, Kondylis FI, Jewett MAS. The natural history of incidentally detected small renal masses. *Cancer*. 2004;100(4):738-745. doi:10.1002/cncr.20025
3. NAKASHIMA K, KITAGAWA Y, IZUMI K, MIZOKAMI A, GABATA T, NAMIKI M. Diagnostic accuracy of pre-operative imaging findings in presumed clinical T1a renal cell carcinomas. *Oncol Lett*. 2016;11(5):3189-3193. doi:10.3892/ol.2016.4330
4. Volpe A, Finelli A, Gill IS, et al. Rationale for percutaneous biopsy and histologic characterisation of renal tumours. *Eur Urol*. 2012;62(3):491-504. doi:10.1016/j.eururo.2012.05.009
5. Marconi L, Dabestani S, Lam TB, et al. Systematic Review and Meta-analysis of Diagnostic Accuracy of Percutaneous Renal Tumour Biopsy. *European Urology*. 2016;69(4):660-673. doi:10.1016/j.eururo.2015.07.072

6. Hoare D, Evans H, Richards H, Samji R. Evaluating the role for renal biopsy in T1 and T2 renal masses: A single-centre study. *Can Urol Assoc J*. 2018;12(5):E226-E230. doi:10.5489/cuaj.4831
7. Patel RM, Safiullah S, Okhunov Z, et al. Pretreatment Diagnosis of the Small Renal Mass: Status of Renal Biopsy in the United States of America. *Journal of Endourology*. 2018;32(9):884-890. doi:10.1089/end.2018.0175
8. Ward RD, Tanaka H, Campbell SC, Remer EM. 2017 AUA Renal Mass and Localized Renal Cancer Guidelines: Imaging Implications. *RadioGraphics*. 2018;38(7):2021-2033. doi:10.1148/rgr.2018180127
3. Chang KD, Abdel Raheem A, Kim KH, Oh CK, Park SY, Kim YS, Ham WS, Han WK, Choi YD, Chung BH, Rha KH. Functional and oncologic outcomes of open, laparoscopic and robotic partial nephrectomy: A multicenter comparative matched-pair analyses with a median 5 years follow up. *BJU Int*. 2018 Apr 12. doi: 10.1111/bju.14250.
4. Antonelli A, Mari A, Longo N, Novara G, Porpiglia F, Schiavina R, Ficarra V, Carini M, Minervini A; Collaborators. Role of Clinical and Surgical Factors for the Prediction of Immediate, Early and Late Functional Results, and its Relationship with Cardiovascular Outcome after Partial Nephrectomy: Results from the Prospective Multicenter RECORD 1 Project. *J Urol*. 2018 Apr;199(4):927-932
5. Mari A, Antonelli A, Bertolo R, Bianchi G, Borghesi M, Ficarra V, Fiori C, Furlan M, Giancane S, Longo N, Mirone V, Morgia G, Porpiglia F, Rovereto B, Schiavina R, Serni S, Simeone C, Volpe A, Carini M, Minervini A. Predictive factors of overall and major postoperative complications after partial nephrectomy: Results from a multicenter prospective study (The RECORD 1 project). *Eur J Surg Oncol*. 2017 Apr;43(4):823-830.
6. Masson-Lecomte, A., et al. A prospective comparison of the pathologic and surgical outcomes obtained after elective treatment of renal cell carcinoma by open or robot-assisted partial nephrectomy. *Urol Oncol*, 2013. 31: 924.
7. Choi, J.E., et al. Comparison of perioperative outcomes between robotic and laparoscopic partial nephrectomy: a systematic review and meta-analysis. *Eur Urol*, 2015. 67: 891.
8. Jeong IG, Khandwala YS, Kim JH, Han DH, Li S, Wang Y, Chang SL, Chung BI. Association of Robotic-Assisted vs Laparoscopic Radical Nephrectomy With Perioperative Outcomes and Health Care Costs, 2003 to 2015. *JAMA*. 2017 Oct 24;318(16):1561-1568.

2605.4

Partial nephrectomy

G. Siena, R. Tellini, M. Carini, A. Minervini

Department of Urology, University of Florence, Careggi Hospital, Florence, IT

According to current European Association of Urology (EAU) guidelines, surgery represents the standard treatment to achieve cure in localized (cT1-T2) Renal Cell Carcinoma (RCC) in patients fit for surgery [1]. In detail, partial nephrectomy (PN) -also indicated as nephron sparing surgery (NSS)- has comparable oncological outcomes (in terms of cancer-specific survival and/or recurrence-free survival) with radical nephrectomy (RN) in T1 (< 7cm) tumours but with the advantage of showing better functional outcomes, in terms of preserved renal healthy parenchyma, and consequently renal function, that ultimately translates into a lower risk of cardiovascular events and all-cause mortality. Therefore, PN, whenever technically feasible, is indicated for the treatment of T1 tumours [1]. However, in some cases, PN is unsuitable in localized RCC due to insufficient volume of remaining parenchyma to maintain proper organ function, renal vein thrombosis or an unfavourable tumour location (e.g. adherence to the renal vessels). In these cases, RN represents the curative therapy. For T2 (> 7cm) tumours, RN still represents the treatment of choice. However, in recent years, thanks also to the diffusion of minimally-invasive techniques, NSS has shown to achieve acceptable surgical morbidity, equivalent cancer control and better preservation of renal function, with potential for better long-term survival, with a slightly increased risk of perioperative complications [2]. Thus, NSS for complex and/or large (T2) renal masses should be adopted in high volume centres and should be performed by experienced surgeons. Of course, further prospective, better if randomized, studies are needed to better define the role of PN in this challenging clinical scenario.

As regards instead the surgical approach when performing PN (open versus pure laparoscopic versus robot-assisted), all three techniques seem to have similar oncological outcomes [3] with the robotic approach showing a lower incidence of renal function impairment [3-4] and perioperative complications [5]. Indeed, the robotic approach shows lower estimated blood loss and shorter hospital stay when compared both to open and laparoscopic approach [6-7]. The advantages of robot-assisted approach are mainly due to the 3D vision associated with the "endowrist" technology that allows for excellent vision of the operative field and the possibility of dissecting the tissue optimally by varying the degree of incidence with the target structures allowing the surgeon to perform a more ergonomic tumorectomy and a rapid and effective reconstructive phase. In this context, EAU guidelines suggest that PN can be performed with open, laparoscopic or robot-assisted approach, based on surgeon's expertise and skills [1].

References

1. EAU Guidelines. Edn. presented at the EAU Annual Congress Copenhagen 2018. ISBN 978-94-92671-01-1.
2. Mir MC, Derweesh I, Porpiglia F, Zargar H, Motttrie A, Autorino R. Partial Nephrectomy Versus Radical Nephrectomy for Clinical T1b and T2 Renal Tumors: A Systematic Review and Meta-analysis of Comparative Studies. *Eur Urol*. 2017 Apr;71(4):606-617.

2605.5

Percutaneous ablation

D.K. Filippiadis, N.L. Kelekis

2nd Department of Radiology, ATTIKON University General Hospital, Athens, GR

According to the GLOBOCAN 2018 statistics, kidney cancer's incidence is 8th among cancers in Europe with more than 130.000 new cases and more than 54.000 deaths per year. There are various ablation modalities applied in the treatment of renal tumors, including radiofrequency, cryoablation, microwave and laser; the majority of available literature is coming from the experience with radiofrequency and cryoablation, however, microwave is recently gaining more and more importance [1-3]. In literature, there are no randomized prospective clinical trials that have compared different ablation techniques for treatment of RCC with a resulting lack of compelling evidence suggesting that one technique is superior to any of the other. Each technique has advantages and disadvantages that have to be considered by the interventional radiologist in each particular setting to achieve best patient outcome. Radiofrequency ablation and cryoablation are the techniques that are advised by current guidelines and are considered equivalent as they both have excellent technical success rates and low tumor recurrence rates (even in cases of repeated ablation) [4-7].

All percutaneous ablative techniques are minimally invasive and technically suited for the treatment of tumors generally not exceeding 4 cm, which has been described as the upper threshold of T1a kidney tumors. Any therapeutic decision should be taken within a multidisciplinary tumor board including at least an interventional radiologist, an urologist and an oncologist. Ideal candidates for renal tumor ablation are patients with a T1a (≤ 4 cm) RCC, with contraindications or unwillingness to undergo surgery and with any grade of impairment of renal function or those who have already undergone tumor enucleation, partial- or complete-nephrectomy, with possible renal function impairment [8]. Other indications include patients affected by genetic syndromes (i.e. Von Hippel Lindau) that develop multiple renal tumors during the course of their life [8].

A successful ablation depends upon personalized treatment planning including appropriate planning, targeting, monitoring and last but not least result assessment. In the literature there are practical algorithms for procedure planning, such as the ABLATE approach (A, axial tumor diameter; B, bowel proximity; L, location within the kidney; A, adjacency to the ureter; T, touching renal sinus fat; and E, endophytic or exophytic position) [9]. Percutaneous ablation is imaging guided using state-of-the-art modalities such as US, CT, CBCT, PET/CT or MR. Recently, real time fusion of multiple imaging modalities has been implemented and successfully applied in the guidance of tumor ablation allowing technique application even in complex lesions without a relevant increase in the operatory environment complexity [10].

Regardless the ablation technique used, clinical outcomes are invariably associated with the size of the renal tumor. Ablations of T1a (≤ 4 cm) lesions show technical success approaching 100% and excellent primary local control. In a recent paper, Talenfeld and colleagues evaluated retrospectively T1a lesions treated either with radiofrequency-, cryo- or microwave ablation reporting similar outcomes of total or partial nephrectomy (5-year cancer-specific survival 95-98%), but observing less peri-procedural complications, less unplanned hospital readmissions, reduced 30- and 90-day mortality and a lower risk of long-term renal insufficiency [11]. Another recent retrospective analysis performed on a large patient cohort with long-term follow up confirmed 3-, 5-, 9-year specific and non-specific cancer survival rates not to be statistically significant among thermal ablation, partial and total nephrectomy [12]. Within the T1a classification, tumors larger than 3 cm have been associated with higher incidence of recurrence, with a disease-free survival of 68% compared to 97% of tumors ≤ 3 cm [13].

During the ablation session protective maneuvers such as saline hydrodissection, CO₂ insufflation or "torquing" can be used to protect adjacent structures from damage. When the excretory system is at risk for damage, cold pyeloperfusion can be performed through a ureteral single J connected to a cold fluid bag [10, 14]. Reported complications [8, 14, 15] include:

- renal infection
- haemorrhage
- pneumothorax
- thermal damage to surrounding structures (ureter, bowel, genitofemoral nerve, psoas muscle)
- track seeding
- post-ablation syndrome

In the literature there is no level 1 evidence regarding the comparison of the different ablation techniques with surgery for stage T1a RCC. Thermal ablation, on contrary to surgery can be performed without the need of general anesthesia and is a nephron-sparing technique facilitating preservation of renal function similar to partial nephrectomy [16]. Published data has shown that major complication rates were significantly lower or similar in thermal ablation treatment compared to partial nephrectomy and overall lower complication rates following thermal ablation [17]. Thermal ablation exhibits metastasis-free and cancer-specific survival rates comparable to surgery whilst percutaneous techniques have been shown to be more cost-effective than partial nephrectomy due to their minimal-invasive approach and less cost and procedure time [18, 19]. Percutaneous ablation for RCC is considered as a treatment alternative to partial nephrectomy and is advised by various published guidelines: The 2017 National Comprehensive Cancer Network (NCCN) Clinical Practice guidelines in oncology: ablative techniques can be considered only in selected patients with clinical stage T1a RCCs, are associated with a higher local recurrence rate than conventional surgery and also highlighted the lack of a randomized phase III comparison of ablative techniques with surgery [4].

The 2017 American Society for Clinical Oncology (ASCO) guidelines on the management of small RCCs: percutaneous thermal ablation should be considered for patients with tumors that are located such that complete ablation can be achieved and TA should be reserved for carefully selected and counseled patients [5].

The 2017 American Urological Association (AUA) guidelines: thermal ablation should be considered as an alternate approach for management of cT1a renal masses < 3 cm in diameter and a percutaneous approach is preferred [6].

The 2019 European Society of Medical Oncology (ESMO) guidelines: percutaneous ablation techniques (incl. RFA, MWA and CWA) are options for patients with small cortical tumors < 3 cm in diameter especially in cases of co-morbidities [7].

Percutaneous ablation of RCC is a safe and efficacious technique for the treatment of T1a renal masses. Percutaneous ablation procedures for the treatment of RCC are low cost, of short duration of hospitalization with low complication rates when compared to surgical approaches. Further evaluation of the technique against surgical therapies in a comparative randomized mode as well as registries is warranted.

References

1. Stone MJ, Venkatesan AM, Locklin J, Pinto P, Linehan M, Wood BJ. Radiofrequency ablation of renal tumors. *Tech Vasc Interv Radiol*. 2007;10(2):132-139 <http://dx.doi.org/10.1053/j.tvir.2007.09.011>.
2. Cornelis FH, Marcelin C, Bernhard J-C. Microwave ablation of renal tumors: A narrative review of technical considerations and clinical results. *Diagn Interv Imaging*. 2017;98(4):287-297 <http://dx.doi.org/10.1016/j.diii.2016.12.002>.
3. Maria T, Georgiades C. Percutaneous cryoablation for renal cell carcinoma. *J kidney cancer VHL*. 2015;2(3):105-113 <http://dx.doi.org/10.15586/jkcvhl.2015.34>.
4. Motzer RJ, Jonasch E, Agarwal N, Bhayani S, Bro WP, Chang SS, et al. Kidney Cancer, Version 2.2017, NCCN Clinical Practice Guidelines in Oncology. *Journal of the National Comprehensive Cancer Network : JNCCN*. 2017;15(6):804-34.
5. Finelli A, Ismaili N, Bro B, Durack J, Eggener S, Evans A, et al. Management of Small Renal Masses: American Society of Clinical Oncology Clinical Practice Guideline. *Journal of clinical oncology : official journal of the American Society of Clinical Oncology*. 2017;35(6):668-80.
6. Campbell S, Uzzo RG, Allaf ME, et al. Renal Mass and Localized Renal Cancer: AUA Guideline. *J Urol*. 2017;198(3):520-529. doi:10.1016/j.juro.2017.04.100.
7. Escudier B, Porta C, Schmidinger M, Rioux-Leclercq N, Bex A, Khoo V, Grünwald V, Gillesen S, Horwich A; ESMO Guidelines Committee. Renal cell carcinoma: ESMO Clinical Practice Guidelines for diagnosis, treatment and follow-up. *Ann Oncol*. 2019 Feb 21. pii: mdz056. doi: 10.1093/annonc/mdz056. [Epub ahead of print]
8. Krokidis ME, Orsi F, Katsanos K, Helmberger T, Adam A. CIRSE Guidelines on Percutaneous Ablation of Small Renal Cell Carcinoma. *Cardiovascular and interventional radiology*. 2017;40(2):177-91.
9. Schmit GD, Kurup AN, Weisbrod AJ, et al. ABLATE: a renal ablation planning algorithm. *Am J Roentgenol*. 2014;202(4):894-903 <http://dx.doi.org/10.2214/AJR.13.11110>.
10. Mauri G, Nicosia L, Varano GM, et al. Tips and tricks for a safe and effective image-guided percutaneous renal tumour ablation. *Insights Imaging*. 2017;8(3):357-363 <http://dx.doi.org/10.1007/s13244-017-0555-4>.
11. Talenfeld AD, Gennarelli RL, Elkin EB, et al. Percutaneous Ablation Versus Partial and Radical Nephrectomy for T1a Renal Cancer: A Population-Based Analysis. *Ann Intern Med*. 2018;169(2):69-77 <http://annals.org/article.aspx?doi=10.7326/M17-0585>. Accessed February 13, 2019.
12. Xing M, Kokabi N, Zhang D, Ludwig JM, Kim HS. Comparative Effectiveness of Thermal Ablation, Surgical Resection, and Active Surveillance for T1a Renal Cell Carcinoma: A Surveillance, Epidemiology, and End Results (SEER)-Medicare-linked Population Study. *Radiology*. 2018;288(1):81-90 <http://dx.doi.org/10.1148/radiol.2018171407>.

13. Johnson BA, Sorokin I, Cadeddu JA. Ten-Year Outcomes of Renal Tumor Radio Frequency Ablation. *J Urol*. 2019;201(2):251–258<http://dx.doi.org/10.1016/j.juro.2018.08.045>.
14. Lee SJ, Choyke LT, Locklin JK, Wood BJ. Use of hydrodissection to prevent nerve and muscular damage during radiofrequency ablation of kidney tumors. *J Vasc Interv Radiol*. 2006;17(12):1967–1969<http://dx.doi.org/10.1097/01.RVI.0000248829.49442.0E>.
15. Gervais DA, McGovern FJ, Arellano RS, McDougal WS, Mueller PR. Renal cell carcinoma: clinical experience and technical success with radio-frequency ablation of 42 tumors. *Radiology*. 2003;226(2):417–424<http://dx.doi.org/10.1148/radiol.2262012062>.
16. Katsanos K, Mailli L, Krokidis M, McGrath A, Sabharwal T, Adam A. Systematic review and meta-analysis of thermal ablation versus surgical nephrectomy for small renal tumours. *Cardiovasc Intervent Radiol*. 2014;37(2):427–437<http://dx.doi.org/10.1007/s00270-014-0846-9>.
17. Pierorazio PM, Johnson MH, Patel HD, Sozio SM, Sharma R, Iyoha E, et al. Management of Renal Masses and Localized Renal Cancer: Systematic Review and Meta-Analysis. *The Journal of urology*. 2016;196(4):989-99.
18. Yin X, Cui L, Li F, Qi S, Yin Z, Gao J. Radiofrequency Ablation Versus Partial Nephrectomy in Treating Small Renal Tumors: A Systematic Review and Meta-Analysis. *Medicine*. 2015;94(50):e2255.
19. Castle SM, Gorbatiy V, Avallone MA, Eldefrawy A, Caulton DE, Leveillee RJ. Cost comparison of nephron-sparing treatments for cT1a renal masses. *Urologic oncology*. 2013;31(7):1327-32.

2605.6

Combined treatments

A.H. Mahnken

Department of Diagnostic and Interventional Radiology, University Hospital Marburg, Philipps University of Marburg, Marburg, DE

Thermal ablation is effective for treating small renal cell carcinomas (RCC). This approach is currently challenging nephron sparing surgery in RCCs smaller than 4cm (T1a). For long-term treatment success, it is crucial to achieve complete ablation. The latter is known to depend on tumour size (<3-4 cm), tumour geometry, relation to its surrounding structures (e.g. renal vein), and lesion vascularity ("heat sink" effect) [1-2]. Corresponding to the roughly four times higher blood flow in the kidney, when compared to the liver, the latter is of particular relevance. Reducing the blood flow during hyperthermal ablation increases the volume of ablation. Considering that RCCs are almost entirely supplied by the renal arteries, most combination therapies for treating RCCs focus on combining transcatheter arterial embolization (TAE) with thermal ablation. TAE may not only be used for reducing the blood flow, but also for lesion tagging, thereby facilitating the ablation procedure [3]. TAE for treating hypervascularized RCCs is a long known technique. It has most often been used for preoperative embolization in order to reduce intraoperative blood loss, ease dissection, and decrease procedure time. There is even evidence suggesting an embolization induced immune response, which is thought to improve tumor control and survival time [4,5]. However, as a standalone technique TAE has no role in the treatment of small RCCs.

Results of combined hyperthermal ablation and TAE are very promising with local control rates of 97 to 100% defined as eradication of contrast enhancing tumor tissue [6-9]. Interestingly many lesions treated by this combination approach were smaller than 4 cm, where ablation alone is thought to be equally effective. Moreover, repeat treatments may be required if tumors > 4 cm (T1b) are treated. A relevant downside is the limited data on these combination treatments, with the biggest series comprising on 36 lesion [7].

It has been hypothesized that TAE prior to ablation may be beneficial in lesions with a higher risk for bleeding, e.g. if multiple applicators or cryotherapy are applied. Most recent data, however, does support

these assumptions. Particularly cryotherapy appears not to benefit from additional TAE as far as the very limited data on this topic indicates [10]. The current literature on combination therapies is not only inhomogeneous on indication, but also on the embolic materials as well as on the interval between both therapies with intervals of few minutes up to several days between treatments. While particles, gelfoam and liquid embolics have been described in the literature, there is evidence from animal studies, indicating the use of small particles (40µm) for TAE prior to ablation to be the most effective treatment sequence [11-12]. For lesion tagging the use of iodinated oil as part of the embolic agents is indicated. There is no data if the interval between ablation and TAE affects outcome. However, from a patient perspective a short interval between both treatments - ideally a single session treatment - appears to be desirable. In summary, TAE as add-on to percutaneous ablation, particularly radiofrequency ablation (RFA), is feasible, safe and very effective. While combination therapies can be applied for dealing with T1a tumors in difficult locations, the combination of ablation should more often be considered in T1b tumors.

References

1. Mayo-Smith WW, Dupuy DE, Parikh PM, et al. Imaging guided percutaneous radiofrequency ablation of solid renal masses: Techniques and outcomes of 38 treatment sessions in 32 consecutive patients. *AJR Am J Roentgenol* 2003; 180: 1503-1508
2. Gervais DA, McGovern FJ, Arellano RS, et al. Renal cell carcinoma: Clinical experience and technical success with radiofrequency ablation of 42 tumors. *Radiology* 2003; 226:417-424
3. Mahnken AH, Penzkofer T, Bruners P, et al. Interventional management of a renal cell carcinoma by radiofrequency ablation with tagging and cooling. *Korean J Radiol* 2009; 10: 523-526
4. Bakke A, Göthlin JH, Haukaas SA, et al. Augmentation of natural killer cell activity after arterial embolization of renal carcinomas. *Cancer Res* 1982; 42: 3880-3883
5. Nakano H, Nihira H, Toge T. Treatment of renal cancer patients by transcatheter embolization and its effects on lymphocyte proliferative responses. *J Urol* 1983; 130: 24-27
6. Yamakado K, Nakatsuka A, Kobayashi S, et al. Radiofrequency ablation combined with renal arterial embolization for the treatment of unresectable renal cell carcinoma larger than 3.5 cm: initial experience. *Cardiovasc Intervent Radiol* 2006; 29: 389-394
7. Arima K, Yamakado K, Kinbara H, et al. Percutaneous radiofrequency ablation with transarterial embolization is useful for treatment of stage 1 renal cell carcinoma with surgical risk: results at 2-year mean follow up. *Int J Urol* 2007; 14: 585-590
8. Nakasone Y, Kawanaka K, Ikeda O, et al. Sequential combination treatment (arterial embolization and percutaneous radiofrequency ablation) of inoperable renal cell carcinoma: single-center pilot study. *Acta Radiol* 2012; 53: 410-414
9. Duan XH, Li YS, Han XW, et al. C-arm CT-guided renal arterial embolisation followed by radiofrequency ablation for treatment of patients with unresectable renal cell carcinoma. *Clin Radiol* 2016; 71: 79-85
10. Gunn AJ, Mullenbach BJ, Poundstone MM, et al. Transarterial embolization of renal cell carcinoma as an adjunctive therapy prior to cryoablation: a propensity score matching analysis. *Diagn Interv Radiol* 2018; 24: 357-363
11. Tanaka T, Isfort P, Braunschweig T, et al. Superselective particle embolization enhances efficacy of radiofrequency ablation: effects of particle size and sequence of action. *Cardiovasc Intervent Radiol* 2013; 36: 773-782
12. Sommer CM, Kortess N, Mogler C, et al. Super-micro-bland particle embolization combined with RF-ablation: angiographic, macroscopic and microscopic features in porcine kidneys. *Eur J Radiol* 2012; 81: 1165-1172

Focus Session

Radial access: how and when

2702.1

The rationale behind it

M. Guimaraes, A. Uflacker, D.T. Johnson, R. Yamada
Vascular Interventional Radiology, Medical University of South Carolina,
Charleston, SC, US

Learning Objectives

1. To learn the rationale for radial access
 2. To understand the advantages of radial access
 3. To learn for which patients radial access can be performed
- The rationale of using radial access for arterial interventions will be discussed from different perspectives: patient's preference, access-related complications, supplies-related costs, anatomy, economics, prevention of blood products transfusion, optimization of space and human resources and radiation exposure to the interventionist.

References

1. Posham R, Biederman DM, Patel RS, et al. Transradial approach for noncoronary interventions: a single-center review of safety and feasibility in the first 1,500 cases. *J Vasc Interv Radiol* 2016;27:159–66.
2. Resnick NJ, Kim E, Patel RS, et al. Uterine artery embolization using a transradial approach: initial experience and technique. *J Vasc Interv Radiol* 2014;25:443–7.
3. Wu T, Sun R, Huang Y, et al. Partial splenic embolization of patients with hypersplenism by transradial or transfemoral approach: a prospective randomized controlled trial. *Acta Radiol (Stockholm, Sweden: 1987)* 2016;57:1201–4.
4. Iezzi R, Pompili M, Posa A, et al. Transradial versus transfemoral access for hepatic chemoembolization: inpatient prospective single-center study. *J Vasc Interv Radiol* 2017;28:1234–9.
5. Yamada R, Bracewell S, Bassaco B, et al. Transradial versus transfemoral arterial access in liver cancer embolization: randomized trial to assess patient satisfaction. *J Vasc Interv Radiol* 2018;29:38–43.
6. Zhang J, Stanley M, Richard H, et al. Transradial versus transfemoral access in radioembolization for hepatocellular carcinoma with yttrium-90 microspheres. *Journal of Vascular and Interventional Radiology* 2017;28:e21.
7. Rammohan A, Sathyanesan J, Ramaswami S, et al. Embolization of liver tumors: past, present and future. *World J Radiol* 2012;4:405–12.
8. Thakor AS, Alshammari MT, Liu DM, et al. Transradial access for interventional radiology: single-centre procedural and clinical outcome analysis. *Can Assoc Radiol J* 2017;68:318–27.
9. Aliberti C, Carandina R, Sarti D, et al. Transradial access (TRA) for TACE and hepatic arterial infusion chemotherapy (HAIC) of primary and metastatic liver cancer. *Cardiovasc Interv Radiol* 2017;40:S268.
10. Bishay V, Patel RS, Kim E, et al. Transradial approach for hepatic radioembolization: Initial results and technique. *J Vasc Interv Radiol* 2014;25:S90–1.
11. Linville RM, Holayter RA, Dalvie P, et al. Transradial arterial access for intra-arterial liver directed therapy: a single center initial experience. *J Vasc Interv Radiol* 2015;26:e36–7.
12. Hamon M, Pristipino C, Di Mario C, et al. Consensus document on the radial approach in percutaneous cardiovascular interventions: position paper by the European Association of Percutaneous Cardiovascular Interventions and Working Groups on Acute Cardiac Care and Thrombosis of the European Society of Cardiology. *Euro Interv* 2013;8:1242–51.

2702.2

Radial vs. femoral vs. brachial

E. Brountzos

2nd Department of Radiology, ATTIKON University General Hospital,
Athens, GR

Learning Objectives

1. To learn how to select the more suitable arterial access
2. To learn about the potential complications of different techniques
3. To compare the literature data

Radial access [RA] has gained popularity in the interventional cardiology clinical practice in the expense of transfemoral [FA] and brachial access [BA]. There are several advantages of RA over FA and BA including less puncture site hematomas, zero retroperitoneal hematomas, less limb ischemic complications, while patients' comfort is increased. In most studies RA was compared to FA, while comparison to BA is limited. There is compelling evidence that in cardiology practice the outcomes after radial access (RA) are superior to those of femoral access (FA) in most clinical settings. In a study comparing all three accesses major entry site complications were encountered in 2.3% in the transbrachial group, 2.0% in the transfemoral group and none in the transradial group (p 5 0.035). Lower complication and mortality rates have led to adoption of the radial access in many parts of the world. As a consequence, radial access is gradually adopted by Interventional Radiologists (IRs) performing oncologic or vascular procedures. However, there are several difficulties for the general adoption of this technique in IR. Drawbacks include increased cost of the tools, longer learning curve, difficulty of puncture, decreased catheter maneuverability, less size flexibility in case one needs to upsize the catheters, inability to cross over, and possibly increased radiation to the operator. Additional limitations to the use of RA include the lack of the necessary length of balloon catheters and stents to reach areas such as below the knee or even splanchnic arteries in tall patients, or in cases of tortuous arteries. Conversely, RA technique is welcome to the patients, because it allows for immediate ambulation, however in the majority of IR practice the patient should stay overnight in the hospital for close monitoring. In conclusion, FA cannot currently be replaced in many IR procedures such as those requiring large bore devices or antegrade vascular procedures below the knee. BA access will be still in use when an alternative to FA is needed because the brachial artery can accommodate quite large devices and the required device lengths are not as long as those needed for the RA. RA will be the ideal access for oncologic and embolization procedures in the abdominal region, while gradually will be applied in the remaining IR fields if the technology provides suitable tools.

References

1. Pasala TKR, Turi ZG. Revisiting femoral vs. radial access: do vascular closure devices level the playing field? *Cathet Cardiovasc Interv*. 2017;89:982–983.
2. Kiemeneij F, Laarnman GJ, Odekerken D, Slagboom T, van der Wieken R. A Randomized Comparison of Percutaneous Transluminal Coronary Angioplasty by the Radial, Brachial and Femoral Approaches: The Access Study. *J Am Coll Cardiol* 1997;29:1269–75

2702.3

Which procedure, which devices?

G. Andrade

AngioRad - Interventional Radiology, Hospital Santa Joana Recife, Recife,
BR

Learning Objectives

1. To learn which interventional procedures are more suitable for radial access
2. To learn about the different devices available
3. To understand the technical difficulties

Radial access (RA) is a well-established option in coronary interventions with lower complication rates and mortality, representing half of the procedures worldwide. However, among interventional radiology (IR) practice, it represents less than 5% of endovascular accesses. Lack of training and adaptation of devices are the main reasons, the development and familiarization with specific devices and propagation of experiences are opening minds of IR teams leading to an increase of acceptance and use. RA need to be considered as an option, once patient and material selection is mandatory, the radial artery can accept until 6F sheaths in almost all adults. Active anticoagulation or coagulopathy are not contra-indication. Obese or superobese patients are not a problem and procedure and fluoroscopy time are almost the same. Spasm and tortuosity can be managed with drugs and soft wires. Aortic arch can be a difficulty, but double curved catheters can deal with. Remember to avoid its use in chronic kidney disease patients, except for arteriovenous fistula recanalization. The distance from the puncture site and the target has to be considered. If a recanalization of a chronic vessel is the objective, forget far distant access. Even for other procedures, the distance has to be considered. There are 125cm long, 4 to 6F, catheters that can be used to reach from the intracranial to common femoral arteries. Long sheaths can be used with excellent support and large internal lumen. Some neurointerventional devices are very usable for visceral interventions, such as the long, straight or curved, 0.088" 6F sheathless guiding catheter. It allows the use of two parallel devices through the same sheath or guiding catheter, making remodelling technique, balloon flow control or double microcatheterism possible with just one RA.

Long microcatheters are available in all sizes. Depending on the objective and the material to be introduced, microcatheters from 1.5F to 3.0F can be used through a standard 0.038" 4 or 5F diagnostic catheter. An important point is to know the length of the catheter and the Y connector. For example, a 125cm 5F MPA and a standard Y connector has a total length of 135cm. We have to use a microcatheter between 145 and 165cm. For most of the abdominal and pelvic visceral interventions my first option is the 4 or 5F MPA 125cm. It has enough length, good tractability making RA my preference nowadays to fibroids, liver, spleen and renal embolization. Particularly in prostatic embolization, I use RA only when the patients tall is under 175cm. The reason is that I observe dangerous anastomosis in about 5-10% of patients and it needs to be coiled. In taller men, the target may not be reached and another access necessary. As RA should be seen as an option, I do not force to perform it in all cases. Carotid stenting or aneurysm coiling can be performed through contralateral RA with long sheath or 6F guiding catheter. Always contralateral to avoid kinking. Vertebro-basilar intervention is straightforward. Stenting or Coiling with or without remodelling can be performed with a 5 or 6F access, as well as flow diversion.

After the procedure, no anticoagulation reverse is necessary to withdraw the sheath. Haemostatic bracelet devices are accessible, easy and safe. Haemorrhagic or ischemic complications are less common than femoral or any other access option. If you are not convinced yet, ask the patient about his satisfaction and you will consider radial access as an option. During presentation, I will be forced to nominate devices and companies.

References

1. Aldemir J, Abath C, Andrade G, Lylyk P. Radial access for cerebrovascular interventions. In: Raimundo Furtado; Bedson de Sá. *Transradial: diagnóstico e intervenção*. São Paulo: Atheneu, 2009. (Portuguese)
2. Andrade G, Ayub JP, Cavalcanti DE, Rivera MA, Abud DG. Radial access for non-coronary interventions. *Revista de Angiologia e Cir Vascular*, dez. 2018. (article in portuguese).
3. Andrade G, Ayub JP, Marques R, Cavalcanti DE. Radial access for visceral interventions. In "SOBRICE Visceral Interventions Volume", São Paulo, Elsevier 2019.
4. Chen SH, Snelling BM, Shah SS, Sur S, et al. Transradial approach for flow diversion treatment of cerebral aneurysms: a multicenter study. *J Neurointerv Surg*, 2019. [Epub ahead of print]
5. Posham R, Biederman DM, Patel RS, Kim E, et al. Transradial Approach for Noncoronary Interventions: A Single-Center Review of Safety and Feasibility in the First 1,500 Cases. *J Vasc Interv Radiol*. 2016 Feb;27(2):159-66.
6. Snelling BM, Sur S, Shah SS, Caplan J, et al. Transradial Approach for Complex Anterior and Posterior Circulation Interventions: Technical Nuances and Feasibility of Using Current Devices. *Oper Neurosurg* 2018. [Epub ahead of print]
7. Thakor AS, Alshammari MT, Liu DM, Chung J, Ho SGF et al. Transradial Access for Interventional Radiology: Single-Centre Procedural and Clinical Outcome Analysis. *Can Assoc Radiol J*. 2017 Aug;68(3):318-327.

2702.4

Complications and their management

M. Schoder

Cardiovascular and Interventional Radiology, Medical University of Vienna, Vienna, AT

Learning Objectives

1. To learn the potential complications of a radial access
2. To learn how to manage complications
3. To understand how to avoid complications

Trans-radial access for coronary interventions is associated with a lower incidence of major access site complications as compared to the transfemoral access.¹ Due to decreased vascular complications, early ambulation and higher patient comfort, trans-radial interventions have gained growing interest in the interventional-radiological community. However, awareness of potential difficulties and complications is of crucial importance. Technical failures via access by the radial artery occur in 1%-5% of cases and reportedly, these are mainly due to anatomic variations. An Italian study, including more than 2000 patients with angiography of the upper limb before coronary intervention, found anatomic variations in nearly 23% of patients.² Most commonly, hypoplasia (7.7%), abnormal origin of radial artery (8.3%), and a tortuous vessel route (3.8%) were noted. Far less common, a radioulnar loop or lusoria subclavian artery were detected. Putting it all together, in this study, anatomic variations led to a significantly lower puncture and procedural success. However, with appropriate techniques, anatomic variations do not necessarily preclude catheter access.

Spasm of the access-site artery is reported in 5%-10% and leads to difficult manipulation, pain and can result in procedure failure necessitating crossover to a femoral access. Thus, appropriate patient setup, adequate local anesthesia and sedation, if necessary in anxious patients, can reduce the risk for arterial spasm. Technical advises to reduce the risk of spasm include insertion of hydrophilic sheaths and gentle manipulation. Furthermore, it has been shown that sheath-to-radial artery ratios > 1 cause higher rates of spasm and radial artery occlusions.³ If spasm occurred, intraarterial administration of spasmolytic agents, usually 2,5-5 mg of verapamil and/or 100-200mg of nitroglycerin, is the advised treatment.

Radial artery occlusion with an reported incidence rate of 2%-18% is the most common complication after trans-radial catheterization.^{4,5} Although, occlusion of the radial artery is usually asymptomatic, it inhibits future access, the use for coronary artery bypass grafting and will limit the option for arteriovenous fistula creation in patients with forthcoming dialysis. To minimize the risk of arterial occlusion adequate anticoagulation, a sufficient sheath-to-artery ratio, avoidance of repeated entries and patent hemostasis are proven concepts. Functional impairment and ischemia of the hand is extremely rare, however, it might occur in the lack of palmar collateral circulation which has to be excluded preprocedural by Barbeau or Allen's test.

Apart from the above mentioned problems, acute injuries and nonocclusive structural changes of the arterial wall were present in all patients in the study by Costa et al. with dissections (~ 90%) and wall hematoma (~ 74%) as the most common.⁶ Furthermore, in this study, more than half of the patients had lumen narrowing and 4% thrombus formation

at any time point. Small pseudoaneurysm formations were detected in nearly 56% of patients at 30-day follow-up. However, contrary to multiple puncture attempts, wall injuries did not affect postprocedural radial artery occlusion and loss of pulsation.

To conclude, optimized patient preparation, appropriate technique/medication and knowledge of anatomic variations should enable safe trans-radial procedures and minimization of complications.

References

1. Jolly SS et al. Radial versus femoral access for coronary angiography and intervention in patients with acute coronary syndromes (RIVAL): a randomized, parallel group, multicentre trial. *Lancet* 2011;377:1409-20
2. Valsecchi O et al. Failure of transradial approach during coronary interventions: anatomical considerations. *Catheter Cardiovasc Interv* 2006;67:870-8
3. Aminian A et al. Impact of sheath size and hemostasis time on radial artery patency after transradial coronary angiography and intervention in Japanese and non-Japanese patients: A substudy from RAP and BEAT randomized multicenter trial. *Catheter Cardiovasc Interv* 2018;92:844-51
4. Hahalis G et al. Prevention of radial artery occlusions following coronary procedures: forward and backward steps in improving radial artery patency rates. *Angiology* 2018;69:755-62
5. Kanei Y et al. Transradial cardiac catheterization: a review of access site complications. *Catheter Cardiovasc Interv* 2011; 78:840-6
6. Costa F et al. The Rotterdam radial access research. Ultrasound-based radial artery evaluation for diagnostic and therapeutic coronary procedures. *Circ Cardiovasc Interv* 2016;9:e003129. DOI: 10.1161/CIRCINTERVENTIONS.115.003129

Clinical Evaluation Course Stroke management

2703.1

Logistics in stroke

M. Ribo

Neurology, University Hospital Vall d'Hebron, Barcelona, ES

No abstract available.

2703.2

Essential imaging for treatment

S. Duda

Berufsausübungsgemeinschaft Radiologie/Neuroradiologie & Zentrum für Minimal Invasive Therapie, Berlin, DE

No abstract available.

2703.3

Are the time windows extended by the new trials?

S. Mangiafico

Department of Neuroradiology, Careggi University Hospital, Florence, IT

Since 2015 endovascular treatment of ischemic stroke patients with large vessel occlusion has been terribly boosted after the publication of five major trials (MR CLEAN, ESCAPE, REVASCAT, SWIFT PRIME, and EXTEND IA) that proved the efficacy of mechanical thrombectomy in selected patients with onset of symptoms within 6 hours. The number-needed-to-treat to reduce one level of disability on mRS was 2.6 and there was no heterogeneity of treatment effect across all subgroups, including patients older than 80 years (cOR 3.68, 95% CI=1.95-6.92) and randomisation more

than 300 minutes (1.76, 1.05- 2.97). From that moment on, the national guidelines and consensus statements in the United States, Europe, and Canada have recommended endovascular recanalization up to 6 h of stroke onset in case of LVO. However, the time of stroke onset is typically defined as the time the patient was last known to be well, which is often uncertain. The recently published DAWN (DWI or CTP Assessment with Clinical Mismatch in the Triage of Wake-Up and Late Presenting Strokes Undergoing Neurointervention with Trevo) and DEFUSE 3 (Endovascular Therapy Following Imaging Evaluation for Ischemic Stroke 3) went one step further in this revolution. As a matter of fact, these two trials suggest that the window for endovascular treatment may be extended up to 12-24 h for selected patients based on imaging and clinical examination (clinical-radiological mismatch or just neuroimaging mismatch between core and ischemic penumbra). Despite the longer onset-to-treatment time compared with previous endovascular thrombectomy trials, the treatment benefit (number-needed-to-treat=2 for better score for disability at 90 days) remains highest among all the acute stroke trials to date. The scientific evidence today is that we should change our paradigm of 'time window' and shift from 'clock time' to 'salvageable tissue' which change from patient to patient.

The extended therapeutic window for endovascular thrombectomy will substantially increase the number of stroke patients who require urgent assessment, timely neuroimaging tests, and immediate endovascular intervention.

National health care systems should take the lead and proactively improve the acute stroke care and hospitals should also prepare themselves for the surging awareness of stroke and treatment expectations of the general public after DAWN and DEFUSE 3.

References

1. Berkhemer OA, Fransen PS, Beumer D, van den Berg LA, Lingsma HF et al (2015) A randomized trial of intraarterial treatment for acute ischemic stroke. *N Engl J Med* 372(1):11-20
2. Campbell BC, Mitchell PJ, Kleinig TJ, Dewey HM et al (2015) Endovascular therapy for ischemic stroke with perfusion-imaging selection. *N Engl J Med* 372(11):1009-1018
3. Goyal M, Demchuk AM, Menon BK, Eesa M et al (2015) Randomized assessment of rapid endovascular treatment of ischemic stroke. *N Engl J Med* 372(11):1019-1030
4. Jovin TG, Chamorro A, Cobo E, de Miquel MA et al (2015) Thrombectomy within 8 hours after symptom onset in ischemic stroke. *N Engl J Med* 372(24):2296-2306
5. Saver JL, Goyal M, Bonafe A, Diener HC et al (2015) Stent-retriever thrombectomy after intravenous t-PA vs. t-PA alone in stroke. *N Engl J Med* 372(24):2285-2295
6. Jovin TG, Liebeskind DS, Gupta R, Rymer M (2011) Imaging-based endovascular therapy for acute ischemic stroke due to proximal intracranial anterior circulation occlusion treated beyond 8 hours from time last seen well: retrospective multicenter analysis of 237 consecutive patients. *Stroke* 42(8):2206-2211
7. Lansberg MG, Cereda CW, Mlynash M, Mishra N et al (2015) Response to endovascular reperfusion is not time-dependent in patients with salvageable tissue. *Neurology* 85(8):708-714
8. Albers GW, Marks MP, Kemp S, Christensen S et al (2018) Thrombectomy for stroke at 6 to 16 hours with selection by perfusion imaging. *N Engl J Med* 378(8):708-718
9. Nogueira RG, Jadhav AP, Haussen DC, Bonafe A, Budzik RF, Bhuva P, Yavagal DR, for the DAWN Trial Investigators. Thrombectomy 6 to 24 hours after stroke with a mismatch between deficit and infarct. *N Engl J Med* 2018;378:11-21
10. Albers GW, Marks MP, Kemp S, Christensen S for the DEFUSE 3 Investigators. Thrombectomy for stroke at 6 to 16 hours with selection by perfusion imaging. *New Engl J Med*. 2018;378:708-718.

2703.4

Should patients with basilar artery thrombosis be randomised?

J.A. Vos

Interventional Radiology, St. Antonius Hospital, Nieuwegein, NL

The Mr Clean trial¹ published in Jan 2015, was the first randomized controlled trial (RCT) on acute anterior circulation ischemic stroke to establish the superiority of Endovascular Treatment (EVT) over the prevailing standard of care, which included Intra Venous Thrombolysis (IVT) in eligible patients. All patients had a proven intracranial Large Vessel Occlusion (LVO). The publication of these results prompted the Data Safety and Monitoring Boards of 4 other ongoing RCTs on (EVT) in anterior circulation stroke to halt their respective trials and perform an interim analysis. These analyses all corroborated the Mr Clean trial results, whereupon the trials were terminated. The results were published shortly thereafter: Extend-IA², ESCAPE³, Revascat⁴ and SWIFT-PRIME⁵.

Following the publication of the results of these trials IAT has, almost overnight, become the recognized standard of care for all anterior circulation LVO strokes, in patients who present within the appropriate time window. This time window has since been expanded to 24 hours in selected patients, following the publication of the DAWN trial⁶.

The basilar artery is the main feeding vessel of the intracranial posterior circulation. It normally supplies the occipital lobes, thalami, brainstem, and cerebellum. An acute Basilar Artery Occlusion (BAO) may hence cause a great disparity of neurologic symptoms, varying from isolated cranial nerve deficit, to loss of consciousness and death. It may also cause hemiplegia, which is why it is sometimes misdiagnosed as anterior circulation (hemispheric) stroke. As opposed to anterior circulation stroke, the severity of symptoms often progresses over time. The prognosis is generally grave, with a death or major disability rate of about 70%. Owing to this poor prognosis, endovascular revascularisation has been proposed earlier for BAO, than for anterior circulation stroke. The first reports were on Intra Arterial Thrombolysis (IAT). However the results were generally not much better than with IVT⁷. An early attempt at randomizing between IAT and best medical treatment⁸ was halted in 2004 after only 16 patients were randomised, on account of poor recruitment rates. After the introduction of stentriever and thrombosuction catheters and in view of the results of the anterior circulation stroke trials, the use of EVT for BAO became much more widespread.

However the anterior and posterior circulation territories are quite different in their pathophysiology. The only way to establish the best treatment modality is by performing an RCT.

One such trial was the BEST trial⁹. This Chinese multicenter trial had a 1:1 randomisation between Best Medical Management (BMM) and BMM with additional EVT. The trial was unfortunately terminated by the Data Safety and Monitoring Board (DSMB) after only 131 of the projected 344 patients had been randomized. The reason for termination was not a safety issue, nor a proven efficacy in either arm, but an excessive number of crossovers. The intention to treat analysis did not show superiority of EVT. The only remaining RCT on BAO is the Basilar Artery International Cooperation Study¹⁰. It is a multinational trial, with participating centers in The Netherlands, Germany, Switzerland, the Czech republic, Italy, Spain and Brazil. It has a similar design to the BEST trial and has clinical equipoise as its central theorem. This makes clinicians much less reluctant to participate. The trial is also helped by the fact that the Brazilian government has made participation in a randomized trial a prerequisite for reimbursement of EVT in BAO. This also occurred in The Netherlands in the MR Clean trial era, significantly aiding recruitment. BASICS has currently randomized 267 patients, with a target of 282 the goal is near and the results are eagerly awaited.

Although several non-randomised studies have shown benefit of EVT in BAO, others have not. In the end, the only way to establish the superiority of any treatment is by sound scientific evidence, which can only be provided by RCT's. Therefore the answer to the question: 'Should patients with basilar artery thrombosis be randomized?' is unequivocally: 'YES'.

References

1. Berkhemer OA, Fransen PS, Beumer D, van den Berg LA, Lingsma HF, Yoo AJ, Schonewille WJ, Vos JA, et al. A randomized trial of intraarterial treatment for acute ischemic stroke. *N Engl J Med*. 2015 Jan 1;372(1):11-20.
2. Campbell BC, Mitchell PJ, Kleinig TJ, Dewey HM, Churilov L, Yassi N, Yan B, Dowling RJ, et al. Endovascular therapy for ischemic stroke with perfusion-imaging selection. *N Engl J Med*. 2015 Mar 12;372(11):1009-18.
3. Goyal M, Demchuk AM, Menon BK, Eesa M, Rempel JL, Thornton J, Roy D, Jovin TG, et al. Randomized assessment of rapid endovascular treatment of ischemic stroke. *N Engl J Med*. 2015 Mar 12;372(11):1019-30.
4. Jovin TG, Chamorro A, Cobo E, de Miquel MA, Molina CA, Rovira A, San Román L, Serena J, et al. Thrombectomy within 8 hours after symptom onset in ischemic stroke. *N Engl J Med*. 2015 Jun 11;372(24):2296-306.
5. Saver JL, Goyal M, Bonafe A, Diener HC, Levy EI, Pereira VM, Albers GW, Cognard C, et al. Stent-retriever thrombectomy after intravenous t-PA vs. t-PA alone in stroke. *N Engl J Med*. 2015 Jun 11;372(24):2285-95.
6. Nogueira RG, Jadhav AP, Haussen DC, Bonafe A, Budzik RF, Bhuva P, Yavagal DR, Ribo M, et al. Thrombectomy 6 to 24 Hours after Stroke with a Mismatch between Deficit and Infarct. *N Engl J Med*. 2018 Jan 4;378(1):11-21.
7. Schonewille WJ, Wijman CA, Michel P, Rueckert CM, Weimar C, Mattle HP, Engelter ST, Tanne D, et al. Treatment and outcomes of acute basilar artery occlusion in the Basilar Artery International Cooperation Study (BASICS): a prospective registry study. *Lancet Neurol*. 2009;8:724-730.
8. Macleod MR, Davis SM, Mitchell PJ, Gerraty RP, Fitt G, Hankey GJ, Stewart-Wynne EG, Rosen D, et al. Results of a multi-centre, randomised controlled trial of intra-arterial urokinase in the treatment of acute posterior circulation ischaemic stroke. *Cerebrovasc Dis*. 2005;20:12-17.
9. Liu X, Xu G, Liu Y, Zhu W, Ma M, Xiong Y, Zi W, Dai Q, et al. Acute basilar artery occlusion: Endovascular Interventions versus Standard Medical Treatment (BEST) Trial-Design and protocol for a randomized, controlled, multicenter study. *Int J Stroke*. 2017 Oct;12(7):779-785.
10. van der Hoeven EJ, Schonewille WJ, Vos JA, Algra A, Audebert HJ, Berge E, Ciccone A, Mazighi M et al. The Basilar Artery International Cooperation Study (BASICS): study protocol for a randomised controlled trial. *Trials*. 2013 Jul 8;14:200

2703.5

How to deal with difficult access

A. Consoli

Diagnostic and Interventional Neuroradiology, Foch Hospital, Suresnes, FR

No abstract available.

2703.6

How to deal with complications

A. Krajina

Department of Radiology, University Hospital, Hradec Králové, CZ

A prolonged endovascular procedure beyond one hour is correlated with higher complication rates, which underlines the importance of a swift and complete revascularization.

Extracranial dissection:

Injury due to guiding catheter tip, or due to overinflation of the balloon. Care should be taken during withdrawal of the stent-retriever when

the guiding catheter has tendency to go up – towards the stent which can stick in the M1 or carotid siphon. This might be more dangerous in tortuous anatomy of the extracranial course of the access artery. (dissection of extracranial artery occurs in approx. in 2% cases of mechanical thrombectomies). It is more frequent in the vertebral artery

Intracranial perforation:

This complications occurs in 1.6% (10 in 634 randomized patients in HERMES)

Arterial injuries were associated with less successful recanalization, and were associated with longer procedural time, only 18 % of complicated patients achieved functional independence.

Comparison of techniques and stent-retrievers:

The Penumbra aspiration catheter uses negative pressure to retrieve the clot without crossing the lesion.

The second generation stent-retrievers Solitaire and Trevo are self-expanding stents that trap the thrombus against the arterial wall and can be retrieved while being fully expanded.

The Trevo device has a higher radial force compared with the Solitaire. The higher radial force might explain the increased efficacy in embolus removal but also the increased probability of symptomatic intracranial hemorrhage (Saber 2018). Lower rates of symptomatic intracerebral hemorrhages with aspiration technique may be attributed to clear visualization of the catheter on roadmaps, and the fact that there is no device opening greater than the catheter size in aspiration (2.9% for contact aspiration versus 5.4% of symptomatic intracerebral hemorrhage for stent-retrievers). Mechanical thrombectomy for M2 occlusions is associated with high functional independence, but may also be associated with an increase risk of hemorrhage (Saber 2018)

Angiographically visible distal emboli:

An incidence rate of new emboli has been reported at least 15%, however were not associated with poor outcome at discharge or 90-day follow up (Mazur 2016). Endovascular recanalization of major anterior cerebral artery branches secondarily occluded by reembolisation reduced the incidence of infarcts with no adverse events (Kurre 2013).

Rescue stenting for failed mechanical thrombectomy:

Acute stent implantation is associated with good outcomes without increasing symptomatic intracranial hemorrhage or mortality. Should be considered in failure to recanalize the ICA and M1. Patency was in 87% - in 20 out of 23 patients (Chang 2018). When mechanical thrombectomy does not retrieve any clot, beside underlying atherosclerotic stenotic lesion also spontaneous intracranial arterial dissection should be considered as a cause of large vessel occlusion (Labeyrie 2018).

General anesthesia versus conscious sedation:

GA is recommended in uncooperative patient and most patients with posterior circulation. In all patients receiving locatl anesthesia, the anesthesiology team should ready to rapidly convert to the GA if needed. Generally, the procedure can be faster if done in analgesedation and safe when head immobilization with a standard cervical collar is used (Janssen 2016).

When should thrombectomy attempts be halted:

The likelihood of successful recanalization got sequentially lower as the number of stent-retriever passes increased. Five or more passes of the stent retriever became futile in terms of the recanalization rate and functional outcomes (Baek 2018). Some operators mentioned "golden hour" or even "golden 35 min" as time dedicated to successful procedure (Alawieh 2018). Keep eye on the clock

Blood brain barrier disruption and arterial wall enhancement:

Contrast staining is negative prognostic factor and is associated with delayed hemorrhagic transformation. Gadolinium vessel wall enhancement occurs in up to 57% cases and is associated with alteplase use before thrombectomy and with more stent-retriever passes, along with the presence of severe blood brain barrier disruption (Renu 2017).

Is expertise of vascular interventional radiologists sufficient?

There are several studies reporting this issue. In many countries and many hospital are not interventional neuroradiologists available. It seems that result might be similar, however, licencing of these operators is

under responsibilities of local government authorities (Fjetland 2012, Burkart 2013, Overhagen 2018).

References

- Behne D, Gondecki L, Fiethen S et al. Complications of mechanical thrombectomy for acute ischemic stroke – a retrospective single-center study of 176 consecutive cases. *Neuroradiol* 2014;56,467-476.
- Saber H, Rajah GB, Kherallah RY, Jadhav AP, Narayanan S. Comparison of the efficacy and safety of thrombectomy devices in acute stroke: a network meta-analysis of randomized trials. *J Neurointervent Surg* 2018;10,729-734.
- Fjetland L, Roy S, Kurz KD, Larsen JP, Kurz MW. Endovascular acute stroke treatment performed by vascular interventional radiologists: is it safe and efficacious? *CVIR* 2012;35,1029-1035.
- Burkart DJ, Day JS, Henderson K, Borsa JJ. Efficacy of peripheral interventional radiologists performing endovascular stroke therapy guided by CT perfusion triage of patients. *JVIR* 2013;24,1267-1272.
- Overhagen H, van Zwaam W, Krajina A et al. CIRSE Position Statement: Interventional Radiologists and Intraarterial Stroke Therapy. *CVIR* 2018;41, <https://doi.org/10.1007/s00270-018-2051-8>
- Nguyen TN, Malisch T, Castonguay AC et al. Balloon guide improves revascularization and clinical outcomes with the Solitaire device. *Stroke* 2014;45,141-145.
- Zaidat OO, Castonguay AC, Lifante I et al. First pass effect. A new measure for stroke thrombectomy devices. *Stroke* 2018;49,660-666.
- Leishangthem L, Satti SR. Vessel perforation during withdrawal of Trevo ProVue stent retriever during mechanical thrombectomy for acute ischemic stroke. *J Neurosurg* 2014;121,995-998.
- Renu A, Laredo C, Lopez-Rueda A et al. Vessel wall enhancement and blood-cerebrospinal fluid barrier disruption after mechanical thrombectomy in acute ischemic stroke. *Stroke* 2017;48,651-657.
- Seo WK, Oh K, Suh S, Seol HY. Clinical significance of wall changes after recanalization therapy in acute stroke. High-resolution vessel wall imaging. *Stroke* 2017;48,1077-1080.
- Baek JH, Kim BM, Heo JH et al. Number of stent retriever passes associated with futile recanalization in acute stroke. *Stroke* 2018;49,2088-2095.
- Chang Y, Kim BM, Bang OY et al. Rescue stenting for failed mechanical thrombectomy in acute ischemic stroke. A multicenter experience. *Stroke* 2018; 49,958-964.
- Fiehler J. Failed thrombectomy in acute ischemic stroke. Return of the stent? *Stroke* 2018;49,811-812.
- Labeyrie MA, Civelli V, Reiner P et al. Prevalence and treatment of spontaneous intracranial artery dissections inpatients with acute stroke due to intracranial large vessel occlusion. *J Neurointervent Surg* 2018;10,761-763.
- Kurre W, Vorlaender K, Aguilar-Perez M, Schmid E, Bazner H, Henkes H. Frequency and relevance of anterior cerebral artery embolism caused by mechanical thrombectomy of middle cerebral artery occlusion. *AJNR*, 2013;34,1606-1611.
- Mazur MD, Kilburg C, Park MS, Taussky P. Pattenrnsand clinical impact of angiographically visible distal emboli during thrombectomy with Solitaire for acute ischemic stroke. *Neurosurg* 2016;78,242-250.
- Saber H, Narayanan S, Palla M et al. Mechanical thrombectomy for acute ischemic stroke with occlusion of the M2 segment of the middle cerebral artery: a meta-analysis. *J Neurointervent Surg* 2018;10,620-624.
- Janssen H, Buchholtz G, Killer M, Ertl L, Bruckmann H, Lutz J. General anesthesia versus conscious sedation in acute stroke treatment: the importance of head fixation. *CVIR* 2016;39,1239-1244.
- Spiotto AM, Arthur AS, Fiorella D et al. Is discretion the better part of valor? *J Neurointervent Surg* 2018;10,719-718.

20. Alawieh A, Pierce AK, Vargas J et al. The golden 35 min of stroke intervention with ADAPT: effect of thrombectomy procedural time in acute ischemic stroke on outcome. *J Neurointerv Surg* 2018;10,213-220.
21. Neuberger U, Kickingereder P, Schonenberger S et al. Risk factors of intracranial hemorrhage after mechanical thrombectomy of anterior circulation ischemic stroke. *Neuroradiology* 2019;61,461-469.

Fundamental Course

Essential skills for a clinical interventional radiologist

2704.1

10 commandments for interventional radiologists

B.T. Katzen

Miami Cardiac and Vascular Institute, Baptist Hospital of Miami, Miami, FL, US

Learning Objectives

1. To consolidate your 30 years experience into 10 minutes
2. To learn how to forge good clinical relationships
3. When or if to break away from diagnostic radiology

No abstract available.

2704.2

What you need to know about coagulation

J. Garnon

Interventional Radiology, University Hospital of Strasbourg, Strasbourg, FR

Learning Objectives

1. To learn more about NOACs and low-molecular-weight heparin
 2. To learn about the peri-operative management of anticoagulation
 3. To learn how to manage heparin induced thrombocytopenia
- Even though it is sometimes overlooked, the management of anticoagulant therapies is part of any percutaneous procedure. The interventional radiologist should therefore be able to manage the different therapies before and after the procedure, in order to perform the intervention with maximal safety. Hemostasis can be divided into two major phases: the primary hemostasis which leads to the aggregation of the platelets on the vascular tear and coagulation itself that leads to the meshing of fibrin around the platelets in order to form the definitive clot. Antiplatelet therapies inhibit the primary hemostasis while anticoagulation therapies aim to reduce the formation of the fibrin which is the ultimate active factor of coagulation. There are different mechanisms, and as a result different medications, to decrease the efficacy of coagulation. Hence, the IR should be well aware of the different classes of anticoagulation therapies: the antithrombotic K, the unfractionated heparin, the low-molecular weight heparin and the more recent direct oral anticoagulation therapies. When to stop and when to resume those treatments depends on the half-life of each treatment and should always be driven by the evaluation of the thromboembolic risk (when the medication is stopped) and the bleeding risk of the procedure (if the medication is still active at the time of treatment). The IR should be able to identify the situations at high risk for a thromboembolic event: history of multiple venous thrombotic events or acute (<3 months) thrombophlebitis and/or pulmonary embolism, atrial fibrillation with embolic event, mechanical valve. Those situations require to stop as shortly as possible the anticoagulation. On the other hand, procedures at high risk of bleeding complications are mostly represented by non-vascular liver and kidney procedures, TIPSS and arterial access >7F. For those cases, the IR should always cautiously verify that the coagulation is as much normal as possible during the intervention.

2704.3

Pain management

A. Buecker

Klinik für Diagnostische und Interventionelle Radiologie, Universitätsklinikum des Saarlandes, Homburg, DE

Learning Objectives

1. To learn about pain pathways relevant to IR
 2. To learn how to manage pain intra-op and post-op
 3. To briefly describe how to perform my top 3 nerve blocks
- Pain is a symptom, which is hard to tolerate for affected patients. Therefore, pain release or pain management before the occurrence of pain is important. Many patients wish to sleep through the intervention. Due to potential complications of general anesthesia this is often not necessary for interventional procedures. Additionally, there are indications, where general anesthesia will be detrimental due to ensuring time delays: local anesthesia in the MR CLEAN trial had three times more likely a good outcome compared to general anesthesia. But in general, the patient's wish to experience no pain can be accepted. One has to distinguish between acute and chronic pain; the latter might be aggravated by acute episodes of pain exacerbation. For chronic pain in general there is a recommendation to treat it in a stepwise fashion. Interventional Radiology usually comes into play relatively late, which can be debated. Acute pain, which might be due to an interventional procedure like uterine fibroid embolisation, needs to be prevented. To achieve this, early pain treatment before the onset of pain itself is essential in order to keep the amount of pain killers needed as low as possible. Furthermore, the combination of peripheral and central acting pain medications is usually more effective than a higher dose of a single drug or the combination of drugs with the same mechanism. Medication for chronic pain should be taken regularly and not "as needed". Nerve blocks like superior hypogastric nerve block can be very helpful to avoid acute pain due to fibroid embolization. In case of chronic cancer-related pain, Interventional Radiology can help to reduce the pain by direct ablation treatment of a tumor. Special chronic pain scenarios like those related to pancreatic carcinoma or pancreatitis might be helped by a celiac plexus block. Even arterial embolization can be a means to control by, as has been shown in first cases of chronic inflammation caused by osteoarthritis of the knee.

2704.4

Consulting and breaking bad news

J.C. van den Berg

Interventional Radiology, Ospedale Regionale di Lugano, sede Civico, Lugano, CH

Learning Objectives

1. To learn how to set up a consultation service
 2. To learn how to break bad news
 3. To learn how to deal with a case that went badly
- The value of communication in medicine lies within effectively obtaining a patient history, collaborative communication between members of the treatment team, patient education, informed consent, and forming a therapeutic alliance between physician and patient.¹ Apart from those caused by improper medical care, a significant number of problems of medical malpractice are related, to a disturbed physician-patient relationship.² The way to deliver information is an art, and it has been reported that optimal physician-patient communication can improve the patient's health outcomes in various ways.³ Since over the last years interventional radiologists have become more involved in the clinical-therapeutic management of patients, development of these skills is of paramount importance in order to be considered a clinician, both by patients and peers. The main types of conversation that need to be faced are obtaining informed consent, conveying bad news and admitting medical error.²

An intervention may only be performed after obtaining informed consent, and the patient should be provided appropriate information as to the purpose and nature of the intervention as well as on its consequences and risks in a way and language that is adapted to patient's level of understanding. Consent may be withdrawn at any time. The patient should be allowed enough time to decide or even to refuse the proposed therapy.⁴ Formal education to communicate difficult news during medical training has traditionally been limited to direct observation of attending physicians. More recently more focus on this aspect has been addressed by establishing formal education in how to break bad news by using various techniques.⁵ One of the techniques that can be used is the SPIKES protocol: Setting up the interview; assessing the patient's Perception; obtaining patient's Invitation; giving Knowledge and information to the patient; addressing patient's Emotions with empathic response; and Strategy and summary.⁶ The disclosure of medical errors requires additional verbal and non-verbal communication skills in order to properly explain the patient and facilitate a positive error disclosure, and avoid malpractice litigation.² The need for setting guidelines and continuous education from the professional societies is an important issue in this respect, in order to ensure safety and professional protection.⁴

Conclusions

The role of the interventional radiologist has changed significantly over the recent years, and has become similar to the role of a surgeon. The development of good communication skills is mandatory in order to properly manage patients and for interventional radiology to be considered a clinical specialty.

References

1. Sugai DY, Deptula PL, Parsa AA, Don Parsa F. The importance of communication in the management of postoperative pain. *Hawaii J Med Public Health*. 2013;72(6):180-184.
2. Cannavale A, Santoni M, Mancarella P, Passariello R, Arbarello P. Malpractice in radiology: what should you worry about? *Radiol Res Pract*. 2013;2013:219259.
3. Stewart MA. Effective physician-patient communication and health outcomes: a review. *CMAJ*. 1995;152(9):1423-1433.
4. Mavroforou A, Giannoukas A, Mavrophoros D, Michalodimitrakis E. Physicians' liability in interventional radiology and endovascular therapy. *Eur J Radiol*. 2003;46(3):240-243.
5. Kiluk JV, Dessureault S, Quinn G. Teaching medical students how to break bad news with standardized patients. *J Cancer Educ*. 2012;27(2):277-280.
6. Baile WF, Buckman R, Lenzi R, Glober G, Beale EA, Kudelka AP. SPIKES-A six-step protocol for delivering bad news: application to the patient with cancer. *Oncologist*. 2000;5(4):302-311.

Focus Session

Musculoskeletal: metastatic disease

2705.1

Biopsy in the spine and the peripheral skeleton

M. Cifrian Perez

Radiology, Hospital Universitario y Politécnico La Fe, Valencia, ES

Learning Objectives

1. To become familiar with the most common indications
 2. To know about technical considerations when performing MSK biopsy
 3. To justify the utility of biopsy in the diagnostic pathway
- Image-guided percutaneous biopsy of the spine and peripheral skeleton is a safe and useful procedure for diagnosing and managing patients who have suspected bone and soft tissue lesions. Preprocedural careful planning is required, including completion of staging before biopsy and being absolutely certain of the biopsy track. Employment of the appropriate imaging technique to guide biopsy,

needle selection, specimen handling, adopting a meticulous approach, and being aware of potential complications are mandatory.

References

1. Stacy J. UyBico, MD, Kambiz Motamedi, MD, Michelle C. Omura, MD, Scott D. Nelson, MD, Relevance of Compartmental Anatomic Guidelines for Biopsy of Musculoskeletal Tumors: Retrospective Review of 363 Biopsies over a 6-Year Period. *Vasc Interv Radiol*. 2012; 23:511-518
2. McCarthy EF. CT-guided needle biopsies of bone and soft tissue tumors: a pathologist's perspective. *Skeletal Radiol*. 2007;36:181-2.
3. Anderson MW, Temple HT, Dussault RG, Kaplan PA. Compartmental anatomy: relevance to staging and biopsy of musculoskeletal tumors. *AJR Am J Roentgenol*. 1999;173:1663-71.
4. Schwartz HS, Spengler DM. Needle tract recurrences after closed biopsy for sarcoma: three cases and review of the literature. *Ann Surg Oncol*. 1997;4:228-36.
5. Hoppenfeld S. Surgical exposures in orthopedics: the anatomic approach. 3rd ed. Philadelphia: Lippincott Williams & Wilkins; 2003.
6. Liu PT, Valadez SD, Chivers FS, Roberts CC, Beauchamp CP. Anatomically based guidelines for core-needle biopsy of bone tumors: implications for limb-sparing surgery. *Radiographics*. 2007;27:189-205, discussion 206.

2705.2

Advanced image guidance for musculoskeletal interventions

W.B. Lea

Interventional Radiology, Medical College of Wisconsin, Milwaukee, WI, US

Learning Objectives

1. To become familiar with the most common advanced imaging guidance techniques
2. To know about technical considerations
3. To justify the utility of such techniques

No abstract available.

2705.3

Treatment algorithm in spinal metastatic disease

J.W. Jennings

Radiology, Washington University/Mallinckrodt Institute of Radiology, Saint Louis, MO, US

Learning Objectives

1. To become familiar with the most common indications
2. To know about the treatments used and how to choose them
3. To define the patient pathway and collaboration with other specialists

Spine metastases are a common presentation of osseous metastatic disease in adult oncology patients. Patients with spinal metastasis can have asymptomatic lesions, identified radiographically, or more complex lesions, such as pathologic fractures and spinal cord compression, which often present with devastating symptoms. Historically, treatment options have been limited to surgery, external beam radiation therapy (EBRT), or a combination of both. Both traditional approaches are supported by evidence but have shortcomings. For surgery, en-bloc resection has improved local control benefits, but at the cost of higher surgical complication rates. Similarly, EBRT has been proven effective for treatment of bone metastases and spinal cord compression. However, duration of disease control with radiation therapy alone may be suboptimal in the modern era, as improvements in systemic therapy prolong survival in patients with metastatic disease.

In recent years, additional novel treatment modalities have emerged to address spinal lesions. Interventional radiology procedures such as vertebroplasty and percutaneous ablation have shown to be effective in

pain relief, and have the advantage of being minimally invasive, with low subsequent complication rates. Within radiation oncology, stereotactic body radiation therapy (SBRT) has increased in popularity as a treatment option, due to the capacity to deliver highly conformal, high-dose radiation to targeted lesions. Investigators have established that SBRT can produce prolonged pain relief and local control of spinal metastases. While traditional surgical techniques and EBRT still play an important role, particularly in the treatment of unstable compression fractures and lesions causing cord compression, the approach to spinal metastases is becoming increasingly sub-specialized. Selection of the most appropriate treatment modalities and sequence of treatments can be challenging, and approaches may vary substantially between institutions due to a scarcity of strong evidence. Guidelines such as the neurologic, oncology, mechanical and systemic (NOMS) decision framework have been developed to offer clinicians a basic algorithm regarding decisions about surgery or radiation therapy, but lack information about modern IR procedures. Given the variety and nuances of treatment options, a multi-disciplinary approach is required to manage patients with metastatic spine disease.

References

1. Wong, D. A., Fornasier, V. L. & Macnab, I. Spinal metastases: The obvious, the occult, and the impostors. *Spine (Phila. Pa. 1976)*. 15, 1–4 (1990).
2. Boriani, S., Gasbarrini, A., Bandiera, S., Ghermandi, R. & Lador, R. En Bloc Resections in the Spine: The Experience of 220 Patients During 25 Years. *World Neurosurg.* 98, 217–229 (2017).
3. Rich, S. E. *et al.* Update of the systematic review of palliative radiation therapy fractionation for bone metastases. *Radiother. Oncol.* 126, 547–557 (2018).
4. Kim, J. M. *et al.* Clinical Outcome of Metastatic Spinal Cord Compression Treated With Surgical Excision ± Radiation Versus Radiation Therapy Alone. *Spine (Phila. Pa. 1976)*. 37, 78–84 (2012).
5. Maranzano, E. *et al.* Short-course versus split-course radiotherapy in metastatic spinal cord compression: results of a phase III, randomized, multicenter trial. *J Clin Oncol* 23, 3358–3365 (2005).
6. Topalian, S. L. *et al.* Survival, durable tumor remission, and long-term safety in patients with advanced melanoma receiving nivolumab. *J. Clin. Oncol.* 32, 1020–1030 (2014).
7. Nakatsuka, A. *et al.* Radiofrequency ablation combined with bone cement injection for the treatment of bone malignancies. *J. Vasc. Interv. Radiol.* 15, 707–712 (2004).
8. Wallace, A. N., Greenwood, T. J. & Jennings, J. W. Radiofrequency ablation and vertebral augmentation for palliation of painful spinal metastases. *J. Neurooncol.* 124, 111–118 (2015).
9. Gerszten, P. C., Burton, S. A., Ozhasoglu, C. & Welch, W. C. Radiosurgery for spinal metastases: Clinical experience in 500 cases from a single institution. *Spine (Phila. Pa. 1976)*. 32, 193–199 (2007).
10. Sahgal, A., Larson, D. A. & Chang, E. L. Stereotactic Body Radiosurgery for Spinal Metastases: A Critical Review. *International Journal of Radiation Oncology Biology Physics* 71, 652–665 (2008).
11. Laufer, I. *et al.* The NOMS framework: approach to the treatment of spinal metastatic tumors. *Oncologist* 18, 744–51 (2013).
12. Wallace, A. N. *et al.* The Metastatic Spine Disease Multidisciplinary Working Group Algorithms. *Oncologist* 20, 1205–1215 (2015).

2705.4

Treatment algorithm in peripheral skeleton metastatic disease

R.F. Grasso

Radiology, Campus Biomedico University, Rome, IT

Learning Objectives

1. To become familiar with the most common indications
2. To know about the treatments used and how to choose them
3. To define the patient pathway and learn about collaboration with other specialists

Radiotherapy (RT) and medical therapy (including analgesics, bisphosphonates and denosumab) are the current treatment modalities to treat pain and prevent fractures but unfortunately pain is not adequately treated in 56–82.3% of the cases.

Stereotactic body RT yields higher rates of local tumor control and pain management compared with standard external beam RT but it leads to an increased risk of secondary fractures.

Interventional radiology procedures may play an important primary or complementary role to manage bone metastasis, especially in the palliative setting where pain and fracture management is necessary.

Percutaneous osteoplasty refers to polymethylmethacrylate (PMMA) injection into weakened or fractured bone. For long bones, effective pain management and functional amelioration can be achieved in 89.4% and in 71.8% cases, respectively.

Percutaneous osteosynthesis is consistent with screw fixation to consolidate minimally/non-displaced fractures of the pelvic ring. In a study of 64 patients undergoing pelvic osteosynthesis alone or in combination with osteoplasty, a median pain reduction of 6/10 points was noted, with only two secondary fractures observed in the proximal femur (1).

Thermal ablation is used to destroy tumors through the direct application of heat- or cold-based energies delivered percutaneously or in non-invasive way with High-intensity focused ultrasound (HIFU).

Compared to RT, the effects of ablation are immediate and there is no limit to the number of ablative treatments that can be performed on the same tumor, which is not the case for RT as it cannot be repeated once the maximum dose of the target organ is reached.

Thermal ablation can be performed with a curative (2,3) or palliative intent (4) and there is growing evidence in demonstrating the effectiveness of such therapeutic treatments in selected patients.

Given the “non-invasive” profile of HIFU, it is likely that it will obtain a prominent position in the future for the palliative management of BM. The aim of trans-arterial embolization (TAE) is to devascularize hypervascular bone metastasis and to preserve all non-target vessels. For these reasons, TAE should be as selective as possible.

In the multidisciplinary tumor board, interventional techniques may be considered as the sole therapeutic option or as part of a more complex therapeutic strategy integrating different interventional and non-interventional treatments.

References

1. Deschamps F, de Baere T, Hakime A, Pearson E, Farouil G, Teriitehau C *et al* (2016) Percutaneous osteosynthesis in the pelvis in cancer patients. *Eur Radiol* 26(6):1631–1639
2. Deschamps F, Farouil G, Ternes N, Gaudin A, Hakime A, Tselikas L *et al* (2014) Thermal ablation techniques: a curative treatment of bone metastases in selected patients? *Eur Radiol* 24(8):1971–1980.
3. Ma Y, Wallace AN, Waqar SN, Morgensztern D, Madaelil TP, Tomasian A *et al* (2018) Percutaneous Image-guided ablation in the treatment of osseous metastases from non-small cell lung cancer. *Cardiovasc Interv Radiol* 41(5):726–733.
4. Callstrom MR, Dupuy DE, Solomon SB, Beres RA, Littrup PJ, Davis KW *et al* (2013) Percutaneous image-guided cryoablation of painful metastases involving bone: multicenter trial. *Cancer* 19(5):1033–1041.

CIRSE meets CIRSE meets CAIR

2706.1

From CIRA to CAIR, the evolution of IR in Canada

R. Abraham¹, J.K. Wong²

¹Diagnostic Imaging and Interventional Radiology, QE II Health Sciences Centre/Dalhousie University, Halifax, NS, CA, ²Radiology, University of Calgary, Calgary, AB, CA

Canadian Interventional Radiology has grown through its journey from inception to a strong patient centered organization inclusive of all involved in the care of IR patients. Early in our development, we sought information to understand the varying IR challenges across the country through surveys and direct communication. Key factors identified included poor visibility, awareness and understanding of Interventional Radiology. Limited resources for IR and difficulty in recruitment were additionally problematic. Through strategic planning processes, these were addressed and plans put in place to increase membership and promote IR to clinical colleagues, hospital administrators and the public. We embarked on a process to obtain Sub-Specialty recognition and though unsuccessful in our initial attempt, we eventually achieved Sub-Specialty status under Diagnostic Radiology in 2012. This key national recognition has been an important factor for IR's development in Canada as "IR" has since become a common term used throughout the hospital with a true understanding of how IR makes a difference for patients. Fellowship programs and a certification exam have been developed to support the IR Sub-Specialty. CAIR has also increased education opportunities for all IRs through our annual meeting and also through new satellite meetings such as our successful M&M conference. Recruitment has improved significantly through direct engagement and presentations to medical students with a significant increase in the number who are pursuing a career in IR. More recently, we rebranded under the name, Canadian Association for Interventional Radiology (CAIR) with our focus on patient-centred care and emphasis on longitudinal clinical care of patients referred to IR. Our "CAIR initiative" is raising awareness through engagement of patient groups, promotion to our clinical colleagues, and through meetings with healthcare administration and local and national government. One important part of the CAIR initiative is to inform and educate patients through various strategies. First, we will seek ways to introduce Interventional Radiology to patients and inform them on how they can contact IRs in their community. UFE and Interventional Oncology will next be the main areas that we focus as we introduce these to patients and to family physicians through social media as well as traditional print media. Additionally, the CAIR organization will work with patient advocate organizations to promote and demonstrate the value of IR to key decision makers in our healthcare system in order to make patient friendly, minimally invasive, IR treatments more widely accessible to Canadians.

References

1. Kennedy SA, Abraham RJ, Mujoomdar A, Valenti DA, Klass D, Wong JK. Interventional Radiology in Canada: Current Challenges and Future Directions. *AJR Am J Roentgenol*. 2018 Oct;211(4):736-739.
2. Baerlocher, Asch, M, Hayeems, E. (2005). Current Issues of Interventional Radiology in Canada: A National Survey by the Canadian Interventional Radiology Association. *Canadian Association of Radiologists journal = Journal l'Association canadienne des radiologistes*. 56. 129-39.
3. Royal College of Physicians and Surgeons of Canada, "Subspecialty Training Requirements in Interventional Radiology", <http://www.royalcollege.ca/rcsite/documents/ibd/interventional-radiology-otr-e.pdf>
4. CAIR Initiative: <https://www.cairweb.ca/en/cair-initiative/what-is-the-cair-initiative/>

2706.2

Endovascular stroke therapy: a Canadian perspective

M. Eesa

Diagnostic and Interventional Neuroradiology, University of Calgary, Calgary, AB, CA

Introduction: The principles of treatment in patients with ischemic stroke are simple. A thrombus occludes an artery supplying the brain; collaterals provide some blood supply to the ischemic brain which infarcts over time. For many years since the first endovascular treatment (EVT) in patients with acute stroke, the treatment raised skepticism. It took many years to understand that selecting the right patients for EVT and administering that therapy quickly were core to the success of the treatment. These tenets were integral to the success of the MR CLEAN, ESCAPE, REVASCAT, EXTEND IA and SWIFT PRIME trials.

Objectives: This talk will be a practical approach from a Canadian perspective focusing on how we select patients for EVT and administer EVT safely and efficiently throughout our healthcare systems. By applying these simple principles and techniques, physicians will be able to provide their patients very reasonable chances of recovery from acute ischemic stroke. **Technical:** Patients being treated for acute stroke are best managed at high volume centres. Imaging must include an NC CT followed by a CTA to document a large vessel occlusion. Some centres use a multiphasic CT protocol for collateral evaluation.

The thrombectomy procedure varies from centre to centre but most sites use a stent-retriever strategy or aspiration primarily. There is a trend towards adopting a combined approach.

Conclusion: The future of care in the modern era of endovascular therapy for acute stroke patients looks promising. However much work remains to be done to ensure timely treatment including EVT is available to all patients who are candidates for treatment.

References

1. Berkhemer OA, Fransen PS, Beumer D, van den Berg LA, Lingsma HF, Yoo AJ, Schonewille WJ, Vos JA, Nederkoorn PJ, Wermer MJ, van Walderveen MA, Staals J, Hofmeijer J, van Oostayen JA, Lycklama a Nijeholt GJ, Boiten J, Brouwer PA, Emmer BJ, de Bruijn SF, van Dijk LC, Kappelle LJ, Lo RH, van Dijk EJ, de Vries J, de Kort PL, van Rooij WJ, van den Berg JS, van Hasselt BA, Aerden LA, Dallinga RJ, Visser MC, Bot JC, Vroomen PC, Eshghi O, Schreuder TH, Heijboer RJ, Keizer K, Tielbeek AV, den Hertog HM, Gerrits DG, van den Berg-Vos RM, Karas GB, Steyerberg EW, Flach HZ, Marquering HA, Sprengers ME, Jenniskens SF, Beenen LF, van den Berg R, Koudstaal PJ, van Zwam WH, Roos YB, van der Lugt A, van Oostenbrugge RJ, Majoie CB, Dippel DW and Investigators MC. A randomized trial of intraarterial treatment for acute ischemic stroke. *N Engl J Med*. 2015;372:11-20.
2. Goyal M, Demchuk AM, Menon BK, Eesa M, Rempel JL, Thornton J, Roy D, Jovin TG, Willinsky RA, Sapkota BL, Dowlatshahi D, Frei DF, Kamal NR, Montanera WJ, Poppe AY, Ryckborst KJ, Silver FL, Shuaib A, Tampieri D, Williams D, Bang OY, Baxter BW, Burns PA, Choe H, Heo JH, Holmstedt CA, Jankowitz B, Kelly M, Linares G, Mandzia JL, Shankar J, Sohn SI, Swartz RH, Barber PA, Coutts SB, Smith EE, Morrish WF, Weill A, Subramaniam S, Mitha AP, Wong JH, Lowerison MW, Sajobi TT, Hill MD and Investigators ET. Randomized assessment of rapid endovascular treatment of ischemic stroke. *N Engl J Med*. 2015;372:1019-30.
3. Jovin TG, Chamorro A, Cobo E, de Miquel MA, Molina CA, Rovira A, San Roman L, Serena J, Abilleira S, Ribo M, Millan M, Urra X, Cardona P, Lopez-Cancio E, Tomasello A, Castano C, Blasco J, Aja L, Dorado L, Quesada H, Rubiera M, Hernandez-Perez M, Goyal M, Demchuk AM, von Kummer R, Gallofre M, Davalos A and Investigators RT. Thrombectomy within 8 hours after symptom onset in ischemic stroke. *N Engl J Med*. 2015;372:2296-306.
4. Campbell BC, Mitchell PJ and Investigators E-I. Endovascular therapy for ischemic stroke. *N Engl J Med*. 2015;372:2365-6.

5. Saver JL, Goyal M, Bonafe A, Diener HC, Levy EI, Pereira VM, Albers GW, Cognard C, Cohen DJ, Hacke W, Jansen O, Jovin TG, Mattle HP, Nogueira RG, Siddiqui AH, Yavagal DR, Baxter BW, Devlin TG, Lopes DK, Reddy VK, du Mesnil de Rochemont R, Singer OC, Jahan R and Investigators SP. Stent-retriever thrombectomy after intravenous t-PA vs. t-PA alone in stroke. *N Engl J Med*. 2015;372:2285-95.

2706.3

Experience and lessons learned in a stroke endovascular thrombectomy programme performed by IRs

A. Menard

Diagnostic Imaging, Kingston Health Sciences Center, Queen's University, Kingston, ON, CA

In the past decade, endovascular mechanical thrombectomy has rapidly progressed to become the standard of care for large vessel occlusion in acute stroke treatment. In Canada, the vast majority of this service is offered by neuro-interventional radiologists or neurosurgeons in academic centers in large cities. Given the geographical expense of a country like Canada, dissemination of this procedure into smaller communities, geographically separated from the largest centers has been limited. We describe the challenges faced and the lessons learned while instituting an endovascular mechanical thrombectomy program in a smaller center delivered only by body vascular interventional radiologists. We will outline the planning steps taken, including training, tele-fluoroscopy mentoring, outcome monitoring, and compare the outcome of our center to larger academic centers in the Canadian province of Ontario.

Honorary Lecture Josef Roesch Lecture

2901.1

Pathways and challenges to innovation in interventional oncology

G. Narayanan

Miami Cardiac and Vascular Institute, Baptist Hospital, Miami, FL, US

Interventional Oncology (IO) has evolved into its own subspecialty in IR and locoregional treatments have grown from a last resort treatment option to becoming the standard of care for some cancers. This growth has its own set of challenges.

In the past adoption of new technology was based mostly on anecdotal evidence, case series, or retrospective studies. A few randomized controlled trials (RCT) were completed, but none in the scope or size of medical oncology trials. IO has seen major advances in two main forms of locoregional treatments, mainly ablation and embolization. Alcohol ablation led to RFA, Microwave, Cryoablation and Irreversible electroporation. Transarterial chemoembolization was followed by drug eluting embolics and Selective Internal Radiation therapy. Regulatory approvals in the USA for many of these technologies has been without a specific indication, and they are used in an off-label fashion. Insurance reimbursement for IO procedures usually requires a specific indication for a particular type of cancer, which in turn requires investment in trials. Lack of data has insurance providers dismissing promising technologies as experimental, leading to scant adoption or even early demise of promising technologies. Finally introduction of new versions of devices at break neck speed, takes away the ability to study them in a meaningful fashion and produce robust data.

Our colleagues who deal with oncology patient have also had significant improvements. Robotic surgery, combination chemotherapy and checkpoint inhibitors in medical oncology, SBRT and Proton beam therapy in radiation oncology and Immuno-oncology, all have the potential to revolutionize the way cancer is managed.

So how does IO compete with these challenges, stay relevant and make progress? Embracing the clinical model and being a part of multidisciplinary tumor boards is a start. Collaborations with other specialists to find treatment synergies, will help broaden the spectrum of treatment options in oncology. IO delivers precise, cutting edge, minimally invasive treatment solutions with less morbidity and good outcomes. Recording outcome measures for the care we deliver will be key in demonstrating this ability to all the health care players with data to back up the claims. Well planned registries right from when a technology is introduced will collect data points to understand outcomes and pitfalls. Positive RCT's will help pave the way for approvals for specific indications and move IO treatments into national treatment guidelines. These steps and the spirit of innovation in IO will cement IO as the fourth pillar in cancer care.

Focus Session Musculoskeletal: ablation, consolidation, embolisation

3004.1

Percutaneous consolidation: basics of biomechanics

P. Clavert

Centre de Chirurgie orthopédique et de la Main / CCOM, CHRU Strasbourg, Strasbourg, FR

Learning Objectives

1. To learn about the basic biomechanics for bone and spine consolidations
2. To understand the best indications of cementoplasty and bone pinning
3. To learn surgical technique of consolidation

No abstract available.

3004.2

Overview of ablation methods

M.R. Callstrom

Department of Radiology, Mayo Clinic, Rochester, MN, US

Learning Objectives

1. To learn about different ablation technique
2. To understand the best indications of ablation
3. To report the results and limitations of ablation in palliative and focal control

No abstract available.

3004.3

Ablation and consolidation

A.N. Kurup

Radiology, Mayo Clinic, Rochester, MN, US

Learning Objectives

1. To learn about the indications and techniques of ablation and consolidation
 2. To understand the benefits of this combination
 3. To report the results of this combination
- Combined percutaneous ablation and consolidation of musculoskeletal tumors may be performed for palliation of pain, prevention of morbidity from skeletal-related events including fracture or neurologic compromise, and durable local tumor control of oligometastatic or oligoprogressive disease. Consolidative techniques include cementoplasty, percutaneous screw fixation, and placement of various implants.

Minimally invasive ablation and consolidation has unique advantages compared to surgery or radiation therapy and adds to the armamentarium of the interventional oncologist. Successful treatment requires appropriate patient selection, pre-procedural planning, intraprocedural care to designed to avoid complications, and attentive post-procedure follow up. Prospective, multicenter clinical trials have evaluated the use of ablation +/- cementoplasty for painful skeletal metastases. These have shown a clinically significant 4-6 point decrease in mean pain score (using 10-point scales) within 3-6 months of follow up. Additionally, several single-institution series have shown local tumor control rates of 70-98%, depending on tumor location and histology. Combined ablation and consolidation may limit the development of new fractures (up to 20%, depending on series). Results may depend upon completeness of tumor ablation.

References

1. Aubry S, Dubut J, Nueffer JP, et al. Prospective 1-year follow-up pilot study of CT-guided microwave ablation in the treatment of bone and soft-tissue malignant tumours. *Eur Radiol* 2017; 27(4):1477-1485.
2. Bang HJ, Littrup PJ, Currier BP, et al. Percutaneous cryoablation of metastatic lesions from non-small-cell lung carcinoma: initial survival, local control, and cost observations. *J Vasc Interv Radiol* 2012; 23:761-769.
3. Bang HJ, Littrup PJ, Goodrich DJ, et al. Percutaneous cryoablation of metastatic renal cell carcinoma for local tumor control: feasibility, outcomes, and estimated cost-effectiveness for palliation. *J Vasc Interv Radiol* 2012; 23:770-777.
4. Barral M, Auperin A, Hakime A, et al. Percutaneous Thermal Ablation of Breast Cancer Metastases in Oligometastatic Patients. *Cardiovasc Intervent Radiol* 2016; 39:885-893.
5. Bauones S, Garnon J, Chari B, et al. Protection of the Proximal Articular Cartilage During Percutaneous Thermal Ablation of Acetabular Metastasis Using Temperature Monitoring. *Cardiovasc Intervent Radiol*. 2018 Jan;41(1):163-169.
6. Brace CL. Radiofrequency and microwave ablation of the liver, lung, kidney, and bone: what are the differences? *Current problems in diagnostic radiology* 2009; 38:135-143.
7. Callstrom MR, Dupuy DE, Solomon SB, et al. Percutaneous image-guided cryoablation of painful metastases involving bone: multicenter trial. *Cancer* 2013; 119:1033-1041.
8. Cazzato RL, Koch G, Buy X, Ramamurthy N, et al. Percutaneous Image-Guided Screw Fixation of Bone Lesions in Cancer Patients: Double-Centre Analysis of Outcomes including Local Evolution of the Treated Focus. *Cardiovasc Intervent Radiol*. 2016 Oct;39(10):1455-63.
9. Cazzato RL, Garnon J, Caudrelier J, et al. Low-power bipolar radiofrequency ablation and vertebral augmentation for the palliative treatment of spinal malignancies. *Int J Hyperthermia*. 2018 Dec;34(8):1282-1288.
10. Chow E, Zeng L, Salvo N, Dennis K, Tsao M, Lutz S. Update on the systematic review of palliative radiotherapy trials for bone metastases. *Clin Oncol (R Coll Radiol)* 2012; 24:112-124.
11. Deschamps F, Farouil G, Ternes N, et al. Thermal ablation techniques: a curative treatment of bone metastases in selected patients? *Eur Radiol* 2014; 24:1971-1980.
12. Deschamps F, Farouil G, Hakime A, et al. Percutaneous stabilization of impending pathological fracture of the proximal femur. *Cardiovasc Intervent Radiol* 2012; 35:1428-1432.
13. Di Staso M, Zugaro L, Gravina GL, et al. A feasibility study of percutaneous Radiofrequency Ablation followed by Radiotherapy in the management of painful osteolytic bone metastases. *Eur Radiol* 2011; 21:2004-2010.
14. Dupuy DE, Liu D, Hartfeil D, et al. Percutaneous radiofrequency ablation of painful osseous metastases: a multicenter American College of Radiology Imaging Network trial. *Cancer* 2010;116(4):989-97.
15. Erie AJ, Morris JM, Welch BT, et al. Retrospective Review of Percutaneous Image-Guided Ablation of Oligometastatic Prostate Cancer: A Single-Institution Experience. *J Vasc Interv Radiol* 2017; 28(7):987-992.
16. Filippidis DK, Marcia S, Ryan A, et al. New Implant-Based Technologies in the Spine. *Cardiovasc Intervent Radiol*. 2018 Oct;41(10):1463-1473.
17. Gardner CS, Ensor JE, Ahrar K, et al. Cryoablation of Bone Metastases from Renal Cell Carcinoma for Local Tumor Control. *J Bone Joint Surg Am*. 2017 Nov 15;99(22):1916-1926.
18. Garnon J, Koch G, Ramamurthy N, et al. Percutaneous CT and Fluoroscopy-Guided Screw Fixation of Pathological Fractures in the Shoulder Girdle: Technical Report of 3 Cases. *Cardiovasc Intervent Radiol*. 2016 Sep;39(9):1332-8.
19. Goetz MP, Callstrom MR, Charboneau JW, et al. Percutaneous image-guided radiofrequency ablation of painful metastases involving bone: a multicenter study. *J Clin Oncol* 2004; 22:300-306.
20. Guenette JP, Lopez MJ, Kim E, Dupuy DE. Solitary painful osseous metastases: correlation of imaging features with pain palliation after radiofrequency ablation--a multicenter american college of radiology imaging network study. *Radiology* 2013; 268:907-915.
21. Hartung MP, Tutton SM, Hohenwarter EJ, King DM, Neilson JC. Safety and Efficacy of Minimally Invasive Acetabular Stabilization for Periacetabular Metastatic Disease with Thermal Ablation and Augmented Screw Fixation. *J Vasc Interv Radiol* 2016; 27:682-688 e681.
22. Hurwitz MD, Ghanouni P, Kanaev SV, et al. Magnetic resonance-guided focused ultrasound for patients with painful bone metastases: phase III trial results. *Journal of the National Cancer Institute* 2014; 106.
23. Kelekis A, Filippidis DK, Kelekis NL, Martin JB. Percutaneous augmented osteoplasty of the humeral bone using a combination of microneedles mesh and cement. *J Vasc Interv Radiol* 2015; 26:595-597.
24. Kelekis A, Filippidis D, Anselmetti G, et al. Percutaneous Augmented Peripheral Osteoplasty in Long Bones of Oncologic Patients for Pain Reduction and Prevention of Impeding Pathologic Fracture: The Rebar Concept. *Cardiovasc Intervent Radiol*. 2016 Jan;39(1):90-6.
25. Kelekis A, Cornelis FH, Tutton S, Filippidis D. Metastatic Osseous Pain Control: Bone Ablation and Cementoplasty. *Semin Intervent Radiol*. 2017 Dec;34(4):328-336.
26. Kurup AN, Morris JM, Boon AJ, et al. Motor evoked potential monitoring during cryoablation of musculoskeletal tumors. *J Vasc Interv Radiol* 2014; 25:1657-1664.
27. Kurup AN, Morris JM, Schmit GD, et al. Balloon-assisted osteoplasty of periacetabular tumors following percutaneous cryoablation. *J Vasc Interv Radiol* 2015; 26:588-594.
28. Kurup AN, Schmit GD, Morris JM, et al. Avoiding Complications in Bone and Soft Tissue Ablation. *Cardiovasc Intervent Radiol* 2017; 40:166-176.
29. Kurup AN, Schmit GD, Atwell TD, et al. Palliative Percutaneous Cryoablation and Cementoplasty of Acetabular Metastases: Factors Affecting Pain Control and Fracture Risk. *Cardiovasc Intervent Radiol*. 2018 Nov;41(11):1735-1742.
30. Lutz S, Berk L, Chang E, et al. Palliative radiotherapy for bone metastases: an ASTRO evidence-based guideline. *Int J Radiat Oncol Biol Phys* 2011; 79:965-976.
31. McMenomy BP, Kurup AN, Johnson GB, et al. Percutaneous cryoablation of musculoskeletal oligometastatic disease for complete remission. *J Vasc Interv Radiol* 2013; 24:207-213.
32. Prologo JD, Passalacqua M, Patel I, Bohnert N, Corn DJ. Image-guided cryoablation for the treatment of painful musculoskeletal metastatic disease: a single-center experience. *Skeletal Radiol* 2014; 43:1551-1559.

33. Pusceddu C, Sotgia B, Fele RM, Melis L. Treatment of bone metastases with microwave thermal ablation. *J Vasc Interv Radiol* 2013; 24:229-233.
34. Thacker PG, Callstrom MR, Curry TB, et al. Palliation of painful metastatic disease involving bone with imaging-guided treatment: comparison of patients' immediate response to radiofrequency ablation and cryoablation. *AJR Am J Roentgenol* 2011; 197:510-515.
35. Tomasian A, Wallace A, Northrup B, Hillen TJ, Jennings JW. Spine Cryoablation: Pain Palliation and Local Tumor Control for Vertebral Metastases. *AJNR American journal of neuroradiology* 2016; 37:189-195.
36. Tsoumakidou G, Buy X, Garnon J, Enescu J, Gangi A. Percutaneous thermal ablation: how to protect the surrounding organs. *Tech Vasc Interv Radiol* 2011; 14:170-176.
37. Tsoumakidou G, Garnon J, Ramamurthy N, Buy X, Gangi A. Interest of electrostimulation of peripheral motor nerves during percutaneous thermal ablation. *Cardiovasc Interv Radiol* 2013; 36:1624-1628.
38. Tsoumakidou G, Koch G, Caudrelier J, et al. Image-Guided Spinal Ablation: A Review. *Cardiovasc Interv Radiol*. 2016 Sep;39(9):1229-38.
39. Wallace AN, Greenwood TJ, Jennings JW. Radiofrequency ablation and vertebral augmentation for palliation of painful spinal metastases. *Journal of neuro-oncology* 2015; 124:111-118.
40. Wallace AN, Greenwood TJ, Jennings JW. Use of Imaging in the Management of Metastatic Spine Disease With Percutaneous Ablation and Vertebral Augmentation. *AJR Am J Roentgenol* 2015; 205:434-441.
41. Wallace AN, Tomasian A, Vaswani D, Vyhmeister R, Chang RO, Jennings JW. Radiographic Local Control of Spinal Metastases with Percutaneous Radiofrequency Ablation and Vertebral Augmentation. *AJNR American journal of neuroradiology* 2016; 37:759-765.
42. Welch BT, Callstrom MR, Morris JM, et al. Feasibility and oncologic control after percutaneous image guided ablation of metastatic renal cell carcinoma. *J Urol* 2014; 192:357-363.

3004.4

The role of arterial embolisation

A.G. Ryan

Division of Interventional Radiology, Department of Radiology, University Hospital Waterford, Waterford City, IE

Learning Objectives

1. To learn about the indications of vascular procedures
2. To learn about the combined treatments
3. To learn about the techniques of embolisation

Introduction

Osseous metastases can result in intractable pain, fracture, neurologic compromise and devastating disability, particularly when the spine is involved. Embolisation should be considered as part of the treatment algorithm, alone or in combination with other techniques¹⁻³.

Indications

Instrumental stabilisation and corpectomy (in the spine) are the treatments of choice to restore stability and relieve or prevent neural compression. Without pre-operative embolisation, it is occasionally necessary to abandon these resections due to uncontrolled haemorrhage^{1,2}.

Pre-operative embolisation limits intraoperative blood loss⁴⁻¹², ensuring optimal visualization and adequate resection⁴, reducing operative duration and mortality.

In the non-operative palliative setting, the goal is tumour devascularisation without non-target compromise, reducing tumour turgor and periosteal pain-fibre stimulation. In this setting, embolisation may be employed in combination with other percutaneous modalities²⁻³. Additional potential benefits include reduced recurrence rate and prolonged survival (documented in Hepatocellular carcinoma⁵).

Contraindications

When a radiculomedullary artery arises directly from the segmental artery, this is usually considered an absolute contraindication to embolisation; however, in centres with expertise, test occlusion or vessel provocation, with monitoring evoked potentials to determine the risk of cord infarction, are used. In the periphery, atherosclerosis may contraindicate an adequate embolisation and / or protective coiling if the distal circulation depends on the collateral circulation.

Patient selection

Predictably, lesions with histologies known to produce hypervascular metastases respond more favourably. Embolisation is not precluded by the presence of prior instrumentation and may be repeated. If both Embolisation and Radiotherapy are planned, the latter should be performed first, given its dependency on target oxygenation (the oxygen effect¹³).

Predictors on pre-procedural imaging of a positive outcome post-embolisation are: purely lytic tumours, pathologic fracture, rapid size increase, and/or progressive destruction⁷.

Angiographic Anatomy

Critical to avoiding complications, especially in the spine where profound neurologic ischaemia is a potential adverse outcome, is a thorough knowledge of the arterial anatomy, its variants and the variations in flow dynamics that may occur during the procedure.

Spinal and Radiculomedullary arteries

The spinal cord is supplied by a single midline anterior spinal artery (ASA) and paired posterolateral posterior spinal arteries. The ASA commences at the vertebrobasilar junction and extends to the filum terminale.

The anterior and posterior spinal arteries are narrowest between T4 and T8, with usually only one radiculomedullary artery (T4 or 5) supplying the ASA at this level, resulting in the particular vulnerability of these segments of the cord to ischaemic insult.

The radiculomedullary arteries arise from the radicular branch of the dorsospinal branch of aortic segmental arteries, each radicular branch dividing into anterior and posterior radiculomedullary arteries which run alongside the anterior and posterior nerve roots. The radiculomedullary arteries supply the cord, adjacent nerve roots, dura and bony wall of the spinal canal. Crucially, at the expansions, they may be the dominant supply to the cord.

The largest radiculomedullary artery (of Adamkiewicz¹⁴, with the classic "hairpin" appearance, found in 75% of cases between T9 and T12, three times more commonly on the left) gives most supply to the ASA in the lower thoracic and upper lumbar levels. A less frequently visualised radiculomedullary artery has a shared origin with the right bronchial artery from a T4 level intercostobronchial trunk, hence the risk associated with bronchial artery embolisation.

Vertebral supply

In the majority of cases, the principal supply to a vertebral lesion is from the segmental artery at that level; however, the two levels above and below must also be interrogated to identify anastomotic supply), and to identify radiculomedullary branches.

In the cervical spine, there are four potential additional arterial supplies, namely, the occipital artery, the ascending cervical arteries, the deep cervical arteries and the vertebral arteries. For skull base and C1/2 lesions, the ascending pharyngeal artery also requires interrogation given its potential anastomoses with the occipital artery. In the high thoracic spine, the superior intercostal arteries and supreme intercostal arteries must be assessed.

For lesions in the sacrum, the median sacral artery (from the aorta) the iliolumbar and lateral sacral arteries (both from the posterior division of the internal iliac artery) need to be assessed.

Embolisation

The goal of embolisation is complete devascularisation of the tumour. Guiding catheters are recommended to secure stable access in the cervical spine and for lesions deriving supply from the internal iliac circulation. The segmental arteries at the level of the lesion should be catheterised and once access is stable, angiography performed to demonstrate the arteries supplying the tumour, supply to the cord and potential non-target

circulations. Roadmapping and superselective microcatheters are routinely employed.

Calibrated particles are the preferred embolic agent given their reduced tendency to clump and consequent more predictable capillary distribution and lesser likelihood of microcatheter occlusion. Either polyvinyl alcohol or clear acrylic copolymer (trisacryl) microspheres can be used as, in this setting, no clinical advantage has been identified with the use of either¹⁵. 300–500 micron particles are most frequently used. Extra caution must be used when using 100–300 micron particles as there is an increased risk of non-target embolisation through intralesional arteriovenous anastomoses. Particles less than 100 microns should be avoided because of potential passage into the systemic venous circulation.

In order to protect tissues distal to the tumour circulation, the segmental artery distal to the takeoff of the tumour vessels may require protective coiling. When this is performed, it also effects “flow-diversion” as this occlusion can encourage more antegrade flow of embolic into the tumour-feeding artery^{16–17}. This same technique is employed in the periphery, where, provided an adequate collateral circulation is present, coil protection may be employed.

To ensure an adequate embolisation, repeat angiography +/- further embolisation of the embolised branches is recommended, as the particles “pack” distally, resulting in incomplete occlusion if unrecognised. Spasm may give rise to a false impression of occlusion. Proximal embolisation of feeding vessels (e.g. with coils or gelfoam) without microparticle embolisation is doomed to failure as rapid collateralisation occurs (within hours). For this same reason, larger embolic particles e.g. greater than 700 microns should also be avoided.

Countering this long held principle, Cernoch et al reviewed 46 patients who underwent preoperative embolisation with coils, particles or a combination of both and found that at a mean pre-operative time of 23 hours, there was no statistically significant difference in intraoperative blood loss between the groups¹⁸. The authors did question the rationale for using the coils in addition to particles however, given the lack of apparent benefit, and the potential obstruction they would present in the event of a delay to surgery and rapid collateralisation.

The more complete the embolisation, the greater the reduction in perioperative blood loss¹⁷. Schmidt showed that the adequacy of embolisation in a group of metastases was the only predictor of the extent of blood loss¹². Although there are contradictory reports in the literature regarding the efficacy of preoperative embolisation in reducing intraoperative blood loss, Clausen's 2015 randomised controlled trial¹⁹ reconfirmed the reduction in operative time and reduced blood loss in truly hypervascular spinal metastases. The more recent systematic reviews and meta-analyses performed by Luksanapruksa and Griessenauer both confirmed the reduction in intraoperative blood loss in spinal tumours post-embolisation^{20–21}.

Evidence regarding the use of liquid agents (e.g. Onyx and n-butyl cyanoacrylate (nBCA)) is growing, but remains limited, and these are not first-line agents given their expense and the expertise required for their use. Alcohol is discouraged in this setting given its propensity to pass into radiculomedullary branches with resultant spinal cord infarction¹; however, Sundaresan²² reported good results using alcohol in 17 patients with renal cell metastases. A superselective position and a slow infusion technique are mandatory.

The sooner resection follows embolisation, the greater the reduction in perioperative blood loss²³.

Combination therapies.

Embolisation and radiotherapy: Murakami et al reviewed compared the effects of embolotherapy and radiation therapy for painful osseous HCC metastases, showing both were effective with a possibly greater effect from embolisation, although this was not statistically significant²⁴. Uemura et al compared the efficacy of three different methods of treating bone metastases from hepatocellular carcinoma: Transarterial embolisation alone, the combination of transarterial embolization and external radiotherapy, and External radiotherapy alone²⁵. Although each treatment was successful in providing initial pain relief, patients who underwent transarterial embolization experienced relief more rapidly and a reduced rate of pain recurrence (20% for the combination group compared to 88%

for the external radiotherapy only group and 75% for the transarterial embolization only group). The authors hypothesized that the radiation effect on the arterioles helps prevent tumor revascularization, thus resulting in an additive effect to the occlusion of larger vessels achieved by transarterial embolization.

Chemoembolisation:

In 1998, Nagata et al treated a selection of primary and metastatic bone tumors with Doxorubicin and Cisplatin²⁶. At 2-week follow-up, 89% of patients with primary bone tumors and 76% of patients with metastatic lesions had sustained pain relief. Numerous case studies / series have been described treating HCC metastases with Doxorubicin mixed with Lipiodol and Gelfoam.

Koike et al, in 2011, demonstrated significant pain palliation in metastases from a variety of origins using epirubicin, fluorouracil or mitomycin²⁷. In 2016, Jiang et al showed improved pain control, symptom free interval and a survival benefit in patients with advanced bone and soft tissue sarcomas using 5-FU, Oxaliplatin, Epirubicin or Cisplatin²⁸. Chiras et al treated 25 patients with analgesic-resistant bone pain secondary to surgically unresectable lytic metastases following failure of radiotherapy and chemotherapy²⁹. Superselective chemoembolisation with pirarubicin mixed with PVA foam was performed, followed by chemoinfusion of carboplatin. Pain relief was superior in the Chemoembolisation group (83% percent significant pain relief for a mean duration of 12 months).

Embolisation and Radiofrequency ablation:

Pellerin et al evaluated the impact on pain relief and quality of life using a ‘triple therapy’ of embolisation, radio-frequency ablation and cementoplasty (ERC) for management of painful pelvic bone metastasis of renal cell carcinoma². In 54 % of patients, narcotic consumption was halved at discharge and halved in 77 % at 1 and 6 months compared with baseline. Five patients had complete pain relief at 1 month. Median VAS score decreased from 7 at baseline to 2 ± 1.6 (ranges 0–5) at 6 months. All patients reported a major improvement in quality of life, especially regarding mood and motion.

Embolisation and Cryoablation:

Lee, Stein and Roychowdhury have described their experience treating a patient with a large sacral metastasis involving the foramina with combined, sequential ‘Quadruple therapy’ of Embolisation, Cryoablation, Alcohol ablation and Cement Sacroplasty achieving local tumour and pain control³. 5mg Sodium Brevital was used as a provocative during embolisation, and sacral forminal thermal monitoring was used during cryoablation.

Embolisation and Microwave ablation:

Tsikopoulos et al in their case report from 2017 described an excellent clinical outcome using a combination of transarterial Bleomycin and Microwave ablation in the management of a very large scapular Epithelioid Haemangioma³⁰.

There are cases where Embolisation on its own is more appropriate than in combination with thermal ablation e.g. where nerves cannot be adequately protected while achieving a result. Provocation testing with Sodium Brevital is recommended in these cases.

When to combine Embolisation with other techniques – take home points:

When faced with a lesion, first ask yourself, if embolisation is appropriate on its own merits? If the answer is yes, include it in the treatment plan, decide the other optimal treatments, and plan the relative timings. If Radiotherapy a consideration, this should precede Embolisation, as Hypoxia renders cells more radioresistant¹⁷.

If thermal ablation is planned, do this as soon after embolisation as possible, as this is when Heat-sink will be minimised. If cement osteoplasty / consolidation is appropriate, this should ideally precede radiotherapy as the induced fibrosis limits cement spread.

Complications

Without adequate care, devastating neurologic ischaemia is a risk i.e. stroke, quad- or paraplegia; however, in experienced hands, the risk of neurologic complications is less than the usually quoted 2%.

Conclusion

Transarterial embolisation is effective and safe in the palliation of pain and disability due to osseous metastases and in the reduction of perioperative blood loss. Coil protection, in the spinal and peripheral settings prevents non-target embolisation and increases payload delivery. Meticulous technique and avoidance of embolisation of radiculomedullary arteries prevents serious permanent neurologic deficits.

References

- Heran MK. Preoperative embolisation of spinal metastatic disease: rationale and technical considerations. *Semin Musculoskelet Radiol.* 2011 Apr; 15(2): 135-42.
- Pellerin O, Medioni J, Vulser C, Déan C, Oudard S, Sapoval M. Management of painful pelvic bone metastasis of renal cell carcinoma using embolization, radio-frequency ablation, and cementoplasty: a prospective evaluation of efficacy and safety. *Cardiovasc Intervent Radiol.* 2014 Jun; 37 (3): 730-6.
- Lee JH, Stein M, Roychowdhury S. Percutaneous treatment of a sacral metastasis with combined embolization, cryoablation, alcohol ablation and sacroplasty for local tumor and pain control. *Interv Neuroradiol.* 2013 Jun; 19 (2): 250-3.
- Truumees E, Dodwad S-N, Kazmierczak C D. Preoperative embolization in the treatment of spinal metastasis. *J Am Acad Orthop Surg.* 2010; 18 (8) 449-453.
- Tralhão J G, Kayal S, Dagher I, Sanhueza M, Vons C, Franco D. Resection of hepatocellular carcinoma: the effect of surgical margin and blood transfusion on long-term survival. Analysis of 209 consecutive patients. *Hepatogastroenterology.* 2007; 54 (76) 1200-1206.
- Owen R JT. Embolization of musculoskeletal tumors. *Radiol Clin North Am.* 2008; 46 (3) 535-543 vi.
- Prabhu V C, Bilsky M H, Jambhekar K et al. Results of preoperative embolization for metastatic spinal neoplasms. *J Neurosurg.* 2003; 98 (2, Suppl) 156-164.
- Shi H, Jin Z, Suh D C, Lee H K, Li L. Preoperative transarterial embolization of hypervascular vertebral tumor with permanent particles. *Chin Med J (Engl).* 2002; 115 (11) 1683-1686.
- Gellad F E, Sadato N, Numaguchi Y, Levine A M. Vascular metastatic lesions of the spine: preoperative embolization. *Radiology.* 1990; 176 (3) 683-686.
- Nair S, Gobin YP, Leng LZ, Marcus JD, Bilsky M, Laufer I, Patsalides A. Preoperative embolisation of hypervascular thoracic, lumbar, and sacral spinal column tumors: technique and outcomes from a single center. *Interv Neuroradiol.* 2013 Sep; 19(3): 377-85.
- Kato S, Murakami H, Minami T, Demura S, Yoshioka K, Matsui O, Tsuchiya H. Preoperative embolisation significantly decreases intraoperative blood loss during palliative surgery for spinal metastasis. *Orthopedics.* 2012 Sep; 35(9): e1389-95. doi: 10.3928/01477447-20120822-27.
- Schmidt R, Rupp-Heim G, Dammann F, Ulrich C, Nothwang J. Surgical therapy of vertebral metastases. Are there predictive parameters for intraoperative excessive blood loss despite preoperative embolisation? *Tumori.* 2011 Jan-Feb; 97(1): 66-73.
- Churchill-Davidson I. The Oxygen Effect in Radiotherapy. *Oncologia* 1966; 20: Suppl. 1: 18-29.
- Manjila S, Haroon N, Parker B, Xavier AR, Guthikonda M, Rengachary SS. Albert Wojciech Adamkiewicz (1850-1921): unsung hero behind the eponymic artery. *Neurosurg Focus.* 2009 Jan; 26(1): E2.
- Basile A, Rand T, Lomoschitz F et al. Trisacryl gelatin microspheres versus polyvinyl alcohol particles in the preoperative embolization of bone neoplasms. *Cardiovasc Intervent Radiol.* 2004; 27 (5) 495-502.
- Hai Bin Shi, Dae Chul Suh, Ho Kyu Lee, Soo Mee Lim, Dae Hong Kim, Choong Gon Choi, Choon Sung Lee and Seung Chul Rhim. Preoperative Transarterial Embolisation of Spinal Tumor: Embolisation Techniques and Results. *AJNR Am J Neuroradiol* 1999 20: 2009-2015.
- Sun S, Lang E V. Bone metastases from renal cell carcinoma: preoperative embolization. *J Vasc Interv Radiol.* 1998; 9 (2) 263-269.
- Cernoch P, Hechelhammer L, von Hessling A, Spross C, Erhardt J, Jost B, Külling FA. Pre-operative embolisation of spinal metastasis: technique, complication rate and outcome-clinical experience. *Int Orthop.* 2015 Jul; 39(7):1399-404. doi: 10.1007/s00264-015-2769-8. Epub 2015 Apr 29.
- Clausen C, Dahl B, Frevert SC, Hansen LV, Nielsen MB, Lönn L. Preoperative embolization in surgical treatment of spinal metastases: single-blind, randomized controlled clinical trial of efficacy in decreasing intraoperative blood loss. *J Vasc Interv Radiol.* 2015 Mar; 26 (3): 402-12.
- Luksanaprukpa P, Buchowski JM, Tongsai S, Singhatanadgige W, Jennings JW. Systematic review and meta-analysis of effectiveness of preoperative embolization in surgery for metastatic spine disease. *J Neurointerv Surg.* 2018 Jun; 10(6):596-601. doi: 10.1136/neurintsurg-2017-013350. Epub 2017 Sep 16.
- Griessenauer CJ, Salem M, Hendrix P, Foreman PM, Ogilvy CS, Thomas AJ. Preoperative Embolization of Spinal Tumors: A Systematic Review and Meta-Analysis. *World Neurosurg.* 2016 Mar; 87:362-71. doi: 10.1016/j.wneu.2015.11.064. Epub 2015 Dec 15.
- Sundaresan N, Choi IS, Hughes JEO, Sachdev VP, Berenstein A, Treatment of spinal metastases from kidney cancer by presurgical embolization and resection. *J Neurosurg* 1990; 73:548-554.
- Tan BWL, Zaw AS, Rajendran PC, Ruiz JN, Kumar N, Anil G. Preoperative embolization in spinal tumour surgery: Enhancing its effectiveness. *J Clin Neurosci.* 2017 Sep; 43:108-114. doi: 10.1016/j.jocn.2017.05.021. Epub 2017 Jun 16.
- Murakami R, Baba Y, Furusawa M, et al. Short communication: the value of embolization therapy in painful osseous metastases from hepatocellular carcinomas: comparative study with radiation therapy. *Br J Radiol.* 1996; 69:1042-1044.
- Uemura A, Fujimoto H, Yasuda S, et al. Transcatheter arterial embolization for bone metastases from hepatocellular carcinoma. *Eur Radiol.* 2001; 11:1457-1462.
- Nagata Y, Mitsumori M, Okajima K, et al. Transcatheter arterial embolization for malignant osseous and soft tissue sarcomas: II. Clinical results. *Cardiovasc Intervent Radiol.* 1998; 21:208-213.
- Koike, Y., Takizawa, K., Ogawa, Y. et al. Transcatheter Arterial Chemoembolization (TACE) or Embolization (TAE) for Symptomatic Bone Metastases as a Palliative Treatment. *Cardiovasc Intervent Radiol* (2011) 34: 793.
- Jiang, C., Wang, J., Wang, Y. et al. Treatment Outcome Following Transarterial Chemoembolization in Advanced Bone and Soft Tissue Sarcomas. *Cardiovasc Intervent Radiol* (2016) 39: 1420.
- Chiras J, Adem C, Vallee J N, Spelle L, Cormier E, Rose M. Selective intra-arterial chemoembolization of pelvic and spine bone metastases. *Eur Radiol.* 2004; 14:1774-1780.
- Tsikopoulos K, Perdikakis E, Georgiannos D, Bisbinas I. Epithelioid hemangioma of the scapula treated with chemoembolization and microwave ablation: A case report. *Acta Orthop Traumatol Turc.* 2017 Jan 31. pii: S1017-995X(16)30031-1.

Focus Session Biliary

3102.1

PTBD for benign disease: strictures and stones

C. Lanciego

Radiología Intervencionista, Hospital Virgen de la Salud, Toledo, ES

Learning Objectives

1. To learn about indications and work-up for PTBD for benign disease
2. To learn the techniques for treatment of benign strictures and stones with PTBD
3. To learn about complications, outcomes and results of PTBD for benign disease

1. Biliary tract stones:

Percutaneous anterograde evacuation of bile duct stones with dilation of the papilla using an angioplasty catheter and helped with an occlusion balloon to expel the calculi is an effective, non-traumatic and safe procedure which retains the anatomical and functional integrity of the sphincter. This approach is a viable alternative in the hands of experienced interventional radiologists.

Biliary duct lithiasis is a frequent phenomenon. In patients with gallbladder lithiasis, there is an estimated 15-20% presence of calculi within the choledocus, also appearing as residual lithiasis in 2%-5% of patients subsequent to surgery of the biliary duct. The use of endoscopic sphincterectomy for the removal of these calculi still represents the method of choice. However, this approach is sometimes not feasible, for instance when duodenal diverticuli are present, when there is a pre-existing gastrointestinal surgery, when calculi were higher than 15 mm in size as well as when the calculi are impacted or hard to be found (intrahepatic or subsequent to an associated stenosis). For all these indications, a percutaneous approach represents the preferred choice before considering more conventional surgical options.

The removal of residual calculi through the mature biliary tract with a T tube (Kher's tube) is a well established, standardized procedure.

A percutaneous approach is the best choice at hand when facing a number of constraints, such as for instance when a Kher's tube is not available, after failure of an endoscopic intervention, when there is either a transcystic T tube or a transhepatic catheter previously placed in the biliary pathway. More recently, the choice of a transcolecystic approach has also been appointed as a feasible alternative for expelling the calculi to the duodenum.

According to available literature, an overall success of more than 90% has been reported, together with less than 2%-5% of adverse events.

2. Biliary Benign Stenosis:

Benign biliary strictures have diverse etiologies, these including anastomotic strictures after surgical repair or liver transplantation, non-anastomotic strictures secondary to intraoperative injuries -most commonly during laparoscopic cholecystectomy- as well as other inflammatory-related causes such as chronic pancreatitis. In such situations, percutaneous transhepatic treatments, including balloon dilation with or without long-term indwelling catheters and stent placement have been suggested as possible alternatives to either endoscopic or surgical management.

Traditionally, percutaneous balloon dilation has been the alternative to endoscopic treatment most widely used by large, an still represents the best choice at hand when facing these types of lesions for the first time. However, balloon dilatations often need to be repeated over time, and it has been estimated that three repeated dilatations represent the threshold suggested before considering switching to other interventional treatments such as for instance the stent placement. In this regard, most recently available data reported a primary patency after balloon dilation of 38%-67% with a follow-up of 3 years.

Accordingly, it has also been appointed the use of temporary fully covered metallic stents, these affording a primary patency rates of up to 90% in the mid-term (up to 34 months). Contrary to uncovered stents, covered metallic stents have the advantage of minimal tissue ingrowth and easy retrievability. However, it is also worth noting that fully covered stents do not incorporate into the host tissue and may have high migration rates (reported ratios ranging from 11%-27%), together with a number of complications such as obstruction by biliary sludge and cholangitis. Moreover, the use of these type of stents remains controversial, bearing in mind that these stents need to be removed subsequently, and this might not be possible in all the cases.

More recently, the biodegradable stent has been added as a new tool to the available technical arsenal. Main indication for biodegradable stent is the management of strictures refractory to standard bilioplasty, in direct competition with the covered retrievable stents. To the very best of our knowledge, the longest series reported so far comprised 107 patients being treated this way without major complications. However, the reported percentages of recurrences have been of 7.2%, 26.4% and close to 30% after a follow-up of 1, 2 and 3 years, respectively. Furthermore it has also been reported the use of biodegradable stents in 20 patients showing post-liver transplantation stenosis, with a ratio of recurrences of 18.8% , 25 months after the intervention. Indeed, the unanswered question is how to proceed in these situations. In other words, there is a pressing need to reach a consensus on how to approach this complication that has been related either to the degradation process of the stent in itself or to the presence of inflammatory mucosal reaction.

References

1. Mauro M , Murphy KP, Thomson KR, Venbrux AC, Zollkofer C. Image-Guided Interventions. Section 22: The Biliary tract Chap-134-138, pages 1425-1490. 2008, Ed.Saunders-Elsevier (colección Expert Radiology)
2. García García L, Venegas JL. Tratamiento percutáneo transhepático de la colédocolitiasis. Radiología 1996; 38:179-184
3. García García L, Lanciego C. Percutaneous treatment of biliary stones. Sphincteroplasty and Occlusion balloon for the clearance of bile duct calculi. AJR 2004; 182:663-670
4. García García L. Tratamiento Percutáneo de la Litiasis Biliar Nativa . Intervencionismo (vol 7.2 Editorial) Abril-Junio 2007 ; 58-60.
5. Lanciego C. Manejo percutáneo de la Litiasis biliar. Doctoral Thesis. University Salamanca , Spain .2002
6. Lanciego Pérez C, García-García L. Interventional radiology for bile duct stones. Radiología 2009; 51 (6):559-567
7. Burke D, Lewis CA, Cardella JF et al. Quality improvement guidelines for percutaneous transhepatic cholangiography and biliary drainage. JVIR 2003;14:s243-s246
8. Williams HJ, Bender CE, May GR. Benign postoperative biliary strictures : dilation with fluoroscopic guidance . Radiology 1987; 163:629-634
9. Gibson RN, Adam A, Yeung E, et al. Percutaneous techniques in benign hilar and intrahepatic strictures. JVIR 1988;3:125-130
10. Lee MJ, Mueller PR, Saini S et al. Percutaneous dilataion of benign biliary strictures : single-session therapy with general anesthesia . AJR 1991; 157: 1263-1266
11. Citron SJ, Martin LG: Benign biliary strictures: treatment with percutaneous cholangioplasty. Radiology **1991**; 178:339-341
12. Cantwell CP, Pena CS, Gervais DA, Hahn PF, Dwason SL, Mueller PR. Thirty year's experience with balloon Dilation of Benign post-operative Biliary strictures : Long-term outcomes. Radiology 2008; 249(3):1050-57
13. Muchart J, Perendreu J, Casas JD, Diaz Ruiz MJ. Balloon catheter sphincteroplasty and biliary stone expulsion into the duodenum in patients with an indwelling T-tube. Abdom Imaging 1999; 24:69-71
14. Berkman WA, Bishop AF, Pallagallo GL, Cashman MD. Transhepatic balloon dilatation of the common bile duct and ampulla of Vater for removal of calculi. Radiology 1988; 167:453-455

15. Gil S, De la Iglesia P, Verdú JF, España F, Arenas J, Irurzun J. Effectiveness and Safety of balloon Dilation of the Papilla and the use of an Occlusion Balloon for clearance of Bile duct calculi. *AJR* 2000; 174:1455-1460
16. García-Vila J, Redondo-Ibañez M, Díaz-Ramón C. Balloon Sphincteroplasty and transpapillary elimination of bile Duct stones: 10 years' experience. *AJR* 2004; 182:1451-1458
17. Park YS, Kim JH, Choi YW, Lee Th, Hwang CM, Cho YJ, et al. Percutaneous treatment of extrahepatic bile duct stones assisted by Balloon Sphincteroplasty and occlusion balloon. *Korean J Radiol* 2005; 6(4):235-240
18. Krokidis M, Fanelli F, Orgera G, Bezzi M, Passariello R, Hatzidakis A. Percutaneous Treatment of malignant jaundice due to extrahepatic Cholangiocarcinoma : Covered Viabil Stent versus uncovered Wallstents. *Cardiovasc Intervent Radiol* 2010 ; 33:97-106
19. Krokidis M, Fanelli F, Orgera G, et al. Percutaneous palliation of pancreatic head cancer : Randomized comparison of ePTFE/ FEP-Covered versus uncovered nitinol biliary stents. *Cardiovasc Intervent Radiol* 2011 ; 34:352-361
20. Gwon D, Ko GY, Sung KB, Kim JH, Yoon HK. Percutaneous transhepatic treatment of postoperative bile leaks : prospective evaluation of retrievable covered stent. *J Vasc Intervent Radiol* 2011; 22:75-83
21. Kim JH, Gwon D, Ko GY, et al. Temporary placement of retrievable fully covered metallic stents versus percutaneous balloon dilation in the treatment of benign biliary strictures. *J Vasc Intervent Radiol* 2011; 22:893-899
22. Choo SW, Shin SW, Do YS et al. The balloon dilatation and large profile catheter maintenance method for the management of the Bile duct Stricture following Liver transplantation. *Korean J Radiol* 2006; 7 (1):41-49
23. Szulman C, Giménez M, Sierre S. Antegrade papillary balloon dilation for extrahepatic bile duct stone clearance: Lessons learned from treating 300 patients. *J Vasc Intervent Radiol* 2011; 22:346-353.
24. Saad WE, Wallace MJ, Wojak JC, Kundu S, Cardella JF. Quality Improvement Guidelines for Percutaneous transhepatic Cholangiography, Biliary Drainage, and Percutaneous Cholecystostomy. *J Vasc Intervent Radiol* 2010; 21: 789-795
25. Adam A, Bezzi, M, Hatzidakis A, Burke DR, Quality Improvement Guidelines for Percutaneous transhepatic Cholangiography and Biliary Drainage.. CIRSE guidelines, CVIR 2003
26. Uberoi R., British Society of Interventional Radiology: Biliary Drainage and Stent ing Registry (BDSR), CVIR , 2012: 35(1): 127-138
27. Mauri G et al. Biodegradable biliary stent implantation in the treatment of benign bilioplastic-refractory biliary strictures: preliminary experience..*Eur Radiol.* **2013** Dec;23(12):3304-10.
28. Mauri G, Michelozzi, C, Melchiorre F, et al Benign biliary strictures refractory to standard bilioplasty treated using polydoxane biodegradable biliary stents ; retrospective multicentric data analysis on 107 patients . *Eur Radiol* 2016; 26:4057-4063
29. Jones L et al. The novel use of a biodegradable stent placed by percutaneous transhepatic cholangiography for the treatment of a hepaticojejunostomy biliary leak following an extended left hepatectomy and pancreaticoduodenectomy. *Ann R Coll Surg Engl.* 2014 Sep;96(6):e 1-3
30. Bello C, Lario S, Wong S, López S, Criado E. Treatment of benign lesions of the bile duct via absorbable stents. Retrospective analysis in a single center . *Intervencionismo* **2018**;18(1):2-13
31. Köcher M. Cerná M, Havlik R, Kál V, Gryga A, Duda M, Percutaneous treatment of benign bile duct strictures . *Eur Radiol* 2007; 62:170-174
32. Dopazo C, Diez I, Quintero J, et al. Role of biodegradable Stents as a part of treatment of biliary strictures after pediatric and adult liver transplantation : An observational Single-center study . *JVIR* 2018; 29: 899-904
33. Jung GS, Kim YJ, Yun JH et al. Percutaneous transcholecystic Removal of common bile duct stones : Case series in 114 patients. *Radiology* 2018; 290(1). 246-252

3102.2

PTBD for palliation of malignant bile duct obstruction

P.E. Huppert

Radiology, Neuroradiology and Nuclear Medicine, Klinikum Darmstadt, Darmstadt, DE

Learning Objectives

1. To learn about indications and work-up for PTBD for palliation of malignant bile duct obstruction
2. To learn about different stent types and stenting strategies including single and bilobar stenting
3. To learn about complications, outcomes and results of PTBD for palliation of malignant disease

PTBD is indicated if endoscopic treatment has failed or seems to be impossible to overcome symptomatic malignant biliary obstruction. Diagnostic workup prior to PTBD includes abdominal CT, laboratory check and if possible MRCP. In case of multiple intrahepatic malignant stenoses efficacy of PTBD is limited and usually not indicated. Stenting strategies depend on cholangiographic findings and liver morphology. In case of bilobar obstructions, several but not multiple stenosis and duodenal involvement appropriate strategies are necessary. Significant differences concerning relevant clinical outcome parameters for different stent types, including covered and uncovered stent types have not been proven. In comparison to endoscopic treatment including EUS guided techniques technical and clinical results and overall frequency of complications are comparable; however spectrum of complications is different. To minimize bleeding complications fine needle puncture technique should be used. Various interventional techniques are available to prevent and if happen, to overcome complications like portal venous or arterial bleeding, catheter dislocation and stent occlusion.

3102.3

PTBD for biliary leakage, bowel perforation and enteral feeding

A. Moelker

Department of Radiology and Nuclear Medicine, Erasmus Medical Center Rotterdam, Rotterdam, NL

Learning Objectives

1. To learn about indications and techniques for PTBD in patients with biliary leakage, bowel perforation
2. To learn how PTBD can be used for enteral feeding
3. To learn about complications, outcome and results of PTBD for biliary leakage and bowel perforation

PTBD for biliary leakage

Although still quite rare, bile duct injuries resulting in leakage are mostly frequently of iatrogenic origin. Proximately 0.5% of patients undergoing laparoscopic cholecystectomy will suffer from iatrogenic bile leakage. With the increasing use of laparoscopic cholecystectomy, biliary complications are increasing along. Other less frequent causes of biliary leakage are after hepaticoenterostomy and, even less frequent, after trauma. Bile leaks occur in 5-15% of liver transplants, usually within 1 month due to surgical failure or arterial stenosis or occlusion.

Patients generally present with nonspecific symptoms such as right upper quadrant abdominal pain, malaise, nausea, vomiting, fever and anorexia. As a consequence, the diagnosis of biliary leakage may be delayed with days to even years after surgery. Early biliary manifestations are jaundice, biliary peritonitis and cholangitis; in later stage recurrent cholangitis or even biliary cirrhosis may occur. Patients with untreated bile leakage may present with jaundice and fever as a result of biloma and abscess, which should be treated with CT- or US-guided drainage and antibiotics. Drain fluid can be analyzed for amylase and bilirubin to prove bile duct injury.

Bile duct injuries are classified according to the location of the injury, either leakage or stricture (e.g. surgical ligation), but do not recommend a type of treatment. The Bismuth classification describes four types of bile duct strictures, rather than leakage, from distal to hilar and a fifth type for a strictured aberrant right hepatic duct. The Strasberg classification describes four types of biliary leakage from small (e.g. accessory ducts of Luschka in the gallbladder fossa) to large ducts in addition to the Bismuth classification system for biliary injury. A more recent classification offered by Bektas et al. [1] gives greater detail of each lesion with better correlation between injury and management.

The diagnosis of biliary leakage is supported by imaging showing the extent and location of the injury, and is of importance in choosing the appropriate treatment. Endoscopic retrograde cholangiopancreatography (ERCP) has high sensitivity for detecting bile leakage and can be combined with simultaneous treatment with stents and catheters. The main limitations of ERCP are its retrograde nature resulting in low sensitivity for bile leakage behind a stricture (e.g. clipped aberrant biliary duct) and the inability to reach surgical hepaticocenterostomy through an enteric loop. Computed tomography and ultrasound are limited to the detection of perihepatic fluid collections such as biloma and abscesses, dilated bile ducts in case of obstruction and, in more chronic disease, the presence of lobar atrophy or biliary cirrhosis. CT angiography may demonstrate hepatic artery stenosis or occlusion which is a cause of bile duct necrosis and leakage. Magnetic resonance cholangio-pancreatography (MRCP) may clearly depict the intra- and extrahepatic biliary tree and perihepatic fluid collections. The location of biliary leakage is less reliably established with non-contrast enhanced MRCP, but can be improved with hepatocyte specific contrast agents such as Primovist or Multihance [2].

According to the revised appropriateness criteria of ACR 2018, ERCP is gold standard for bile leakage treatment in most situations. The principle of healing a bile leak with endoscopic or transhepatic percutaneous approaches is to create a low-pressure system along the biliary tract. Small bile leaks of the peripheral ductal branches, classified as type A according to the Strasberg system, or cystic duct stump leakage can be treated by either drainage of biloma, PTBD or ERCP with plastic stent placement. Larger leakages or leakage concurrent with ligation or stricture requires biliary decompression followed by definitive surgical treatment. A transhepatic percutaneous approach may be valuable in both diagnosis and treatment. Because bile injury after cholecystectomy is generally repaired with a surgical hepatico-jejunostomy, a vast majority of patients with iatrogenic bile leakage need to undergo PTCB as first treatment. Therefore, in case of a failed endoscopic approach after hepaticocenteric anastomosis, or in case of injuries to the larger hepatic ducts, percutaneous drainage provides immediate control of biliary leakage. As an additional advantage of PTBD, the antegrade approach enables better detection of bile duct leakage with ligated or completely transected central bile ducts. PTBD in patients with biliary obstruction and dilated bile ducts access can easily be achieved. However, in patients with bile leakage, the ducts are nondilated and PTBD becomes difficult. An early clinical study on PTBD in nondilated bile ducts reported a 25% technical success rate and a 21% complication rate [3]. A more recent study demonstrated a high technical success rate of 90.5% with a low complication rate of 7.9% [4].

Technique of percutaneous biliary drainage in small bile ducts

Most patients are treated with antibiotics for abscess or biloma. If not, antibiotic prophylaxis should be given 30 to 60 minutes before PTBD (e.g. Augmentin). In our institution, PTBD for nondilated ducts are performed under local anesthesia and sedation using propofol rather than general anesthesia. As a drawback, propofol sedation is hampered by breathing motion, which makes the procedure more challenging for the interventional radiologist. The site of the percutaneous puncture of the intrahepatic bile duct is chosen under ultrasound and performed using of a 21-gauge needle (Chiba Tip Needle; Cook Medical, Inc., Bloomington, Ind., USA). Depending on the site of the ductal injury, a left sub-xiphoid or right mid-axillary approach can be performed. Attempts to puncture the central bile ducts should be avoided because of the risk of damaging accompanying portal vein and hepatic artery. If the bile ducts are not visible with ultrasound, a second to third portal bifurcation can be

targeted to probe a nondilated bile duct. To this end, after puncturing, contrast agent is gently injected while withdrawing the needle. The position of the needle with respect to the bile duct is checked with fluoroscopy. When the contrast injection shows that the needle tip is successfully located in a bile duct, a 0.018-inch guidewire is advanced. The needle is subsequently exchanged for a small coaxial catheter and a cholangiography is performed. If the opacified duct is too central or otherwise suboptimal, a second needle in more peripheral location is introduced, either ultrasound guided or fluoroscopically guided by the contrast agent injected in the bile ducts through the first needle. Next, the small coaxial catheter is exchanged by a larger sheath (Neff set, Cook Medical) using the 0.018-inch guidewire. Next, a formal cholangiogram can be made to demonstrate the anatomy and leakage. Excessive contrast administration should be avoided not to induce cholangiosepsis in patients with (subclinical) cholangitis. Finally, a catheter with hydrophilic guidewire can be introduced through the sheath to cross the leakage and enter the small bowel. An internal-external multi-side-hole drain is left in place to diverge bile to the bowel or externalize to a bag (gravity dependent drainage).

The risk of complications in PTBD in patient with non-dilated ducts is higher compared to dilated ducts. Major complications are sepsis, cholangitis, venous and arterial hemobilia, hemoperitoneum and liver hematoma, pleural complications and death.

Periodic cholangiograms show decreasing size of the leakage and extravasation. The catheter is removed when no further biliary leak is visible or can be left in place for some additional weeks according to local protocols. Cessation of surgical drain fluids discharge may aid in the decision of PTBD removal.

Treatment of bile leakage with PTBD alone is clinically effective in 69.8% [4]. In the remainder, usually larger defects such as complete transections, a definite surgical treatment is required. Use of larger drain diameter (up to 14 French) are correlated with lower risk of biliary stenosis.

Implantation of covered stents is an option to immediately seal a leakage. Stents are self-expandable to avoid dilation of the tract and increase the leakage. There is insufficient data to compare covered metal and covered plastic stents in the percutaneous treatment of bile leakage. Stent migration is one important complication after PTBD and covered stents may therefore be avoided.

PTBD for bowel perforation

PTBD reduces duodenal pressure in internal-external position removing bile, pancreatic and duodenal juice from the tip of the catheter. This may be beneficial in terms of bowel wall healing in case of bowel perforation. Although PTBD is mentioned as a treatment option in patients with bowel perforation, data in literature is scarce. Most data concerns patients after gastrectomy complicated with high output duodenal stump fistula (DSF). DSF is as potentially life-threatening complication with a high morbidity, prolonged hospital-stay and mortality of up to 20% due to sepsis and multi-organ failure. Obviously, patient with peritonitis and severe sepsis need surgery, but this is associated fistula recurrence and a mortality of up to 50%. In 1996, Villar et al. [5] reported successful treatment of a patient with DSF after Billroth II surgery using PTBD. A 7 Fr internal-external drainage catheter was placed with the tip in the duodenum at a distance of 2 centimeter from the surgical stump. Within 10 days the catheter output increased to 400 ml/day while the surgical drain ceased completely. In a more recent retrospective study on 19 patients [6], mean time to start liquid or soft diet after PTBD was 3.4 days and hospital stay 34.4 days. Mortality was about 11% (1 of 9 patients). In another series [7], PTBD was combined with a bile duct occlusion balloon. Although DSF output decreased after PTBD, 3 out of 6 patients died from sepsis of whom 2 were related to other digestive fistula developed before PTBD placement. To conclude: in case of DSF, PTBD should probably be performed immediately, oral intake reduced and intravenous fluid administration and antibiotic therapy started. Oral intake can be restarted if the patient's clinical and bowel mobility status allow. Surgery is advised in case of diffuse peritonitis, hemorrhage or would dehiscence.

PTBD for transhepatic feeding

Nasoenteral feeding tubes are discomforting and may dislodge and a feeding jejunostomy or percutaneous endoscopic gastrostomy is recommended for longstanding feeding. Endoscopic and fluoroscopic direct jejunal access would have been difficult, surgical jejunostomy extremely challenging and potentially dangerous.

Transhepatic feeding tubes have been suggested as early as 1983 by McDonald et al. [8], but with only small number of patients. In 2017, Gerritsen et al. [9] performed a retrospective single-center cohort study in patients with a PTBD catheter, requiring prolonged enteral access for enteral nutrition (79%) or bile restitution (21%) because of gastroparesis, insufficient intake or duodenum perforation. Placement of a transhepatic feeding tube is a relatively simple procedure. A pre-existing PTBD is replaced by a sheath and two wires are placed in the efferent bowel loop. A feeding tube is inserted (in the study of Gerritsen a 8 Fr Corflo (Corpak MedSystems, UK) nasogastric feeding tube was placed; as an alternative a 7 Fr pigtail catheter may be used). The feeding tube's distal end should be beyond the ligament of Treitz or deep in the jejunal loop in case of hepaticojejunostomy. Next, the PTBD is placed parallel to the feeding tube. Technical success is up to 95% and complications are tube dislodgement (20%), occlusion (8%), and those possibly attributable to PTCB, i.e. bleeding (5%) and cholangitis (2%). About one quarter of patients reported pain and discomfort around the entry site. The minor severity of tube related complications is favorable compared to parenteral feeding with possible line sepsis, thrombosis, etc.

References

1. Bektas et al. *Br J Surg* 2007; 94: 1119-27
2. Thompson et al. *Radiographics* 2013; 33:117-134
3. Teplick et al. *Gastrointest Radiol* 1991;16:193-197
4. De Jong et al. *Dig Surg* 2013;30(4-6):444-450
5. Villar et al. *CVIR* 1996; 19:371-373
6. Ki-Han et al. *Int Surg* 2016; 101:78-83
7. Cozzaglio et al. *J Gastrointest Surg* 2011; 15:1977-1981
8. McDonald et al. *Radiology* 1983; 148:309-310

3102.4**PTBD in the ERCP era****H.-U. Laasch***Dept. of Radiology, The Christie, Manchester, UK***Learning Objectives**

1. To learn about new developments in ERCP including EUS
2. To learn about the strengths and weaknesses of ERCP and PTBD for various indications
3. To learn about indications and techniques for the combined use of ERCP and PTBD

Endoscopic biliary intervention is pushing back percutaneous intervention due to a number of factors:

- Improvement in technique and devices has increased technical success rates in managing perihilar strictures, which used to be considered the domain of the radiologist
- Reimbursement by procedure discourages referring the patient to a different speciality
- In most countries the patient's are initially referred to gastroenterology and not radiology
- EUS guided intervention has rightly or wrongly opened new avenues of intervention, which are more exciting to explore than to refer the patient for PTC
- Endoscopy is a bigger market for industry and device development is more lucrative

There is poor understanding where the two techniques become complementary.

ERCP has a number of advantages:

- Use of an anatomic route into the bile duct, avoiding liver puncture
- Ability to remove stones and generally improve drainage through sphincterotomy

- Wide range of temporary stents, plastic or metal
- Application of cholangioscopy

Disadvantages of ERCP are

- The need for long devices to pass through the duodenoscope, even with short-wire systems
- Resulting limitations in device manipulation in the biliary tree
- Limitation of device size by the width of the working channel
- Limited ability to selectively cannulate a specific lobe or segment
- Higher cost
- Lack of radiation awareness

Strengths of PTBD are

- Performed by a radiologist, who usually has ensured adequate pre-procedure imaging
- Ability to selectively puncture a specific segment
- Wide range of short devices allowing good intra-procedure manipulation and control
- Ability to terminate the procedure an secure access and drainage with an external drain
- Easy re-intervention once access has been established, facilitating staged and repeated procedures
- Additional treatment options due to less limitation on access size (e.g. biodegradable self-expanding stents)
- Intraluminal forceps biopsy for histology
- Ability to access biliary bypass and afferent loops
- Better and safer patient positioning for general anaesthesia

Drawbacks of PTBD are

- (Perceived) higher risk
- Less availability

EUS adds another level to the endoscopic options by facilitating direct puncture into the lower bile duct or into the left lobe of the liver. This adds all the risks of PTBD to an already very complex procedure without the benefits of temporising drains and staged procedures.

Lumen apposing stents allow for minimally invasive bypass procedures and internal cholecystostomy and provide a good non-surgical alternative. However trans-oesophageal or transgastric biliary drainage and stenting would seem to combine the worst of both worlds.

Endoscopy is in most cases the modality of first choice for biliary intervention. As a consequence the patients attending for percutaneous intervention are negatively selected towards failed attempts at endoscopic procedure, deemed too high risk for endoscopy or with particularly hostile anatomy.

A patient group, which is going to slowly increase the need for PTBD are patients after biliary bypass. More patients are receiving radical surgery for HPB cancer, either because of earlier diagnosis, improved surgical technique and outcomes or successful downstaging after neoadjuvant treatment. As a consequence there will be more patients with tumour relapse requiring intervention, but also more patients with benign anastomotic strictures. The same applies to the increasing number of liver transplantations.

In these cases endoscopic access is usually not possible and the percutaneous route offers easy access for repeat procedures and a larger number of treatment options than ERCP. These include large calibre drains, intraductal ablation, cutting balloons, biodegradable stents and removable metal stents.

In cases of uncertain aetiology percutaneous intraluminal forceps biopsy has a much higher yield than brush cytology and internal/external drainage catheters may be used as a temporary method to relieve jaundice and conserve bile.

Iatrogenic benign biliary strictures after laparoscopic treatment for gallstone disease are also still increasing, due the number of procedures being performed. PTBD Percutaneous facilitates easy access for the repeat procedures often required in recalcitrant strictures, while maintaining biliary drainage and control of sepsis. IR offers additional treatment strategies such as cutting balloons and biodegradable self-expanding stents, which are not available for the endoscopic route.

Combined ("rendez-vous") procedures where percutaneous access facilitates subsequent endoscopic management by passing a wire into the

duodenum are underused. As they combine the expertise of the radiologist and the endoscopist, they offer maximum expertise to the patient. Key to success for all aspects of PTBD is close collaboration with the interventional endoscopy team and education of the referrers to the options and limitations of both approaches.

References

- Atar E, Bachar GN, Bartal G, Mor E, Neyman H, Graif F, Belenky A (2005) Use of peripheral cutting balloon in the management of resistant benign ureteral and biliary strictures. *J Vasc Interv Radiol* 16 (2 Pt 1):241-245.
- Bukhari MA, Haito-Chavez Y, Ngamruengphong S, Brewer Gutierrez O, Chen YI, Khashab MA (2018) Rendezvous Biliary Recanalization of Complete Biliary Obstruction With Direct Peroral and Percutaneous Transhepatic Cholangioscopy. *Gastroenterology* 154 (1):23-25.
- Curcio G, Traina M, Miraglia R, Tarantino I, Barresi L, Granata A, Luca A, Gridelli B (2012) Endoscopy after radiology: two-step combined therapy for biliary stricture after Roux-en-Y hepaticojejunostomy. *Dig Endosc* 24 (4):271-274.
- Gimenez ME, Palermo M, Houghton E, Acquafresca P, Finger C, Verde JM, Cuneo JC (2016) Biodegradable Biliary Stents: A New Approach for the Management of Hepaticojejunostomy Strictures Following Bile Duct Injury. Prospective Study. *Arq Bras Cir Dig* 29 (2):112-116.
- Gwon DI, Ko GY, Ko HK, Yoon HK, Sung KB (2013) Percutaneous transhepatic treatment using retrievable covered stents in patients with benign biliary strictures: mid-term outcomes in 68 patients. *Dig Dis Sci* 58 (11):3270-3279.
- Gwon DI, Laasch HU (2015) Radiological approach to benign biliary strictures. *Gastrointest Interv* 4:9-14.
- Inchingolo R, Spiliopoulos S, Nestola M, Nardella M (2018) Outcomes of percutaneous transluminal biopsy of biliary lesions using a dedicated forceps system. *Acta Radiol* 60(5):602-607
- Janssen JJ, van Delden OM, van Lienden KP, Rauws EA, Busch OR, van Gulik TM, Gouma DJ, Lameris JS (2014) Percutaneous balloon dilatation and long-term drainage as treatment of anastomotic and nonanastomotic benign biliary strictures. *Cardiovasc Intervent Radiol* 37 (6):1559-1567.
- Kawakami H, Ban T, Kubota Y, Ashizuka S, Sannomiya I, Imamura N, Hamada T (2018) Rendezvous biliary recanalization with combined percutaneous transhepatic cholangioscopy and double-balloon endoscopy. *Endoscopy* 50 (7):E146-E148.
- Kerr RM, Gilliam JH, 3rd (1988) The team approach to biliary tract intervention: current status of combined percutaneous-endoscopic techniques. *Gastrointest Endosc* 34 (5):432-434.
- Khashab M, Perez-Miranda M (2018) Finding the middle ground in bile duct injury: the evolving role of biliary rendezvous. *Endoscopy* 50 (6):559-560. doi:10.1055/a-0580-714.
- Laasch HU (2010) Obstructive jaundice after bilioenteric anastomosis: transhepatic and direct percutaneous enteral stent insertion for afferent loop occlusion. *Gut Liver* 4 Suppl 1:S89-95.
- Mauri G, Michelozzi C, Melchiorre F, Poretti D, Tramarin M, Pedicini V, Solbiati L, Cornalba G, Sconfienza LM (2013) Biodegradable biliary stent implantation in the treatment of benign bilioplastic-refractory biliary strictures: preliminary experience. *Eur Radiol* 23 (12):3304-3310.
- Mohkam K, Malik Y, Derosas C, Isaac J, Marudanayagam R, Mehrzad H, Mirza DF, Muiesan P, Roberts KJ, Sutcliffe RP (2017) Percutaneous transhepatic cholangiographic endobiliary forceps biopsy versus endoscopic ultrasound fine needle aspiration for proximal biliary strictures: a single-centre experience. *HPB* 19 (6):530-537.
- Mukund A, Rajesh S, Agrawal N, Arora A (2015) Percutaneous management of resistant biliary-enteric anastomotic strictures with the use of a combined cutting and conventional balloon cholangioplasty protocol: a single-center experience. *J Vasc Interv Radiol* 26 (4):560-565.
- Park JG, Jung GS, Yun JH, Yun BC, Lee SU, Han BH, Ko JH (2017) Percutaneous transluminal forceps biopsy in patients suspected of having malignant biliary obstruction: factors influencing the outcomes of 271 patients. *Eur Radiol* 27 (10):4291-4297.
- Petryl J, Bruha R, Horak L, Zadorova Z, Dosedel J, Laasch HU (2010) Management of benign intrahepatic bile duct strictures: initial experience with polydioxanone biodegradable stents. *Endoscopy* 42 Suppl 2:E89-90.
- Saad WE, Davies MG, Saad NE, Waldman DL, Sahler LG, Lee DE, Kitanosono T, Sasson T, Patel NC (2006) Transhepatic dilation of anastomotic biliary strictures in liver transplant recipients with use of a combined cutting and conventional balloon protocol: technical safety and efficacy. *J Vasc Interv Radiol* 17 (5):837-843.
- Taunk P, Cosgrove N, Loren DE, Kowalski T, Siddiqui AA (2015) Endoscopic ultrasound-guided gastroenterostomy using a lumen-apposing self-expanding metal stent for decompression of afferent loop obstruction. *Endoscopy* 47 Suppl 1 UCTN:E395-396.
- Weigand K, Kandulski A, Zuber-Jerger I, Mueller M, Goessmann H (2018) Cholangioscopy-guided electrohydraulic lithotripsy of large bile duct stones through a percutaneous access device. *Endoscopy* 50 (5):E111-E112.

Focus Session

The 20 most important studies on hepatocellular carcinoma

3201.1

The 5 most important studies on ablation

L. Crocetti

Diagnostic and Interventional Radiology, Pisa University School of Medicine Cisanello Hospital, Division of Diagnostic Imaging, Pisa, IT

Learning Objectives

- To explain the criteria according to which the studies have been chosen
- To underline the merits and limitations of the selected studies
- To assess the impact of selected studies in clinical practice

No abstract available.

3201.2

The 5 most important studies on transcatheter arterial chemoembolisation

K. Malagari

2nd Dept. of Radiology, University of Athens Medical School, Athens, GR

Learning Objectives

- To explain the criteria according to which the studies have been chosen
- To underline the merits and limitations of the selected studies
- To assess the impact of selected studies in clinical practice

In view of the advances of chemoembolization and the availability of drug eluting beads in several sizes including smaller than 150µm the options today include Drug Eluting chemoembolization, Bland embolization and conventional chemoembolization. There is a long debate whether the antitumoral effect of transarterial chemoembolization (embolization with chemotherapeutic, lipiodol and embolizing particles –herein addressed as conventional c-TACE) is the result of feeding artery occlusion - induced ischemia or the result of the local action of chemotherapeutic/s. On the other hand it is now known that both anticancer drugs and hypoxia may have opposite effects through the development of neovascularisation. There are two important prospective randomized trials comparing bland embolization and chemoembolization with drug eluting microspheres with the same number of patients. The rationale for the addition of

chemotherapeutic agent/s in transarterial HCC embolization is based on the assumption that chemotherapeutics augment the antitumoral action of ischemia counteracting to stimulation of neoangiogenesis resulting from hypoxia from embolization. The data of the earlier study (1) showed a clear advantage of DEB TACE over bland embolization within one year, with notably 26.8%, 22.5% and 20% complete response for DEB TACE and 14%, 14.6% and 16.2% for the bland embolization group at 6, 9, and 12 months respectively. These rates showed that there is an unquestionable effect from ischemia and a clear additional benefit from the doxorubicin. Local response was better for the DEB TACE group presenting CR and SD 26.8% and 14.6% at 6 months and 20% and 25.7% at 12 months (Table 2). For the bland group CR and SD were 14% and 23.3% at 6 months and 16.2% and 2.7% at 12 months respectively. SD at 12 months was retained statistically higher in the DEB TACE group ($p=0.006$) however no significance was found for 6 and 9 month response. Overall, OR rates were higher in the DEB TACE group with statistical significance only at 9 months (55% vs 31.7%; $p=0.04$). PD at 12 months developed in 48.6% in the DEB TACE group and in 78.4% in the bland group. Correlation showed that patients treated with DEB TACE were less likely to present PD compared to bland ($p=0.014$). The Man Whitney test showed that larger tumors (above 7cm) were less likely to exhibit OR or DC ($p=0.007$ and 0.019 respectively). Recurrence overall (including local recurrence and new lesions) were observed in 7.3% at 6 months reaching 45.7% at 12 months for the DEB TACE group. For the bland group respective recurrence rates were 20.9% and 78.3%. It was also shown that recurrence rates are lower for DEB TACE compared to bland embolization after 6 months. TTP was longer for the DEB TACE group compared with the bland group (42.4 ± 9.5 vs 36.2 ± 9.0 weeks) at a statistically significant level ($p=0.008$). The second study (2) on the same prospective randomized comparison of DEB TACE and bland embolization with bland microspheres of the same diameter showed a median follow-up time for survivors of 34 months; 73 patients had died at the time of data analysis. There were three RECIST responders in each group, yielding response rates of 5.9% and 6% in the BB and LCB groups, respectively (95% CI for the difference, 29% to 9%; $P=1.0$). There was no difference in response rate between the two groups, either within 2 to 3 weeks (the primary end point) by EASL, RECIST 1.0, and mRECIST, or at quarterly follow-up by RECIST 1.0 or mRECIST (Fig 3). Median PFS by RECIST was 6.2 months for BB and 2.8 months for DEB ($P=.11$; hazard ratio [HR], 1.36; 95% CI, 0.91 to 2.05). Median OS was 19.6 months for BB and 20.8 months for DEB ($P=.64$; HR, 1.11; 95% CI, 0.71 to 1.76). There was also no difference in OS for the 92 treated and imaged patients, with a median survival of 21.4 months in the BB group and 20.8 months for DEB ($P=.64$; HR, 1.31; 95% CI, 0.81 to 2.12). Comparing only patients who were treated, there was no difference between BB and LCB in any other measure, including PFS or response rate, at any time point. The study found no difference in survival between the two groups. Both these studies show no differences in short term survival while for the other differences the patient population should be taken into consideration. In the first study there were no patients with portal vein or branch invasion, no extrahepatic disease and the patients were naïve to other locoregional treatments. In the second study portal vein invasion was in 12% and 25% in the two groups while extrahepatic metastasis were also present in 39% and 42% of the patients in the two groups respectively.

The third significant study (3) was a randomized trial comparing conventional TACE (cTACE) with TACE with DC Bead for the treatment of cirrhotic patients with HCC. Two hundred twelve patients with Child-Pugh A/B cirrhosis and large and/or multinodular, unresectable, N0, M0 HCCs were randomized to receive TACE with DC Bead loaded with doxorubicin or cTACE with doxorubicin. Randomization was stratified according to Child-Pugh status (A/B), performance status (ECOG 0/1), bilobar disease (yes/no), and prior curative treatment (yes/no). The primary endpoint was tumor response (EASL) at 6 months following independent, blinded review of MRI studies. The drug-eluting bead group showed higher rates of complete response, objective response, and disease control compared with the cTACE group (27% vs. 22%, 52% vs. 44%, and 63% vs. 52%, respectively). The hypothesis of superiority was not met (one-sided $P=0.11$). However, patients with Child-Pugh B, ECOG 1, bilobar disease, and

recurrent disease showed a significant increase in objective response ($P=0.038$) compared to cTACE. DC Bead was associated with improved tolerability, with a significant reduction in serious liver toxicity ($P.001$) and a significantly lower rate of doxorubicin-related side effects ($P=0.0001$). TACE with DC Bead and doxorubicin is safe and effective in the treatment of HCC and offers a benefit to patients with more advanced disease.

The fourth significant study was another randomized trial comparing conventional TACE (cTACE) with TACE with DC Bead for the treatment of cirrhotic patients with HCC, called also PRECISION V (4). A local CR (of the target lesions) was observed in 101 patients (57.1%), overall CR in 91 (51.4%), PR in 66 (37.3%), SD in 6 (3.4%), and progressive disease (PD) in 13 (7.3%). Thus, OR was obtained in 157 patients (88.7%) and DC in 163 (92.1%). No significant differences were found in the rates of local (CR, OR, and DC) and overall tumour responses during the follow-up period ($P.0.05$ in all cases), except for a more frequent overall CR at 1 month after cTACE than after DEB-TACE (59.8% vs 43.8%; $P.0.036$). Conversely, a trend towards a higher rate of local CR after DEB-TACE was observed at 6 months (68.7% vs 63.5%). This trend, however, conflicted with a tendency to a higher rate of overall CR after cTACE at the same time point (58.1% vs 52.2%), due to the lower occurrence of new nodules in cTACE (5 out of 20, 25%) than in DEB-TACE patients (9 out of 23, 39%) at the time of progression, although this difference did not reach statistical significance. At 30 days, an overall CR was significantly more frequent after cTACE than after DEB-TACE in ECOG-0 and BCLC class A patients. For all patients, the median TTP was 9 months (95% CI: 7.3–10.7), namely 9 months (95% CI: 6.3–11.7) in the cTACE arm and 9 months (95% CI: 6.8–11.2) in the DEB-TACE arm. In the entire population, the 1- and 2-year survival rates were 84.8% and 56.2%, respectively. The corresponding figures were 83.5% and 55.4%, respectively after cTACE, and 86.2% and 56.8% after DEB-TACE ($P.0.949$). Based on these figures, the median survival projection was 29 months for all patients, 28 months for cTACE patients and 29 months for DEB-TACE patients. A post hoc analysis on survival showed that the 1- and 2-year survival rates were 88.6% and 68.6% in BCLC A, 85.4% and 64.2% in BCLC B, and 77.5% and 50.1% in BCLC C patients. Conversely, the 1- and 2-year survival rates were not significantly affected by the 'naïve' status, being 89.5% and 65.9% in naïve cases against 75.4% and 55.6% in previously treated individuals.

The fifth most significant study was a prospective randomized comparison of radioembolization and DEB TACE for treating hepatocellular carcinoma (HCC). Both groups were comparable in demographics, initial tumor load, and BCLC (Barcelona Clinic Liver Cancer) stage. Median progression-free survival (PFS) was 180 days for radioembolization versus 216 days for TACE patients ($p=0.6193$) with a median TTP of 371 days versus 336 days, respectively ($p=0.5764$). Median OS was 592 days for radioembolization versus 788 days for TACE patients ($p=0.9271$). Seven patients died in each group. Causes of death were liver failure ($n=4$ SIRT group), tumor progression ($n=4$ TACE group), cardiovascular events, and inconclusive ($n=1$ in each group). No significant differences were found in median PFS, OS, and TTP. The lower rate of tumor progression in the radioembolization group was nullified by a greater incidence of liver failure. However, it must be kept in mind that patients treated with radioembolization were more advanced. We cannot help but also refer to the excellent results of segmental radioembolization published by Padia et al (6) including 101 patients with 132 tumors underwent segmental radioembolization, and 77 patients with 103 tumors underwent segmental doxorubicin-based drug-eluting embolic or conventional chemoembolization. Patients receiving chemoembolization had worse performance status and Child-Pugh; patients receiving radioembolization had larger tumors (32 mm vs 26 mm; $P<.001$), more infiltrative tumors (23% vs 9%; $P.0.01$), and more vascular invasion (18% vs 1%; $P<.001$). Toxicity rates were low, without significant differences. Index and overall complete response rates were 92% and 84% for radioembolization and 74% and 58% for chemoembolization. Index tumor progression at 1 and 2 years was 8% and 15% in the radioembolization group and 30% and 42% in the chemoembolization group ($P<.001$). Median progression-free and overall survival was 564 days and 1,198 days in the radioembolization group and 271 days and 1,043 days in the chemoembolization group (PS-adjusted $P.0.002$ and

P ¼ .35; censored by transplant PS-adjusted P < .001 and P ¼ .064). This important study showed that segmental radioembolization demonstrates higher complete response rates and local tumor control compared with segmental chemoembolization for HCC, with similar toxicity profiles. Superior progression-free survival was achieved.

References

1. Malagari K, Pomoni M, Kelekis A, Pomoni A, Dourakis S, Spyridopoulos T, Moschouris H, Emmanouil E, Rizos S, Kelekis D. Prospective randomized comparison of chemoembolization with doxorubicin-eluting beads and bland embolization with BeadBlock for hepatocellular carcinoma. *Cardiovasc Intervent Radiol*. 2010;33(3):541-51.
2. Brown KT, Do RK, Gonen M, Covey AM, Getrajdman GI, Sofocleous CT, Jarnagin WR, D'Angelica MI, Allen PJ, Erinjeri JP, Brody LA, O'Neill GP, Johnson KN, Garcia AR, Beattie C, Zhao B, Solomon SB, Schwartz LH, DeMatteo R, Abou-Alfa GK. Randomized Trial of Hepatic Artery Embolization for Hepatocellular Carcinoma Using Doxorubicin-Eluting Microspheres Compared With Embolization With Microspheres Alone. *J Clin Oncol*. 2016 10;34(17):2046-53.
3. Lammer J, Malagari K, Vogl T, Pilleul F, Denys A, Watkinson A, Pitton M, Sergeant G, Pfammatter T, Terraz S, Benhamou Y, Avajan Y, Gruenberger T, Pomoni M, Langenberger H, Schuchmann M, Dumortier J, Mueller C, Chevallier P, Lencioni R; PRECISION V Investigators. Prospective randomized study of doxorubicin-eluting-bead embolization in the treatment of hepatocellular carcinoma: results of the PRECISION V study. *Cardiovasc Intervent Radiol*. 2010;33(1):41-52.
4. Golfieri R, Giampalma E, Renzulli M, Cioni R, Bargellini I, Bartolozzi C, Breatta AD, Gandini G, Nani R, Gasparini D, Cucchetti A, Bolondi L, Trevisani F; PRECISION ITALIA STUDY GROUP. Randomised controlled trial of doxorubicin-eluting beads vs conventional chemoembolization for hepatocellular carcinoma. *Br J Cancer*. 2014 15;111(2):255-64.
5. Pitton MB, Kloeckner R, Ruckes C, Wirth GM, Eichhorn W, Wörns MA, Weinmann A, Schreckenberger M, Galle PR, Otto G, Dueber C. Randomized comparison of selective internal radiotherapy (SIRT) versus drug-eluting bead transarterial chemoembolization (DEB-TACE) for the treatment of hepatocellular carcinoma. *Cardiovasc Intervent Radiol*. 2015;38(2):352-60.
6. Padia SA, Johnson GE, Horton KJ, Ingraham CR, Kogut MJ, Kwan S, Vaidya S, Monsky WL, Park JO, Bhattacharya R, Hippe DS, Harris WP. Segmental Yttrium-90 Radioembolization versus Segmental Chemoembolization for Localized Hepatocellular Carcinoma: Results of a Single-Center, Retrospective, Propensity Score-Matched Study. *J Vasc Interv Radiol*. 2017;28(6):777-785.

3201.3

The 5 most important studies on transarterial radioembolisation

A. Denys

Radiology and Interventional Radiology, CHUV, Lausanne, CH

Learning Objectives

1. To explain the criteria according to which the studies have been chosen
 2. To underline the merits and limitations of the selected studies
 3. To assess the impact of selected studies in clinical practice
- This presentation will review the most recent studies on radioembolization and hepatocellular carcinoma. The results of the comparative randomized trial (Sarah, Soramic etc) will be detailed and critically analysed with an emphasis on dosimetry. The most recent studies comparing standard and adapted dosimetry will be given.

3201.4

The 5 most important studies on systemic treatments

Y. Arai

Department of Diagnostic Radiology, National Cancer Center Hospital, Tokyo, JP

Learning Objectives

1. To explain the criteria according to which the studies have been chosen
 2. To underline the merits and limitations of the selected studies
 3. To assess the impact of selected studies in clinical practice
- Interventional radiologists are usually not familiar to systemic treatment for hepatocellular carcinoma (HCC), because systemic treatment is generally carried out by medical oncologists. However, in the last decade, systemic medical treatment, especially new drugs such as molecular target agents, for HCC has greatly advanced, and now it affects the role of interventional radiology (IR) in the treatment of HCC. These five studies are chosen from the perspective of research that created the stream of systemic treatment for HCC and also affected IR treatments for HCC. Interventional radiologists should know the recent systemic treatments for HCC and its future trends.

SHARP study¹⁾

This study was multicenter, phase 3, double-blind, placebo-controlled trial involving 602 patients with advanced HCC who had not received previous systemic treatment. The patients were randomly allocated into the sorafenib group (at a dose of 400 mg twice daily) or the placebo group. Primary outcomes were overall survival and the time to symptomatic progression. Secondary outcomes included the time to radiologic progression and safety.

At the second planned interim analysis, 321 deaths had occurred, and the study was stopped. Median overall survival was 10.7 months in the sorafenib group and 7.9 months in the placebo group (hazard ratio in the sorafenib group, 0.69; 95% confidence interval, 0.55 to 0.87; P<0.001). There was no significant difference between the two groups in the median time to symptomatic progression (4.1 months vs. 4.9 months, respectively, P=0.77). The median time to radiologic progression was 5.5 months in the sorafenib group and 2.8 months in the placebo group (P<0.001). Seven patients in the sorafenib group (2%) and two patients in the placebo group (1%) had a partial response; no patients had a complete response. Diarrhea, weight loss, hand-foot skin reaction, and hypophosphatemia were more frequent in the sorafenib group.

SHARP study is the first study demonstrated the efficacy of sorafenib, a molecule-target agent, for advanced HCC by RCT, along with the Asia-Pacific study²⁾. The results of this study have made sorafenib the 1st-line standard treatment for advanced HCC. To date, it is a study that has become the backbone of systemic treatment for advanced HCC.

REFLECT study³⁾

This study was an open-label, phase 3, multicenter, non-inferiority trial that recruited patients with unresectable HCC, who had not received treatment for advanced disease, at 154 sites in 20 countries throughout the Asia-Pacific, European, and North American regions. The aim of this study was to compare overall survival in patients treated with lenvatinib versus sorafenib as a first-line treatment for unresectable HCC. The primary endpoint was overall survival, measured from the date of randomization until the date of death from any cause. The efficacy analysis followed the intention-to-treat principle, and only patients who received treatment were included in the safety analysis. The non-inferiority margin was set at 1.08. 954 eligible patients were randomly assigned to lenvatinib (n=478) or sorafenib (n=476). BCLC-C accounted for 78%, but median survival time for lenvatinib of 13.6 months (95% CI 12.1–14.9) was non-inferior to sorafenib (12.3 months, 10.4–13.9; hazard ratio 0.92, 95% CI 0.79–1.06), meeting criteria for non-inferiority. The response rate (m-RECIST) of lenvatinib (40.6%) was significant higher comparing to that in the lenvatinib group (12.4%). The most common any-grade adverse events were hypertension (201 [42%]), diarrhoea (184 [39%]), decreased appetite (162 [34%]), and decreased weight (147 [31%]) for lenvatinib, and palmar-plantar

erythroderma (249 [52%]), diarrhoea (220 [46%]), hypertension (144 [30%]), and decreased appetite (127 [27%]) for sorafenib. Lenvatinib was non-inferior to sorafenib in overall survival in untreated advanced HCC. The safety and tolerability profiles of lenvatinib were consistent with those previously observed.

REFLECT study demonstrated the non-inferiority of lenvatinib to sorafenib with overall survival as a primary endpoint, and established lenvatinib as the 1st line another standard treatment for advanced HCC similar as sorafenib.

RESORCE study⁴⁾

This study was randomized, double-blind, parallel-group, phase 3 trial done at 152 sites in 21 countries, adults with HCC who tolerated sorafenib (≥ 400 mg/day for ≥ 20 of last 28 days of treatment), progressed on sorafenib, and had Child-Pugh A liver function. The aim was to assess the efficacy and safety of regorafenib in patients with HCC who have progressed during sorafenib treatment. The primary endpoint was overall survival (defined as time from randomisation to death due to any cause). 573 patients were randomly assigned (2:1) (379 to regorafenib and 194 to placebo; population for efficacy analyses), and 567 initiated treatment (374 received regorafenib and 193 received placebo; population for safety analyses). The patients were stratified by geographical region, Eastern Cooperative Oncology Group performance status, macrovascular invasion, extrahepatic disease, and α -fetoprotein level to best supportive care plus oral regorafenib 160 mg or placebo once daily during weeks 1–3 of each 4-week cycle. Regorafenib improved overall survival with a hazard ratio of 0.63 (95% CI 0.50–0.79; one-sided $p < 0.0001$); median survival was 10.6 months (95% CI 9.1–12.1) for regorafenib versus 7.8 months (6.3–8.8) for placebo. Adverse events were reported in all regorafenib recipients (374 [100%] of 374) and 179 (93%) of 193 placebo recipients. The most common clinically relevant grade 3 or 4 treatment-emergent events were hypertension (57 patients [15%] in the regorafenib group vs nine patients [5%] in the placebo group), hand–foot skin reaction (47 patients [13%] vs one [1%]), fatigue (34 patients [9%] vs nine patients [5%]), and diarrhoea (12 patients [3%] vs no patients).

RESORCE study demonstrated the efficacy of regorafenib in placebo-controlled randomized study for patients who progressed on sorafenib treatment, and successfully positioned regorafenib as a 2nd-line treatment for advanced HCC. However, because regorafenib is similar profile of toxic events to sorafenib, sorafenib intolerant cases are not targeted. This trial showed that OS of sorafenib-regorafenib sequential treatment was 26 months after the initiation of sorafenib. This OS was comparable to the outcome of transcatheter arterial chemoembolization (TACE), so it suggested that systemic treatment has the possibility of affecting the indication of TACE.

CELESTIAL study⁵⁾

This study was a randomized, double-blind, phase 3 trial to evaluate cabozantinib as compared with placebo in previously treated patients with advanced HCC. Eligible patients had received previous treatment with sorafenib, had disease progression after at least one systemic treatment for hepatocellular carcinoma, and might have received up to two previous systemic regimens. The primary end point was overall survival. Secondary end points were progression-free survival and the objective response rate. 707 patients were randomly assigned in a 2:1 ratio to receive cabozantinib (60 mg once daily) or matching placebo. At the second planned interim analysis, the trial showed significantly longer overall survival with cabozantinib than with placebo. Median overall survival was 10.2 months with cabozantinib and 8.0 months with placebo (hazard ratio for death, 0.76; 95% confidence interval [CI], 0.63 to 0.92; $P = 0.005$). Median progression-free survival was 5.2 months with cabozantinib and 1.9 months with placebo (hazard ratio for disease progression or death, 0.44; 95% CI, 0.36 to 0.52; $P < 0.001$), and the objective response rates were 4% and less than 1%, respectively ($P = 0.009$). Grade 3 or 4 adverse events occurred in 68% of patients in the cabozantinib group and in 36% in the placebo group. The most common high-grade events were palmar-plantar erythro-dysesthesia (17% with cabozantinib vs. 0% with placebo), hypertension (16% vs. 2%), increased aspartate aminotransferase level (12% vs. 7%), fatigue (10% vs. 4%), and diarrhea (10% vs. 2%).

CELESTIAL study demonstrated the efficacy of cabozantinib against placebo for patients who were refractory or intolerant of sorafenib, and cabozantinib was another 2nd-line (or 3rd-line) treatment similar as regorafenib. This trend clearly showed the rapid progress of systemic treatment for HCC.

EMERALD-1 study⁶⁾

This study was a randomized, double-blind, placebo-controlled, multicenter phase 3 study assessing efficacy and safety for durvalumab monotherapy when given with either drug-eluting bead (DEB)-TACE or conventional TACE (cTACE) followed by durvalumab with or without bevacizumab therapy in patients with HCC not amenable to curative therapy. The primary endpoint is progression-free survival (PFS) for Arm A vs Arm C by blinded independent radiology review using RECIST v1.1. Secondary endpoints include PFS for Arm B vs Arm C, overall survival, health-related quality of life measures, and safety. 600 patients will be randomized 1:1:1 to Arm A (DEB-TACE or cTACE + durvalumab and following last TACE procedure, durvalumab + placebo), Arm B (DEB-TACE or cTACE + durvalumab followed by durvalumab + bevacizumab), or Arm C (DEB-TACE or cTACE). Durvalumab therapy will begin at least 7 days following the initial TACE procedure. Durvalumab $\pm$ bevacizumab will begin at least 14 days following the last TACE procedure.

Numerous studies of immunotherapy for HCC have also been conducted, and some promising results have been shown^{7–8)}. It is very important for IR physicians to know the possibility of systemic treatment combined with TACE and to understand the future trends of treatment of HCC. EMERALD-1 study is currently on going, but the results need to be closely watched.

References

1. Llovet JM, et al. Sorafenib in advanced hepatocellular carcinoma. *The New England journal of medicine*; 2008; 359: 378–390
2. Cheng AL, et al. Efficacy and safety of sorafenib in patients in the Asia-Pacific region with advanced hepatocellular carcinoma: a phase III randomized, double-blind, placebo-controlled trial. *The Lancet Oncology* 2009; 10:25–34
3. Kudo M, et al. A randomized phase 3 trial of lenvatinib vs. sorafenib in first-line treatment of patients with unresectable hepatocellular carcinoma. *Lancet (London, England)* 2018; 391:1163–1173
4. Bruix J, et al. Regorafenib for patients with hepatocellular carcinoma who progressed on sorafenib treatment (RESORCE): a randomized, double-blind, placebo-controlled, phase 3 trial. *Lancet (London, England)* 2017; 389: 56–66
5. Abou-Alfa GK, et al. Cabozantinib in patients with advanced and progressing hepatocellular carcinoma. *The New England journal of medicine* 2018; 379:54–63
6. <https://clinicaltrials.gov/ct2/show/NCT03778957>
7. Ikeda M, et al. A phase 1b trial of lenvatinib (LEN) plus pembrolizumab (PEM) in patients (pts) with unresectable hepatocellular carcinoma (uHCC). https://ascopubs.org/doi/abs/10.1200/JCO.2018.36.15_suppl.4076
8. Kudo M, et al. Checkmate-040: Nivolumab (NIVO) in patients (pts) with advanced hepatocellular carcinoma (aHCC) and Child-Pugh B (CPB) status. *J Clin Oncol* 2019; 37(4) suppl:327 (Feb 1, 2019)

Focus Session

Prostate artery embolisation: 360°

3202.1

The science behind prostate artery embolisation

F.C. Carnevale

Interventional Radiology, University of Sao Paulo Medical School, São Paulo, BR

Learning Objectives

1. To learn about the most important and current evidence for PAE
2. To understand what is unknown about the still unknown areas
3. To learn how to put current evidence into clinical practice

Prostatic artery embolization (PAE) is a novel minimally invasive treatment for LUTS attributed to benign prostate hyperplasia (BPH). Embolization of the prostatic arteries leads to ischemic shrinkage of the prostate gland and subsequent reduction of LUTS. This effect may be potentiated by a reduction of the alpha-1 adrenergic receptor density in the embolized prostate, causing relaxation of smooth muscle. The therapeutic effect of PAE was first described in a case report in 2000 and animal studies over the next decade substantiated the effect. The first intentional treatment of BPH in humans was reported in 2010, and early cohort studies from around the world soon followed.

The first randomized controlled trial comparing PAE to transurethral resection of the prostate (TURP) was previously reported. 114 patients with moderate-to-severe LUTS, peak flow <15 mL/s, and prostate volume <100 cm³ were randomized to PAE or TURP and followed for 24 months. TURP demonstrated better functional outcomes at 1 and 3 months post-procedure, but all outcomes, including IPSS, QoL, peak flow, and post-void residual volume (PVRV) were equivalent between the two groups at 12 and 24 months. Patients who underwent TURP were more likely to require bladder catheterization and inpatient hospitalization, and duration of hospitalization was longer in the TURP group. Major complications were encountered only in the TURP group.

A second randomized controlled trial prospectively randomized 30 patients to either PAE or TURP. These patients were also compared to a non-randomized cohort of 15 patients who underwent PAE using a specialized technique with both proximal and distal embolization (PERFECTED). Patients had severe LUTS and prostate volumes of 30-90 cm³. All 3 groups experienced significant improvement at 1-year follow-up, with IPSS improving by 21.5 points in the TURP group, 12.5 points in the PAE group, and 21.0 points in the PERFECTED PAE group. Urinary QoL and peak flow rates were superior in the TURP group during follow-up, though all groups significantly improved. No major complications were observed in the PAE groups.

A third randomized controlled trial compared 48 patients who underwent PAE to 51 patients who underwent TURP. Recruited patients had prostate volume of 25-80 cm³, IPSS of at least 8, urinary QoL of 3 or higher, and urinary flow rate of less than 12 mL/s or urinary retention. At 12 weeks post-procedure, the mean improvement in IPSS was not significantly different between the two groups (9.2 points for PAE and 10.8 points for TURP). All other patient-reported symptoms were also similar, including urinary QoL, frequency of urination, and nocturia. Peak urinary flow (Q_{max}) and PVRV were improved in both groups, but the degree of improvement was greater with TURP (+5.2 mL/s vs +15.3 mL/s and -86.4 mL vs -200.0 mL, respectively). TURP was associated with twice as many adverse events as PAE, including more than three times as many severe adverse events. Blood loss, duration of hospitalization and bladder catheterization time were higher for TURP compared to PAE.

Also, the results of the United Kingdom Register of Prostate Embolization (UK-ROPE) study were published. This registry-based observational study recruited 305 patients from 17 centers across the UK, 216 of who underwent PAE and 89 of who underwent TURP. PAE patients were younger (66 vs 70 years) and had larger prostates (101.2 vs 65.6 cm³). At 1 year post-intervention, both groups significantly improved, but the TURP group demonstrated greater improvements in IPSS (15.2 vs 10.9 points), urinary QoL (3.4 vs 2.6 points) and peak flow rate (8.6 vs 4.4 points). Length of stay was shorter for PAE (median 0 vs 2 days) and the complication profile of PAE was milder, including a lower rate of hematuria and retrograde ejaculation. Median return to normal activities was 5 days for PAE and 14 days for TURP.

Twelve prospective and 5 retrospective unique cohort studies of PAE for BPH were published in the last 4 years. The largest cohort of PAE patients, and the one with the longest follow-up, remains those of the Portuguese group, expanded and published in 2016 (n = 630). Technical success, defined as bilateral PAE, was achieved in 92.6% of patients, and cumulative clinical success rates were 81.9% at 1-3 years and 76.3% at 3-6.5 years. There was significant improvement in all clinical parameters, including IPSS, urinary QoL, prostate volume, peak flow rate, PVRV, and international index of erectile function (IIEF). All the other 16 cohort

studies at different institutions reported similar positive outcomes in terms of both efficacy and safety. Considering the 7 cohort studies of PAE with 25 or more patients and 1 year or longer follow-up, mean IPSS improvement ranged from 11.2 to 18.0 points and QoL improvement ranged from 1.9 to 4.7 points. Technical success rates were 93.2-100% for unilateral embolization and 86.3-97.4% for bilateral embolization. Peak flow rates increased by 3.1-10.0 mL/s, PVRV decreased by 30.6-75.5%, and prostate volumes decreased by 21.1-44.9%, while erectile function was stable to slightly improved.

Six meta-analyses of PAE for BPH have been published. The largest and most recent was a systematic review of trials studying the efficacy of PAE to treat LUTS, performed according to the PRISMA guidelines, with a meta-analysis done using the random-effects model. Their review extracted data from 13 PAE studies between 2014 and 2017, totaling 1254 patients. Baseline LUTS were severe with a mean IPSS of 23.5 and a QoL score of 4.7. Summative results at one year showed a mean reduction of 16.2 points in IPSS (a 67% improvement) and an improvement of QoL by 3.0 points, along with prostate volume reduction averaging 26%. IPSS, QoL, PV, PVR and IIEF remained statistically significantly improved after 3 years. Five smaller meta-analyses published in the three years previous to this study analyzed overlapping data and produced similar results.

What could we consider as a missing study capable of providing stronger supportive data for PAE? Larger trials comparing PAE to surgeries with longer follow-up? A randomized trial comparing PAE to LUTS medications? Or a randomized trial comparing PAE to SHAM? From the Interventional Radiologist's side, it would be necessary. However, from the Urologist perspective, it is essential... From the IR's side, studies comparing different techniques and materials would be very interesting to improve safety and efficacy, bringing the IR community one step closer to a gold standard PAE technique. This would also help mitigating reproducibility issues across the centers. In spite of this, there are strong data showing that PAE is already used around the world with excellent safety profile. What could be considered as an unknown is the long-term data recurrence after PAE and the best candidates for PAE. What are the best predictors of success for PAE? Some interesting studies have shown that imaging (MRI and US) could bring important data to understand the best candidates for PAE. The zonal volumetric index (ZVI) measuring the percentage of the central gland compared to the whole prostate size should be validated in large scale. The role of MRI analyzing the adenomatous-dominant BPH as a predictor for clinical success following PAE should also be further investigated. Another interesting investigational study showed the effects of PAE on the dynamic component of BPH as assessed by US elastography. All these important fields of research should be explored in the near future by IRs.

Interventional radiologists, working in a strong and emerging speciality with several tools available and under development, should work in a strategic multidisciplinary approach to develop pre-clinical and clinical research, and ultimately transfer put current evidence into clinical practice.

References

1. Sun, F., V. Crisostomo, C. Baez-Diaz, and F.M. Sanchez, Prostatic Artery Embolization (PAE) for Symptomatic Benign Prostatic Hyperplasia (BPH): Part 2, Insights into the Technical Rationale. *Cardiovasc Intervent Radiol*, 2016. 39(2): p. 161-9.
2. DeMeritt, J.S., F.F. Elmasri, M.P. Esposito, and G.S. Rosenberg, Relief of benign prostatic hyperplasia-related bladder outlet obstruction after transarterial polyvinyl alcohol prostate embolization. *J Vasc Interv Radiol*, 2000. 11(6): p. 767-70.
3. Jeon, G.S., J.H. Won, B.M. Lee, et al., The effect of transarterial prostate embolization in hormone-induced benign prostatic hyperplasia in dogs: a pilot study. *J Vasc Interv Radiol*, 2009. 20(3): p. 384-90.
4. Sun, F., F.M. Sanchez, V. Crisostomo, et al., Benign prostatic hyperplasia: transcatheter arterial embolization as potential treatment-preliminary study in pigs. *Radiology*, 2008. 246(3): p. 783-9.

5. Carnevale, F.C., A.A. Antunes, J.M. da Motta Leal Filho, et al., Prostatic artery embolization as a primary treatment for benign prostatic hyperplasia: preliminary results in two patients. *Cardiovasc Intervent Radiol*, 2010. 33(2): p. 355-61.
6. Antunes, A.A., F.C. Carnevale, J.M. da Motta Leal Filho, et al., Clinical, laboratorial, and urodynamic findings of prostatic artery embolization for the treatment of urinary retention related to benign prostatic hyperplasia. A prospective single-center pilot study. *Cardiovasc Intervent Radiol*, 2013. 36(4): p. 978-86.
7. Bagla, S., C.P. Martin, A. van Breda, et al., Early results from a United States trial of prostatic artery embolization in the treatment of benign prostatic hyperplasia. *J Vasc Interv Radiol*, 2014. 25(1): p. 47-52.
8. Pisco, J.M., L.C. Pinheiro, T. Bilhim, et al., Prostatic arterial embolization to treat benign prostatic hyperplasia. *J Vasc Interv Radiol*, 2011. 22(1): p. 11-9.
9. Gao, Y.A., Y. Huang, R. Zhang, et al., Benign prostatic hyperplasia: prostatic arterial embolization versus transurethral resection of the prostate--a prospective, randomized, and controlled clinical trial. *Radiology*, 2014. 270(3): p. 920-8.
10. Carnevale, F.C., A. Iscafe, E.M. Yoshinaga, et al., Transurethral Resection of the Prostate (TURP) Versus Original and PerFecTED Prostate Artery Embolization (PAE) Due to Benign Prostatic Hyperplasia (BPH): Preliminary Results of a Single Center, Prospective, Urodynamic-Controlled Analysis. *Cardiovasc Intervent Radiol*, 2016. 39(1): p. 44-52.
11. Abt, D., L. Hechelhammer, G. Mullhaupt, et al., Comparison of prostatic artery embolisation (PAE) versus transurethral resection of the prostate (TURP) for benign prostatic hyperplasia: randomised, open label, non-inferiority trial. *BMJ*, 2018. 361: p. k2338.
12. Ray, A.F., J. Powell, M.J. Speakman, et al., Efficacy and safety of prostate artery embolization for benign prostatic hyperplasia: an observational study and propensity- matched comparison with transurethral resection of the prostate (the UK-ROPE study). *BJU Int*, 2018. 122(2): p. 270-282.
13. Brown, N., D. Walker, R. McBean, et al., Prostate artery Embolisation Assessment of Safety and feasibility (P-EASY): a potential alternative to long-term medical therapy for benign prostate hyperplasia. *BJU Int*, 2018.
14. Carnevale, F.C., A.M. Moreira, S.H. Harward, et al., Recurrence of Lower Urinary Tract Symptoms Following Prostate Artery Embolization for Benign Hyperplasia: Single Center Experience Comparing Two Techniques. *Cardiovasc Intervent Radiol*, 2017. 40(3): p. 366- 374.
15. Franiel, T., R. Aschenbach, S. Trupp, et al., Prostatic Artery Embolization with 250-µm Spherical Polyethylene-Coated Hydrogel Microspheres for Lower Urinary Tract Symptoms with Follow-up MR Imaging. *J Vasc Interv Radiol*, 2018. 29(8): p. 1127-1137.
16. Gabr, A.H., M.F. Gabr, B.N. Elmohamady, and A.F. Ahmed, Prostatic Artery Embolization: A Promising Technique in the Treatment of High-Risk Patients with Benign Prostatic Hyperplasia. *Urol Int*, 2016. 97(3): p. 320-324.
17. Grosso, M., A. Balderi, M. Arno, et al., Prostatic artery embolization in benign prostatic hyperplasia: preliminary results in 13 patients. *Radiol Med*, 2015. 120(4): p. 361-8.
18. Isaacson, A.J., M.C. Raynor, H. Yu, and C.T. Burke, Prostatic Artery Embolization Using Embosphere Microspheres for Prostates Measuring 80-150 cm³: Early Results from a US Trial. *J Vasc Interv Radiol*, 2016. 27(5): p. 709-14.
19. Kurbatov, D., G.I. Russo, A. Lepetukhin, et al., Prostatic artery embolization for prostate volume greater than 80 cm³: results from a single-center prospective study. *Urology*, 2014. 84(2): p. 400-4.
20. Maclean, D., M. Harris, T. Drake, et al., Factors Predicting a Good Symptomatic Outcome After Prostate Artery Embolization (PAE). *Cardiovasc Intervent Radiol*, 2018. 41(8): p. 1152-1159.
21. Rampoldi, A., F. Barbosa, S. Secco, et al., Prostatic Artery Embolization as an Alternative to Indwelling Bladder Catheterization to Manage Benign Prostatic Hyperplasia in Poor Surgical Candidates. *Cardiovasc Intervent Radiol*, 2017. 40(4): p. 530-536.
22. Salem, R., J. Hairston, E. Hohlastos, et al., Prostate Artery Embolization for Lower Urinary Tract Symptoms Secondary to Benign Prostatic Hyperplasia: Results From a Prospective FDA-Approved Investigational Device Exemption Study. *Urology*, 2018.
23. Wang, M., L. Guo, F. Duan, et al., Prostatic arterial embolization for the treatment of lower urinary tract symptoms as a result of large benign prostatic hyperplasia: A prospective single-center investigation. *Int J Urol*, 2015. 22(8): p. 766-72.
24. Yu, S.C., C.C. Cho, E.H. Hung, et al., Prostate Artery Embolization for Complete Urinary Outflow Obstruction Due to Benign Prostatic Hypertrophy. *Cardiovasc Intervent Radiol*, 2017. 40(1): p. 33-40.
25. de Assis AM, Maciel MS, Moreira AM, de Paula Rodrigues VC, Antunes AA, Srougi M, Cerri GG, Carnevale FC. Prostate Zonal Volumetry as a Predictor of Clinical Outcomes for Prostate Artery Embolization. *Cardiovasc Intervent Radiol*. 2017 Feb;40(2):245-251.
26. Little MW, Boardman P, Macdonald AC, Taylor N, Macpherson R, Crew J, Tapping CR. Adenomatous-Dominant Benign Prostatic Hyperplasia (AdBPH) as a Predictor for Clinical Success Following Prostate Artery Embolization: An Age-Matched Case-Control Study. *Cardiovasc Intervent Radiol*. 2017 May;40(5):682-689.
27. de Assis AM, Moreira AM, Carnevale FC, Marcelino ASZ, de Oliveira Cerri LM, Antunes AA, Srougi M, Cerri GG. Effects of Prostatic Artery Embolization on the Dynamic Component of Benign Prostate Hyperplasia as Assessed by Ultrasound Elastography: A Pilot Series. *Cardiovasc Intervent Radiol*. 2019 Apr 16. [Epub ahead of print].

3202.2

Defining the anatomy

S. Modi

Radiology, University Hospital Southampton, Southampton, UK

Learning Objectives

1. To understand the anatomy of the arterial supply of the prostate
2. To learn how to use imaging to identify the arterial supply of the prostate
3. To learn how to deal with variant anatomy

No abstract available.

3202.3

Embolisation technique

A.G. Rampoldi

Interventional Radiology, Ospedale Niguarda, Milan, IT

Learning Objectives

1. To learn how to perform PAE step-by-step
 2. To understand the current evidence on embolic material for PAE
 3. To learn how to avoid non-target embolisation
- 1-Prostatic artery embolization (PAE) is performed through femoral or radial 4 or 5 french access and by unilateral or bilateral approach. Placement of bladder Foley balloon is optional. Angiography of hypogastric artery in 30-45 degrees ipsilateral oblique view is done to detect the prostatic artery origin and the gland vascularization pattern. Microcatheter 2.0 or less is than advanced inside the prostatic artery with support of 0.014-0.016 multishapeable guidewires. Before starting embolization selective prostatic angiography must be perform in A-P view ; CBCT could be useful to confirm the correct target.

Nitroglycerin injection before particles is used to improve prostatic perfusion.

Embolic particles must be injected very slow through 1 ml syringe; afterwards 1ml saline slow injection followed by faster 3 ml syringe saline to push particles inside the gland.

The first goal is to reach near stasis; in adjunct to obtain better clinical results microcatheter is advanced deeper inside the prostate, when is possible, to add more particles (PERFECTED TECHNIQUE).

Final angiography should be done showing lack of gland vascularization. 2-In term of particles sizes, published studies have suggested that larger particles (300-500 micron trisacryl gelatin microspheres or 180-300 micron PVA) perform better in different ways, as clinical success, showing also trends toward less adverse events and reduced prostatic regrowth.

3-Arterial vascular anatomy of the pelvis is very complex and its knowledge is mandatory to obtain better clinical results after PAE.

In order to avoid side effects, middle rectal artery must be visualized and also internal pudendal and accessory internal pudendal.

The anastomotic plexus at the apex of the gland is part of the network whose tributaries are again internal pudendal, middle rectal and inferior mesenteric artery.

CBCT must be performed everytime in case of uncertain target.

Take care also during embolization because possible collaterals not visible at the beginning of the procedure could open up after few ml of embolic. 2 or 3 mm microcoils must be used to occlude dangerous collaterals.

3202.4

Complications and management

I. Insausti Gorbea¹, A. Sáez de Ocariz García²,

R. Monreal Beortegui², S. Solchaga Álvarez², F. Urtasun Grijalba²

¹Interventional Radiology, Clínica Universidad de Navarra, Pamplona, ES, ²Interventional Radiology, Complejo Hospitalario de Navarra, Pamplona, ES

Learning Objectives

1. To learn about the type and frequency of complications
2. To learn how to assess and treat complications
3. To learn about the cause and time of occurrence

Benign prostatic hyperplasia (BPH) is the most frequent benign tumour in men, estimated to affect 50% of men above the age of 60 (1). Prostatic enlargement is associated with lower urinary tract symptoms (LUTS), which can reduce quality of life and cause complications such as acute urinary retention or urinary tract infection.

Medical therapy is usually the first-line treatment option for moderate to severe LUTS, but often fails in the medium- to long-term and may cause side effects. Patients with LUTS refractory to medical therapy may be treated with surgery or minimally invasive therapy (2,3).

Transurethral resection of the prostate (TURP) is currently the "Gold Standard" treatment option for patients with moderate- to-severe LUTS who are unresponsive to medical therapy and have prostate volumes (PV) < 80-100 cm³ (4). Notably, BPH essentially affects men aged > 60 years with concomitant diseases, which increases the risk of complications and serious adverse events associated with invasive surgical techniques. Therefore, the development of minimally invasive techniques, to improve outcomes and quality of life, and minimize patient's morbidity when managing BPH is necessary.

Prostatic artery embolization (PAE) has emerged as a minimally invasive procedure for BPH associated with LUTS, and as an alternative to TURP, with fewer complications and shorter recovery time, with data supporting mid- and long-term outcomes (5-8). More than 1000 procedures have been published, showing significant improvements in BPH-LUTS, favourable side effect profile, and quicker return to normal activities (9). Recently, NICE guidelines included PAE as a standard procedure for patients with LUTS secondary to BPH (10). Based on current evidence, these guidelines define PAE as an effective and safe technique.

To date, only three randomized clinical trials have been published comparing the efficacy and safety of PAE versus TURP for BPH (11,12,13). Gao et al

published the first clinical trial, and had a significantly higher percentage of complications in the PAE group comparing with the TURP group. This clinical trial was criticized for under-reporting the complications in the TURP group and overstating the clinical outcome with PAE. The other two clinical trials (Carnevale et al and Abt et al) reported a higher number of complications in the TURP group than in the PAE group, and the TURP complications were more serious.

Complications should be graded with the modified Clavien-Dindo classification system (14), with grades I and II considered minor complications and grades III and IV considered major complications. Pisco et al published long term outcomes for 630 patients with a minor complication rate less than 10% and a major complication rate of less than 1%.

Complications should be divided into intraoperative and postoperative complications. Intraoperative events may include vascular access, catheterization and embolization technique, device failure or incompatibility, manufacturing defects, or inappropriate use of materials, and drug or contrast reactions. Post-PAE adverse events generally include dysuria, urinary infection, macroscopic hematuria, hematospermia, AUR and rectal bleeding.

Other post-PAE adverse events such as radiodermatitis, non-target embolization, post-procedure pain and ejaculatory disorders have been reported. The following are vital to minimize post-PAE complications:

- Pre-procedure CT angiography
- Use Cone Beam CT (to avoid con-target embolization)
- Radiation reduction protocols
- Training (proctorship, workshops, simulators)
- Work closely with Urologist

References

1. SEMERGEN, Ed. Documentos Clínicos SEMERGEN -- Urología. Urología. Madrid:EDICOMPLET, Urología ed. 2008.
2. MichelMC, MehlburgerL, BresselHU, SchumacherH, SchäfersRF, GoepelM. Tamsulosin treatment of 19,365 patients with lower urinary tract symptoms: does comorbidity alter tolerability? *JUrol* 1998;160(3pt1):784-791.
3. McConnellJD, BruskewitzR, WalshP, et al. The effect of finasteride on the risk of acute urinary retention and the need for surgical treatment among men with benign prostatic hyperplasia. Finasteride Long-Term Efficacy and Safety Study Group. *N Engl J Med* 1998;338:557-563.
4. Pinheiro LC, Martins Pisco J. Treatment of benign prostatic hyperplasia. *Tech Vasc Interv Radiol*. 2012;15(4):256-260.
5. Carnevale FC, Antunes AA, da Motta Leal Filho JM, de Oliveira Cerri LM, Baroni RH, Marcelino AS, Freire GC, Moreira AM, Srougi M, Cerri GG. Prostatic artery embolization as a primary treatment for benign prostatic hyperplasia: preliminary results in two patients. *Cardiovasc Intervent Radiol*. 2010;33(2):355-61. doi:10.1007/s00270-009-9727-z.
6. Pisco JM, et al. Medium- and long-term outcome of prostate artery embolization for patients with benign prostatic hyperplasia: results in 630 patients. *J Vasc Interv Radiol*. 2016;27:1115-22.
7. Uflacker A, Haskal ZJ, Bilhim T, Patrie J, Huber T, Pisco JM. Meta-analysis of prostatic artery embolization for benign prostatic hyperplasia. *J Vasc Interv Radiol*. 2016; doi:10.1016/j.jvir.2016.08.004.
8. Kuang M, Vu A, Athreya S. A Systematic Review of Prostatic Artery Embolization in the Treatment of Symptomatic Benign Prostatic Hyperplasia. *Cardiovasc Intervent Radiol*. 2017 May;40(5):655-663. doi: 10.1007/s00270-016-1539-3.
9. Shim SR, Kanhai KJ, Ko YM, Kim JH. Efficacy and safety of prostatic arterial embolization: systematic review with meta-analysis and meta-regression. *J Urol* 2017;197:465-79. doi:10.1016/j.juro.2016.08.100.
10. NICE. Guidance on prostate artery embolization for benign prostatic hyperplasia. April 2018. <https://www.nice.org.uk/guidance/ipg453>

11. Gao YA, Huang Y, Zhang R, et al. Benign prostatic hyperplasia: prostatic arterial embolization versus transurethral resection of the prostate—a prospective, randomized, and controlled clinical trial. *Radiology* 2014;270:920-8. doi:10.1148/radiol.13122803.
12. Carnevale FC, Iscaife A, Yoshinaga EM, Moreira AM, Antunes AA, Srougi M. Transurethral resection of the prostate (TURP) versus original and PErFecTED prostate artery embolization (PAE) due to benign prostatic hyperplasia (BPH): preliminary results of a single center, prospective, urodynamic-controlled analysis. *Cardiovasc Intervent Radiol* 2016;39:44-52. doi:10.1007/s00270-015-1202-4.
13. Abt D, Hechelhammer L, Müllhaupt G, et al. Comparison of prostatic artery embolization (PAE) versus transurethral resection of the prostate (TURP) for benign prostatic hyperplasia: randomised, open label, non-inferiority trial. *BMJ* 2018; 361:k2338
14. Dindo D, Demartines N, Clavien PA. Classification of surgical complications: a new proposal with evaluation in a cohort of 6336 patients and results of a survey. *Ann Surg* 2004;240:205-13. doi:10.1097/01.sla.0000133083.54934.4e

Focus Session

Thyroid management of nodular diseases

3301.1

Tools and techniques for nodular thyroid diseases

F. Stacul

Radiology, ASUITS, Trieste, IT

Learning Objectives

1. To learn about the techniques suitable for treating thyroid lesions
2. To understand how to guide and monitor thyroid ablation
3. To understand the specific risks and complications of thyroid ablation and the tools to manage them

Minimally invasive image-guided thermal ablation has been proved effective and safe treatment of thyroid nodules. Different techniques are available: radiofrequency ablation (RFA) and laser ablation (LA) have been successfully used in large series, microwave ablation (MWA) is increasingly applied and high intensity focused ultrasound (HIFU) is another promising technique.

Treatment of benign symptomatic nodules is the main clinical indication of such procedures. Mean nodular volume reduction at 12 months is reported between 70 and 80%. Other indications include hyperfunctioning nodules, primary papillary microcarcinoma (to be validated) and recurrent thyroid cancer.

The safety of these techniques has been investigated in several studies, their tolerability is high and the rate of major complications is low, ranging from 0.9% (treatment of benign lesions) to 5.4% (treatment of recurrent cancers) following RFA. Similar complication rates were reported following LA. The most frequent major complication is transitory voice change due to vocal cord palsy.

Optimal ablation of the nodules were achieved with the “moving shot” technique (RFA) and with the “pull back” technique (RFA and LA). The trans-isthmus approach was advocated to prevent thermal injury of the recurrent laryngeal nerve. Pre-treatment hydrodissection, thus separating the nodule from adjacent critical structures, was suggested when treating nodules whose location was considered at high risk (i.e. very close to the recurrent laryngeal nerve). Injection of cold solution of 5% dextrose was advocated in patients experiencing symptoms of nerve damage during the procedure. Very short active tips were introduced for precise RFA treatment of malignant lesions with minimal adjacent tissue damage. Bipolar electrodes improved safety in pregnant women and in patients with implanted electrical devices referred to RFA. Contrast-enhanced ultrasound was proved of paramount importance to assess the success of malignant nodules ablation. However this list is not complete as thyroid thermal ablation is increasingly being adopted worldwide, advances are

frequently introduced and additional new devices and new techniques are currently under validation.

References

1. Chung S.R., Baek J.H., Choi Y.I. et al. Management strategy for nerve damage during radiofrequency ablation of thyroid nodules. *Int J Hyperthermia* DOI:10.1080/02656736.2018.1554826
2. Korkusuz Y., Groner D., Raczynski N. et al. Thermal ablation of thyroid nodules: are radiofrequency ablation, microwave ablation and high intensity focused ultrasound equally safe and effective methods? *Eur Radiol* 28: 929-935, 2018
3. Kotewall N., Lang B.H.H. High-intensity focused ultrasound ablation as a treatment for benign thyroid diseases: the present and future. *Ultrasonography* 38: 135-142, 2019
4. Mauri G., Nicosia L., Della Vigna P. et al. Percutaneous laser ablation for benign and malignant thyroid diseases. *Ultrasonography* 38: 25-36, 2019
5. Papini E., Pacella C.M., Misicchi I. et al. The advent of ultrasound-guided ablation techniques in nodular thyroid disease: towards a patient-tailored approach. *Best Practice & Research Clinical Endocrinology & Metabolism* 28: 601-618, 2014
6. Park H.S., Baek J.H., Park A.W. et al. Thyroid radiofrequency ablation: updates on innovative devices and techniques. *Korean J Radiol* 18: 615-623, 2017
7. Radzina M., Cantisani V., Rauda M. et al. Update on the role of ultrasound guided radiofrequency ablation for thyroid nodule treatment. *Int J Surgery* 41: S82-S93, 2017
8. Xiaoying T., Ping L., Dan C. et al. Risk assessment and hydrodissection technique for radiofrequency ablation of thyroid benign nodules. *J Cancer* 9: 3058-3066, 2018

3301.2

Interventional radiology in benign thyroid lesions: how to select the “fit” patient

R. Cervelli

Diagnostic and Interventional Radiology, University of Pisa, Pisa, IT

Learning Objectives

1. To understand the specific indications and contraindications for ablation of benign thyroid tumours
2. To understand the role of IR in the management of benign nodular disease
3. To report results of ablation in the treatment of benign thyroid lesions

The selection of the “fit patient” with thyroid nodule to treat by radiofrequency ablation (RFA) is the first step to perform in order to obtain the best therapeutic response.

First, the guideline clinical indications have to be considered to define patients who may benefit from the RFA procedure, when affected by benign thyroid lesions, either in the case of “cold” or “hot” (Autonomous Functioning Thyroid Nodules - AFTNs) nodules. The end-points of the RFA procedure are nodule volume reduction and the solution of the compressive symptoms or symptoms related to the toxic/pre-toxic phase of hyperthyroidism, when dealing with AFTNs.

Then, there are other important issues that need to be evaluated. The nodule location has to be assessed to identify deep and difficult to reach lesions, such as the ones located in the upper anterior mediastinum, or lesions in close adhesion to critical structures, such as the laryngeal nerve. In the latter case, the hydrodissection technique could represent a useful tool to safely perform RFA. The nodule dimension has to be taken into account, especially when the lesion is larger than 30 mL: in this case RFA could be performed in two separate sessions to reduce the risk of complications.

Finally, vascular variant/abnormality has to be carefully evaluated during the feasibility US examination. In fact, the arterial bleeding in the neck compartment is a life-threatening complication, which should be avoided by a correct planning of the procedure. However, when this complication

occurs, the patient's rapid intubation and feeder vessel embolization represent the optimal solution. This presentation will discuss the relevant issues in decision-making and optimal selection of the technique for the patients who are affected by benign thyroid lesions.

3301.3

Interventional radiology management options for thyroid cancer: algorithm proposal

J.-H. Kim

Department of Radiology, Seoul National University College of Medicine, Seoul, KR

Learning Objectives

1. To learn about the current guidelines for the management of thyroid cancer
2. To understand the specific limitations of surgical and interventional approaches in naive and recurrent malignant disease
3. To propose an algorithm including interventional radiology for the management of thyroid cancer

The current standard treatment of primary and recurrent differentiated thyroid cancer is surgery.

However, according to 2015 American thyroid association management guidelines, the strategy for less extensive surgery has been widely adopted, based on the belief that the most primary papillary thyroid carcinomas and the recurrent thyroid cancers are very indolent.

In addition, active surveillance has been spotlighted recently, based on the results of some observational studies, especially for low-risk papillary thyroid microcarcinoma (PTMC) and small recurrent cancers.

Meanwhile, various interventional modalities have been successfully challenging these issues.

However, to deal with these issues, we should know that each management option including surgery, active surveillance, and interventional treatment has its own advantage and disadvantage.

The radiologic definition of "low risk" for PTMC should be also clarified for this issue as well.

In this lecture, an overview of current management guidelines for primary and recurrent thyroid cancer, the outcome of interventional management, pros and cons among surgery, active surveillance, and intervention will be presented. Finally, some algorithm will be proposed for the management of primary and recurrent thyroid cancers.

References

1. Haugen BR, Alexander EK, Bible KC, Doherty GM, Mandel SJ, Nikiforov YE, et al. 2015 American Thyroid Association Management Guidelines for Adult Patients with Thyroid Nodules and Differentiated Thyroid Cancer: The American Thyroid Association Guidelines Task Force on Thyroid Nodules and Differentiated Thyroid Cancer. *Thyroid*. 2016;26(1):1-133.
2. Kim BW, Yousman W, Wong WX, Cheng C, McAninch EA. Less is More: Comparing the 2015 and 2009 American Thyroid Association Guidelines for Thyroid Nodules and Cancer. *Thyroid*. 2016;26(6):759-64.
3. Ito Y, Miyauchi A, Inoue H, et al. (2010). An observational trial for papillary thyroid microcarcinoma in Japanese patients. *World J Surg* 34:28-35.
4. Rondeau G, Fish S, Hann LE, Fagin JA, Tuttle RM. Ultrasonographically detected small thyroid bed nodules identified after total thyroidectomy for differentiated thyroid cancer seldom show clinically significant structural progression. *Thyroid*. 2011;21(8):845-53.
5. Kim JH, Yoo WS, Park YJ, Park DJ, Yun TJ, Choi SH, et al. Efficacy and Safety of Radiofrequency Ablation for Treatment of Locally Recurrent Thyroid Cancers Smaller than 2 cm. *Radiology*. 2015;276(3):909-18.

6. Kim J-h, Baek JH, Sung JY, Min HS, Kim KW, Hah JH, et al. Radiofrequency ablation of low-risk small papillary thyroid carcinoma: preliminary results for patients ineligible for surgery. *International Journal of Hyperthermia*. 2017;33(2):212-9.
7. Kim EK. Re: papillary thyroid carcinoma treated with radiofrequency ablation in a patient with hypertrophic cardiomyopathy: a case report. *Korean J Radiol* 2016;17:965.
8. Baek JH, Na DG, Park HS. RE: Management of Low-Risk Papillary Thyroid Microcarcinoma. *Korean J Radiol*. 2017 Mar-Apr;18(2):408-409.

3301.4

Treatments in metastatic thyroid cancer

R.L. Cazzato, P. Auloge, P. De Marini, J. Caudrelier, G. Koch, J. Garnon, A. Gangi

Interventional Radiology, University Hospital of Strasbourg, Strasbourg, FR

Learning Objectives

1. To learn about the epidemiology of metastatic thyroid cancer
 2. To understand the rationale for interventional treatment
 3. To assess techniques and results of interventional treatment
- The metastatic disease from thyroid cancer represents a complex clinical scenario, which mandates a case-based multi-disciplinary approach in tertiary referral centers. Minimally invasive interventional radiology procedures can play a vital role in providing palliative or curative treatment in accordance with the patients' clinical status. In this presentation, we will present the current status of interventional radiology treatments for the management of visceral and bone metastases from thyroid cancer.

References

1. Current role of interventional radiology in the management of visceral and bone metastases from thyroid cancer. **Cazzato RL**, Garnon J, Koch G, Shaygi B, Tsoumakidou G, Caudrelier J, Boatta E, Buy X, Palussiere J, Gangi A. **Gland Surg**. 2018 Apr;7(2):80-88. doi: 10.21037/gs.2017.12.08.
2. Over ten years of single-institution experience in percutaneous image-guided treatment of bone metastases from differentiated thyroid cancer. **Cazzato RL**, Bonichon F, Buy X, Godbert Y, de Figueiredo BH, Pointillart V, Palussiere J. **Eur J Surg Oncol**. 2015 Sep;41(9):1247-55. doi: 10.1016/j.ejso.2015.06.005.

Barcelona, Spain
September 7-11
CIRSE 2019

PART 2

**Abstracts of
Free Papers
News on Stage
(oral communications)
sorted by presentation
numbers**

News on Stage Peripheral interventions

404.1

ZILVERPASS study - ZILVER PTX versus bypass surgery for long femoropopliteal lesions: final 12-month and preliminary 24-month results

M. Bosiers

Department of Vascular Surgery, AZ Sint-Blasius, Hamme, BE

Purpose: ZILVER PTX stenting demonstrated its safety and effectiveness in single-arm studies for the treatment of femoropopliteal lesions. We set up a multicenter, prospective, randomized controlled trial to determine if the ZILVER PTX drug-eluting stent was non-inferior in terms of safety and efficacy, when compared to golden standard surgical bypass.

Material and methods: Between October 2013 and July 2017, 220 patients with TASC C&D femoropopliteal arterial disease, were randomized to either the Zilver PTX group (n=113) or the bypass surgery group (n=107), in 13 clinical centers in Belgium, Germany, Italy and Brazil.

Results: Final 12-month results of the total patient cohort showed promising results in favour of the ZILVER PTX group, in terms of patency (74.50% vs 72.50% ; $p=0.9979$), freedom from TLR (80.90% vs 76.20% ; $p=0.4707$) and 30-day freedom from complications (98.10% vs 98.00% ; $p=0.004$). Also, procedural time & hospital stay was significantly lower in the ZILVER PTX group. These findings seem to be sustained also on the longer term, as shown by the preliminary 24-month results in 110 out of 220 patients. 24-month primary patency was 68.20% for the ZILVER PTX group and 63.70% for the BYPASS group. Freedom from TLR rate was 80.40% for the ZILVER PTX group and 70.30% of the BYPASS group.

Conclusion: With the same patency results, but fewer complication rate, less hospital stay, less procedural time and last but not least a much lesser impact for the patient, endovascular intervention / Drug-eluting stenting might become a recommended treatment method for TASC C&D femoropopliteal lesions.

404.2

Benefits of DEB post stenting in diabetic patients and males: subgroup analysis of the randomized Freeway stent study

J. Tacke¹, K.A. Hausegger², S. Müller-Hülsbeck³, H. Schröder⁴, S. Stahnke⁵, J. Dambach⁵

¹Institut für Diagnostische und Interventionelle Radiologie und Neuroradiologie, Klinikum Passau, Passau, DE, ²Radiology, General Hospital Klagenfurt, Klagenfurt, AT, ³Department of Diagnostic and Interventional Radiology / Neuroradiology, Ev.-Luth. Diakonissenanstalt zu Flensburg, Flensburg, DE, ⁴Radiology, Vascular Center Jewish Hospital, Berlin, DE, ⁵Clinical Department, Eurocor Tech GmbH, Bonn, DE

Purpose: The prospective randomized multicenter Freeway Stent Study evaluated the possible hemodynamic and clinical benefits of primary stent insertion followed by percutaneous transluminal angioplasty (PTA) with drug eluting balloons (DEB) over post-stent insertion PTA with standard balloons in the treatment of symptomatic femoro-popliteal atherosclerotic lesions.

Material and methods: 204 patients were randomized for postdilatation by either DEB (FREEWAY™) or plain balloon (PTA) of primary implanted stents. The choice of commercially available nitinol stents was on the physician's decision. Primary endpoint is clinically driven target lesion revascularization (TLR) at 6 months; secondary endpoints include patency rate, shift in Rutherford classification, ABI and MAE at 6 and 12 months.

Results: The 12 months follow up overall results highly favor the use of FREEWAY™ DEB over PTA postdilatation. The subgroup of diabetic patients comprises approximately one quarter of the total population. In terms of 12 months primary patency, diabetic patients seem to profit

more from a DEB treatment compared to non-diabetic patients. The subgroup analysis on gender shows that male patients perform better in 12 months TLR and primary patency rate after DEB treatment compared to females.

Conclusion: The Freeway Stent Study demonstrated that the usage of DEB as a restenosis prophylaxis seems to be safe and feasible. Subgroup analyses underline the beneficial effects of DEB postdilatation with an advantage for diabetic and male patients.

404.3

Cost-effectiveness of a polymer-coated, paclitaxel-eluting stent (Eluvia) compared to a polymer-free, paclitaxel-coated stent (Zilver PTX) for endovascular femoropopliteal intervention: a payer perspective

S. Müller-Hülsbeck¹, P.W.M. Elroy², R. Akehurst³, S.L. Amorosi⁴, C. Giretti⁵, R.I. Griffiths⁶, W.A. Gray⁷

¹Department of Diagnostic and Interventional Radiology/Neuroradiology, Ev.-Luth. Diakonissenanstalt zu Flensburg, Flensburg, DE, ²Health Economics Analysis Team, BresMed, Utrecht, NL, ³Chairman, BresMed Health Solutions, Sheffield, UK, ⁴Health Economics, Boston Scientific, Marlborough, MA, US, ⁵Health Economics and Market Access, Boston Scientific International, Milan, IT, ⁶Health Economics Center of Excellence, Boston Scientific, Maple Grove, MN, US, ⁷Division of Cardiovascular Diseases, Lankenau Heart Institute, Philadelphia, PA, US

Purpose: The IMPERIAL randomized trial compared the safety and efficacy of the sustained-release, paclitaxel-eluting Eluvia stent to the paclitaxel-coated Zilver PTX stent for endovascular femoropopliteal intervention. This study evaluated the cost-effectiveness of these interventions.

Material and methods: A state-transition, decision-analytic model was constructed from a US Medicare perspective with a 12-month time horizon. Patients entering the model were assigned to an initial endovascular intervention with either Eluvia or Zilver PTX. Each month patients were exposed to the risks of primary patency loss, target lesion revascularization, amputation, and death. Clinical input parameters were taken from IMPERIAL at 12-months follow-up. Cost parameters were obtained from 2017 Medicare claims data. Analysis entailed sampling a complete set of clinical and cost parameters from their respective distributions, and then running cohorts of 1,000 patients through each intervention arm of the model. One-way and probabilistic sensitivity analyses were performed.

Results: At 12 months, modeled primary patency was 86.8% for Eluvia and 77.8% for Zilver PTX, and mean total direct costs were \$16,102 and \$16,786, respectively (Eluvia average savings = \$684). In probabilistic sensitivity analyses, Eluvia was cost-effective in 98.9% of all simulations at a threshold of \$10,000 per primary patency loss prevented. Eluvia was more effective and less costly (dominant) than Zilver PTX in 80.9% of simulations.

Conclusion: In the first year after the endovascular femoropopliteal intervention, Eluvia was more effective and less costly than Zilver PTX, making Eluvia the dominant treatment strategy. These findings should be considered when formulating policy and practice guidelines.

404.4

T.I.N.T.I.N. trial: combining luminor DCB and iVolution self-expanding stent in real life: 6-month outcomes

K.R. Deloose

Vascular Surgery, AZ St. Blasius, Dendermonde, BE

Purpose: T.I.N.T.I.N. is a prospective, investigator-initiated, multicenter trial that will investigate the 12-month safety and efficacy of combined Luminor DCB and iVolution BMS treatment in Trans-Atlantic Inter-Society Consensus C and D femoropopliteal atherosclerotic lesions.

Material and methods: The primary endpoint is the freedom from clinically-driven TLR at 12 months: defined as a repeat intervention to maintain or re-establish patency within the region of the treated arterial

vessel plus 5mm proximal and distal to the treated lesion edge at the respective time points. Secondary endpoints are primary patency rate at 6- and 12-month follow-up, technical success, freedom from clinically-driven TLR at 6-month follow-up, clinical success at follow-up and serious adverse events as defined per ISO 14155:2011

Results: At CIRSE, Barcelona 7-10 September 2019, the 6-month outcomes will be presented for the first time.

Conclusion: Related to the 12 months results of the Evolution- and EffPac trial, the iVolution stent and the Luminor DCB reach high efficacy and safety outcomes. Combining the Luminor DCB + the iVolution stent is currently investigated in the T.I.N.T.I.N. trial to create a win-win situation in the "real life" TASC C & D lesions.

404.5

Cost-effectiveness of drug-eluting stents versus PTA with bail-out bare metal stents for infrapopliteal lesions in critical limb ischemia (PADI Trial)

T. Wakkie¹, M. Spreen¹, L. Konijn¹, J. Wever¹, R. van Eps¹, H. Veger¹, L.C. van Dijk¹, W.P.T.M. Mali², M. Maessen³, N. van Herpen³, H. van Overhagen⁴

¹Radiology, Haga Ziekenhuis, The Hague, NL, ²Dept. of Radiology, University Hospital Utrecht, Utrecht, NL, ³Na, VGZ Health Insurance, Arnhem, NL, ⁴Department of Radiology, Haga Teaching Hospital, Leyenburg, The Hague, NL

Purpose: Drug-eluting stents (DES) improve clinical and morphological long-term results compared to percutaneous transluminal angioplasty (PTA) with bail-out bare metal stenting (BMS) in patients with critical limb ischemia (CLI) and infrapopliteal lesions (PADI trial). We performed a cost-effectiveness analysis of DES compared to PTA±BMS in cooperation with VGZ (a Dutch health insurance company), using data from the PADI trial.

Material and methods: The PADI trial randomized adults with CLI (Rutherford category ≥4) and infrapopliteal lesions to receive PTA±BMS or DES with paclitaxel. 74 limbs (73 patients) were treated with DES and 66 limbs (64 patients) with PTA±BMS. The estimated 5-year major amputation rate was lower in the DES group (19.3% versus 34.0% for PTA-BMS; $p=0.091$). In addition, the 5-year amputation- and event-free survival were significantly higher in the DES group (31.8% versus 20.4%, $p=0.043$; and 26.2% versus 15.3%, $p=0.041$, respectively).

Results: The costs were calculated by using the mean costs per stent multiplied by the mean number of stents used per patient (€750x1.8 for DES versus €250x0.3 for PTA±BMS). These costs were compared to the costs of major amputation and revalidation (€16.000 per amputation and €3.600-€15.750 for revalidation depending on the time after amputation, provided by VGZ). After one year the cost difference per patient between DES and PTA±BMS is €1.679 in favor of DES up to €2.878 after 3 years follow-up.

Conclusion: Long-term morphological and clinical effects of DES below the knee in CLI are promising. In our analysis DES seem to be cost effective due to the higher hospital costs of amputation and revalidation in the PTA±BMS group.

404.6

The Lutonix® global drug coated balloon registry real world patients with below the knee disease

M. Lichtenberg¹, M. Brodmann², D. Scheinert³

¹Vascular Center, Klinikum Arnsberg, Arnsberg, DE, ²Clinical Division of Angiology, Medizinische Universität Graz, Graz, AT, ³Angiology and Cardiology, University of Leipzig Heart Center, Leipzig, DE

Purpose: Paclitaxel-coated balloons are safe and effective in treating PAD. This ongoing multicenter registry study is designed to assess the safety and effectiveness of the Lutonix® 014 Drug Coated PTA Dilatation Catheter (DCB) for the treatment of stenosis or occlusion of native below-the-knee (BTK) arteries in a real world clinical practice.

Material and methods: This registry trial enrolled 371 real world patients presenting with claudication or critical limb ischemia (Rutherford Category (RCC) 3- 5). Patients with significant stenosis (≥70%) or occlusion of one or more native artery(s) below the tibial plateau and above the tibiotalar joint and the target vessel(s) reconstitute(s) at or above the ankle with inline flow to at least one patent inframalleolar outflow vessel were included. All patients were treated per standard of care when using the Lutonix® DCB. The DCB procedure was performed per the IFU. Follow-up visits, through 24 months, were also done per standard of care.

Results: Majority of the patients were RCC 5 (65.5%), 64.1% were diabetic, 86.8% were hypertensive and 62.5% had dyslipidemia. Mean lesion length was 121±97.8mm, calcification was present in 68.6% and 20.5% with severe calcification. Lesion locations were 6.8% popliteal, 20.5% TP trunk, 51% AT, 22.5% PT, and 22.7% peroneal. Freedom from Primary Safety Events at 30 days was 98.3%, at 6 months 94.4% and 12 months 91.7%. Primary efficacy of Freedom from TLR at 12 months was 76.8%.

Conclusion: These interim 12 month outcomes suggest the Lutonix® DCB 014 is safe with sustained treatment effect for BTK arterial disease.

Free Paper Session

FIRST@CIRSE – First data release on endovascular research

601.1

e-PTFE covered stent to treat stenosis in arteriovenous fistula: "first look" at the 12-month results from the randomized AVeNEW study

B. Dolmatch

Radiology, The Palo Alto Medical Foundation, Mountain View, CA, US

Purpose: AVeNEW is a prospective, international multi-center, randomized (1:1), controlled clinical study designed to assess the Covera Vascular Covered Stent compared to angioplasty (PTA) for the treatment of stenotic lesions in the venous outflow of upper extremity arteriovenous (AV) access circuits in patients dialyzing with an autogenous fistula.

Material and methods: 280 patients with stenoses ≥ 50% in the venous outflow of the AV access circuit, and with clinical or hemodynamic evidence of fistula dysfunction, were enrolled at 20 centers in the United States, Europe, Australia, and New Zealand. Patients received either PTA alone or PTA followed by covered stent placement. The primary endpoints were 6-month target lesion primary patency (TLPP) and 30-day safety. Secondary outcomes included TLPP at 12 months, and access circuit primary patency (ACPP) at 6 and 12 months.

Results: Most patients were male (61.8%) with a mean age of 63 ± 12.4 years, predominantly Caucasian (68.6%), and were overweight to obese (mean body-mass index of 29.8 ± 6.1 kg/m²). Patients had multiple risk factors for renal dysfunction (e.g., diabetes mellitus-69.6%, hypertension-97.1%). Lesions were restenotic in 73.2% of cases, were on average 29.3 ± 17.2 mm long (percent diameter stenosis: 72.5 ± 12.5%), and 53% were in the cephalic vein arch. The proportion of patients free from a primary safety event with the stent graft (95%) was non-inferior to PTA (96.4%) at 30 days ($p=0.002$, significant for noninferiority). TLPP was significantly better for the stent-graft group (78.7%) versus the PTA group (47.9%) at 6 months (Kaplan-Meier analysis) and remained statistically significant at 12 months (57.5% versus 21.2%, respectively; $p<0.001$). ACPP at 6 months numerically favored the stent-graft (50.7%) group compared to the PTA group (43.8%) while at 12 months the difference was statistically significant (28.9% versus 17.7%, respectively; $p=0.016$).

Conclusion: AVeNEW is the first level-one clinical trial dedicated solely to the use of a covered stent designed to treat stenoses in the AV fistula access circuit. The stent-graft group demonstrated significantly better target lesion primary patency compared to the PTA group at 6 months, with the difference sustained at the 12-month data. ACPP was

numerically different at 6 months, and statistically better for the stent-graft group at 12 months.

601.2

Primary endpoint results of the IN.PACT AV access randomized trial: outcomes through six months

A. Holden

Radiology, Auckland City Hospital, Auckland, NZ

Purpose: The IN.PACT AV Access Randomized Trial evaluates the safety and effectiveness of the IN.PACT AV Access drug-coated balloon (DCB) compared to percutaneous transluminal angioplasty (PTA) for the treatment of subjects with obstructive lesions (de-novo or restenotic) of the native arteriovenous dialysis fistulae (AVF) in the upper extremity.

Material and methods: IN.PACT AV Access is an independently-adjudicated, prospective, global, multicenter, randomized, single-blinded study that enrolled 330 subjects with de novo and/or non-stented restenotic lesions located between the arteriovenous (AV) anastomosis and axillosubclavian junction with $\geq 50\%$ stenosis. The primary effectiveness endpoint was target lesion primary patency rate defined as freedom from clinically-driven target lesion revascularization (CD-TLR) or access circuit thrombosis measured through 6 months post procedure. The primary safety endpoint was defined as the serious adverse event (SAE) rate involving the AV access circuit through 30 days post procedure.

Results: The baseline clinical and lesion characteristics will be reviewed. The primary safety and effectiveness endpoints through six months will be presented for the first time globally.

Conclusion: Detailed six-month results will be available at the time of this meeting.

601.3

Efficacy and safety of a novel paclitaxel-nano-coated balloon for femoro-popliteal angioplasty: 2-year results of EffPac trial

U. Teichgräber

Radiology, University Hospital Jena, Jena, DE

Purpose: Paclitaxel drug-coated balloon (DCB) angioplasty is an endovascular technology for inhibiting restenosis. We conducted a randomized-controlled trial to assess a novel DCB with an innovative nanotechnology coating.

Material and methods: We compared a DCB catheter to non-coated plain-old-balloon-angioplasty (POBA) in stenotic or occlusive lesions of the femoropopliteal artery. In total, 171 subjects were treated in 11 German study centers. Primary endpoint is late lumen loss (LLL) at 6 months. Secondary endpoints at 6, 12 and 24 months are primary patency, target lesion (TLR) and vessel (TVR) revascularization, quality of life (EQ-5D), change of Rutherford-Becker classification (RBC), ankle-brachial index (ABI), major and minor amputation rate, and others.

Results: At six months the LLL was on average 0.92mm lower in the DCB-group than in the POBA-group (95% CI: -1.36mm; -0.49mm, $p < 0.001$). Significantly more patients showed a walking improvement after DCB treatment at 6 months ($p = 0.021$). 44.6%/50% of the patients in the DCB-group improved by 3 stages after 6/12 months (POBA: 27.8%/36.8%). Only one patient needed a TLR in the DCB-group whereas did 14 patients in the POBA-group after 12 months (TLR DCB vs. POBA: 1.3% vs. 18.7%, relative risk (RR) = 0.08, 95% CI: 0.01; 0.53, $p < 0.001$).

Conclusion: The 12-months results showed that the investigational DCB catheter is highly effective and safe in inhibiting restenosis. It demonstrated a walking improvement in change of RBC compared to POBA. If the achieved results can be preserved after 24 months will be presented for the first time at the CIRSE 2019.

601.4

Stellarex DCB in real world: 1000 patient analysis from the SAVER registry

B. Mees¹, F.E. Vermassen², G. Torsello³, A. Cremonesi⁴, A. Sauguet⁵

¹Vascular Surgery, University Hospital Maastricht, Maastricht, NL,

²Department of Vascular Surgery, University Hospital Ghent, Ghent, BE,

³Vascular and Endovascular Surgery, University Hospital, Münster, DE,

⁴Interventional CV Unit, Maria Cecilia Hospital - GVM Care & Research,

Cotignola, IT, ⁵Cardiologie Générale et Interventionnelle, Clinique Pasteur Toulouse, Toulouse, FR

Purpose: To demonstrate the safety and effectiveness of the Stellarex drug-coated balloon (DCB) in lower extremity arteries in a broad, real-world patient population.

Material and methods: This is a prospective, single-arm, multi-center, registry conducted in the EU. The patient population included those with Rutherford Clinical Classification (RCC) of 2-6 and are indicated for percutaneous transluminal angioplasty. Cohort 1 included patients with RCC 2-3, and Cohort 2 included RCC 4-6. Hemodynamic, clinical and functional outcomes are evaluated at 12, 24, and 36 months. A CEC provided oversight, including adjudication of clinical events. Additionally, core laboratories analyzed angiographic/duplex ultrasound images. For Cohort 1, the primary effectiveness endpoint was freedom from clinically driven target lesion revascularization (CD-TLR) at 12 months. CD-TLR is defined as absence of target lesion revascularization determined by duplex ultrasound PSVR of ≥ 2.5 . The primary safety endpoint was freedom from device- and procedure-related death through 30 days post-procedure and freedom from target limb major amputation and CD-TLR through 12 months. Key secondary outcomes include all-cause mortality, major target limb amputation, and change in ankle-brachial index (ABI).

Results: The interim analysis included 1000 patients. 12-month data is being analyzed in time for presentation at CIRSE. Primary safety and effectiveness endpoint data will be presented along with key secondary outcomes.

Conclusion: Conclusions will be presented at CIRSE.

601.5

ZILVER® PTX® drug-eluting peripheral stent: last update

M.D. Dake

Medicine/UA Health Sciences, The University of Arizona, Tucson, AZ, US

Purpose: A meta-analysis suggesting an association of paclitaxel-devices with long-term mortality did not include patient-level information. We analyzed patient-level data from two large studies of the Zilver PTX stent (DES) with long-term follow-up and concurrent comparator groups to determine if there is an increased mortality risk.

Material and methods: Data from the Zilver PTX randomized controlled trial (RCT) and Zilver PTX and bare metal stent (BMS) Japan post-market surveillance studies were analyzed. Five-year follow-up is complete in both DES studies and follow-up for the BMS study was limited to 3 years and is complete. All-cause mortality was evaluated, and a Cox proportional hazards model identified significant factors related to mortality.

Results: In the RCT, there were 336 patients treated with the DES and 143 patients treated with angioplasty (PTA) or BMS. In Japan, there were 904 DES patients and 190 BMS patients. There was no difference in all-cause mortality for the DES compared to PTA/BMS in the RCT (18.9% DES versus 15.6% PTA/BMS through 5 years, $p = 0.46$) or Japan (15.6% DES versus 15.3% BMS through 3 years, $p = 0.92$). Cox proportional hazards models revealed that age, tissue loss, and congestive heart failure were significant predictors of mortality in the RCT, and critical limb ischemia, age, gender, and renal failure were significant predictors of mortality in Japan (all $p < 0.05$). Neither treatment with Zilver PTX ($p = 0.51$ RCT, $p = 0.55$ Japan) nor paclitaxel dose ($p = 0.87$ RCT, $p = 0.13$ Japan) were predictors of mortality.

Conclusion: Analyses of the Zilver PTX patient-level data demonstrated no increase in long-term all-cause mortality.

Free Paper Session Spinal interventions

607.1

CT-guided pulsed radiofrequency for the treatment of acute low back pain and sciatica: 1-year follow-up

A. Napoli, S. Dababou, C. Marrocchio, R. Scipione, G. Alfieri, D. Fierro, C. Catalano
Radiological Sciences, University of Rome La Sapienza, Rome, IT

Purpose: To study the clinical efficacy of CT-guided Pulsed Radiofrequency (pRF) in the management of patients with acute or sub-acute neuro-radicular pain from lumbar disc herniation.

Material and methods: Single center, prospective, randomized trial (1:1) in patients with acute or sub-acute neuro-radicular low back pain (EMG confirmed) refractory to conservative treatment. PRF was performed using a needle-electrode with probe tip directed to the symptomatic dorsal root ganglion under CT guidance. E-pulsed radiofrequency was administered for 10 min at 45V with constant local temperature of 42°C. Masking group received 1 to 3 sessions of CT-guided steroid injection. The primary outcome was the clinical efficacy measured with Visual Analogue Scale (VAS), Oswestry Disability Index (ODI) and Roland-Morris (RM) score for quality of life assessment, at baseline and at 1-week, 1-3-6 and 12-month follow-up.

Results: 128 out of 260 patients enrolled received pRF whereas 120 patients were treated with steroid injection only. Median VAS scores decreased linearly in both groups; patients that received radiofrequency obtained a significant overall improvement in pain and disability scores ($P < 0.001$). Relief of leg pain was faster for patients assigned to pRF ($P < 0.001$), they also reported a faster rate of perceived recovery (hazard ratio, 1.97; 95% confidence interval, 1.72 to 2.22; $P < 0.001$). The perceived recovery after 1-year follow-up was 95% in the pRF group and 61% in the steroid injection group. Six patients considered partial responders required a second pRF session. Eight patients required further surgical management.

Conclusion: CT-guided Pulsed Radiofrequency is an effective and repeatable percutaneous treatment option for patients with acute or sub-acute neuro-radicular low back pain refractory to conservative treatment.

607.2

Long term outcome from CT-guided transforaminal cervical epidural injection for pain and function. A prospective study including correlation with MRI appearances

Z.A.H. Aldin¹, H. Mahmoud¹, K. St Pierre¹, T. Sadik¹, M. Ahmed¹, Z. Danawi¹, A. Gul¹, M.S. Hamady², A.S. Syed-Noor³
¹Radiology, The Princess Alexandra Hospital, Essex, UK, ²Interventional Radiology, Imperial College-London - St Mary's Campus, London, UK, ³Department of Surgery, Umea University, Umea, SE

Purpose: Primary aim, to assess immediate, mid-term and long-term outcomes after CT guided cervical transforaminal epidural injections for neck pain and quality of life. Secondary aim, to assess if MRI findings could be correlated with outcomes from the primary aim.

Material and methods: This is a prospective study assessing patient response to CT guided cervical transforaminal epidural injections. Patients included in this study are those who have failed conservative management and have been referred for this procedure as part of their normal management. Total population size 116. Each patient is interviewed before procedure, immediately after, 1 month, 3 months and 12

months after their initial procedure. Responses are measured using the numeric rating scale (NRS) and neck disability index (NDI). The pre-procedural MRIs were assessed by two Consultant Radiologist. Assessments included disk herniation, degree of nerve root compromise, facet joint degeneration, cervical stenosis and presence of modic changes.

Results: There are statistically significant (paired sample T test, $p < 0.001$) reductions between pre-procedural NRS when compared to NRS immediately post procedure, as well as, 1 month, 3 months and 12 months' post-procedure. 84%, 36%, 45% and 53% respectively. There are statistically significant (paired sample T test, $p < 0.001$) reductions between pre-procedural NDI when compared to NDI 1 month, 3 months and 12 months' post-procedure. Reductions of 29%, 43% and 51% respectively. No significant correlation was seen with MRI findings and NDI and NRS scores.

Conclusion: There is statistically significant long term reduction in pain and function. No significant correlation is observed between MRI findings and NDI and NRS scores.

607.3

Preliminary results of percutaneous treatment of degenerative disc disease with intradiscal lumbar interbody fusion

R. Fiori¹, L. Spiritiglozzi², A. D'Onofrio³, M. Forcina¹, C. Di Donna², A.U. Cavallo¹, R. Floris³

¹Diagnostic Imaging and Interventional Radiology, University of Rome, Rome, IT, ²Diagnostic Imaging and Interventional Radiology, Policlinico Tor Vergata, Rome, IT, ³Diagnostic and Molecular Imaging, Radiation Therapy and Interventional Radiology, University Hospital Policlinico Tor Vergata, Rome, IT

Purpose: The treatment of degenerative disc disease is vertebral interbody fusion. Usual approaches require a long recovery period and could carry several complications. We introduced a new technique with a percutaneous trans-foraminal approach in order to achieve vertebral fusion with the RISE™ 8 mm width self-expandable cage (Globus Medical Inc., Audubon, PA, USA), that implies minimum invasive surgery, fewer complications, and faster recovery.

Material and methods: During the period between February 2017 and December 2017, we performed this innovative and full percutaneous vertebral interbody fusion procedure in 36 patients with degenerative disk disease with associated low back pain resistant to medical therapy and/or spondylolisthesis up to grade 1. We performed pre-operative X-rays, CT scans and MRI of each patient. The outcomes were scored with a visual analogic scale (VAS) at 1, 6 and 12 months follow-up and included also after procedure x-rays to evaluate the correct bone fusion and the absence of migration of the cage.

Results: No poor results and no major complications such as neurological damage, vascular or visceral injuries and major blood loss were reported. Mean operation time was 150 minutes and median postoperative time until hospital discharge was 3 days. Postoperative values for VAS scores improved significantly compared to pre-operative data.

Conclusion: The percutaneous transforaminal lumbar interbody fusion technique is an innovative and suitable method, with fewer complications and faster post-operative recovery for treating degenerative disk diseases with low back pain resistant to medical therapy with or without spondylolisthesis up to grade 1.

607.4

Evaluation of the biomechanical performance of a novel transpedicular PEEK implant for the treatment of vertebral compression fracture

F.H. Cornelis¹, M. Aebi², C. Maas³, T. Di Pauli Von Treuheim⁴, H. Friedrich⁴, H.J. Wilke⁴

¹Radiology, Tenon Hospital, Paris, FR, ²Orthopedic Surgery, Ruckenzentrum Bern, Bern, CH, ³Hyprevention, Pessac, FR, ⁴Surgery, Universitaetsklinikum, Ulm, DE

Purpose: This study aims to assess the biomechanical efficacy of a novel transpedicular implant compared with vertebroplasty in vertebral compression fracture.

Material and methods: A total of 17 vertebrae from 3 human osteoporotic spine segments (T9-L5) were selected. Vertebral compression fractures were generated by eccentric compressive loading on the vertebral body. Then the vertebrae were either filled with PMMA bone cement alone (control group; n=8) or implanted with V-STRUT® (Hyprevention, France) combined with bone cement (device group; n=9). Following the treatment, a new compressive loading was performed and maximal load and stiffness, as well as total energy to fracture were measured. These data were used to analyse their efficacy in supporting axially applied load on the vertebral body.

Results: Fracture force and energy to fracture were both increased either after V-STRUT® implantation or vertebroplasty compared to when the initial fracture was generated. Mean increase percentage between the initial value and the post-treatment value for each parameter were +77% vs +39% regarding fracture load and +126% vs +99% for energy to fracture, for the device group vs vertebroplasty group respectively. No pedicle fractures and no implant breaking or bending were observed in the device group.

Conclusion: These results show the ability of V-STRUT® combined with bone cement to reinforce the vertebral body strength, at least equivalent with vertebroplasty. Therefore, further clinical investigation (SPINEO, ClinicalTrials ID: NCT03580434) is now undertaken in order to confirm these results and demonstrate clinical safety and efficacy.

607.5

Does vertebroplasty increase the risk of subsequent vertebral compression fracture? An evidence-based review of the literature.

C.A. Byrne¹, M.P. Bolger², L. Greene¹, A.E. Stroiescu³, J.B. Hennebry³, A.G. Ryan⁴

¹Radiology, University Hospital Waterford, Waterford, IE, ²Radiology, Mater Misericordiae Hospital, Dublin, IE, ³Division of Interventional Radiology, University Hospital Waterford, Waterford, IE, ⁴Division of Interventional Radiology, Department of Radiology, University Hospital Waterford, Waterford City, IE

Purpose: To review the current evidence regarding the risk of vertebral compression fracture following vertebroplasty for osteoporotic compression fracture.

Material and methods: The evidence based approach of ask, search, appraise, apply and evaluate was used to address the following clinical question 'Does percutaneous vertebroplasty for osteoporotic compression fracture increase the risk of subsequent vertebral compression fracture?'. A PICO question was formulated and this guided a search of the literature beginning with the primary literature and including a search of syntheses and systems. Initial search of the primary literature on Pubmed yielded 200 results. Filters were applied (systematic review, meta-analysis, human subjects, English language and published within 5 years) and results were narrowed to 15. A search of systems and syntheses yielded one further relevant publication. Abstracts were screened for relevance and levels of evidence were assigned according to Centre for Evidence Based Medicine (CEBM) guidelines. Systematic review and meta-analysis

by Han et al 'Is Vertebroplasty a Risk Factor for Subsequent Vertebral Fracture, Meta-Analysis of Published Evidence?' and an updated Cochrane review of vertebroplasty were selected for appraisal using CEBM appraisal tool on the basis that they most closely matched the PICO question and were the highest available level of evidence.

Results: Han et al and the Cochrane review found that there was heterogeneity between included results. Both analyses found results tended towards an increased risk of fracture with vertebroplasty however, this was not statistically significant.

Conclusion: Current evidence does not support the hypothesis that vertebroplasty increases the risk of vertebral compression fracture.

607.6

Safety and effectiveness of the SpineJack® system versus the KyphX Xpander® inflatable bone tamp for the reduction of vertebral compression fractures: a prospective, international, multicenter, randomized clinical trial (SAKOS study)

D.C. Noriega¹, S. Marcia², N. Theumann³, B. Blondel⁴, A. Simon⁵, F. Hassel⁶, G. Maestretti⁷, A. Petit⁸, P.A. Weidle⁹, A. González Mandly¹⁰, J.-M. Kaya¹¹, A. Touta¹¹, S. Fuentes¹², R. Pflugmacher¹³
¹Orthopedic Unit, Hospital Clinico Universitario de Valladolid, Valladolid, ES, ²Radiology SS Trinita' Hospital, ATS Sardegna, Cagliari, IT, ³Radiology, Clinique Bois-Cerf, Lausanne, CH, ⁴Service du Pr Tropiano, CHU Timone, Marseille, FR, ⁵Service de Neurochirurgie, CHU Brest Cavale Blanche, Brest, FR, ⁶Wirbelsäulenchirurgie, Loretto Krankenhaus Freiburg, Freiburg, DE, ⁷Service Chirurgie Orthopedique, HFR Fribourg, Fribourg, CH, ⁸Service de Neurochirurgie, Hopital Jean Minjoz, Besancon, FR, ⁹Krankenhaus Neuwerk Sankt Augustinus Kliniken, Mönchengladbach, DE, ¹⁰Interventional Neuroradiology, Hospital Universitario Marqués de Valdecilla, Santander, ES, ¹¹Service de Neurochirurgie, APHM, Hopital Nord, Marseille, FR, ¹²Unite de Neurochirurgie, CHU La Timone-Hopital Adultes, Marseille, FR, ¹³Orthopädie und Unfallchirurgie, Universitätsklinikum Bonn, Bonn, DE

Purpose: Balloon kyphoplasty (BKP) is the most commonly performed vertebral augmentation procedure in painful osteoporotic vertebral compression fractures (VCFs). This study aimed to support a non-inferiority finding for use of SpineJack® (SJ) system versus BKP.

Material and methods: A comparative study was conducted in adults with painful osteoporotic VCFs who failed conservative treatment. Patients were randomly assigned (1:1) to SJ system or BKP. Neither patients nor clinicians were masked to the intervention. The primary composite endpoint was the 12-month responder rate (responder if "reduced pain intensity > 20 mm" + "ODI unchanged or improved" + "absence of device-related AEs or surgical re-intervention"). An additional composite endpoint "absence of adjacent level fractures" and midline height restoration at 6 and 12 months were tested for SJ superiority.

Results: A total of 141 patients were randomized to SJ system (n=68) or BKP (n=73) and 126 patients completed the 12-month follow-up period (SJ=61; BKP=65). Bayesian analysis of primary endpoint demonstrated non-inferiority of SJ system to BKP (posterior probability of 0.09969 met study success criteria > 0.987). Frequentist analysis of responder rates using "observed case" method confirmed non-inferiority (SJ=89.8% vs. BKP=87.3%; p=0.0016). The incidence of adjacent fractures was significantly lower with SJ system than BKP (12.9% vs. 27.3%; p=0.043).

Conclusion: The SAKOS study demonstrated non-inferiority of the SJ system to predicate BKP as a treatment for painful VCFs. In addition, study results further demonstrated superiority of the SJ system over BKP for freedom from adjacent fractures and midline vertebral body height restoration at 6 and 12 months.

607.7

Preventive vertebroplasty for long-term consolidation of vertebral metastases

F. Deschamps, A. Delpla, L. Tselikas, T. de Baère
Interventional Radiology, Gustave Roussy, Villejuif, FR

Purpose: To evaluate the long-term consolidation of vertebral metastases (VM) after preventive vertebroplasty (PV) and to report risk factors of pathological fracture despite PV.

Material and methods: The files of 100 consecutive cancer patients referred for PV of VM were retrospectively analyzed. We enumerated 215 VM at the time of the PV procedure (T0): 138 VM were considered at risk of pathological fracture (Treated-VM) and 77 VM were not considered at risk (Untreated-VM). We compared the VM characteristics using the spine instability neoplastic score (SINS) at T0 and the rate of pathologic fracture at 1, 2 and 3 years between the treated-VM and the untreated-VM. We analyzed the risk factors of fracture despite PV using treated-VM characteristics and quality of cement injection criteria.

Results: Despite a lower SINS value at T0 (4.5 vs. 5.8; $p < 0.001$), the rates of pathological fracture at 1, 2 and 3 years, were significantly higher among untreated-VM compared to the treated-VM ($p < 0.005$). Major risk factors of fracture among treated-VM were: SINS value ≥ 8 (OR=6.3, $p=0.012$), mechanical pain (OR=11.295, $p=0.001$), osteolytic lesion (OR=8.280, $p=0.033$) and metastatic vertebral body involvement $>50\%$ with no collapse (OR=12.325, $p < 0.001$), Saliou-score <9 (OR=8.334, $p=0.008$), vertebral metastasis filling with cement $<50\%$ (OR=7.396 $p=0.007$) and the absence of cement's contact with vertebral endplates (OR=4.876, $p=0.014$).

Conclusion: PV is long-term effective for consolidation of VM and must to be discussed at the early diagnosed. Quality of cement injection matters, suggesting that techniques that improve the quantity and the quality of cement diffusion into the VM must be developed.

Free Paper Session

Dialysis and AV fistula

608.1

Significant reduction in radiation using intraoperative ultrasound and the 4 French instead of 6 Fr. WavelinQ endoAVF system in creating endovascular AV-fistulas

T.M. Steinke

Vascular and Endovascular Surgery, Schoen Klinik Duesseldorf, Duesseldorf, DE

Purpose: To report the results of a single center prospective observational study for the creation of endovascular AV-Fistulas in endstage renal disease (ESRD) patients with the new 4Fr. WavelinQ System.

Material and methods: The purpose of this observational study is to assess the clinical outcomes of the 4Fr. WavelinQ-System used in clinical daily practice according to the approved commercial indications in Europe especially focusing on intraoperative radiation dose. The 4Fr. WavelinQ-System is a novel device designed to facilitate arterial and venous access from the wrist to create an endovascular AV-Fistula between the proximal ulnar or radial artery and the concomitant vein for hemodialysis access. 10 patients were enrolled between Sept. 2017 and Sept. 2018 and compared to a previous series of 16 patients being treated with the 6Fr-System before.

Results: In all patients, catheters were placed according to indications with a 100% success in achieving radial arterial and venous access. There was one conversion due to an active bleeding at the intended creation site. Although some of the steps can be done by ultrasound guidance, angiographic imaging during the procedure is still required. With the 6Fr-System we had an average radiation dose of $2,15 \text{ Gy/cm}^2$ (minimal 0,82, maximal 4,89, median $1,77 \text{ Gy/cm}^2$). The launch of the 4Fr-System

more than halved the radiation exposure with an average of $0,91 \text{ Gy/cm}^2$ (minimal 0,41, maximal 1,74, median $0,78 \text{ Gy/cm}^2$), showing a remarkable reduction in intraoperative radiation dose.

Conclusion: Positive results demonstrated safety and clinical utility of the 4Fr. WavelinQ-System as a primarily option gaining radial access for creating endovascular AV-fistulas for ESRD-patients and proving a significant reduction in radiation dose.

608.2

Initial experience with the Covera™ covered stent for the treatment of dysfunctional or thrombosed arterio-venous grafts. A retrospective analysis of 64 patients

P.N. Papadimitos¹, P.M. Kitrou¹, K.N. Katsanos¹, M. Theofanis¹, M. Papasotiriou², S. Papadoulas³, D. Karnabatidis⁴

¹Department of Interventional Radiology, University Hospital of Patras, Patras, GR, ²Department of Nephrology, University Hospital of Patras, Patras, GR, ³Vascular Surgery, University Hospital of Patras, Patras, GR, ⁴Department of Diagnostic and Interventional Radiology, Rion University Hospital, Patras, Patras, GR

Purpose: To retrospectively evaluate the safety and effectiveness of the Covera™ covered stent (CS) for the treatment of dysfunctional or thrombosed arterio-venous grafts (AVGs).

Material and methods: Within 29 months (February 2016 – August 2018), 79 patients underwent Covera™ CS placement in our department for the treatment of their dysfunctional AVGs. Data were available for 64 patients, undergoing 64 procedures, using 64 devices. Minimum follow up was 6 months unless re-intervention occurred. Mean follow-up was 277 days (6-923 days). Lesion characteristics were: 51 cases with venous-graft anastomosis (VGA) stenosis (79.7%), 13 cases of puncture zone stenosis (20.3%), 14 cases of in-stent-graft (SG) stenosis (21.9%), 8 cases of pseudoaneurysm treatment (12.5%) (one lesion may have more than one characteristic). Thirty-six patients presented with thrombosis (56.2%) and 31/64 case were De novo lesions (48.4%). Primary outcome measure was post-intervention primary patency (PIPP) at six months, while secondary outcome measures included factors influencing primary outcome.

Results: Technical success was 100%. Median PIPP was 336 days and 73.58% of lesions were patent at 6 months. There was no significant difference in terms of PIPP when de novo lesions were compared with restenotic (519 vs. 320 days, $p=0.1$), patients presented with or without thrombosis (320 vs 583 days, $p=0.07$), puncture zone stenosis or elsewhere (686 vs. 329 days, $p=0.52$), VGA stenosis or elsewhere (336 vs. 335 days, $p=0.9$).

Conclusion: Use of the Covera™ CS for AVG treatment was safe and effective in every type of lesion presented in this retrospective analysis.

608.3

Stentgrafts as an endovascular option for hemodialysis-related venous occlusive disease (VOD)

T.M. Steinke, L. Nuth

Vascular and Endovascular Surgery, Schoen Klinik Duesseldorf, Duesseldorf, DE

Purpose: This prospective single center observational registry evaluated the efficacy and durability of a new covered stent (Covera/ CR Bard) in treating VOD to preserve a functional dialysis access circuit.

Material and methods: In 53 patients (45,3% men; mean age 67,4 years, 28-89 years) with VOD, covered stents (Covera, CR Bard) were used to treat symptomatic venous stenosis or to enable av-access functionality. The target lesion was accessed via the dialysis access site. The Covera covered stent (BD/Bard Peripheral Vascular) was implanted in all patients.

Results: Technical success was 100%. Target lesion primary patency (PP) at 6 month was 86 %. Mean follow up was 6,9 month. Study Population Mortality was 5 % at 6 month. Secondary patency (SP), access circuit patency rates (ACP), additional procedures for access salvage and

subgroup analysis of different locations of stentgraft implantation (central, cephalic arch, outflow and cannulation zone) are reported.

Conclusion: Placement of covered stents for hemodialysis-related VOD is safe, relieved symptoms, and enabled functionality of dialysis av-access circuits. There is a need for prospective and randomized studies to determine whether and where covered stents provide superior long-term results to those achieved with PTA and DCB-PTA.

608.4

Outcomes of sharp recanalization for treatment of upper extremity central venous occlusions

H. Chung¹, D.Y. Sze², J. Louie²

¹Interventional Radiology, Stanford Hospitals and Clinics, Palo Alto, CA, US,

²Interventional Radiology, Stanford University, Stanford, CA, US

Purpose: To evaluate the safety, effectiveness, and clinical outcomes following sharp recanalization to treat upper extremity central venous occlusions.

Material and methods: A single-center retrospective analysis of 22 consecutive patients referred for attempted sharp recanalization from 2003-2018 was performed. Technical success rate, anticoagulation therapy, and complications were characterized. Outcomes including symptom recurrence, primary stent patency, and re-intervention rate were evaluated by Kaplan-Meier and log rank test analyses.

Results: A total of 22 patients underwent 24 attempted sharp recanalization procedures between 2003 and 2018. The most common indication was swelling of the face, chest, or arm (79%), followed by need to establish central venous access (17%). Overall technical success rate was 79.2%. Following technical success, symptom-free survival at 1 year was 69.2% (CI 47.8-100%), and median time to symptom recurrence was 1.83 years. Over a median follow-up interval of 1.34 years, primary patency rate was 62.5%. Of 19 successfully sharply recanalized patients, 11 received anticoagulation and 8 did not. Anticoagulation did not lead to a statistically significant difference in symptom recurrence ($p=0.62$), patency ($p=0.39$), or re-intervention rate ($p=0.57$). However, one adverse event, a subdural hematoma, occurred at 8 days post-intervention in the anticoagulated group. Intraprocedural complications included pericardial transgression of the wire (8.3%) and extravasation of contrast (8.3%), neither clinically significant. No immediate SIR-classification major complications were noted.

Conclusion: Sharp recanalization for central venous occlusions may lead to durable clinical improvement with an acceptably low re-intervention rate. Anticoagulation led to no difference in symptom recurrence, re-intervention, or stent patency, but was associated with one major adverse event.

608.5

The Lutonix Global AV Registry: final 6-month results and subgroup analysis of target lesion location

P.M. Kitrou

Department of Interventional Radiology, University Hospital of Patras, Patras, GR

Purpose: The Lutonix® Global Registry is a multi-center, single-arm registry investigating the real-world clinical use, safety and efficacy of the Lutonix® Drug Coated Balloon PTA Catheter for the treatment of dysfunctional arterio-venous fistulas (AVF) and grafts (AVG).

Material and methods: Registry enrolled 324 subjects of a heterogeneous patient population from 25 international clinical sites, in real world clinical practice. Target lesions included restenotic lesions, central venous stenosis, in-stent restenosis in both AVGs and AVFs. Patients were treated per standard of care when using the Lutonix® DCB while procedure was performed as per instructions for use. Follow-up visits, through 12 months, were also done per standard of care. Primary endpoints are: Safety: Freedom from any serious adverse event(s) involving the AV

access circuit through 30 days. Efficacy: Target Lesion Primary Patency (TLPP) through 6 months.

Results: Final 6-month and interim 12-month results will be presented. Subgroup results based on lesion location will also be presented.

Conclusion: The Lutonix Global registry is the first large multi-center real-world registry of DCB in dysfunctional grafts and fistulae. Final 6-month results, interim 12-month results and interim sub-group analysis including central veins, in-stent restenosis, and AVGs will also be presented to determine treatment effect.

608.6

Safety and efficacy of midline and peripherally inserted central catheter for intravenous therapy: a randomized controlled trial

A. Bentridi¹, G. Soulez², P. Gilbert¹, M.-F. Giroux³, L. Bouchard⁴, P. Perreault², V.L. Oliva⁵, A. Chouinard¹, P. Bernier¹, E. Therasse⁶

¹Interventional Radiology, CHUM ST LUC, Montreal, QC, CA, ²Radiology, CHUM-University of Montreal, Montreal, QC, CA, ³Radiology, CHUM-Notre Dame, University of Montréal, Montreal, QC, CA, ⁴Radiology, Radio-oncology and Nuclear Medicine, University of Montreal, Montreal, QC, CA, ⁵Division of Vascular and Interventional Radiology, Department of Radiology, Centre Hospitalier de l'Université de Montreal, Montreal, QC, CA, ⁶Radiology, Hôtel-Dieu du CHUM, Montreal, QC, CA

Purpose: To test the hypothesis that Midlines are non-inferior to PICC for intravenous therapy that do not require a central catheter

Material and methods: Prospective randomized open-label clinical trial, in which Midlines are compared to PICCs in adults who required peripheral intravenous therapy of 1-4 weeks. With a noninferiority margin of 10%, 510 patients need to be enrolled in this study. Patients eligible for Midline according to recommendations of the Infusion Nurses Society (2016) were included. Vesicant intravenous therapy were excluded. Patients were followed until one week after venous access removal. The primary efficacy outcome was the percentage of patients who completed their treatment without limitation due to catheter dysfunction.

Results: This interim analysis includes the first 72 patients enrolled (45 men and 27 women) since August 2018; average age: 52.6 years, 35 randomized to the Midline group and 37 to the PICC group. There was one early retrieved catheter in both groups ($P=0.78$). Catheter dysfunction, mostly incapacity to draw blood, was observed in 10/35 (30%) patients in the Midline group versus 1/36 (2.8%) patients in the PICCs group ($p=0.001$). There were 3/35 (8.5%) device related adverse events in midline group and no adverse event in PICCs ($p=0.46$). There was one unrelated death in the PICC group and no major device related event in both groups

Conclusion: Comparison of primary efficacy outcome with available data is not yet conclusive. However, given the greater catheter dysfunction rate with Midlines, these catheters should not replace PICC in patients with difficult venipuncture and who require blood samplings.

608.7

Impact of subcutaneous tunnels on peripherally inserted catheter placement: a multicenter retrospective study

D.J. Shim¹, I.J. Kim², J.H. Lee³, E.T. Kim⁴, J.H. Byeon¹

¹Radiology, Incheon St. Mary's Hospital, Incheon, KR, ²Department of Radiology, Bucheon St. Mary's Hospital, Bucheon, KR, ³Radiology, National Cancer Center, Goyang-si, KR, ⁴Radiology, Hanyang University Guri Hospital, Guri, KR

Purpose: To evaluate the impact of subcutaneous tunneling on peripherally inserted central catheter (PICC) placement in terms of central line-associated blood stream infections (CLABSI).

Material and methods: Our dual-facility central institutional review board approved this retrospective study. We compared 302 of 327 consecutive recipients (mean age $\pm$ SD), 68.0 ± 15.9 years; men, 134; women, 168) of tunneled PICCs (October 2017 to May 2018) with 309 of 328

consecutive recipients (mean age, 68.7±14.6 years; men, 142; women, 167) of conventional PICCs (April 2016 to September 2017). Tunnels were made near puncture sites (~1 inch away) using hemostats or puncture needles. In each group, procedure times and rates of complications, including CLABSI, entry-site infection, dislocation, thrombophlebitis, and occlusion, were examined. Risk factors for CLABSI were analyzed via logistic and Cox regression models.

Results: Subcutaneous tunnels were achieved in all patients, enabling successful peripheral vein cannulations. Group procedure times were similar ($p=0.414$). CLABSI proved to be significantly less frequent after tunneling (8/6972 catheter-days) than after conventional (28/7574 catheter-days) PICC placement (adjusted hazard ratio=0.328, 95% confidence interval: 0.149-0.721). Other risk factors (i.e., age, gender, comorbidity, PICC duration, veins, hospital stay, and intensive care unit stay) showed no significant correlations with CLABSI.

Conclusion: Compared with conventional means, a subcutaneous tunneling approach for PICC placement significantly reduces the rate of CLABSI.

Free Paper Session Biliary interventions

704.1

Simulation of the biliary metal stent recanalisation using endoluminal irreversible electroporation on porcine liver - in vivo experiment

T. Rohan¹, T. Andrašina¹, P. Matkulčík², T. Juza¹, J. Zavadil¹, I. Svobodova³, D. Cervinka⁴, V. Válek¹

¹Department of Radiology and Nuclear Medicine, University Hospital Brno, Masaryk University, Brno, CZ, ²Medical Faculty, Masaryk University Brno, Brno, CZ, ³First Department of Pathological Anatomy, St. Anne's Faculty Hospital and Masaryk University, Brno, CZ, ⁴Faculty of Electrical Engineering and Communication, Technical University Brno, Brno, CZ

Purpose: To demonstrate feasibility of endoluminal irreversible electroporation using tubular catheter in biliary metal stent for recanalisation.

Material and methods: 25 simulations of metal stent obstruction on porcine liver in vivo were performed by liver lower edge incision and its insertion in the biliary metal stent. In 14 cases endoluminal irreversible electroporation with tubular catheter prototype were performed, others were set as controls. Three different scenarios of IRE were simulated (one, two or zero electrodes in contact with metal stent). Ninety 100 us pulses with 300,650,1000 and 1300 Volts were used in each scenario. Electrical parameters, macroscopical changes, side effects were monitored during the procedure. Early complications were evaluated by CT immediately and 72 hours after the procedure, followed by samples harvesting.

Results: There were no complications detected during the procedure and on following CTs, endoluminal IRE was successful in all cases. Significant difference in impedance was observed between all scenario settings ($p=0.02$, Mann-Whitney). Short circuit occurred immediately in 1300 V in all scenarios, in both cases of 1000 V with one electrode in contact with stent and in case where both electrodes were in contact with stent. The highest observed safe voltage for IRE in metal stent was 850 V/cm. Histopathological analysis showed signs of tissue necrosis which were not present in control samples.

Conclusion: Endoluminal irreversible electroporation using tubular catheter seems safe and feasible method and has potential for non-thermal metal stent ingrowth treatment.

704.2

Percutaneous endoluminal RFA & stenting for biliary and pancreatic duct recanalization in cases of unresectable cancer of the head of pancreas

M. Mizandari¹, T. Azrumelashvili¹, N. Habib²

¹Diagnostic and Interventional Radiology, New Hospitals LTD, Tbilisi, GE,

²Surgery, Imperial College London, London, UK

Purpose: The novel technique of biliary and pancreatic duct (PD) malignant stricture recanalization is presented

Material and methods: 13 patients with inoperable cancer of the head of pancreas underwent percutaneous RF treatment attempt after preliminarily performed PTBD and PD drainage. Manipulation by 5 Fr diameter guiding catheter is used to conduct the guidewire across the biliary and PD blocked segment using mature drainage tracks. 15 Watts power was applied for 2 minutes using bipolar endoluminal RF device (Habib™ EndoHPB, EMcision Ltd., London, UK), placed in biliary and PD blocked segment according the guidewire. The number of RF application sessions depends on stricture length. After RF application and stricture balloon pre-dilatation self-expanding stents are positioned and duct patency restoration is documented by contrast injection. Procedure is completed by drainage catheters reposition in order to maintain the access.

Results: Biliary procedure was completed in all cases, PD – in 12 (92.3%) cases; biliary and pancreatic duct patency was documented in all completed cases, restoring the biliary and pancreatic fluid normal passage in duodenum. Contrast extravasation from bile duct was documented in 1 (7.7%) case after RFA processing, which was not seen after stent implantation. No major complications were observed

Conclusion: Biliary and PD percutaneous recanalization by RFA & stenting is a safe and feasible. Biliary and pancreatic fluid passage restoration regulates digestion, improving quality of life and patient's condition; RFA abscopal effect may have the positive impact activating immune response.

704.3

ReCAAP (retrograde CBD access with antegrade puncture) technique to cross challenging proximal biliary strictures

J. Kyaw Tun, M.R. Akhtar, A. Hussain, A. Antonietti, O.S. Jaffer, I. Renfrew, T. Fotheringham

Interventional Radiology, Barts Health NHS Trust, London, UK

Purpose: Proximal biliary strictures, which cannot be crossed via antegrade percutaneous access or ERCP are a significant challenge. Surgical bypass is often not feasible due to advanced disease or hostile abdomen. Alternatives such as EUS guided extra-anatomical hepatico-gastric stenting have been suggested but can be problematic in terms of stent migration, bile leak and gastric content reflux. We report our experience in the ReCAAP technique – combined antegrade transhepatic access with retrograde CBD puncture to allow for anatomical drainage and stenting.

Material and methods: Between 2015 and 2018, the ReCAAP technique was performed in 3 patients (1 post cholecystectomy stricture, 2 malignant hilar strictures), who previously had repeated failed canalisation of their proximal biliary stricture via transhepatic approach and ERCP. For the ReCAAP technique, transhepatic access was obtained with a conventional approach under ultrasound and fluoroscopy. Retrograde CBD puncture was performed with a 22-gauge needle under US and fluoroscopic guidance. CBD access sheath size was 4Fr (2 patients) to 6Fr (1 patient). An 0.18 guidewire is then passed retrograde through the stricture and snared from above for through and through access allowing for anatomical drainage or stenting.

Results: The ReCAAP procedure was technically successful in all 3 patients and anatomical drainage and stenting was achieved. No bile leak was detected both clinically and on check cholangiogram.

Conclusion: The ReCAAP technique facilitates traversing difficult hilar strictures allowing for anatomical drainage. The procedural appears to be safe with no biliary leak observed in this series.

704.4

Novel use of a disposable, single-use, digital endoscope for percutaneous transhepatic cholangioscopy: technical success, advantages, and cost comparison

R.W. England, H. Singh, A. Solomon, M. Thomas, K. Hong
Interventional Radiology, Johns Hopkins Hospital, Baltimore, MD, US

Purpose: Percutaneous transhepatic cholangioscopy (PTCS) is an emerging technique in interventional radiology, providing direct visualization of the biliary system for diagnosis and treatment. PTCS has been shown to be safe and effective, and favored especially in patients with altered anatomy prohibiting a peroral approach. In this study, single-use endoscopes were utilized for PTCS with lithotripsy to assess for advantages as compared to traditional reusable endoscopes.

Material and methods: Sixteen contiguous PTCS procedures with laser lithotripsy were performed on 10 patients from January 2018 to January 2019 using either reusable (n=7) or disposable endoscope (n=9). Technical metrics, success, complications, and cost were analyzed and compared to a commonly used reusable endoscope. Technical success was defined as biliary system access, identification of pathology, and at least partial stone removal.

Results: Single-use endoscopy performed as well or better in several performance metrics compared to reusable endoscopy, including flexion, tip deflection, irrigation flow, and ease-of-use. Fluoroscopy times were similar between reusable (12.8 minutes) and disposable (6.9 minutes, p=0.15) endoscopes. Video definition was slightly inferior in the single-use endoscope, though sufficient for all aspects of the procedure. Technical success was 85.7% (n=6) and 100% (n=9) for reusable and disposable endoscopes, respectively. There were no major complications in the perioperative period for either endoscope type. Cost analysis demonstrated a cost-per-case of \$4,934 and \$1500 for reusable and disposable endoscopes, respectively. Differences in cost were primarily due to costs for repair.

Conclusion: For patients undergoing PTCS, single-use endoscopes may provide a safe and effective alternative to reusable endoscopes, with the potential for cost savings.

704.5

Combined fluoroscopic and endoscopic approach to performing endoscopic ultrasound-guided hepatogastrostomy (EUS-HGS) in patients with malignant biliary obstruction

B. Moosavi¹, Y.-I. Chen², D.A. Valent¹, L.-M.N.J. Boucher¹, T. Cabrera¹, K. Muchantef¹, A. Bessissow¹

¹Radiology, McGill University Health Centre, Montreal, QC, CA,

²Gastroenterology, McGill University Health Center, Montreal, QC, CA

Purpose: Endoscopic ultrasound-guided hepatogastrostomy (EUS-HGS) is an alternative method for biliary drainage in patients who have failed conventional treatments. In our practice, we have developed a novel approach to perform this procedure using both EUS and interventional radiology (IR) techniques. The purpose of this study is to report on our experience using this collaborative approach for biliary drainage in patients with malignant biliary obstruction.

Material and methods: We retrospectively evaluated 6 patients who required internal biliary drainage and underwent EUS-HGS using combined transhepatic and endoscopic techniques. Patient demographics, relevant clinical history, laboratory values, and clinical and imaging information were reviewed before and after the procedure.

Results: Our patient cohort consisted of 4 males and 2 females, average age 59 (range 43-70) with malignant biliary obstruction (4 extra-hepatic, 2 hilar). Five patients had failed biliary stents. Technical success was

achieved in all patients. Average procedure time was 80.8 minutes (60-120). Average serum bilirubin level decreased from 69.1 mg/dL (14.4-133) to 20.5 mg/dL (10.5-31.3) two weeks after the procedure. Percutaneous drain was removed in all patients 5.6 days (3-8) after the procedure. Four patients were able to resume chemotherapy. Endoscopic re-intervention was required in 1 patient due to stent occlusion. Average length of hospital stay was 12 days (range 2-20). One patient developed acute cholangitis which was successfully treated with antibiotics. Average survival time after the procedure was 5.5 months (range 1-12).

Conclusion: EUS-HGS using combined transhepatic and endoscopic techniques is safe and has high technical and clinical success in relieving malignant biliary obstruction.

704.6

Biodegradable versus multiple plastic stent implantation in benign biliary strictures: A systematic review and meta-analysis

G.G.G. Almeida¹, P. Donato²

¹Faculty of Medicine, University of Coimbra, Coimbra, PT, ²Radiology, Hospitais da Universidade de Coimbra, Coimbra, PT

Purpose: Benign biliary strictures arise mostly from iatrogenic injuries during surgical procedures and various inflammatory causes. Endoscopic placement of multiple plastic stents is often regarded as the first-line therapy, albeit not without limitations. Biodegradable biliary stents present a novel therapeutic option aimed at overcoming these shortcomings. The purpose of this work was to analyze and compare long-term stricture resolution rates between biodegradable and multiple plastic biliary stent implantation in patients with benign biliary strictures, regardless of etiology.

Material and methods:

Data Sources

A systematic review of original articles was conducted on MEDLINE, EMBASE and The Cochrane Library databases. Additional studies were identified by manually searching through article references.

Eligibility Criteria

Randomized controlled trials, cohort studies and case series regarding biodegradable biliary stent and/or multiple plastic stent use in the bile duct for strictures of benign etiology were selected. Articles were excluded according to predefined criteria.

Data Extraction Methods

Two authors independently extracted the articles using predefined data fields. Any disagreements between authors on study selection were resolved by consensus.

Results: 3 studies for biodegradable stent (n = 133) and 6 for multiple plastic stent technique (n=441) met the inclusion criteria. The overall success rate (defined as no stricture recurrence during follow-up) for biodegradable biliary stent implantation was 83% (95% confidence interval [CI], 0.76–0.89), compared to 84% (95% confidence interval [CI], 0.78–0.89) in the multiple plastic stent group.

Conclusion: The insertion of biodegradable biliary stents in the treatment of benign biliary strictures does not seem to be inferior to multiple plastic stents in maintaining long-term biliary duct patency.

704.7

Preoperative virtual planning, 3D printing, and computer-assisted radiology and surgery (CARS) for intractable biliary strictures after liver transplantation

P. Huespe¹, L. Ritacco², J.C. Spina³, A.S. Oggero¹, M. de Santibañes⁴, G. Boldrini⁵, J. Pekolj⁴, D. D'Agostino⁵, M. Ciardullo⁶, E. de Santibañes⁶, S.H. Hyon¹

¹Image Guided Minimally Invasive Surgery, Hospital Italiano de Buenos Aires, Buenos Aires, AR, ²Computer Assisted Radiology and Surgery (CARS) Unit, Hospital Italiano de Buenos Aires, Buenos Aires, AR, ³Radiology Department, Hospital Italiano de Buenos Aires, Buenos Aires, AR, ⁴Hepato Pancreatic Biliary Surgery, Hospital Italiano de Buenos Aires, Buenos Aires, AR, ⁵Paediatric Gastroenterology, Hospital Italiano de Buenos Aires, Buenos Aires, AR, ⁶Liver Transplant Unit, Hospital Italiano de Buenos Aires, Buenos Aires, AR

Purpose: To describe effectiveness and safety of CARS methodology applied to intractable biliary stricture after liver transplantation.

Material and methods: Five patients with post liver-transplant biliary anastomotic stricture, refractory to multiple transhepatic and endoscopic attempts of recanalization were discussed at multidisciplinary-CARS workup meeting (including minimally-invasive surgeons, senior radiologist and CARS specialists). Three female patients (ages 5, 6, and 49-yr) had Roux-en-Y hepatojejunostomy (RYHJ), while 2 patients (1 female, 51-yr; 1 male, 78-yr) had duct-to-duct stricture. Cholangio-CT, contrast-MRCP and hepato-specific contrast-enhanced sequences were used for 3D-image reconstruction, preoperative virtual planning (PVP) and 3D printing of biliary anatomy and surrounding structures. Strategy for recanalization of RYHJ or duct-to-duct anastomosis was tailored to each case by determining spatial localization of bile duct, jejunal loop, stomach and vascular structures, as well as distance-to-target and trajectory of the needle. An Rösch-Uchida Transjugular Liver Access Set was used under US/fluoroscopy guidance. Effectiveness was defined as successful recanalization of stricture. Morbimortality was stratified according to Dindo-Clavien (D-C).

Results: Technical variants were: jejunal loop needle-access from hepatic duct (2 cases of RYHJ); transcutaneous jejunal loop access followed by guide-wire rendez-vous from biliary duct (1 case of RYHJ); gastric needle-access from hepatic duct (1 case of duct-to-duct); and percutaneous/endoscopic choledochostomy (1 case, duct-to-duct). All procedures successfully recovered biliary patency (duct-to-jejunum, duct-to-stomach, or duct-to-duct). No procedure-associated complications occurred (e.g., bleeding, bile leak, intestinal perforation). One patient had transient sepsis due to multiresistant bacteria.

Conclusion: Computer-assisted radiology and surgery (CARS) methodology applied to the treatment of complex cases of biliary stricture may be effective and safe.

Free Paper Session

Non-vascular interventions

705.1

Computed tomography guided percutaneous radiofrequency ablation of the splanchnic nerves for pain reduction in patients with pancreatic cancer: a single center study

M. Ioannidi¹, A. Mazioti², L. Reppas², A.D. Kelekis¹, E. Brountzos², N.L. Kelekis², D.K. Filippiadis²

¹2nd Department of Radiology, National and Kapodistrian University of Athens, ATTIKON University General Hospital, Athens, GR, ²2nd Department of Radiology, ATTIKON University General Hospital, Athens, GR

Purpose: To retrospectively evaluate the efficacy and safety of percutaneous computed tomography (CT)-guided neurolysis of splanchnic nerves

using continuous radiofrequency (RFSN) for pain reduction in patients with pancreatic cancer.

Material and methods: Institutional database research identified 12 consecutive patients with pancreatic cancer and pain refractory to conservative medication who underwent RFSN procedure. In all patients percutaneous neurolysis was performed with a bilateral posterolateral paravertebral approach at T12 level using a 20 Gauge Radiofrequency cannula with an 1cm active tip electrode (Diros OWL® RF Probe, Diros Technology Inc, Ontario, Canada). Self-reported pain scores were assessed before and at the last follow-up using a pain inventory with numeric visual scale (NVS) units (average follow-up 6.2 months). Additionally the length of decreased pain period as well as complications and analgesics usage were evaluated.

Results: Mean patient age was 63.81 years (male-female: 7-5). Mean pain score prior to RFSN was 9.58 NVS units. This score was reduced to a mean value of 3.75 NVS units. Median follow-up was 6.2 months. All patients reported significantly reduced analgesic usage. A single grade 2 complication (pneumothorax) was reported according to the CIRSE classification system.

Conclusion: Radiofrequency ablation of the splanchnic nerves is a minimally invasive, safe and effective procedure for pancreatic cancer pain relief. RFSN can be an attractive alternative to celiac plexus neurolysis in these patients. A larger, randomized trial is justified to substantiate these findings.

705.2

CT-guided gasserian ganglion continuous radiofrequency ablation for the treatment of trigeminal neuralgia

M. Tsitskari¹, P. Zavridis², D.K. Filippiadis¹

¹2nd Department of Radiology, Unit of Interventional Radiology, ATTIKON University General Hospital, Athens, GR, ²Anaesthesiology Department, American Medical Center, Nicosia, CY

Purpose: Trigeminal neuralgia (TN) is a neuropathic pain condition affecting the face with a significant impact on the quality of life and physical function of patients. The purpose of this pilot study was to test the feasibility and provide preliminary data on the safety and efficacy of CT-guided, percutaneous continuous radiofrequency ablation of the gasserian ganglion, for trigeminal neuralgia non responsive to conservative management.

Material and methods: From 09/2016 to 06/2018 we treated 32 patients with intractable trigeminal neuralgia with CT-guided, percutaneous continuous radiofrequency ablation of the gasserian ganglion. All procedures were performed under local anesthesia and sedation. A radiofrequency 22 gauge hybrid cannula with 5mm active tip was placed with its tip within the foramen ovale ipsilateral to the affected site. Motor and sensory test was performed to confirm the right placement of the needle. A post procedure CT was obtained to exclude any complications.

Results: 26/32 patients mentioned significant immediate and sustained pain relief (>80% pain relief) after the procedure. 5/32 patients mentioned moderate pain relief (30-50%) while one patient had only minimal clinical improvement (<20% pain relief). This patient refused reintervention. The rest 5 patients underwent a second session of pulsed radiofrequency with >80% pain relief. No complication was observed. At 12 months there was one recurrence that was retreated with cessation of the pain. Median follow up was 16 months.

Conclusion: CT-guided gasserian ganglion continuous radiofrequency ablation is an effective treatment for trigeminal neuralgia non responsive to medical treatment. Results are durable to at least 1 year. Risk profile is low.

705.3

Percutaneous sclerotherapy of head and neck cystic malformations: ten years experience

I. Paladini¹, R. Menozzi¹, A. Gritti², A. Gemignani¹, A. Andreone¹, E. Epifani¹, C. Marcato³

¹Radiologia Interventistica, Azienda Ospedaliero-Universitaria di Parma, Parma, IT, ²Chirurgia Maxillo-Facciale, Azienda Ospedaliero-Universitaria di Parma, Parma, IT, ³Department of Radiology, University of Parma, Parma, IT

Purpose: To evaluate the therapeutic effect of head and neck cystic malformations treatment by percutaneous injection of sclerosant agents and their recurrence depending on histological nature and site of the lesion.

Material and methods: Between January 2007 and December 2017, 26 lymphangiomas, 11 salivary epithelial duct cysts, 12 salivary mucocoeles, 5 branchial cysts were treated percutaneously by injection of sclerosant agents (Picibanil, Bleomycin, alcohol). Radio-Pathologic correlations and disease recurrence were evaluated.

A 70% reduction of the lesion size was regarded as a satisfactory clinical outcome. Aesthetic effect was estimated by using ANA scale score, life impact and clinical pain by using quality of Life and VAS score.

Results: Satisfactory reduction was recorded in 100% of lymphangiomas; number of the reinterventions was positively correlated to number of lesions ($r = 0.88$). A better treatment response was observed in macrocystic lymphangiomas, as compared to either microcystic or micromacrocystic subtypes. Aesthetic improvement was 5 ANA scale points, with 5.87 VAS points and 3.33 QoL points improvement.

Satisfactory reduction was recorded for 100% of salivary epithelial ductal cysts, with an aesthetic improvement of 5.75 points, with 5.0 VAS points and 4.13 QoL points improvement.

Mucocoeles and branchial cysts showed a worse response. Only 25% of mucocoeles had satisfactory size reduction with 5.4 ANA points and 4 QoL points improvement, while all branchial cyst had a temporary clinical response.

Conclusion: Percutaneous sclerosant treatment seems effective for all histological types of lymphangiomas and salivary epithelial duct cysts. This is not true for both mucocoeles and brachial cysts.

705.4

Image-guided percutaneous sclerotherapy of orbital low flow vascular malformations

O. Abdelaziz¹, K. Ellessawy², F. Hassan¹, S. Emad-Eldin³, R. Ellessawy²

¹Interventional Radiology, Cairo University Hospitals, Cairo, EG, ²Ophthalmology, Cairo University Hospitals, Cairo, EG, ³Radiology, Cairo University Hospitals, Cairo, EG

Purpose: To evaluate the effectiveness and safety of percutaneous sclerotherapy using bleomycin for orbital low flow vascular malformations.

Material and methods: Between October 2015 and November 2018, we prospectively evaluated 24 patients who clinically and radiologically diagnosed with orbital low flow vascular malformations. Sixteen females and 8 males were included in the study; they range in age from 3 to 50 years (mean: 19 ± 15).

All patients were treated with percutaneous sclerotherapy. Ophthalmological assessment, Ultrasound, and contrast-enhanced MRI were performed before and 6 weeks after treatment.

Under general anesthesia, orbital lesions were punctured guided by ultrasound, fluoroscopy and cone beam CT. Prior to sclerotherapy, a small volume of Omnipaque was injected to exclude vascular communication or contrast leakage, then bleomycin was instilled. Procedures were repeated at 8-week intervals, depending on clinical and radiological response. The follow-up period ranges from 2-40 months, mean: 15.8 ± 11.6 .

Results: final diagnoses of the patients were: (lymphatic malformations, $n=15$, venous malformations $n=6$, veno-lymphatic malformations $n=2$ and orbital varix $n=1$). Thirty-five sclerotherapy sessions were performed, (range: 1-3, mean: 1.52, SD: 0.73). After treatment, there was a significant reduction in the proptosis ($P=0.006$) and dystopia ($P=0.016$), with no significant changes in the visual acuity. Additionally, we found a significant reduction in the lesions diameters and volumes ($P=0.005$ and 0.005 respectively) on MR images. Transient edema and ecchymosis occurred following the procedure with no major complications encountered.

Conclusion: Intralesional Bleomycin therapy is a safe and effective first choice treatment for orbital low flow vascular malformations, with high rate of clinical and radiological outcomes.

705.5

Radiofrequency treatment of benign symptomatic thyroid nodules: initial success experience of a Latin American reference center

A. Rahal Jr¹, E.M. Volpi², P.M. Falsarella¹, J.T. Hidal³, G.C. Mariotti¹, G. Mendes¹, M.R.G. Queiroz¹, R.G. Garcia¹

¹Interventional Radiology, Hospital Israelita Albert Einstein, São Paulo, BR, ²Head and Neck Surgery Department, Hospital Israelita Albert Einstein, São Paulo, BR, ³Department of Endocrinology, Hospital Israelita Albert Einstein, São Paulo, BR

Purpose: Radiofrequency (RFA) applied to hepatic, renal, and pulmonary tumors is well established in medical literature. Much more recent is the application of RFA in benign symptomatic thyroid nodules as minimally invasive alternative to surgery, with lower costs and greater acceptability. The commercialization of radiofrequency probes in Latin America is recent. In Brazil the first cases of thyroid nodule submitted to RFA was in March 2018. The purpose of this study is to describe the initial results.

Material and methods: Single-center, prospective study including 20 patients. RFA of benign thyroid nodules, confirmed with at least 1 fine needle puncture (FNA), all of them symptomatic (moderate to severe cosmetic effect, compression of adjacent structures, compression sensation). 19 nonfunctioning nodules and 1 hot nodule with TSH <0.05 mIU / L were treated. Trans-isthmus access and moving shot technique. Volumes of the nodules were evaluated before the procedure and after 1, 3, 6 and 11 months.

Results: Patients age ranged from 24 to 88 years old. 19 female patients, 1 male. Volume of treated nodules ranged from 6.0 cc to 72.0 cc. 19 cases treated in a single session. 1 case treated in 2 sessions. Mean reduction of 42% in the first month, 59% in the third month, 78% in the sixth month and 89% in the eleventh month. No complications. Small cutaneous hematomas with remission within 2 weeks were considered minor events expected.

Conclusion: RFA of symptomatic benign thyroid nodules is a safe, effective and non-invasive therapeutic alternative. The initial experience of our group showed very favorable results.

705.6

IR and EUS guided gastro-jejunal bypass: the McGill experience

A. Ngo¹, Y.-I. Chen², D.A. Valenti¹, L.-M.N.J. Boucher¹, T. Cabrera¹, K. Muchantef¹, A. Bessissow¹

¹Radiology, McGill University Health Centre, Montreal, QC, CA, ²Gastroenterology, McGill University Health Center, Montreal, QC, CA

Purpose: Interventional Radiology and endoscopic ultrasound (EUS) guided gastro-jejunal stenting has emerged as an important treatment option for patients with gastro-duodenal obstruction unsuitable for surgical bypass, or where an endoluminal approach has failed.

We wish to share our early experience and report outcomes for the procedure, practiced at McGill since 2017.

Material and methods: A retrospective review of all patients treated with IR and EUS guided gastro-jejunal stenting at our institution was

performed. Outcomes included safety, technical success, clinical success, length of hospital stay and mortality.

Results: Nine patients were treated since the development of the service. All patients had malignant etiologies of gastro-duodenal obstruction. Three had prior failed duodenal stent placement.

Five patients were treated from a percutaneous transhepatic access and 4 perorally. Placement of a self-expanding fully covered metal stent was successful in 8 of 9 cases. One technical failure was encountered due to colonic interposition between the stomach and jejunum preventing bypass. There were no procedural complications.

Clinical success (return to oral diet) was seen in 6 out of 8 patients. Median length of hospital stay following stenting was 7 days (range 5 – 63). Median number of days prior to a return to oral diet was 1 (range 1 – 2). Six of 8 patients returned to a low residue diet. Thirty-day mortality was zero.

Conclusion: We have demonstrated joint IR/EUS guided gastro-jejunal stenting to be safe and efficacious. The collaboration between the IR and Gastroenterology departments is essential to ensure the efficient, safe and successful outcome of the procedure.

705.7

Safety of lusutrombopag for thrombocytopenia in patients with chronic liver disease undergoing an invasive procedure: pooled safety data from 3 studies

R.S. Brown, Jr.¹, N. Izumi², T. Kano³, T. Ochiai⁴, M. Kurosaki², F. Violi⁵, P. Shrestha⁶

¹Division of Gastroenterology and Hepatology, Weill Cornell Medical College, New York, NY, US, ²Department of Gastroenterology and Hepatology, Musashino Red Cross Hospital, Tokyo, JP, ³Global Project Management Department, Shionogi & Co., Ltd., Osaka, JP, ⁴Biostatistics Center, Shionogi & Co., Ltd., Osaka, JP, ⁵Dipartimento di Medicina Interna e Specialità Mediche, Sapienza Università di Roma, Rome, IT, ⁶Product Safety and Pharmacovigilance, Shionogi Inc., Florham Park, NJ, US

Purpose: Lusutrombopag (LUSU) is a thrombopoietin receptor agonist (TPO-RA) approved in Japan and the US for treatment of thrombocytopenia (TCP) in patients with chronic liver disease (CLD) who are scheduled to undergo an invasive procedure. Treatment with TPO-RAs has been associated with an increased risk of thrombotic events in patients with CLD. A pooled analysis was performed to assess safety of LUSU.

Material and methods: Safety data from 3 double-blind, randomized, placebo-controlled studies in patients with CLD and TCP undergoing a planned invasive procedure (Phase 2b: M0626, Phase 3: L-PLUS 1 and L-PLUS 2) were pooled. Adults with a baseline platelet count (PC; $\times 10^9/L$) < 50 received LUSU 3 mg or placebo for ≤ 7 days before a procedure scheduled 9-14 days after randomization. Platelet transfusion (PT) was mandated for PC < 50 immediately prior to procedure. Adverse event (AE) data were collected from signing of informed consent through final visit.

Results: In the pooled safety population (N=341 [n=171, LUSU; n=170 placebo]), 65.5% (112/171) of LUSU patients and 67.6% (115/170) of placebo patients experienced an AE. Thrombotic and thromboembolic AEs occurred in 1.8% (3/171) of LUSU patients and 2.4% (4/170) of placebo patients. Overall, bleeding-related AEs occurred in fewer LUSU (15 [8.8%]) vs placebo patients (27 [15.9%]). Three AEs leading to death in the LUSU group were not considered treatment-related but due to progression of underlying/concomitant disease.

Conclusion: In this pooled analysis, LUSU was safe and well-tolerated in patients with TCP and CLD undergoing invasive procedures, with approximately 50% fewer bleeding-related AEs associated with LUSU vs placebo.

Free Paper Session Radiation safety issues

706.1

Advanced robotic angiography systems for image guidance during conventional transarterial chemoembolization: impact on radiation-dose and image-quality

L.S. Alizadeh¹, T.J. Vogl², R. Maeder¹, N.N. Naguib¹

¹Institute for Interventional and Diagnostic Radiology Frankfurt, University Hospital Frankfurt, Frankfurt, DE, ²Institut für Diagnostische und Interventionelle Radiologie, Klinikum der Johann Wolfgang Goethe-Universität, Frankfurt, DE

Purpose: To compare two advanced robotic angiography systems for real-time image guidance in terms of radiation-dose and image-quality(IQ) during conventional transarterial chemoembolization(C-TACE) of hepatic malignant tumors.

Material and methods: One hundred six patients(57 women/49 men; mean age, 60 $\pm$ 11 years) who had undergone C-TACE using 2 generations of robotic angiography platforms for image guidance were included in this retrospective study. Patients were divided into 2 groups(n = 53, respectively): group-1(first-generation) and group-2(second-generation). Radiation-dose for fluoroscopy and digital subtraction angiography(DSA) was compared between first-generation and second-generation angiography equipment, respectively. Among several features of the second-generation compared with the first-generation system, improvements included a refined crystalline detector system for enhanced noise reduction and advanced CARE-filter software for lowering radiation-dose. Radiation-dose was measured using an ionization chamber. Image-quality was assessed by 3 radiologists using 5-point Likert scales.

Results: Both groups were comparable in terms of number and location of lesions, as well as body weight, body mass index, and anatomical variants of feeding hepatic arteries(all P > 0.05). Dose-area-product(DAP) for fluoroscopy was significantly lower in group-2(1.4 $\pm$ 1.1Gy-cm) compared with group-1(2.8 $\pm$ 3.4Gy-cm; P=0.001). For DSA, DAP was significantly lower(P=0.003) in group-2(2.2 $\pm$ 1.2Gy-cm) versus group-1(4.7 $\pm$ 2.3Gy-cm). Scores for DSA-IQ indicated significant improvements for group-2 by 30% compared with group-1(P=0.004). Regarding fluoroscopy, IQ-scores were 76% higher in group-2 compared with group-1(P=0.001). Good to excellent interrater agreement with Fleiss-kappa-coefficients of $\kappa=0.75$ for group-1 and $\kappa=0.74$ for group-2 were achieved.

Conclusion: Most recent generation robotic angiography equipment allows for considerable radiation-dose reductions while improving IQ in fluoroscopy and DSA image guidance during C-TACE treatment.

706.2

Chronic radiodermatitis following interventional radiology

J. Guersen¹, M. Guesnier², L. Cassagnes¹, B. Pereira¹, P. Motreff³, P. Chabrot¹, L. Boyer⁴, M. D'Incan²

¹Radiology, University Hospital, Clermont Ferrand Cedex, FR, ²Dermatology, University Hospital, Clermont Ferrand Cedex, FR, ³Cardiology, University Hospital, Clermont Ferrand Cedex, FR, ⁴Service de radiologie B, Clermont Ferrand University Hospital, Clermont-Ferrand, FR

Purpose: To evaluate the incidence of chronic radiodermatitis after interventional radiology procedures in a selected population with significant dosimetric risk.

Material and methods: From 2010 to 2016, in our institution, patients were selected after radiological or cardiological interventional procedures in case of radiodermatitis risk (Peak Skin Dose (PSD) > 3Gy or Product Dose Area (PDA) > 500Gy.cm² or air Kerma > 5Gy or fluoroscopic time > 60min). These patients were evaluated by a dermatologist looking for radiodermatitis.

Results: One of the 4 criteria was achieved for 359 patients out of 55782. 91 were evaluated (129 died, 57 unreachable, 82 refused). 8 patients had evidence of chronic radiodermatitis (8.8%), and 21 reported an acute episode. Elevated PDA and air Kerma were statistically related to the occurrence of radiodermatitis; fluoroscopic time did not show any impact. These 8 patients had a significantly high BMI.

Conclusion: This incidence, even if higher than literature (perhaps because of the preselection according to the doses and the clinical examination), remained relatively low. But dermatological diagnosis takes place usually too late: the treatment of chronic radiodermatitis must be early undertaken, in order to avoid progression to ulcerative sclerosis, meaning the need for prospective follow-up of patients with identified risk.

706.3

Surfacer inside out system - single center use demonstrates safe and effective performance and significant reduction in radiation in comparison to standard recanalisation procedures in total central venous occlusion

T.M. Steinke, L. Nuth

Vascular and Endovascular Surgery, Schoen Klinik Duesseldorf, Duesseldorf, DE

Purpose: To report the results of the prospective, singlecenter, observational registry for the treatment of patients with limited or diminishing upper body venous access or pathology impeding standard access methods.

Material and methods: The purpose of this registry is to assess the clinical outcomes of the Surfacer-Inside-Out-Access-Catheter-System used in clinical routine according to the approved commercial indications. The Surfacer System is a novel device designed to facilitate reliable upper body central venous access suitable for patients with upper body venous occlusions or other conditions that preclude central venous access by conventional methods. 14 patients were enrolled between Oct.-2016 and Nov.-2018. Patients are presented with a variety of occlusion types, including bilateral internal jugular (BIJ) and subclavian (SC) occlusion, brachiocephalic (BC) occlusion, superior vena cava (SVC) occlusion above the azygos and patients with total occlusion of the SVC.

Results: In all patients enrolled in the registry, central venous catheters were placed according to labeled indications with a 100% success in achieving patency and access. Absence of adverse events in data reported for all treated patients. All primary safety and performance endpoints were met. Mean fluoro-time was 3,26min (max. 6,54min, min. 1,33min.) and the launch of the surfacer inside out system reduced the radiation exposure with an average of 5,163 Gy/cm² (minimal 1,7, maximum 29,2, median 3,05 Gy/cm²). This shows a remarkable reduction in intraoperative radiation dose and fluoro-time in comparison to standard recanalisation procedures in central venous occlusion.

Conclusion: Positive results were demonstrated supporting the safety and clinical utility of the Surfacer-Inside-Out-Access-Catheter-System including a reduction in intraoperative radiation dose and fluoro-time.

706.4

Radiation protection - why take the risk? A study utilising real-time dose monitoring

C. Aleman, K. Harborne, W.R. Thomas, G. Hickson

Interventional Radiology, University Hospital Birmingham, Birmingham, UK

Purpose: A recent study demonstrating DNA damage in operators prompted us to review our radiation practices. Standardised dose monitoring (typically a thermoluminescent dosimeter) gives an average dose over a given time period and does not identify individual cases where more damage may occur. We investigated real-time dose monitoring as a tool to improve practices in our department.

Material and methods: Real-time radiation dosimeters (RaySafe™) were worn by staff during IR procedures. For two cohorts patient dose area product (DAP), radiation protection measures, and individual staff doses were recorded. The first cohort required staff to be blinded to their real-time dose. The second cohort was completed 6 months later with staff non-blinded.

Results: 94 cases were analysed, first cohort n = 45, second cohort n = 49. Poor compliance with patient level 'flip-up lead' was a significant contributor to staff dose in the first cohort. Compliance increased in the second cohort. In cohort one there were 13 instances of staff doses > 50μSv, 6 of >100μSv, and 1 of >500μSv per case, in cohort two there were 7 instances of staff doses >50μSv and 3 of >100μSv per case. The highest operator doses did not correlate well with the highest patient DAP.

Conclusion: Real-time dose monitoring empowers staff to identify problems with radiation protection and reduce their risk. Analysis of our data (particularly outlying cases) shows high staff doses may not always arise where expected, revealing unexpected ways to reduce dose.

706.5

Radiation exposure in prostatic artery embolization (PAE) dependent of the interventional radiologist - implication on the procedure and protocol optimization

M. Zeile¹, R.M. Wentz¹, D. Rothfuchs¹, M. Karul¹, H.D. Nagel², C.R. Habermann¹

¹Institute of Diagnostic and Interventional Radiology, Kath. Marienkrankenhaus, Hamburg, DE, ²SASCRAD, Wissenschaft & Technik für die Radiologie, Buchholz, DE

Purpose: PAE may produce high radiation exposure (RE). The aim of the study was to evaluate dose protocols based on the differences between four experienced interventional radiologists (IRs) to potentially reduce RE. The results were compared to the data from the UK-ROPE study.

Material and methods: Between May and September 2018, 73 PAE procedures were performed. Fluoroscopy time (FT), number of DSA images, amount of cone-beam computed tomography (CBCT) series, dose area product (DAP), skin dose (SkD) and effective dose (EffD) were acquired from dose protocols. Using a calculation model, the best individual parameters from each IR and a virtual optimization of CBCT were implemented to calculate the potential radiation dose savings.

Results: Mean DAP was 7,261 cGycm², mean SkD amounted for 982 mGy and mean FT was 45.2 mins. Compared to the UK-ROPE study, our mean DAP was 59% lower and mean SkD was reduced by 28% despite a 19% longer mean FT (17,892 cGycm²; 1,368 mGy and 38.0 min respectively). CBCT amounted for 58% of the total DAP in our patients (4,211 cGy cm²) whereas Fluoroscopy accounted for 26% (1,909 cGycm²) and DSA for only 15% (1,119 cGycm²). Comparing each parameter for every IR individually, significant differences were observed. Theoretically, applying the calculation model, RE reduction of 57% seemed possible.

Conclusion: In a high-volume PAE center, significantly lower RE is achievable than recently published in the UK-ROPE study. The main factor for RE showed to be the CBCT. Optimization of IR behavior and CBCT protocol may additionally reduce RE by up to 50%.

706.6

Investigating the clinical value of pelvic parametric X-ray angiography for image guidance in prostatic artery embolization

L.S. Alizadeh¹, T.J. Vogl¹, D. Szöllösi², M. Gyánó³, K. Szigeti², S. Osváth², J.P. Kiss⁴, V.I. Óriás³

¹Institute for Interventional and Diagnostic Radiology, University Hospital Frankfurt, Frankfurt, DE, ²Department of Biophysics and Radiation Biology, Semmelweis University, Budapest, HU, ³Heart and Vascular Center, Semmelweis University, Budapest, HU, ⁴Scientific Dept., Kinépic Health Ltd, Budapest, HU

Purpose: A major challenge in Prostatic-Artery-Embolization (PAE) is adequate and distinct visualization of the feeding prostatic vessels and other branches of the iliac arteries. Color-coded parametric images calculated from raw angiographic image data provide additional information, compared to standard Digital-Subtraction-Angiography (DSA). Our objective was to investigate the clinical value of parametric images in PAE setting.

Material and methods: We retrospectively examined the selective internal iliac artery image series of 15 patients (mean-age:67.47; SD:9.76, range 42-82) undergoing PAE. We generated 60, parametric, color-coded delay angiograms (CDAs) from raw image-data obtained from a latest-generation angiography system. Then, three experienced interventional radiologists evaluated image-quality for both image-data using a 5-point-Likert scale, based on clinically relevant criteria (identification of dominant feeding arteries, stenoses, collaterals to rectum or pubic areas).

Results: Subjective image-quality was evaluated with mean scores of 4.16 (range3-5;std.deviation+/-0.73) significantly higher for DA compared to mean scores of 3.43 (range2-5;std.deviation+/-1.80) for standard DSA. The evaluators agreed that 1.) CDAs provided more information than the simple BW angiograms (87%); 2.) the image would be useful to select the dominant feeding artery (93%); 3.) the functional stenoses of the branches could also be determined (84%). The interrater agreement, Fleiss' kappa and significance were 1.) 81%, 0.19, p<0.05 2.) 85%, 0.32, p<0.01 and 3.) 79%, 0.11, p<0.05, respectively.

Conclusion: We can conclude that parametric delay images calculated from X-ray angiography series provide more information than standard angiograms and hold additional information about the branches of the internal iliac artery, although decision-making solely based on CDAs will require appropriate prospective safety assessment.

706.7

Optimizing cone-beam-CT in prostatic artery embolization (PAE) to reduce radiation exposure - proposition of a CBCT classification in PAE

M. Zeile¹, R.M. Wentz¹, D. Rothfuchs¹, H.D. Nagel², P. Steffen¹, C.R. Habermann¹

¹Institute of Diagnostic and Interventional Radiology, Kath. Marienkrankenhaus, Hamburg, DE, ²SASCRAD, Wissenschaft & Technik für die Radiologie, Buchholz, DE

Purpose: Cone-beam computed tomography (CBCT) is crucial in identifying the prostatic artery (PA) and determining non-target embolization in PAE. CBCT is also responsible for a main portion of radiation exposure during the procedure.

Material and methods: Between January 2017 and January 2019, 328 PAE procedures were performed at our institution. During the given time period, the way CBCT was performed changed significantly. First, it was used "out of the box" without cranio-caudal collimation (Stage 1). Late 2017, cranio-caudal collimation was introduced (Stage 2) followed by reducing the field of view from 48 cm to 42 cm (Stage 3). Late 2018, an additional 0.1 mm copper filter was introduced (Stage 4). Radiation exposure, measured by the dose area product was recorded for each CBCT series as well as the whole procedure. Each series was referred to one of 4 groups (1 to 4) depending on the abovementioned optimization stage.

Results: Comparing each subsequent stage, with every optimization step radiation exposure was reduced significantly ($p < 0.05$). Overall reduction of radiation exposure (RE) measured by DAP from Stage 1 to Stage 4 was lowered more than 80% leading to an above 50% reduction procedure related RE. Depending on the most cranial margin of CBCT, a classification was introduced as a process of standardization as each of those demands different contrast protocols: Overview-CBCT (aortic bifurcation), Search-CBCT (anterior trunc of the internal iliac artery) and Target-CBCT (distal prostatic artery only).

Conclusion: Implementing of a few easy-to-adopt measures, radiation exposure due to CBCT can be vastly reduced.

News on Stage Embolisation

1204.1

Ethylene vinyl alcohol copolymer (Onyx) for treatment of large venous vascular malformations: long term results and histology

A.S. Gomes¹, P.A. Monteleone¹, S.V. Bukata², J.W. Sayre³

¹Radiological Sciences, David Geffen School of Medicine at UCLA, Los Angeles, CA, US, ²Radiology, David Geffen School of Medicine at UCLA, Los Angeles, CA, US, ³Radiology/School of Public Health, David Geffen School of Medicine at UCLA, Los Angeles, CA, US

Purpose: To describe the use, long term results and histologic findings of ethylene vinyl alcohol copolymer (Onyx) for treatment of large venous vascular malformations.

Material and methods: Since 2005, we have used Ethylene vinyl alcohol copolymers (Onyx 18 and /or 34) in the treatment of 66 patients (28 males) with large, low flow venous vascular malformations. Fifty malformations involved the extremities and 16 involved the chest, abdominal wall or pelvis. All patients underwent imaging pre-treatment. Onyx was delivered by direct injection with ultrasound and fluoroscopic guidance under tourniquet control. In a few cases Onyx was also delivered via a micro catheter positioned into large feeding vessels. 3% Sodium Tetradecyl foam was used with Onyx in patients with smaller associated foci of malformation. Explanted tissues were examined histologically.

Results: Onyx was found useful for occlusion of large venous lakes. It's visibility allowed monitoring of malformation filling during delivery. When used alone, there was minimal post procedure discomfort. Two complications occurred: one extrusion of Onyx from a lesion on the sole of the foot, which healed without sequelae and one embolization of a small Onyx fragment to the lung, without sequelae. On histology, the Onyx was distributed in the intraluminal spaces with associated foreign body type giant cell reaction. Permanency of the copolymer was demonstrated on long term imaging follow-up.

Conclusion: Ethylene vinyl alcohol copolymer is a safe, durable agent for treatment of venous vascular malformations. It is of particular value in malformations with large venous lakes where sodium tetradecyl may be less effective due to lesion size.

1204.2

Bronchial artery embolization for massive hemoptysis: experience from a tertiary referral center in Cape Town, South Africa

H. Chung¹, M. Wojno², K.-L. Pool³

¹Interventional Radiology, Stanford Hospitals and Clinics, Palo Alto, CA, US, ²Interventional Radiology, University of Cape Town, Cape Town, ZA, ³Radiology, University of California Los Angeles, Los Angeles, CA, US

Purpose: To characterize the safety, effectiveness, and outcomes of bronchial artery embolization for patients referred for massive hemoptysis

in a high tuberculosis burden population at a tertiary referral center in Cape Town, South Africa.

Material and methods: A single-center retrospective analysis of 95 consecutive patients referred for massive hemoptysis from 2013-2018 was performed. Twelve patients were lost to followup and excluded from outcomes analysis. Outcomes including recurrent hemoptysis, survival without re-intervention and death were tabulated. Kaplan-Meier and log-rank test analyses were performed.

Results: A total of 95 patients were referred for treatment of massive hemoptysis and underwent a total of 108 procedures. Bronchial artery embolization (BAE) was performed in the majority of cases (93%) with pulmonary artery pseudoaneurysm coiling much less common (7%). The most common underlying etiology for BAE was tuberculosis-related pathology (90%), less common causes in this population including lung cancer (3%), acute pneumonia (3%), nontuberculous bronchiectasis (3%), and bronchial artery aneurysm (1%). The rate of death during hospitalization following successful intervention was 4.3%. Overall survival was 92% during median follow-up of 66 days. Risk of clinically significant recurrent hemoptysis at 1 year by Kaplan-Meier analysis was 41.1% (CI 25.7-53.3%), although repeat bronchial artery embolization was necessary in only 10 patients (11%) during a mean followup period of 280 days. Mycetoma tended to correlate with higher risk of recurrent hemoptysis at 50.9% compared with 36.1% ($p=0.11$).

Conclusion: Bronchial artery embolization is a safe and effective therapy in the management of massive hemoptysis in a high tuberculosis burden patient population.

1204.3

Retrospective multivariate study of the clinical outcomes in patients affected by different grades of varicocele treated using different endovascular approaches

G. Bianchi¹, M.V.M. Micelli¹, P. Palumbo², A. Izzo², A.V. Giordano³, S. Carducci⁴, M. Varrasi⁵, A. Barile², C. Masciocchi²

¹Division of Radiology, Department of Biotechnological and Applied Clinical Science, University of L'Aquila, S. Salvatore Hospital, L'Aquila, IT,

²Applied Clinical Sciences and Biotechnology, University of L'Aquila, L'Aquila, IT, ³Radiology, Ospedale S. Salvatore L'Aquila, L'Aquila, IT,

⁴Biotechnological and Applied Clinical Sciences, San Salvatore Hospital, L'Aquila, IT, ⁵Neuroradiology and Interventional Radiology, S. Salvatore Hospital, L'Aquila, IT

Purpose: The aim of this study is to assess the clinical outcomes of patients affected by different grades of varicocele treated by retrograde scleroembolization.

Material and methods: 201 patients, mean age 32 years, with left varicocele and infertility were treated. Study inclusion criteria were: grade II or III left varicocele according to Dubin classification, infertility and US diagnosis of varicocele. All the patients were divided into 2 groups according to the diameter of the left spermatic vein with a cut-off of 6mm. Group 1 (123 out of 201 patients) underwent scleroembolization using 3% Polidocanol. Group 2 (76 out of 201 patients) underwent scleroembolization using 3% Polidocanol and coiling. Median follow-up time was 3 months. Clinical examination, semen specimen and Doppler US examination were compared to follow-up data.

Results: 199 patients were successfully treated. 2 patients presented intraprocedural spermatic vein rupture. Color-Doppler US examination showed an optimal resolution of reflux in testicular veins (mean value: pre-treatment 7.1 cm/s; post-treatment 1.9 cm/s). 63% of patients showed a complete resolution of varicocele. Three months follow-up semen analysis in all the patients showed an improvement in sperm motility (mean value: pre-treatment 31%; post-treatment 42%) and sperm count (mean value: 3.6 million sperm cells per ml pre-treatment; 20.9 million sperm cells per ml post-treatment).

Conclusion: varicocele embolization is minimally invasive and technically feasible procedure that improves semen quality with a high

successful rate of varicocele resolution. No differences were observed in clinical follow-up among the two groups of patients.

1204.4

Treatment of high-flow priapism: superselective arterial embolization

G. de Magistris¹, F. Pane², F. Corvino³, F. Giurazza⁴, F. Amodio¹, M. Coppola², E. Cavaglià¹, M. Silvestre⁵, G. Cangiano¹, A. Borzelli⁶, A. Paladini⁷, R. Niola¹

¹Vascular and Interventional Radiology, Cardarelli Hospital, Naples, IT,

²Advanced Biomedical Sciences, AOU Federico II Napoli, Naples, IT,

³Department of Advanced Biomedical Sciences, Diagnostic Imaging

Section, Federico II University, Naples, IT, ⁴Interventional Radiology,

Ospedale Antonio Cardarelli di Napoli, Naples, IT, ⁵Diagnostica

per Immagini e Radioterapia, AOU Federico II, Naples, IT, ⁶U.O.C.

Neuroradiologia, AORN, Naples, IT, ⁷SCDU Interventional Radiology,

"Maggiore della Carità" Hospital, Novara, IT

Purpose: To retrospectively evaluate the efficacy of colorDoppler-Ultrasoundography (cD-US) detectability and the safety of transcatheter arterial Embolization for High-Flow Priapism (HFP)

Material and methods: Over a 10-year period (2008-2018), 9 patients (mean age 33 years; range 12-65 years) admitted to our department with traumatic HFP, were reviewed. Patients were evaluated with clinical and cD-US imaging findings. Diagnostic Angiography demonstrated fistulas between the cavernosal artery and the corpora cavernosa. The embolic agents used to embolize these leakages were coils, PVA, gelatin sponge. A cD-US follow-up was performed 24 hours after embolization and patients were followed up by the urologist service at 1-6 weeks and 6 months

Results: At the admittance, cD-US detected pseudoaneurysms/fistulas in all patients. In 5 patients a single side embolization was sufficient for complete resolution; 4 patients presented with bilateral angiographic extravasation of contrast material. 2 patients had recurrence of Priapism (confirmed by cD-US Imaging) in the subsequent 1-3 weeks and required a second embolization session. 6 patients were embolized with microcoils, 2 with PVA and 1 with spongel. cD-US confirmed the absence of fistula and recanalization of the embolized cavernosal artery at follow-up. All patients reported normal erectile function at 6 months

Conclusion: cD-US is useful to detect fistulas and to monitor the effectiveness of procedure. Superselective transcatheter embolization of the internal pudenda artery is an effective strategy and has a high rate of preserving erectile function in patients affected by High-Flow Priapism.

1204.5

Diagnosis and management of thoracic and shoulder arteriovenous malformations

W.F. Yakes

Interventional Radiology, The Yakes Vascular Malformation Center, Englewood, CO, US

Purpose: To determine the efficacy of Endovascular Repair of Thoracic and Shoulder AVMs. Previous reports have documented the utter futility of Onyx, Coils, and nBCA and amputation of the extremity was required.

Material and methods: 13 patients (9f, 4m) presented for repair of shoulder and thoracic AVMs. 3 had extension of AVM to the supraclavicular and axillary areas. 3 had multiple AVMs. 7 had previous failed therapies (PVA/coils/gelfoam; Onyx, nBCA; surgeries: excisions/arterial bypass). All patients underwent ethanol endovascular AVM repair; 4 had additional coil embolizations (132 treatments). Patient age range 18-76 years; mean age 36.

Results: 12 patients cured at long-term arteriographic follow-up (follow-up 22 – 192 months; mean follow-up: 42 months). 1 patient with bilateral shoulder AVM and multiple other AVMs therapy is on-going. Complications include 2 with minor superficial blisters, 1 patient with

transient left radial nerve injury with complete recovery and 1 patient with clot embolus to hand, Rx with urokinase w/distal 3rd phalanx removed. Thus, major complications were 2/132 procedures, 1 being transient. 1 patient at 27-year arteriographic follow-up remains cured.

Conclusion: A JVIR report of shoulder AVM endovascular repair documented total failure of the current approaches even when coupled with shoulder quadrant amputation whereby recurrence was universal. These authors stated that shoulder AVMs were not possible to treat. No other publications in the world literature documents cure of AVMs in this anatomy consistently. Long-term cures are noted with the use of ethanol, and ethanol and coils to successfully treat these complex, problematic lesions. This patient series finally documents a curative procedure for this daunting lesion.

1204.6

Percutaneous glue embolisation as a primary treatment for visceral pseudoaneurysms

U. Gorski¹, V. Bhatia¹, N. Kalra², M. Kang¹, M.S. Sandhu¹

¹Radiodiagnosis, Post-graduate Institute of Medical Education and Research, Chandigarh, IN, ²Radiology, Post Graduate Institute of Medical Education and Research, Chandigarh, IN

Purpose: To evaluate the feasibility and outcome of percutaneous glue embolisation as primary treatment for pseudoaneurysms in selective patients

Material and methods: A review of the pseudoaneurysm cases managed with direct percutaneous glue injection at our institute was done in this study. A total of 21 patients over a period of last one year who were treated for pseudoaneurysm at varied sites primarily with percutaneous n-butyl cyanoacrylate were retrospectively evaluated. Site of pseudoaneurysm was Pulmonary (7 cases), renal (4 cases), pelvic (4 cases) and miscellaneous abdomen (6 cases). Combined ultrasound and fluoroscopy approach was used in 17 cases, CT guidance in 3 cases and combined ultrasound and CT guidance in 1 case. Patients were evaluated for therapeutic response (radiological and clinical) and procedure related complications.

Results: Complete occlusion of the pseudoaneurysm was seen in all patients. Two patients showed mild pneumothorax and one patient showed reflux into the intercostal artery. All the patients showed symptomatic improvement and discharged in stable condition

Conclusion: Percutaneous glue embolisation of the pseudoaneurysms as a primary treatment is feasible and can be safely carried out in select group of patients with good therapeutic response and minimal complications

Free Paper Session

Ablation of liver tumours

1406.1

Radiofrequency versus microwave liver ablation: intermediate analysis of a randomized clinical trial

A. Radosevic¹, R. Quesada², A. Zugazaga¹, J. Sanchez Parrilla¹, F. Burdío³

¹Radiology, Hospital del Mar, Barcelona, ES, ²Localized Hyperthermia Therapy, Fundació IMIM, Barcelona, ES, ³Surgery, Hospital del Mar, Barcelona, ES

Purpose: This randomized study (ISRCTN73194360) aims to evaluate the safety and performance of the Radiofrequency ablation (RFA) compared to microwave ablation (MWA) systems treating hepatocarcinoma (HCC) and liver metastases (LM).

Material and methods: During Phase II of this study, after including more than half of the calculated sample size, 65 patients (48 HCC/17 LM)

were treated by RFA (n=22/9) or MWA (n=26/8) and followed every three months by CT. RFA was performed with a new RF-hybrid applicator (cool-tip with hypertonic saline infusion). Local hepatic recurrence, overall survival (OS) and survival free of hepatic recurrence (SFHR) were observed. Hospital stay (HS) and rate of complications (RC) were reported.

Results: Sixty-four nodules larger than 1.5 cm were treated. The mean number of ablations/nodules was similar among groups (1.9 ± 0.2 vs 1.9 ± 0.2 for RFA and MWA, respectively). The mean ablation time/nodule was not statistically different (10.7 ± 1.2 min vs 8.7 ± 0.8 min). There were two major complications in group RF and one in group MW. HS (2.4 ± 0.6 vs 3.2 ± 0.9 days) was also similar. There was no residual activity at 1-month control scan in 94.7% of patient treated with RFA and in 97.5 % of patients treated with MWA. With a mean follow-up of 35.7 months, the mean OS and SFHR were similar among groups RFA/MWA (36.6 vs 31.4 months and 25.5 vs. 27.1, respectively). Local hepatic recurrence was also similar (4 and 6 patients, respectively).

Conclusion: These preliminary results suggest that this RFA system is as safe and effective as MWA.

1406.2

Comparison of microwave and radiofrequency ablation for the treatment of liver metastases: randomized prospective study (MIRA study)

T.J. Vogl¹, Y. Jaraysa¹, S. Martin¹, A. Mehmedovi¹, N.-E.A. Nour-Eldin², T. Gruber-Rouh¹, R. Hammerstingl²

¹Institut für Diagnostische und Interventionelle Radiologie, Klinikum der Johann Wolfgang Goethe-Universität, Frankfurt, DE, ²Interventional and Diagnostic Radiology Department, Johann Wolfgang Goethe University, Frankfurt, DE

Purpose: To prospectively compare therapy response and safety of microwave (MWA) and radiofrequency ablation (RFA) for the treatment of liver metastases.

Material and methods: Fifty patients with liver metastases (27 females, 23 males, mean: 62.8 ± 11.8 years, range: 40-91) were randomly assigned to MWA or RFA for thermal ablation. MRI was acquired before treatment and 24h post ablation. The location of the liver metastases and the morphologic response to treatment regarding size, volume, necrotic areas, and diffusion characteristics were evaluated by MRI. During the follow-up period of one year, all patients were examined in three-month intervals.

Results: Overall, 50 hepatic lesions with a mean diameter of 1.6 cm (MWA 1.7 cm, RFA 1.5 cm) were treated with thermal ablation. Twenty-six patients received MWA and 24 patients RFA. Mean tumor volume 24 hours after ablation was 37.0 cm^3 (MWA 50.5 cm^3 , RFA 22.9 cm^3 , $p < 0.001$). Local recurrence rate was 0% (0/26) in the MWA group and 8.3% (2/24) in the RFA group during follow-up ($p = 0.09$). The recurrence rate for newly developed malignant formations in other locations than the ablated lesions was 38% (19/50) for both groups (MWA 38.4%, RFA 37.5%, $p = 0.07$). The mortality rate was 14.0% (MWA 19.2%, RFA 8.3%, $p > 0.16$). No major complications were reported.

Conclusion: In conclusion, MWA and RFA are both safe and effective methods for the treatment of liver metastases. No significant differences were found for mortality, development of malignant formations, or major complications between both groups. MWA generates greater volumes of ablation compared to RFA.

1406.3

A preoperative mathematic model for computed tomographic guided microwave ablation treatment of hepatic dome tumors

F. Gao

Minimally Invasive & Interventional Radiology, Sun Yat-sen University Cancer Center, Guangzhou, CN

Purpose: This study sought to prospectively evaluate the feasibility and safety of a preoperative mathematic model for computed tomographic(CT) guided microwave(MW) ablation treatment of hepatic dome tumors.

Material and methods: This mathematic model was a regular cylinder quantifying appropriate puncture routes from the bottom up. A total of 103 patients with hepatic dome tumors were enrolled and randomly divided into 2 groups based on whether this model was used or not: Group A (using the model; n = 43) versus Group B (not using the model; n = 60). All tumors were treated by CT-guided MW ablation and follow-up contrast CT were reviewed.

Results: The average number of times for successful puncture, average ablation time, and incidence of right shoulder pain were less in Group A than Group B (1.4 vs. 2.5, $P = 0.001$; 8.8 vs. 11.1 minutes, $P = 0.003$; and 4.7% vs. 20%, $P = 0.039$). The technical success rate was higher in Group A than Group B (97.7% vs. 85.0%, $P = 0.032$). There were no significant differences between the two groups in primary and secondary technique efficacy rates (97.7% vs. 88.3%, $P = 0.081$; 90.0% vs. 72.7%, $P = 0.314$). No major complications occurred in both groups.

Conclusion: The mathematic model of regular cylinder is feasible and safe for CT-guided MW ablation in treating hepatic dome tumors.

1406.4

Microwave ablation outperforms RFA in the treatment of HCC

J.F. Amaral

Surgery, Brown University, Oldsmar, FL, US

Purpose: Previous studies have documented no difference in LTP for HCC < 3cm and a possible improvement for MWA for tumors greater than 3cm. The purpose of this study was to evaluate the existing literature using a meta-analysis to compare LTP, complications and survival in patients with HCC treated with MWA or versus RFA.

Material and methods: A systematic search of MEDLINE, EMBASE, and CENTRAL was conducted for studies published from 2006 onwards. The primary outcome was LTP and a random effects model was used.

Results: Of 1,379 studies identified, 28 randomized and observational studies met inclusion criteria. The main analysis demonstrated that LTP was significantly reduced by 30% for MWA versus RFA ($RR = 0.70$; $P = 0.02$) (all studies) and by 45% with MWA versus RFA ($RR = 0.55$; $P = 0.007$) (randomized studies). MWA was associated with a significant reduction of 37% ($RR = 0.63$; $P = 0.001$) compared with RFA among patients with tumor sizes ≥ 2.5 cm and a non-significant reduction of 28% in LTP ($RR = 0.72$; 95% CI = 0.41, 1.29; $P = 0.27$) among patients with tumor <2.5 cm. There were no significant differences between MWA and RFA for technique efficacy ($RR = 1.01$; $P = 0.25$), overall survival; disease free survival or safety ($RR = 1.05$; $P = 0.75$).

Conclusion: These results support considering MWA as superior to RFA in the treatment of HCC, justify a higher cost and reimbursement for MWA compared to RFA and document considering MWA the standard in guidelines for ablation of liver tumors greater than 2.5 cm.

1406.5

Iatrogenic arteriportal fistula caused by radiofrequency ablation of hepatocellular carcinoma: clinical courses and treatment outcomes

J.W. Choi¹, W.S. Choi², B. Kang¹, Y.S. Jeong¹, H.-C. Kim¹, J.W. Chung¹

¹Radiology, Seoul National University Hospital, Seoul, KR, ²Radiology, Seoul National University Bundang Hospital, Seongnam, KR

Purpose: To analyze the clinical courses and treatment outcomes of iatrogenic arteriportal fistula (APF) caused by radiofrequency ablation (RFA) of hepatocellular carcinoma (HCC).

Material and methods: Ninety-nine HCC patients who had iatrogenic APF following RFA were retrospectively analyzed. Depending on the extent of portal vein enhanced on arterial phase CT images, APF was classified as massive and non-massive APF. Their clinical courses were investigated and statistically evaluated by univariable and multivariable regression analyses. The effectiveness and safety of embolization for iatrogenic APF were also evaluated.

Results: Iatrogenic APF developed in a 6.1% of HCC patients treated by RFA. Thrombocytopenia (odds ratio [OR] = 3.939; 95% confidence interval [CI], 1.141–13.598) was the only risk factor for developing massive APF. Eleven patients underwent embolotherapy (technical success rate, 90.9%) and no patients experienced serious adverse events. Patients with massive APF (66.7%) had a significantly higher chance of Child-Pugh score increase compared with the patients with non-massive APF (13.6%) ($p < .001$). Massive APF had a significantly lower chance of natural regression than non-massive APF ($p < .001$). Child-Pugh class B (OR = 17.739; 95% CI, 2.361–133.279) and massive APF without treatment (OR = 11.061; 95% CI, 1.257–97.341) were independent risk factors of a death or unexpected liver transplantation within 1-year after RFA.

Conclusion: RFA can induce iatrogenic APF and patients with thrombocytopenia have a higher chance of having massive APF. Massive APF is mostly irreversible and significantly deteriorates patients' outcome, but it may be effectively and safely treated by the embolotherapy.

1406.6

Transarterial chemoembolization with radiofrequency ablation versus hepatectomy in hepatocellular carcinoma beyond the Milan criteria: a retrospective study

H. Yuan, P. Cao, H.L. Li, H.T. Hu, C.Y. Guo, Y. Zhao, Q.J. Yao, X. Geng
Minimally Invasive and Interventional Department, Affiliated Cancer Hospital of Zhengzhou University, Henan Cancer Hospital, Zhengzhou, Henan, CN

Purpose: To compare the efficacies of transarterial chemoembolization (TACE) combined with radiofrequency ablation (RFA) with hepatectomy. Prognostic factors for the patient groups were analyzed.

Material and methods: Data of 314 newly diagnosed cases of hepatocellular carcinoma beyond the Milan criteria were studied from January 2012 to December 2013 in our hospital. Forty-four patients were excluded owing to loss to follow-up or missing imaging data; finally, 270 patients were included. All patients underwent TACE with RFA (TR group, 136 patients) or hepatectomy (HT group, 134 patients). Efficacy evaluation and prognostic factor analysis of the groups were conducted. Overall survival (OS) rate, progression-free survival (PFS) rate, major complications were recorded.

Results: The 1-, 2-, 3-, and 5-year OS rates and median survival times were 98.5%, 83.1%, 66.2%, 37.1%, and 46 months, respectively, for the TR group and 89.6%, 69.4%, 53.7%, 30.3%, and 38 months, respectively, for the HT group. There were significant statistical differences in survival rate and median survival time between the groups. Median PFS were 21 months (TR group) and 8 months (HT group), respectively. Difference between groups was statistically significant. Multivariate analysis showed treatment method, tumor diameter and number, Child-Pugh

classification, antiviral therapy, and alpha-fetoprotein levels were the independent factors affecting OS rates. Treatment mode and tumor diameter and number were the independent factors affecting PFS.

Conclusion: TACE with RFA is superior to hepatectomy in hepatocellular carcinoma treatment beyond the Milan criteria. Treatment method, maximum tumor diameter, tumor number, Child-Pugh classification, whether antiviral therapy and preoperative AFP level are independent factors affecting OS.

1406.7

Locoregional treatments for unresectable early stage HCC in patients with high risk for intraprocedural bleeding: is single-step combined therapy safe and feasible?

F. Carchesio¹, R. Iezzi¹, A. Posa², A. Tanzilli¹, A. Gasbarrini³, R. Manfredi¹

¹Dipartimento di Diagnostica per Immagini, Radioterapia Oncologica ed Ematologia, Fondazione Policlinico Universitario A. Gemelli - IRCCS, Università Cattolica del Sacro Cuore, Rome, IT, ²Department of Radiology, AFaR-IRCCS Fatebenefratelli Hospital Foundation for Health Research and Education, Rome, IT, ³Department of Internal Medicine, Gastroenterology and Hepatology, Fondazione Policlinico Universitario A. Gemelli - IRCCS, Università Cattolica del Sacro Cuore, Rome, IT

Purpose: To assess feasibility and safety of a single-step combined therapy with radiofrequency ablation and transarterial chemoembolization (RFA+TACE) in patients with hepatocellular carcinoma (HCC) and uncontrolled coagulopathy. To compare the effectiveness of this approach with TACE alone performed in a control group

Material and methods: From January 2010 to June 2017, 143 consecutive cirrhotic patients with single HCC < 8 cm were enrolled in an observational prospective single-center study and divided, according to coagulation tests, into 3 groups (A, low risk; B, intermediate and C, high risk of bleeding). Feasibility and safety of a single-step combined treatment (RFA followed by TACE) were evaluated in terms of technical success rate, incidence of peri-procedural complications and laboratory values variations. Efficacy was evaluated comparing tumor response on 1 month CT in group C and in a control group, composed by 16 patients with severe coagulopathy and single HCC < 8 cm, underwent TACE in a previous period performed by the same operator

Results: Technical success was obtained in all patients, without major complications. Incidence of minor complications was significantly higher in group C after RFA, successfully treated with subsequent TACE without differences between pre- and post-procedural laboratory values. The complete response rates on 1-month follow-up were similar in the 3 groups whereas was significantly higher when compared group C with control TACE Group (p<.001).

Conclusion: Single-step RFA plus TACE allows to expand the indication for percutaneous thermal ablation to previously contraindicated cases due to procedural high-risk of bleeding complications improving patient outcome

Free Paper Session Experimental studies in IR

1407.1

Analysis of circulating hypoxia-related microRNAs in transarterial chemoembolization with biodegradable and non-degradable embolic agents - preliminary results

J. Zavadil¹, T. Andrašina², J. Juracek³, B. Cechova⁴, O. Slaby³, N. Goldberg⁵

¹Department of Radiology and Nuclear Medicine, Faculty Hospital Brno and Masaryk University, Brno, CZ, ²Department of Radiology and Nuclear Medicine, Faculty Hospital Brno, Brno, CZ, ³Department of Pediatric Oncology, Masaryk University, Central European Institute of Technology, Brno, CZ, ⁴Department of Radiology and Nuclear Medicine, Masaryk University, Central European Institute of Technology, Brno, CZ, ⁵Radiology, Hadassah University Hospital, Jerusalem, IL

Purpose: Intermediate stage HCC can be treated by transarterial chemoembolization (TACE). However, as a result of hypoxia there appear to be side effects, such as induction of proangiogenic and hypoxia related factors, which expression is co-regulated by microRNAs. This study was designed to compare hypoxia-related microRNAs (miR-21, miR-210, miR-34a) level in plasma of HCC patients undergoing TACE with degradable and non-degradable particles.

Material and methods: This prospective study consisted of 20 patients diagnosed with HCC treated with TACE. Non degradable particles (DCBeads, Biocompatibles Ltd.) and degradable starch microsphere (EmboCept S, PharmaCept GmbH) were used in 10 patients in each group. Plasmatic concentration of miRNA was measured using miRNA-specific TaqMan assays and qRT-PCR method in blood samples from three time points (before intervention, immediately after intervention, 24 hours after intervention). The Mann Whitney U test was used for study groups comparison.

Results: We observed significant increase of miR-210 concentration at time point 24 hours after intervention in plasma of patients receiving nondegradable particles comparing with patients treated with degradable starch microsphere (P=0,0147, FCH=6,5). Plasmatic concentration of miR-21 and miR-34a showed no significant difference between compared groups and observed time points. There were also no significant differences in study groups in terms of tumor burden and demographics.

Conclusion: Our preliminary data show significantly lower level of circulating hypoxia related miR-210 in plasma of patients undergoing TACE with degradable microspheres compared with non-degradable particles. The use of biodegradable particles could potentially lead to decrease of systemic secretion of biomolecules and thus prevent one of TACE treatment shortcomings.

1407.2

In-vitro evaluation of tissue adhesives in lymphatic fluids - influences of glue type and procedural parameters

C.C. Pieper, D. Kütting

Radiology, University of Bonn, Bonn, DE

Purpose: To evaluate polymerization of different acrylate glue/iodized-oil-mixtures for lymphatic interventions in-vitro.

Material and methods: Polymerization of Histoacryl (HA) and Glubran 2 (GL) mixed with iodized-oil (ratios 1:0-1:7) were investigated for two lymphatic fluid samples (low triglycerides (TG) <50mg/dl and high TG >600mg/dl).

For analysis of static polymerization time, the mixtures were dropped on the sample, monitoring morphological changes.

To simulate thoracic-duct embolization dynamic experiments were performed in a silicon tube with different lymph flow-rates (1500ml/24h and 6000ml/24h). Glue was injected into flowing lymph after flushing with

different glucose volumes (only catheter filled and 5ml glucose). Time to total tube occlusion was measured.

Results: For both glues static polymerization took longer with higher iodized-oil- and TG-content. GL generally polymerized faster than HA (low TG: glue/oil-ratio 1:3: 241s (HA) vs. 123s (GL), ratio 1:7: 4096s (HA) vs. 2363s (GL); high TG: ratio 1:3: 374s (HA) vs. 143s (GL), ratio 1:7: 9770s (HA) vs. 5580s (GL)).

In dynamic experiments prolongation of polymerization due to oil content and TG-levels was less pronounced. For low TG total tube occlusion was observed in all cases for HA (32s-56s) and for GL (17s-50s). For high TG-levels polymerization took considerably longer (43s-410s [HA]; 29s-319s [GL]) or failed completely. There were no systematic differences for varying flow rates and glucose flush volumes.

Conclusion: Polymerization time of glue/iodized-oil-mixtures in lymph is prolonged both by increasing iodized-oil and triglyceride concentrations. Polymerization time for Glubran seems to be slightly shorter than for Histoacryl. Lymphatic flow rate and glucose flush volume do not significantly influence polymerization times.

1407.3

pHPC hydrophilic antithrombogenic NiTi coating: evaluation of bare and surface modified low profile flow diverters using the Chandler Loop

T. Lenz-Habijan¹, M. Brodde², C. Bannewitz¹, M. Aguilar Perez³, H. Monstadt⁴, H. Henkes⁵

¹BMZ, phenox GmbH, Bochum, DE, ²OxProtect GmbH, Münster, DE, ³Neuroradiological Clinic, Klinikum Stuttgart, Stuttgart, DE, ⁴CEO, phenox GmbH, Bochum, DE, ⁵Ärztl. Leiter des Radiolog. Zentrums & Ärztl. Dir. der Klinik für Neuroradiologie, Katharinenhospital - Klinikum Stuttgart, Stuttgart, DE

Purpose: Neurovascular stent technology requires "dual antiplatelet therapy" (DAPT). Thereby, the risk for stent thrombosis is reduced but, the risk for hemorrhagic complications increases. A potential solution for this dilemma is the application of an antithrombogenic coating on the device surface. The purpose of this study was to assess the thrombogenicity of polymer coated (p48_HPC) and uncoated (p48) flow diverter stents (FD) in an in vitro Chandler Loop model.

Material and methods: Thrombogenicity of p48 (HPC and uncoated) was assessed using a Chandler Loop. FDs were released in silicon tubes filled with human whole blood and incubated at 37°C under pulsating flow. After 120 min, platelet count was determined in the blood. As an activation marker cleavage of the thrombin receptor (PAR1) was analyzed. Adherent thrombocytes were fixed on the FD, stained with a fluorescence antibody (CD42PE) and analyzed using a fluorescence microscope.

Results: Fluorescence microscopic analysis of CD42 positive platelets on p48 revealed a decreased platelet adhesion on the p48_HPC compared to the uncoated p48. The platelets in contact with the uncoated p48 were significantly more activated than the platelets incubated with the p48_HPC. The platelet count revealed significantly less thrombocytes left in the blood after incubation with the uncoated p48.

Conclusion: The pHPC coating reduces thrombogenicity of the p48 significantly. In future, reduced thrombogenicity of endovascular implants may help to overcome the issues of thromboembolic complications and increased bleeding risks of neurovascular stent procedures.

1407.4

Pickering-emulsion for local delivery of immunotherapies

L. Tselikas¹, F. Deschamps¹, L. Moine², T. Isoardo³, S. Susini³, S. Denis², N. Tsapis², A. Paci², A. Marabelle⁴, T. de Baère¹

¹Interventional Radiology, Institut Gustave Roussy, Villejuif, FR, ²Faculté de Pharmacie, Université Paris Sud-XI, Chatenay-Malabry, FR, ³LRTI - U1015, INSERM, Villejuif, FR, ⁴DITEP - oncoimmunology, Gustave Roussy - Cancer Campus, Villejuif, FR

Purpose: To evaluate feasibility and biologic efficacy of pickering emulsion using ethiodized oil for local administration of anti-CTLA4 antibodies.

Material and methods: Pre-clinical experiments including bench side, and in vivo mice evaluations were performed. Standard and pickering emulsions (using nanoparticles) were formulated (n=5). Microscopic analysis, Mass spectrometry, western blot and release were analyzed (n=5). To evaluate the biological effectiveness of the released aliquot (aCTLA4), cell-based competitive binding assay were performed using. CTLA4 Ig-24:ATCC®CRL-10762™ cells, cultured, and stained with recombinant human B7.2. Fluorescence was measured using flow cytometry. Finally, antitumor efficacy was tested on CT26 tumor implanted on Balb/C immunocompetent mice by direct intratumoral pickering emulsion injection (using aCTLA4 9H10 clone), in comparison with controls (n=10 vs 5).

Results: All pickering emulsions (100%) were water-in-oil (using drop test, and microscopy analysis) in comparison with conventional emulsions (0%), p<0.001. For pickering emulsions, mass spectrometry, and western blot experiments on the release aliquot did not show any difference in comparison with regular Ipilimumab. On binding assays, released Ipilimumab showed a functional activity. Both Ipilimumab from the initial solution and from the aliquot showed similar binding inhibition profile of B7.2 to CTLA-4 with a decrease of fluorescence intensity.

Finally, tumor volume of treated mice was significantly lower than the control group (p<0.001) confirming a biological in vivo activity of the released aCTLA4 antibody after a single intratumoral injection.

Conclusion: Pickering emulsion allows effective immunotherapy loading for local administration and progressive release of aCTLA4. The released aCTLA4 does not show any degradation of its chemical characteristics and keeps a biological activity in vivo.

1407.5

Intra-arterial CT hepatic angiography for tumor detection and ablation endpoint assessment: a proof-of-concept analysis

E.Y. Lin¹, G. Chintalapani², K. Brock³, R. Avritscher⁴, B.C. Odio⁵

¹Interventional Radiology, The University of Texas MD Anderson Cancer Center, Sugar Land, TX, US, ²Siemens Healthineers, Houston, TX, US, ³Physics - Morfeus Lab, The University of Texas MD Anderson Cancer Center, Houston, TX, US, ⁴Radiology, UT MD Anderson Cancer Center, Houston, TX, US, ⁵Interventional Radiology, The University of Texas MD Anderson Cancer Center, Houston, TX, US

Purpose: To evaluate the feasibility of using intra-arterial computed tomography hepatic angiography (CTHA) for intra-procedural tumor identification and primary efficacy assessment on patients undergoing liver ablation.

Material and methods: This proof-of-concept prospective study evaluated 15 tumors (6 HCC, 2 prostate cancer, 3 melanoma, 4 colorectal cancer, mean tumor size: 1.7 cm, range 0.9 – 3.1 cm) in 8 patients (mean age 64.8 y/o, 5 male) treated with microwave (MW) ablation on a hybrid Angio-CT room. CTHA was acquired during MW antenna placement for tumor identification and immediately after ablation for tumor coverage assessment using 10 mL of 1:1 contrast: saline solution via a 5-Fr catheter in the common hepatic artery. Study endpoints were: A) ability to identify tumor during MW antenna placement; and B) ability to predict full coverage of ablated tumor (primary efficacy) on the first intra-venous contrast-enhanced CT (ivCT) performed 4-12 weeks following ablation

(FUI-1, [mean time from ablation procedure to FUI-1: 57 days, range 36 – 82 days]). Two radiologists analyzed CTHA, pre- and post-ablation ivCT images based on consensus agreement.

Results: Of the 15 tumors, 9 (60%) were not detected on the non-contrast enhanced CT. CTHA was able to identify 15 of 15 (100%) tumors during MW antenna placement. CTHA predicted full ablation coverage in all 15 ablated tumors, which was confirmed by FUI-1 (primary efficacy: 100%).

Conclusion: CTHA during MW liver ablation was able to identify all target tumors and predict primary efficacy of this therapy on FUI-1.

1407.6

In vivo feasibility of arterial embolization with permanent and absorbable suture: The FAIREMBO concept

V. Vidal¹, J.-F. Hak¹, P. Brige², G. Soulez³, J.-M. Bartoli⁴, B. Guillet²

¹Service de Radiologie, Hôpital Timone Adultes, Marseille, FR, ²Faculté de Médecine, CERIMED LiiE, Marseille, FR, ³Radiology, CHUM-University of Montreal, Montreal, QC, CA, ⁴Radiologie Adulte, APHM CHU La Timone, Marseille, FR

Purpose: We propose to evaluate the proof of concept of feasibility and effectiveness of arterial embolization with absorbable and non-absorbable sutures in a porcine model.

Material and methods: Two groups of porcines were embolized: Group 1 (acute) (n = 1): tested for feasibility and technical efficiency for digestive, splenic, carotid and renal artery embolization; Group 2 (chronic) (n = 3): tested for medium-term efficacy with an evaluation of tissue and functional consequences: embolization of the lower lobe renal arteries and a three-month follow-up. The pigs received arteriography CT (D-1, D0, M1 and M3), ^{99m}Tc-DMSA renal scintigraphy (D-1 and M3), digital subtraction angiography (DSA) (D0 and M3) and histological analysis (M3).

Embolization materials:

Group 1 (acute): embolization with non-absorbable sutures (NAS): Mersutures™ braided sutures (Polyethylene terephthalate).

Group 2 (chronic): embolization with NAS, and with the most absorbable suture (AS) on the market: Vicryl® braided suture (polyglactin 910).

Results: All vascular targets were effectively embolized without any pre- or post-operative complications. Both DSAs and CTs at M3 showed a 100% repermeabilization rate for the AS embolization and a partial reversal rate for the NAS embolization.

A renal hypotrophy in the embolized region was observed during both the M1 and M3 scans for both sutures (AS and NAS) with a clear hypotrophy for the NAS embolized kidney.

Histological analysis identified a small amount of the classical post-embolization inflammation parameters for both groups.

Conclusion: Embolization by AS and NAS is a feasible and effective treatment which opens up the possibility of use of this inexpensive and widely available embolization agent.

1407.7

Reduced non-target embolization and increased targeted delivery with SEQUIRE microcatheter demonstrated in swine model

G. Maleux¹, T. de Baère², F. Sun³, N. Holtzman⁴, O. Harbater⁴, S. Rizzitelli⁵, P. Robert⁵, C. Robic⁵, A. Seron⁵, C. Corot⁵

¹Radiology, University Hospitals Leuven, Leuven, BE, ²Interventional Radiology, Institut Gustave Roussy, Villejuif, FR, ³Endoluminal Therapy and Diagnosis Unit, Jesús Usón Minimally Invasive Surgery Centre, Cáceres, ES, ⁴A Guerbet Company, Accurate Medical Therapeutics LTD, Rehovot, IL, ⁵Research & Innovation, Guerbet, Roissy Cdg Cedex, FR

Purpose: The SEQUIRE microcatheter utilizes fluid dynamics to minimize the risk of nontarget embolization and improve microspheres delivery in targeted arteries. The purpose of this study is to compare, in a swine

model, the microspheres embolization outcome of SEQUIRE and a standard end-hole microcatheter.

Material and methods: Embolization procedures with SEQUIRE microcatheters were compared to a standard microcatheter of the same diameter (Progreat), using radiopaque microspheres. The procedures were performed in renal arterial trees in 4 swine.

An automated pulsatile injection protocol was used to ensure equivalent injection parameters for all cases. The number of pulses was determined by the embolization endpoint, defined as the first visualized reflux from targeted vessel into nontarget vessel. Assessment of embolization outcome was performed using pre- and post-embolization angiography, gross pathology and image processing of the extracted kidneys Micro-CT scans.

Results: Ex-Vivo Micro-CT scans of kidneys embolized with Progreat demonstrated larger nontarget embolization compared to kidneys embolized with SEQUIRE, although contrast reflux was visible in all cases. The SEQUIRE delivered higher microspheres volumes (11.5mL±4.04) into the targeted distal and main branches compared to Progreat (8.5mL±5.4) which only partially filled the targeted main branches. The number of branch nodes filled by microspheres, indicating delivery depth, was higher for SEQUIRE (4131±3968) versus Progreat (974±547). The CT enhancement values indicate that SEQUIRE (28.8±15.3) can deliver higher density of microspheres into the vessels than Progreat (24.2±8.4).

Conclusion: The SEQUIRE microcatheter demonstrated superior microspheres delivery in-vivo versus a standard microcatheter, with reduced nontarget embolization and better microspheres delivery into the main targeted branches.

Free Paper Session Aortic interventions

1408.1

Early outcomes of the off-the-shelf t-branch for the treatment of thoracoabdominal aneurysms: a post-market registry

M.J. Bosiers, M. Austermann

Vascular and Endovascular Surgery, St. Franziskus-Hospital, Münster, DE

Purpose: Purpose of this study was to evaluate the performance and early outcome of the off-the-shelf Zenith t-Branch thoracoabdominal endovascular graft (Cook Medical, Bloomington, IN, USA) in a post-market registry.

Material and methods: This is a prospective and retrospective, multicenter, non-randomized study. Patients with thoracoabdominal pathology between September 2012 and February 2018 were included. The trial was sponsored by Cook Medical and registered at <http://www.clinicaltrials.gov> with the identifier NCT02104089. The primary objective of the study was to assess the procedure-related mortality and morbidity at 30 days. Secondary objectives included technical success, branch patency, endoleaks, and secondary procedures at follow up.

Results: Eighty patients were included. The majority was treated for TAAA (96%). Twenty-one patients (26%) were symptomatic or had a contained rupture. Thirty-day mortality rate was 1.3%. Stroke occurred in 3.8%. Spinal cord ischemia in 8.8%. Three patients had renal events; 2 patients required an intermittent hemofiltration. Secondary interventions were necessary in 4 patients (5%): endovascular thrombectomy for bilateral renal branch occlusion, due to an unknown HIT type II (n:1), stenting of stenosis (n:1); TEVAR for type 1a endoleak (n:1) and stenting of a stenosed internal iliac artery because of paraparesis (n:1). Type 2 endoleaks were found in 43%.

Conclusion: The first commercially available off-the-shelf branched endograft is safe with good 30-day mortality and morbidity results, even in urgent cases. Especially the lack of waiting time can improve our patient care in symptomatic or ruptured cases.

1408.2

Impact of aortic stent-graft oversizing on outcomes of the chimney endovascular technique based on a new analysis of the PERICLES Registry

M.V. Usai¹, K.P. Donas², G. Torsello¹, F.J. Veith³

¹Vascular and Endovascular Surgery, University Hospital, Münster, DE,

²Vascular Surgery, St. Franziskus Hospital, Münster, DE, ³Division of Vascular and Endovascular Surgery, NYU Langone Medical Center, New York, NY, US

Purpose: Chimney EVAR (ch-EVAR) is gaining ever greater acceptance. Persistent gutters leading to type IA endoleaks are an unsolved issue. Aim of the study was to analyze the impact of endograft oversizing to the occurrence of this phenomenon.

Material and methods: Prospectively collected data over standard use of the Endurant stent-graft and balloon expandable covered stents as chimney grafts were included. The oversizing of the aortic stent-graft was divided in two groups, group A (20% and less oversizing) and group B (>20% of oversizing). Primary endpoint was the incidence of persistent type IA endoleak. Secondary endpoints were mortality and freedom from reintervention.

Results: Group A included 21 patients, group B 144. The mean preoperative pathology's neck length and diameter was 5.8mm (+/-4.4) vs. 4.9mm (+/-3.8) and 27.6mm (+/-4.7) vs. 24.9 mm (+/-3.7) for group A and group B, respectively. The mean length of the new sealing zone after chimney graft was similar for both groups (group A vs group B; 17.9mm vs 18.3mm, P = .21). The percentage of oversizing of the aortic stent-graft was between 13.8% and 20% vs. 22.2% and 30%, for group A and group B. Group A had more type IA endoleaks, (14.3%) vs. group B (2.1%) based on the first follow-up imaging, P=.02. Incidence of persistent type IA endoleaks needing a reintervention was 14.3% and 1.4% for the group A and group B respectively, P = .01.

Conclusion: Oversizing of ideally 30% of the Endurant stent-graft is associated with significant lower incidence of type IA endoleaks requiring reintervention for patients treated by ch-EVAR.

1408.3

A novel technique to flush and de-air unsheathed TEVAR stent-grafts to reduce gaseous embolisation during stent-graft deployment

L. Hanna¹, R.G.J. Gibbs¹, M.S. Hamady²

¹Division of Vascular Medicine and Vascular Surgery, St Mary's Hospital, Imperial College NHS Trust, London, UK, ²Interventional Radiology, Imperial College-London - St Mary's Campus, London, UK

Purpose: The Achilles Heel of endovascular interventions in the arch and thoracic aorta will always be periprocedural stroke that will offset any mortality and morbidity benefits from these minimally invasive techniques. Several high-risk phases during TEVAR have been identified that can time-stamp intraoperative cerebral microembolization. One such phase is at stent-graft deployment, where we have found an overwhelming released of gaseous microembolisation to the brain through transcranial doppler monitoring (TCD), with a positive correlation with new DW-MRI lesions. All commercially available TEVAR devices retain air and must be flushed to remove air prior to insertion into the patient. Unsheathed stent-grafts (cTAG-Gore) do not have a device chamber to allow flushing. We present and assess a new technique to flush unsheathed grafts and remove retained air.

Material and methods: 10 patients undergoing TEVAR with unsheathed stent-grafts are included in this observational study. All patients undergo preoperative and postoperative DW-MRI brain scans and intraoperative TCD monitoring. After systemic heparinisation to maintain an APTT >2.5, all unsheathed stent-grafts are flushed with the patient's own blood prior to stent-graft deployment using a specific novel technique.

Results: We quantitatively review gaseous microembolisation detected through TCD monitoring of the middle cerebral artery during stent-graft. New DW-MRI lesions for each vascular territory are quantitatively and qualitatively assessed and compared with control historical data.

Conclusion: Unsheathed stent-grafts can be flushed effectively, and endovascular specialists should continue to refine techniques to reduce gaseous microembolisation and brain injury from stent-graft deployment during TEVAR.

1408.4

Performance of BeGraft and BeGraft+ stent-grafts as bridging devices for fenestrated endovascular aneurysm repair - an in-vitro study

G.F. Torsello¹, M. Herten², A. Frank³, M. Müller³, G. Torsello⁴, M. Austermann⁵

¹Klinik für Radiologie, Charité - Universitätsmedizin Berlin, Campus Virchow-Klinikum, Berlin, DE, ²Klinik für Orthopädie und Unfallchirurgie, University Hospital Essen, Essen, DE, ³Klinik für Unfall- und Wiederherstellungschirurgie, University Hospital Münster, Münster, DE, ⁴Vascular and Endovascular Surgery, University Hospital, Münster, DE, ⁵Vascular and Endovascular Surgery, St. Franziskus-Hospital, Münster, DE

Purpose: Outcomes of endovascular repair of complex aortic aneurysm also depend on durability of bridging stents. For this indication, no dedicated stents are available on the market. Aim of this study was to investigate two commonly used balloon-expandable covered stents as bridging devices in a fenestrated in-vitro model.

Material and methods: 20 BeGraft (BG) covered stents and 20 BeGraft Plus (BG+) were tested. In vitro bench tests evaluated stent morphology after flaring by microscopy and radiography. Maximum pull-out and the shear-stress forces needed to dislocate the stents was measured.

Results: No alteration of ePTFE coverage was detected in the flared stents. Digital radiography and CT-scanning showed marked alteration of the stent geometry, however no fractures were detected. Median (minimum-maximum) pull-out forces were 17.1 N (15.8-19.6 N) (BG 6) and 30.4 N (20.2-31.9 N) (BG+ 6) for the 6 mm stent-grafts (p = 0.006). Median (minimum-maximum) pull-out forces for the 8 mm stent-grafts were 11.3 N (11-12.1 N) (BG 8) and 21.8 N (18.2-25.5 N) (P < 0.0001). The shear-stress test showed median forces of 10.5 vs 15.28 N at 150% stent diameter for the 6 mm stents and 15.23 vs 20.72 N at 150% stent diameter for the 8 mm stents (P = 0.016 and 0.017, respectively).

Conclusion: Flaring changed the stent geometry but did not provoke stent fractures. BeGraft+ is superior to BeGraft in terms of pull-out and shear-stress forces demonstrating greater resilience.

1408.5

Rethinking our treatment paradigm for EVAR: mid-term results from a vascular centre

K. Khan¹, R.K. Fisher²

¹Liverpool Vascular and Endovascular Service, Royal Liverpool University Hospital, Liverpool, UK, ²Liverpool Vascular and Endovascular Service, Royal Liverpool University Hospital, University of Liverpool, Liverpool, UK

Purpose: Recently proposed treatment paradigms in the UK for AAA, are based on the distinction between fit or unfit for open surgery and preclude EVAR. This study explored whether such binary parameters reflect the patient population and the treatment received in a large vascular centre.

Material and methods: Retrospective analyses of baseline data were performed on patients undergoing elective, infra-renal endovascular repair (ER) and open surgery (OR) between 2012-2017 (N=563; ER 370; OR 195). Patients were categorised into low (93 ER; 108 OR), medium (87 ER; 41 OR) and high (123 ER; 16 OR) risk groups based on a validated EVAR risk score. Glasgow Aneurysm Score (GAS) was also calculated for all patients, indicating their fitness for OR. Comparisons of survival between

groups and treatment modalities were made using Kaplan Meier analysis and log rank ($p < 0.05$).

Results: Across the whole cohort, patients having ER were significantly older (76.2 vs 69.8yrs; $p = 0.0001$), had smaller aneurysms (6.3 vs. 6.6cm; $p = 0.035$), and higher GAS (82 vs 74; $p = 0.001$) and EVAR risk score (3.96 vs 2.13; $p < 0.001$).

During the study period patient survival in the low risk group was 97% OR vs 76% ER ($p = 0.001$); medium risk group was 83% OR vs 76% ER ($p = 0.713$); high risk group was 56% OR vs 70% ER ($p = 0.036$).

Conclusion: OR in fit, low risk patients offers excellent survival, whilst ER has benefits as patients become less fit. A binary parameter of fit for OR does not reflect clinical reality and may deny many patients the potential short and mid-term benefits of ER.

1408.6

Investigation of the quality reserve provided by digital variance angiography in fenestrated and branched endovascular aortic aneurysm repair setting

E. Verhoeven¹, A. Katsargyris², D. Szöllősi³, M. Gyánó⁴, K. Szigeti³, S. Osváth³, J.P. Kiss⁵, V.I. Óriás⁴

¹Vascular and Endovascular Surgery, Klinikum Nürnberg Süd, Nürnberg, DE, ²Vascular and Endovascular Surgery, Paracelsus Medical University, Nuremberg, DE, ³Department of Biophysics and Radiation Biology, Semmelweis University, Budapest, HU, ⁴Heart and Vascular Center, Semmelweis University, Budapest, HU, ⁵Scientific Dept., Kinepict Health Ltd, Budapest, HU

Purpose: Kinetic imaging is a new image processing algorithm providing enhanced image quality in X-ray angiography setting. The algorithm produces the so-called Digital Variance Angiography (DVA) images. The study objective was to assess the quality reserve of DVA images by comparing the performance to standard digital subtraction angiography (DSA) in fenestrated and branched endovascular aortic aneurysm repair (F/B-EVAR) setting.

Material and methods: Retrospective evaluation of image data of 30 patients undergoing F/B-EVAR was performed at our institution without any preselection. The signal-to-noise ratio (SNR) of DSA and DVA images was measured and compared. The same raw image data were used to generate dynamic DSA and DVA runs. The videos were compared by six experts in a randomized blinded questionnaire. Fleiss's Kappa-test was used to determine interrater agreement.

Results: DVA images provided 1.49 times higher SNR than DSA (median value, Q1-Q3 interval was 1.14-1.81). Evaluators preferred DVA over DSA images in 85.9% of comparisons. The interrater agreement was 91.3% and Fleiss's kappa was 0.21 ($p < 0.001$).

Conclusion: Kinetic imaging enhances angiographic image quality compared to the current reference standard DSA-imaging in F/B-EVAR setting. The observed quality reserve of DVA images provides opportunities to reduce both radiation-dose and the amount of contrast agent. A prospective study based on these results could confirm the achievable amount of dose reduction without significant image quality loss.

1408.7

Remodeling of aorta after thoracic endovascular aortic repair (TEVAR) for aortic dissection

K. Nakajima¹, N. Kato¹, T. Hashimoto¹, T. Higashigawa¹, T. Ouchi¹, S. Chino¹, H. Sakuma¹, T. Tokui²

¹Radiology, Mie University Hospital, Tsu, JP, ²Cardiovascular Surgeon, Ise Red Cross Hospital, Ise, JP

Purpose: To determine the most appropriate timing of TEVAR for aortic dissection (AD) in terms of remodeling of the aorta.

Material and methods: Fifty-four patients who underwent TEVAR for the treatment of AD and were followed-up with CT over 1 year were included in this study. The diameters of the aorta, the true lumen, and

the false lumen were measured at the levels of the most dilated descending aorta (level M) and the diaphragm (level D) on contrast enhanced CT. In addition, the ratio of the diameter before TEVAR to that 1 year later was calculated.

Results: Median interval between the onset of AD and TEVAR was 3.0 months. According to this interval, patients were divided into two groups: patients who underwent TEVAR within 3 months of the onset of AD ($n = 27$, group A) and patients who underwent TEVAR over 3 months ($n = 27$, group B). All measurements showed favorable remodeling at both levels in group A. In group B, no significant shrinkage was observed with the aortic diameter at level D while favorable remodeling was obtained at level M. In terms of the diameter ratio, the false lumen shrank more in group A compared to group B at both level M ($P = 0.012$, CI: 0.049–0.386) and level D ($P = 0.000$, CI: 0.212–0.638). The ROC curve analysis of interval for the false lumen shrinkage yielded 5.8 months as the optimal threshold to perform TEVAR (AUC: 0.622, CI: 0.360–0.885).

Conclusion: To obtain favorable remodeling of the aorta, it seems to be more effective to perform TEVAR within 5.8 months of the onset of AD.

Free Paper Session Venous interventions

1504.1

Safety, procedural success and outcome of the Aspirex S endovascular thrombectomy system in the treatment of iliofemoral deep vein thrombosis: data from the Arnsberg Aspirex registry

M. Lichtenberg¹, R. de Graaf²

¹Vascular Center, Klinikum Arnsberg, Arnsberg, DE, ²Diagnostic and Interventional Radiology, Clinic of Friedrichshafen, Friedrichshafen, DE

Purpose: Percutaneous mechanical thrombectomy (PMT) represents a treatment option in addition to conventional therapy for patients with iliofemoral deep vein thrombosis (DVT). We sought to determine the safety, patency and short-term outcome of the Aspirex S catheter as a rotational mechanical thrombectomy device in the endovascular treatment of iliofemoral DVT.

Material and methods: 56 patients (66% female, median age 51 years) undergoing mechanical thrombectomy with the Aspirex S catheter for endovascular treatment of iliofemoral DVT were included in the analysis. Device- and procedure-related complications, prevention of post-thrombotic syndrome (PTS) and patency rates were determined at baseline and at 1, 6 and 12 months after intervention.

Results: No device-related complications or malfunction occurred. Procedure-related complications (rehospitalization, re-occlusion of target vein, prolonged hospitalization resulting from access site complication) were seen in 14% of patients. PMT was followed by implantation of a dedicated venous stent in all patients. Low PTS reflected by a revised venous clinical severity score (rVCSS) of < 3 and a clinical, etiologic, anatomic and pathophysiologic (CEAP) score of < 3 were achieved in 64% of the patients at 12 months. Combined patency was 95% after 1 month, 94% after 6 months and 87% after 12 months.

Conclusion: Even though long-term studies are missing, PMT of iliofemoral DVT using the Aspirex S rotational thrombectomy device as a stand-alone approach exhibited an excellent patency at short term associated with substantial prevention of moderate to severe PTS and low device-related complications including bleeding.

1504.2

Acute deep vein thrombosis: early and midterm results of a multicenter prospective Zelé registry of desobstruction using a rheolytic thrombectomy device

C. Del Giudice¹, C. Zadro², A. Galloula³, P. Marek², E. Messas⁴, A. Bura-Rivière⁵, M.R. Sapoval¹, H. Rousseau²

¹Vascular and Oncological Interventional Radiology, Hôpital Européen Georges Pompidou, Université Paris Descartes, Paris, FR, ²Department of Radiology, Centre Hospitalier Universitaire Rangueil, Université Paul Sabatier, Toulouse, FR, ³Vascular Medicine, Hôpital Européen Georges Pompidou, Université Paris Descartes, Paris, FR, ⁴Cardiology, Hôpital Européen Georges-Pompidou, Paris, FR, ⁵Vascular Medicine, Centre Hospitalier Universitaire Rangueil, Université Paul Sabatier, Toulouse, FR

Purpose: To evaluate the safety and efficacy of single staged rheolytic directional thrombectomy (RDT) in patients with acute iliofemoral deep vein thrombosis (DVT) non-responding to conventional anticoagulation therapy

Material and methods: In this prospective registry we evaluated patients admitted in two-university hospital for ilio-femoral deep vein thrombosis treated with Zelante Angiojet RDT (Boston Scientific), associated or not to local fibrinolysis, and venous stenting. All patients were treated after failure of conventional anticoagulation. Primary endpoint was the incidence of post thrombotic syndrome (PTS) at 6 months follow-up (FU). Secondary endpoints were immediate technical success, primary patency at 6 months FU and major adverse events

Results: Between 1- 2016 and 10- 2018, 65 consecutive patients (Mean age 48.4±19.4 years) were enrolled in the registry. Target lesions were native vein thrombosis in 57 patients and venous stent thrombosis in 9 patients. Immediate success was obtained in 98.5% of cases. Associated Venous stenting was performed in 44 patients (67%). In 49 patients (74%) local fibrinolysis was performed with Powerpulse technique. Freedom from PTS at 6 months was observed in 86.2% of patients. Primary patency at 6 months FU was 83% at 6 months FU. 5 major adverse events were reported, respectively 1 arteriovenous fistula at the puncture site, 2 site puncture bleeding requiring transfusion, 1 bleeding needing transfusion and 1 acute renal failure

Conclusion: Single staged rheolytic directional thrombectomy associated to stenting is a safe and efficient treatment for ilio femoral DVT. Longer follow-up is needed to evaluate the real impact in term of post thrombotic syndrome incidence.

1504.3

Patency rates, safety and clinical results of the sinus-Oblique venous stent in the treatment of chronic ilio-femoral venous out-flow obstruction: data from the Arnsberg venous registry

M. Lichtenberg¹, R. de Graaf²

¹Vascular Center, Klinikum Arnsberg, Arnsberg, DE, ²Diagnostic and Interventional Radiology, Clinic of Friedrichshafen, Friedrichshafen, DE

Purpose: We sought to determine the patency and clinical symptom relief following the usage of the sinus-Oblique venous stent in the endovascular treatment of venous obstruction of the ilio-femoral track in short-term.

Material and methods: 48 patients (62% female, mean age 57 years) with chronic unilateral post-thrombotic obstruction (PTO) and non-thrombotic iliac vein obstructive lesions (NIVL) without involvement of inferior vena cava receiving a Sinus oblique venous stent were included in the analysis. Clinical improvement determined by the revised venous clinical severity score (rVCSS) as well as the clinical, etiologic, anatomic and pathophysiologic score (CEAP), safety, and stent patency rates were determined at baseline and at 1, 6 and 12 months after stent placement. Ten of the 48 included patients had a venous ulceration.

Results: Primary patency rates were 98% at FU1, 94% at FU2 and 94% at FU3, respectively. Secondary patency was 100% at FU1, 96% at FU2 and

remained 96% at FU3. At 12 months, the mean rVCSS dropped from 9.0 to 4.8 points ($p<0.001$) whereas the mean CEAP improved from 3.45 to 2.96 ($p<0.001$). A substantial healing of ulcerations was observed in 8 of 10 patients with initial venous ulceration. There were no relevant safety concerns noticed.

Conclusion: Even though long-term studies are missing, the sinus-Oblique venous stent already showed very promising patency rates at short term, associated with substantial clinical improvement and low device-related complications in both NIVL and PTS.

1504.4

Risk stratification of inferior vena cava (IVC) filters in preparation for safe retrieval: the Alfred guideline

H.K. Moriarty, G.S. Goh, W. Clements

Radiology, The Alfred Hospital, Melbourne, VIC, AU

Purpose: There is varying difficulty in the retrieval of optional IVC filters. We aim to establish which factors are associated with challenging filter retrievals and suggest a grading system to attempt to predict a difficult retrieval in advance.

Material and methods: A retrospective review of filter retrieval difficulty was performed at a single institution over 5 years.

Results: 356 consecutive patients undergoing retrieval of 357 IVC filters were reviewed. We defined 'difficult' retrievals as those where angiography screening was >15 minutes, use of advanced technique required, multiple retrieval attempts, filter fracture/migration, and filter not retrieved. We assessed the association of a number of variables using a multivariate regression analysis including filter tilt, dwell time, age, gender, embedded hook, non-hooked filter, leg penetration >3mm, supra-renal location, and thrombosis or occlusion of IVC. The majority of filters were infra-renal ($n=348$), hooked ($n=294$), and were retrieved in males ($n=231$). Dwell time ranged from 1 to 3 years. Leg penetration was only present in 156. Tilt > 15 degrees was present for 20 filters. Fluoroscopy screening time for retrieval ranged from 1 minute to 111 minutes, median 4 minutes. Factors shown to be associated with challenging filter retrieval included embedded hook, non-hooked filter, tilt > 15deg and dwell time > 6 months.

Conclusion: Based on these findings, we propose a clinical prediction rule to attempt to predict the difficulty of filter retrievals in advance, which can lead to increase angiographic efficiency, reduced procedure times, and reduce the need for multiple procedures.

1504.5

Mechanochemical endovenous ablation of lateral marginal vein in pediatric patients with Klippel-Trenaunay syndrome

G. Lambert, M.W. Silva, D.J. Teplisky, I. Szhafir, J.F. Lutereau, M. Garriga, S. Sierre

Interventional Radiology, Hospital de Pediatría Prof. Dr. J.P. Garrahan, Buenos Aires, AR

Purpose: To evaluate the feasibility, safety and results of mechanochemical endovenous ablation (MOCA) for the treatment of lateral marginal varicose veins in pediatric patients with Klippel-Trenaunay syndrome (KTS).

Material and methods: A total of 9 patients (ages 4-16) with KTS and symptomatic dilated lateral marginal veins were treated with MOCA during a 18 months period. All patients were evaluated with Doppler ultrasound (US) and phlebography to assess the anatomy of the lateral marginal vein and patency of the deep venous system respectively. Procedures were performed under general anesthesia, with a ClariVein® catheter and sodium tetradecyl sulphate (STS)/lipiodol foam as a sclerosing agent. US and radioscopy guidance were used in all patients. All patients were discharged 24 hours after the procedure. Technical success rate, primary occlusion rate, adverse effects and recanalization rate

were evaluated. Clinical and radiological (US) regular controls were performed at 7 days, 1 and 6 months after the procedure.

Results: Technical success and primary occlusion (Doppler US 24 hours after ablation) was achieved in all patients, with no adverse events. During follow-up none of the patients showed recurrence of symptoms. Doppler US showed a partial recanalization in 1 asymptomatic case (1/9, 11%), 6 months after treatment and no further treatment was performed.

Conclusion: Mechanochemical endovenous ablation is feasible and seems to be safe and effective for the treatment of varicose veins in pediatric patients with Klippel-Trenaunay syndrome.

1504.6

The results of balloon angioplasty of the pulmonary artery in patients with chronic thromboembolic pulmonary hypertension

N. Marukyan¹, V. Privorotsky¹, D. Zverev¹, O. Moiseeva²

¹Interventional Cardiology, Almazov National Medical Research Center, Saint-Petersburg, RU, ²Cardiology, Almazov National Medical Research Center, Saint-Petersburg, RU

Purpose: Chronic thromboembolic hypertension (CTEPH) is one of the variants of pulmonary arterial hypertension (PAH), which develops due to incomplete resolution of episodes of pulmonary embolism. Alternative to drug therapy in the case of inoperable patients with CTEPH is a transcatheter balloon angioplasty of the pulmonary artery with a recommendation level for today class IIB.

Material and methods: The study included 10 patients with CTEPH (6 men, 4 women, average age 55 ± 11), with lesions of the distal type, who were denied pulmonary artery thrombectomy and a staged balloon angioplasty was performed. All patients take sildenafil therapy.

Results: According to the pressure data of the right heart chambers, the patients showed precapillary mild hypertension of the pPA 95 ± 12.7 mm Hg. All patients underwent 4-6 stages of balloon angioplasty of the branches of the pulmonary artery with a decrease the New York Heart Association class from 3.2 ± 0.5 to 1.9 ± 0.2 ($p < 0.001$). In the postoperative period the mean pulmonary artery pressures decreased from 54 ± 14.2 mm Hg to 30 ± 10.2 mm Hg. ($P = 0.007$) and a decrease in PVR from 15 ± 3.3 Wood units to 2.5 ± 0.7 Wood units ($P = 0.007$). The incidence of complications (reperfusion pulmonary edema) did not exceed 23%.

Conclusion: Transcatheter balloon angioplasty of the pulmonary artery is an effective and safe procedure on condition of the patient selection algorithm and methodology of procedure performance.

1504.7

Treatment of venous iliofemoral occlusive disease with a self-expanding venous stent: a "first look" at 24-month results from the prospective, multicenter VERNACULAR trial

M.D. Dake¹, G.J. O'Sullivan²

¹Falk Cardiovascular Research Center, Stanford University School of Medicine, Stanford, CA, US, ²Interventional Radiology, U.C.H. Galway, Galway, IE

Purpose: To assess the performance of the Venovo Venous Stent for the treatment of iliac and femoral vein occlusions.

Material and methods: The VERNACULAR study was a prospective, multicenter, single-arm study conducted at 22 centers in the United States, Europe, and Australia. Primary endpoints were major adverse events (MAEs) through 30 days and 12-month primary patency, defined as freedom from target vessel revascularization and freedom from thrombotic occlusion and duplex-ultrasound derived stenosis $>50\%$. Secondary outcomes included the Venous Clinical Severity Score (VCSS) Pain Assessment and Quality of Life (CIVIQ-20), both tested for superiority to baseline values; freedom from target lesion revascularization; primary patency; and radiographic assessment of stent fractures (assessed by the Yale Angiographic Core Lab) through 36 months.

Results: The 24-month data will be available for the first time at CIRSE 2019. To date, 156 patients (91.8%) have been reviewed through 12 months, including 84 post-thrombotic syndrome (PTS) and 72 non-thrombotic iliac vein lesion (NIVL) patients. All stents (223) were successfully deployed to the intended location. Freedom from MAEs through 30 days was 93.5%, non-inferior to a performance goal (PG) of 89% ($p = 0.032$). Primary patency at 12 months was 88.3% (81.3% PTS; 96.9% NIVL), superior to a performance goal (74% PG) derived from the venous stent literature ($p < 0.0001$). An additional sensitivity analysis of primary patency estimated a survival probability of 88.9% (Kaplan-Meier) for the intention to treat (ITT) population. The VCSS Pain Score at 12 months was 0.6 (95% CI: 0.46, 0.74), a significant improvement from baseline (2.3; $p < 0.0002$); CIVIQ-20 scores also improved significantly (15.7 points) from baseline values ($p < 0.0001$). Additional observations included 12-month freedom from target lesion revascularization of 92.6% (90% CI: 87.5%, 96.1%) for the ITT group (PTS: 87.6%; NIVL: 98.6%). No stent fractures were observed at 12-months.

Conclusion: Initial results from the VERNACULAR trial demonstrated that the Venovo stent could be deployed successfully in obstructive iliofemoral vein lesions. Primary patency was 88.3% at 12 months. Rates of MAEs and reintervention were low, with no stent fractures reported through one year. Follow up is ongoing, and 2-year results will be available to present for the first time at CIRSE.

Free Paper Session Interventional oncology beyond liver

1505.1

Should lung nodule biopsy be performed prior to or concomitantly with thermal ablation?

Z. Hartley-Blossom, T. Healey

Department of Diagnostic Imaging, Rhode Island Hospital/Brown University, Providence, RI, US

Purpose: The purpose of this study was to determine the frequency with which biopsy results of suspicious lung nodules on imaging would have obviated the need for subsequent treatment in patients referred for image-guided thermal ablation (IGTA).

Material and methods: Retrospective review of an internal database of a single institution revealed 168 consecutive percutaneous lung nodule/mass IGTA performed from April 2015 to January of 2019. In these patients, biopsy was either performed at a separate visit prior to the ablation or at the time of ablation. Lesions were categorized according to malignancy/benignity and by final pathology.

Results: Biopsy was performed for 76.2% (128/168) of the patients undergoing IGTA, and foregone in the remaining 23.8% (40/168) of patients. Overall diagnostic yield for percutaneous biopsy was 94.5% (121/128). Based on biopsy results, 98.3% (119/121) were classified as malignant or suspicious, and 1.7% (2/121) were classified as non-malignant. Of note, one of these nodules was an FDG-avid nodule that had been increasing in size and final pathology yielded a diagnosis of tuberculosis. Definitively non-malignant lesions were designated as obviating the need for IGTA in 1.6% (2/128) of patients. IGTA was supported by biopsy results in the remaining 98.4% (126/128), including adenocarcinomas, squamous cell carcinomas, carcinoid tumors, small cell tumors, metastases, and non-diagnostic biopsy results.

Conclusion: Biopsy of pulmonary nodules with suspicious imaging features rarely (1.6%) obviated the need for IGTA. For patients who have undergone counseling and been selected to undergo ablation as definitive treatment, biopsy can safely be performed concomitantly with ablation.

1505.2

Ablation therapy compared to SBRT and no treatment for unresectable non-small cell lung cancer: a National Cancer Data Base study

J. Wu¹, H.X. Bai², Z.-S. Zhang³

¹Radiology Department, The Second Xiangya Hospital, Changsha, CN,

²Department of Radiology, Hospital of the University of Pennsylvania, Philadelphia, PA, US, ³Department of Radiology, The Second Xiangya

Hospital of Central South University, Hunan, CN

Purpose: To evaluate the overall survival (OS) outcomes of ablation for patients with unresectable non-small cell lung cancer.

Material and methods: Patients with stage IIIB and IV NSCLC from 2004 to 2014 who were treated with ablation or stereotactic body radiation therapy (SBRT) alone, or who received no treatment were identified from the US National Cancer Data Base. OS was estimated using the Kaplan-Meier method and evaluated by log-rank test, univariate and multivariate Cox proportional hazard regression, and propensity score-matched analysis. Relative survival analyses compared to age- and gender-matched US population were performed. Subgroup analysis on patients who did not receive chemotherapy was performed.

Results: A total of 193 patients who received ablation, 1,544 SBRT, and 152,769 no treatment met our inclusion criteria. The 5-year relative survival rates were 9.6% for ablation, 8.4% for SBRT, and 2.7% for no treatment. Propensity matching (1:2 ratio) resulted in 189 patients in the ablation group versus 378 in the no treatment group, and 175 patients in the ablation group versus 316 in the SBRT group. After matching, there was no significant difference in OS between ablation and no treatment (HR, 0.913; 95% CI, 0.76-1.097; $p=0.331$), while ablation was associated with shorter OS when compared to SBRT (adjusted HR, 2.072; 95% CI, 1.695-2.533; $p<0.001$). For patients who did not receive chemotherapy, ablation was associated with longer OS when compared to no treatment (adjusted HR, 0.651; 95% CI, 0.511-0.828; $p<0.001$), but with shorter OS when compared to SBRT (adjusted HR, 1.945; 95% CI, 1.45-2.61; $p<0.001$).

Conclusion: Ablation was associated with improved survival when compared to no treatment only in patients with unresectable NSCLC who did not receive chemotherapy.

1505.3

Mutation status is not a significant predictor of local recurrence in patients undergoing image-guided ablation of lung metastases

M. Drabkin, A. Moussa, F.E. Boas, C.T. Sofocleous, S.B. Solomon, E. Ziv
Radiology, Memorial Sloan Kettering Cancer Center, New York, NY, US

Purpose: To identify gene mutation patterns and associations with local recurrence after image-guided microwave ablation of colorectal adenocarcinoma metastatic to lung.

Material and methods: This HIPAA-compliant institutional review board-approved retrospective review examined colorectal adenocarcinomas metastases to lung in 46 patients (median age = 57 years; range = 30-78 years) treated with percutaneous image-guided microwave ablation with Neuwave probes, and with available genetic mutational analysis. Variables studied include KRAS, PIK3CA, TP53, AKT1, FGFR1, BRAF and NRAS mutations, as well as the total number of mutations. Additional demographic, clinical and technical variables were also recorded. These variables were evaluated in relation to local progression free survival (LPFS). This was calculated from the time of ablation to the first radiographic evidence of local recurrence. Kaplan-Meier plots and Cox regression modeling with hazard ratios were also performed.

Results: Overall Kaplan-Meier plots demonstrated 87% progression free survival at 1 year. Mean follow-up time was 13.2 months. KRAS, PIK3CA, TP53, AKT1, FGFR1, BRAF and NRAS mutations were found in 42%, 11%, 67%, 2%, 19%, 0% and 6%. No significant relationship was found to

suggest that any individual mutation nor the total number of mutations is a predictor of local recurrence.

Conclusion: To our knowledge the relationship between mutation status and local recurrence after image-guided ablation of colorectal adenocarcinoma metastases to lung has not been previously studied. The results of this study suggest that there is likely no strong relationship between the studied mutations and local recurrence after image-guided ablation of colorectal adenocarcinoma lung metastases.

1505.4

A phase 2 study of transarterial chemoperfusion treatment with Cisplatin, Methotrexate and Gemcitabine in patients with unresectable pleural mesothelioma – initial results

B. Kis¹, M. Pereira¹, J. Logeman¹, G. El-Haddad¹, J. Choi¹, J. Fontaine², B. Creelan², T. Tanvetyanon²

¹Diagnostic Imaging and Interventional Radiology, Moffitt Cancer Center and Research Institute, Tampa, FL, US, ²Thoracic Oncology, Moffitt Cancer Center and Research Institute, Tampa, FL, US

Purpose: The current prospective study (NCT02611037) is investigating the disease control rate, overall survival and adverse events of transarterial chemoperfusion (TAC) treatment in patients with relapsed unresectable malignant pleural mesothelioma (MPM).

Material and methods: 23 patients, 3 female and 19 males (age 71 ± 6.5 years), with MPM were enrolled between 3/2016-5/2018. Patients had TAC treatment in every 4 weeks with cisplatin (35 mg/m²), methotrexate (100 mg/m²) and gemcitabine (1000 mg/m²) via the ipsilateral internal mammary artery and/or descending thoracic aorta. All patients had received and progressed on prior chemotherapy. 4 patients also had radiation therapy and 3 patients had pleurectomy. The number of prior treatments were 1.95 ± 1.4 (range: 1-6). Response rate was evaluated by modified RECIST for mesothelioma.

Results: At the data cutoff date (January 31, 2019) 15 of the 23 patients had died. The median follow-up time was 7.9 months. The disease control rate was 70% (1 PR, 15 SD, 7 PD). Median progression free survival from the enrollment was 4.6 ± 1.7 months (95% CI 1.1-8). Median OS was 7.9 ± 2.2 months (95% CI 3.6-12.3). A total of 128 TAC treatments were performed. The median number of treatments was 4/patient (range 1-18). There was no treatment related mortality. Major complication rate was 1.6%. There were 110 events of minor complications; the most common was 52 events of chest pain during TAC into the internal mammary artery, followed by 20 events of nausea.

Conclusion: TAC treatment is safe and has promising disease control rate in patients with MPM who progressed on prior chemotherapies.

1505.5

Cryoablation for stage 1 renal cell carcinoma: oncologic outcomes from a 10-year, prospective study

K. Porosnicu Rodriguez¹, J. Morkos², A.L. Zhou², C. Frangakis³, C.S. Georgiades²

¹Radiology, Johns Hopkins University, Baltimore, MD, US, ²Vascular & Interventional Radiology, Johns Hopkins University, Baltimore, MD, US,

³School of Public Health, Johns Hopkins University, Baltimore, MD, US

Purpose: Ablation has been recognized by the National Comprehensive Cancer Network and American Urologic Association as an option for patients with Stage T1a renal cell carcinoma (RCC). The recommendation however is for select patients and adjunct to a warning of higher local recurrence. Our objective was scientifically rigorous study to determine the long-term oncologic outcomes after cryoablation for Stage 1 RCC.

Material and methods: This was an IRB-approved prospective 10-year study. 134 consecutive patients were treated with CT-guided cryoablation for biopsy-proven RCC. Patients were seen by Urology & Interventional Radiology. We estimated probability of overall survival, recurrence-free survival and disease-free survival. A patient's first time

failing an outcome was either obtained exactly, or narrowed to have occurred beyond a known time (left censored) or within a known time window (interval censored). The probabilities of the outcomes across follow-up were estimated using Turnbull's nonparametric maximum likelihood estimator implemented with the function of Fay and Shaw within the R statistical package.

Results: Of 134 pts, 46 (34%) were women. Nineteen (14%) were Stage 1B. Median size was 2.8+/-1.4 cm. Overall, Recurrence-Free and Cancer-Specific survival was 86.5+/-2.9%, 83.4+/-3.4% and 94.3+/-2.2% respectively at 5-years, and 72.1+/-5.4%, 67.7+/-5.4% and 93.0+/-2.5% respectively at 10 years.

Conclusion: Most newly diagnosed RCC are incidentally detected at Stage 1. Consequently treatment evolved favoring nephron-sparing surgery (NSS). Studies on percutaneous ablation have shown promising intermediate results. This 10-year prospective study validates the equivalency of cryoablation for Stage 1A RCC to NSS in the long-term. The 10-year CSS of 93+/-2.5% is the same as reported in surgical series.

1505.6

Outcome predictors in percutaneous cryoablation for renal cell carcinoma: single center cohort study

K. Mahmoud, A.J. Gunn, H. EL Khudari, W. Joe, A. Salei, E. Keasler, E. Bready, P. Patten, R. Varma, **A.K. Abdel Aal**
Interventional Radiology, University of Alabama at Birmingham, Birmingham, AL, US

Purpose: To evaluate the clinical and technical factors affecting the outcomes of percutaneous cryoablation (PCA) of renal cell carcinoma (RCC).

Material and methods: The medical records of the patients who underwent PCA for RCC between 2004 and 2018 were retrospectively reviewed and 160 patients were included. Patient demographics, tumor characteristics, technical success defined as absence of residual tumor within 3 months of procedure, and complications were reported. Recurrence-free, cancer-specific and overall survival rates were analyzed. A univariate analysis was performed to identify predictors of the outcomes.

Results: Mean age of the patients was 64.8 (SD=11.5) years. Chronic kidney disease at the baseline was seen in 41.3% of patients. The median tumor size was 2.9 (range:0.6 – 6.7) cm with 73 (58.4%) posterior tumor location. The study included T1a (77%) and T1b (23%) tumors. The median number of probes used was 2 (range:1 - 7) and 81 (85.1%) tumors were biopsied. Technical success rate was 92.5%. Minor complications were seen in 25.6% and major in 5.6% of patients. On univariate analysis, tumor biopsy ($p=0.014$), nearness to collecting system ($p=0.002$) and renal sinus involvement ($p=0.006$) were associated with complications. None of the variables predict local recurrence or overall survival. The recurrence free, cancer specific and overall survival at 3 years was 68.4%, 100% and 88% respectively.

Conclusion: Tumor biopsy, nearness to collecting system and renal sinus involvement were predictors of outcomes of PCA of RCC.

1505.7

Prostate cancer chemoembolization in dog pet model: DOGXEL a proof of concept study

O. Pellerin¹, S. Djaber¹, C. Déan², P. Reb³, C. Chaix³, D. Tierny⁴, M.R. Sapoval¹

¹Interventional Radiology, Hopital Européen Georges Pompidou, Paris, FR,

²Interventional Radiology, Hôpitaux de Paris, Hôpital Européen Georges Pompidou, Paris, FR, ³Research and Development, Merit Médical, Roissy En France, FR, ⁴OCR, Oncovet, Villeneuve d'Ascq, FR

Purpose: Prostate cancer is a leading cause mortality and its surgical treatment carry lots of sides effect. To date prostate artery embolization for benign prostate hyperplasia opens the gate to further development such as prostate cancer chemoembolization. Before envisioning human applications preclinical study is mandatory. The goal of our study is to

assess feasibility and efficacy of docetaxel loaded microparticles chemoembolization in dogs suffering from natural prostate cancer.

Material and methods: This study was compliant with ethic rules. All dogs owner gave their informed consent. 5 consecutive dogs with histopathologically proven prostate cancer were referred to docetaxel eluted beads chemoembolization (DEBC). After DEBC animals were clinically and biologically followed every month until death. Contrast enhanced CT were performed at 1 and 3 months. At death all animal had a pathological examination.

Results: For all animals, both prostate arteries were successfully chemoembolized. A mean dose of 13.8 ± 5.02 mg Docetaxel loaded on 2.3 ± 0.88 ml of 20-40 μ m Hepaspher™ was injected in each dog. At 1 and 3 months tumor response rate was 70% and 77% respectively (volume). At death histopathologic analysis show 70% of tumor necrosis, 25% of fibrotic scarring with inflammatory reaction and less than 5% of residual tumor. No urinary symptom worsening was observed at 3 months. Pharmacokinetic analysis showed a limited systemic passage of docetaxel. All dog died of metastatic at 9 months.

Conclusion: Prostate cancer chemoembolization is feasible and safe and could provide a new approach to treat prostate cancer in human.

Free Paper Session Peripheral vascular disease intervention 1

1506.1

Results of the BIOFLEX-COF RCT, comparing high vs low chronic outward force of nitinol stents in the SFA

A. Wressnegger, **M.A. Funovics**

Klinik für Radiodiagnostik, Medizinische Universität Wien, Vienna, AT

Purpose: The BIOFLEX-COF study is the first RCT to assess the correlation between chronic outward force of nitinol stents (COF) and neointimal hyperplasia. COF is the force on the vessel wall which a nitinol stent exerts-it depends on stent oversizing (ratio of vessel diameter/stent diameter) and stent-material ("stiffness" of the stent). In animals and humans, high COF has been correlated with neointimal hyperplasia and lumen loss.

Material and methods: Patients with de novo SFA lesions were randomized (n=80) into high and low COF groups. Stent sizes were chosen after measuring the SFA diameter according to a pre-defined sizing table. To obtain low COF, a soft stent (Pulsar, Biotronic) was implanted with little oversizing. To obtain high COF, a harder stent (Lifestent, Bard) was implanted with ample oversizing. A 2-3x difference in absolute COF between groups was confirmed at post-implantation measurements.

Results: The BIOFLEX COF has completed recruitment in March 2018. Primary outcome parameter is volumetry of in-stent-neointima measured with CT-angiography 1year post implantation.

The free lumen area will be measured at every 2mm along the stent's axis. Thus, an objective assessment of neointimal proliferation is possible, and in addition, correlations of local areas of high or low COF and local neointimal proliferation can be made not only between patient groups, but even within single stents.

Results will be available at the time of oral presentation.

Conclusion: The BIOFLEX-COF study is the first RCT which evaluates COF of nitinol stents, and is expected to have significant influence on our recommendations for nitinol stent sizing and selection.

1506.2

The hemodynamical significance of low-grade serial stenoses

L. van de Velde¹, E. Groot Jebbink¹, M. Versluis², M.M.P.J. Reijnen¹

¹Surgery, Rijnstate Hospital, Arnhem, NL, ²Physics of Fluids group, University of Twente, Enschede, NL

Purpose: Few guiding principles exist on when two hemodynamically insignificant stenoses in proximity become a significant stenosis due to their combined effect. Through an investigation of the pressure gradient in serial stenoses, we set out to identify which features of serial low-grade stenoses contribute to significant flow impediment.

Material and methods: For three idealized stenotic shapes, the pressure gradient over 19 serial stenotic configurations under a steady flow rate was investigated by computational fluid dynamics. The three shapes, all characterized by a 50%-area reduction, consisted of a concentric stenosis (C), a circular-eccentric stenosis (E1) and a crescent-eccentric (E2) stenosis. Combinations were obtained by varying stenosis order, interstenotic distance and, for E1 and E2, the relative angle between their direction of eccentricity. Simulations with pulsatile flow rates were carried out for a selected set of the models.

Results: The pressure gradient was largest for an E2 stenosis (4.7mmHg), with more comparable values for E1 (3.0mmHg) and C (2.3mmHg). For combinations of two stenoses, the pressure gradient was between 67-89% of the sum of the individual stenoses. The highest pressure gradients were present for increased interstenotic distance and for a 90° shift in eccentricity. For pulsatile flow, the mean pressure gradient increased, but otherwise observations were similar as for steady flow.

Conclusion: The flow-limiting effect of serial stenoses is strongest for those with a large interstenotic distance and a 90° shift in eccentricity. For a single lesion, a non-circular shape can strongly augment the pressure gradient, which is not detected by ultrasound and may be unknown to interventionalists.

1506.3

Bollinger scoring application in evaluation of infrainguinal peripheral arterial disease in MR angiography

A.G. Smith¹, S. Seedat², L. Kenning¹, D.F. Ettles², R. Lakshminarayan²

¹Academic Department of Radiology, Hull Royal Infirmary, Hull, UK,

²Radiology, Hull Royal Infirmary, Hull, UK

Purpose: The Bollinger scoring system (BSS) has been utilised to accurately measure atherosclerotic disease burden in digital subtraction angiography (DSA) as demonstrated in the BASIL trial. BSS utilisation in atherosclerosis assessment in CT angiography has also been proven. With increasing use of contrast-enhanced MR angiography (MRA) in atherosclerotic disease assessment, we aim to evaluate the efficacy of the BSS in peripheral arterial disease (PAD) in MRA imaging.

Material and methods: The infrainguinal arterial tree was split into 6 segments in each limb down to the calf as per BSS methodology. Intraobserver (1 radiologist, 179 segments), interobserver (3 radiologists, 468 segments) and MRA vs. gold standard DSA (2 radiologists, 183 segments) scores were obtained. Subgroup analysis was performed on above knee (AK) and below knee (BK) arterial vasculature. Agreement was calculated using Kappa statistics, Spearman's Rho and intraclass correlation coefficients (ICC) using SPSS.v21.

Results: Intraobserver analysis of 179 segments demonstrated very good levels of agreement (Kappa=0.855 p=<0.001). Interobserver analysis between 3 radiologists scoring 468 segments revealed an ICC average measure of 0.945 (95% CI 0.934-0.954). Pairwise Spearman's rho between observers were as follows: Obs1 vs.Obs2=0.796, Obs1 vs. Obs3=0.644, Obs2 vs.Obs3=0.642. Two-tailed significance was P<0.001 for all correlations. Good agreement was observed between MRA and DSA (Kappa=0.764 p=<0.001) when 2 radiologists scored 183 segments. No difference in agreement AK(Kappa=0.722) and BK(Kappa=0.702) was demonstrated.

Conclusion: The BSS methodology is a useful tool to evaluate infrainguinal PAD in MR angiography.

1506.4

The utility of two-dimensional perfusion angiography (2D-PA) in critical limb ischemia (CLI): a single center experience

A.J. Alvi, Z.A. Asseri, A. Bin Habjar, M. Al-Moaikel
Medical Imaging, King Abdulaziz Medical City, Riyadh, SA

Purpose: To analyze the feasibility and utility of 2D-perfusion angiography (2D-PA) to quantify flow and perfusion changes pre- and post-CLI angioplasty.

Material and methods: A retrospective single-center study review of 21 patients from February, 2017 to August 2018 (mean age 84±42 years; 17 men, 8 women) with CLI who underwent lower limb digital subtraction angiography (DSA) A standardized contrast administration protocol was applied during DSA using a 2D perfusion-enabled image intensifier. Representative hindfoot and forefoot regions of interest were analyzed, and representative numeric density values [time to peak (TTP), mean transit time (MTT) and area under the (time-density) curve (AUC)] were calculated using 2D perfusion-enabled angiographic software to assess foot perfusion.

Results: Numeric density values were compared before and after angioplasty and by level of treatment. These parameters were correlated with disease severity and included TTP, MTT, AUC, change in wash-in rate and change in width of the curve.

Conclusion: Our initial experience shows the utility of functional imaging in CLI in providing objective measurements of microvascular perfusion and determining the endpoint and outcome of revascularisation.

1506.5

Demonstrating compliance in Thiel-embalmed arteries: implications for image-guided, minimally-invasive therapies

C. Fitton¹, H. Donald-Simpson², R. Ross³, T. Wilkinson⁴, J.G. Houston⁵

¹Institute for Medical Sciences and Technology, Wilson House, University of Dundee, Dundee, UK, ²Image Guided Therapy Research Facility, University of Dundee, Dundee, UK, ³Vascular Laboratory, University of Dundee, Dundee, UK, ⁴Centre for Anatomy and Human Identification, University of Dundee, Dundee, UK, ⁵Clinical Radiology, Ninewells Hospital, Dundee, UK

Purpose: Percutaneous, minimally-invasive therapies offer reduced infection risk, direct contact with diseased vessels and quicker recovery periods for patients suffering from cardiovascular diseases. An increase in the use of minimally-invasive therapies necessitates appropriate models to test therapy devices and train medical staff. The Thiel cadaveric vascular model offers a dynamic, anatomically-accurate model with durability unachievable in fresh cadavers. The purpose of this study was to demonstrate arterial compliance measurements of Thiel-embalmed cadavers following two medical interventions.

Material and methods: 14Fr introducers were inserted into both superficial femoral arteries of two Thiel-embalmed cadavers, permitting the application of extracorporeal flow. 12Fr introducers were inserted retrograde into the popliteal arteries for outflow. A Shockwave IVL catheter delivered either balloon angioplasty or an experimental lithotripsy treatment (Shockwave, USA) to each vessel. A 6Fr Terumo catheter connected to a pressure transducer (AdInstruments, UK) was located at each treatment site whilst simultaneous transverse B mode ultrasound imaging was conducted. Measuring the parameters at 3ml/s and 6ml/s flow rate permitted calculation of compliance at each treatment site.

Results: Changes in compliance, both pre- and post-intervention were observed indicating elastic properties of the vessels have been maintained post-embalming. No discernible trend was noted between the treatment types. Variation in parameter measurements highlighted

further validation of the technique is required to determine if this technique is statistically accurate and reliable.

Conclusion: This study demonstrated Thiel-embalmed arteries remain compliant post-embalming, offering a superior preclinical tool compared to previous vascular models for the development and testing of endovascular devices and treatments.

1506.6

BioMimics 3D Stent System. 2-year results of the MIMICS-2 Study

P.A. Gaines

Medicine, Sheffield Hallam University, Sheffield, UK

Purpose: The MIMICS-2 study is designed to demonstrate the safety and effectiveness of the BioMimics 3D® Vascular Stent System (Veyan, Horsham UK) in a large population

Material and methods: BioMimics 3D features a Nitinol stent with a unique 3D helical centreline designed to generate swirling blood flow, elevate wall shear and improve biomechanical performance. MIMICS-2 is a prospective, single arm, multicentre study with 3-year follow-up of patients with symptomatic de novo occlusive disease of the native FPA. The primary safety endpoint is a composite of major adverse events (MAE) at 30 days. Primary effectiveness endpoint was 1-year primary patency.

Results: 271 enrolled subjects had a mean age of 68 years, 66% male, 81% smokers and 45% diabetics. Core lab reported mean lesion length was 81.2 ± 38.4 mm and vessel diameter was 5.2 ± 0.9 mm; 46% of lesions were moderately to severely calcified and 30% were total occlusions. Technical success; lesion success and procedure success were all 100%. Primary safety and effectiveness endpoints were met: freedom from MAE through 30 days was 99.6% (268/269) and the Kaplan-Meier estimate of freedom from loss of primary patency at 1-year was 83%. Complete 2-year data will be available at the time of presentation.

Conclusion: MIMICS-2 outcomes at 1-year confirm the safety and effectiveness of the BioMimics 3D stent. Emerging 2-year data show consistency with MIMICS-RCT data, which support the hypothesis that a helical centreline stent promotes naturally antiproliferative swirling flow, providing a clinically-important point of differentiation in stent selection.

1506.7

Next generation of DCB: efficacy and tolerance of drug-coated hyper-compliant balloons (DCHCB) in peripheral arteries of swine

M. Kusmierczuk¹, S. Bienek¹, S. Schurmann-Kaufeld¹, A. Mittag², U. Speck³, B. Scheller⁴

¹R&D, InnoRa GmbH, Berlin, DE, ²R&D, Institute of Medical Technology and Research GmbH, Rottmersleben, DE, ³Radiology, Charité, Berlin, DE,

⁴Clinical and Experimental Interventional Cardiology, University of Saarland, Homburg/Saar, DE

Purpose: After predilatation, atherectomy or stenting long vessel segments rarely display uniform cylindrical lumen. Single DCHCB cover all lumen diameters and shapes including bifurcations in major peripheral arteries. Our aim was to explore whether DCHCB inhibit excessive neointimal proliferation caused in juvenile pigs by vessel overstretch and permanent stents.

Material and methods: First, drug transfer from DCHCB to the vessel wall was explored at low inflation pressure. Then, DCHCB were compared to standard DCB and uncoated balloons in respect of inhibition of neointimal proliferation and tolerance in porcine iliac arteries.

Results: Despite the small surface area of uninflated hyper-compliant balloons approximately 60µg drug/mm length was achieved which is sufficient to treat a vessel of ~7mm diameter. DCHCB, inflated at <1.5 atm, accommodated a wide range of vessel diameters. DCB were inflated at ~10 atm to the predetermined cylindrical shape. Drug transfer with DCHCB was $13.9 \pm 6.4\%$ of dose. Drug distribution within a 20-cm vessel segment was surprisingly homogeneous with somewhat higher

drug concentration in the narrow distal portion. Four week after stenting followed by ballooning angiographic LLL was 0.16 ± 0.07 mm and 0.47 ± 0.43 mm for DCHCB and DCB, and 0.48 ± 0.37 mm and 0.76 ± 0.87 mm for the corresponding uncoated variants. By OCT, neointimal area was 0.78 ± 0.42 mm² and 1.12 ± 0.39 mm² for DCHCB and DCB, and 1.37 ± 0.55 mm² and 2.09 ± 1.44 mm² for the uncoated constructs. Findings were confirmed by histomorphometry, e.g., neointimal thickness, and area and diameter stenosis.

Conclusion: After adequate vessel preparation without or with stenting DCHCB may allow effective restenosis inhibition in irregularly shaped vessel segments with variable diameters.

News on Stage Interventional oncology

2004.1

Performance of a new needle for the displacement of critical structure in thermal ablation

P. Auloge¹, R.L. Cazzato¹, J. Caudrelier¹, P.P. Rao², G. Koch¹, J. Garnon¹, A. Gangi³

¹Interventional Radiology, University Hospital of Strasbourg, Strasbourg, FR,

²Division of Robotics and Department Interventional Radiology, iCube, University of Strasbourg and Nouvel Hopital Civil, Strasbourg, FR,

³Imagerie Interventionnelle, NHC, Strasbourg, FR

Purpose: To present the performance of a new blunt tip non-traumatic needle allowing hydro- or gas-dissection whilst performing thermal ablation (TA).

Material and methods: This prospective single arm observational study included 27 consecutive patients who were treated by TA (cryoablation (CA), radiofrequency (RFA), or microwave (MWA)) due to musculoskeletal (37%, 10/27; [curative intent: 7/10, palliative intent: 3/10]) or parenchymal (63%, 17/27) tumors between April 2018 and January 2019. In all cases, one or more critical structures were close to the tumor (<10mm) thus, requiring displacement/insulation. Technical success (sufficient displacement of critical structure to perform TA), distance between critical structure before and after dissection, and complications were recorded.

Results: Eighteen patients were treated by CA (66.7%), 7 by MWA (25.9%) and 2 by RFA (7.4%). Adjacent critical structures were vessels (11.1%), nerves (37%), ureter/renal pelvis (11.1%), bowel (33.3%), stomach (14.8%), diaphragm (7.4%), and pleura (3.7%). Technical success was 100%. Median minimum distance to adjacent critical structures before hydro-/gas-displacement was 1mm (range 0-9mm; IQR: 0-3 mm) vs 10.5mm (range 4-47mm; IQR: 9.7-18 mm) after displacement ($p=0.01^{10-13}$). Among the 27 patients, 4 developed complications (14.8%; 95% CI: 1.4%-28.2%): 1 major (3.7%) and 3 minors (11.1%) but only one (3.7%) minor complication was related to a sub-optimal dissection.

Conclusion: The presented blunt-tip needled proved to be safe and effective when applied to approach, displace and insulate critical structure during TA procedures.

2004.2

Effects of ablation on systemic therapy for metastatic pulmonary sarcoma: potential synergy?

K. Menon¹, A. Doshi², K. Ganjoo³, D. Wang¹, G. Hwang¹

¹Interventional Radiology, Stanford Hospital and Healthcare, Stanford, CA, US,

²Radiology, Stanford Hospital and Healthcare, Stanford, CA, US, ³Oncology, Stanford Hospital and Healthcare, Stanford, CA, US

Purpose: Soft tissue sarcomas are rare mesenchymal tumors prone to metastatic spread. Ablation of dominant pulmonary metastases with immunotherapy represent a potential treatment strategy. This study

assesses the efficacy of ablation and systemic treatment on progression of pulmonary metastases.

Material and methods: Single-center, retrospective analysis was performed on 10 patients with >1 pulmonary leiomyosarcoma or liposarcoma metastasis who underwent cryoablation or microwave ablation of the dominant lesion(s). Greatest dimension analysis was performed on the targeted and non-ablated index lesion(s) up to 1 year pre-ablation and up to 1 year post-ablation on non-targeted lesion(s). Linear regression analysis was performed to evaluate lesion growth rate. Similar analysis was performed on 6 control patients on immunotherapy alone.

Results: Between Jan 2014 and April 2018, 10 patients underwent lung ablation along with oncologic therapies (immunotherapy, N=6, chemotherapy, N=4). Complications included pneumothorax in 2 patients, 1 resulting in prolonged hospital stay.

Dominant pulmonary metastases demonstrated a growth rate of 2.124 mm/month (range 0.184 to 11.10) pre-ablation. Immunotherapy + ablation showed a pre-/post-ablation growth rate of 0.56/0.53 mm/month; chemotherapy + ablation showed a pre-/post-ablation growth rate of 0.427/1.062 mm/month. There is suggestion of a trend of decreased growth rate after ablation between immunotherapy and chemotherapy subsets, but no statistical significance was reached ($P = 0.14$). Control patients of immunotherapy alone demonstrated lesion growth rate of 0.612 mm/month ($P = 0.57$).

Conclusion: Ablation + immunotherapy of targeted lesions were without adverse effect on growth of non-targeted metastases. Further study with additional patients is needed to determine if ablation improves the systemic efficacy of immunotherapy.

2004.3

Randomized embolization trial for neuroendocrine tumors (RETNET): first safety report

M.C. Soulen¹, N. Fidelman², R.D. Garcia-Mónaco³, S.B. White⁴, R. Avritscher⁵, G. El-Haddad⁶, E.P. Wileyto⁷

¹Radiology, University of Pennsylvania, Philadelphia, PA, US, ²Radiology, University of California San Francisco, San Francisco, CA, US, ³Interventional Radiology, Hospital Italiano de Buenos Aires, Buenos Aires, AR, ⁴Radiology, Medical College of Wisconsin, Milwaukee, WI, US, ⁵Radiology, UT MD Anderson Cancer Center, Houston, TX, US, ⁶Interventional Radiology, Moffitt Cancer Center, Tampa, FL, US, ⁷Biostatistics, University of Pennsylvania, Philadelphia, PA, US

Purpose: Embolotherapy of NET liver metastases is part of international guidelines, without recommendation regarding technique. RETNET (NCT02724540) is a RCT comparing bland, cTACE, and DEB-TACE. The first safety analyses occurred following accrual of 10 subjects in each arm.

Material and methods: QI guidelines for embolization set the performance threshold for major complications at 8%, and for any complications 15%. For RETNET, a 20% incidence of serious adverse events as defined by the SIR (D = unplanned increase in level of care; E = permanent adverse sequelae; F = death) would be grounds for closing an arm. This provides a 62% probability of halting at the first safety review if the true event rate is 20%. Blinded review was performed by an independent DSMB consisting of three senior interventional oncologists at non-participating institutions after a minimum of 10 subjects in each arm had one-month follow-up after their first embolization cycle.

Results: 2/11 subjects in the bland arm had SIR Category D events (pain; unrelated pancreatitis 6 months post-embo). The subject with pain required re-hospitalization and withdrew from the study. 2/10 subjects in the cTACE arm had SIR Category D events (unrelated renal infection, hyponatremia), none resulted in study discontinuation. 4/10 subjects in the DEB arm had Category D (hyponatremia, carcinoid crisis, both requiring ICU admission) or E (hepatobiliary necrosis; biloma) events, two of which resulted in study discontinuation.

Conclusion: 4/10 NET subjects embolized with DEB had treatment-related SAE's, two permanent and two resulting in study discontinuation. Based on the trial stopping rule, the DSMB closed the DEB arm.

2004.4

Chemoembolization for treatment of hepatocellular carcinoma: national registry-based analysis

T. Andrašina¹, M. Uher², T. Rohan¹, P. Matkulčík³, J. Zavadil¹, B. Cechova⁴, L. Jandurova³, V. Válek¹

¹Department of Radiology and Nuclear Medicine, University Hospital Brno, Masaryk University, Brno, CZ, ²Institute of Biostatistics and Analyses of the Faculty of Medicine, Masaryk University Brno, Brno, CZ, ³Medical Faculty, Masaryk University Brno, Brno, CZ, ⁴Department of Radiology and Nuclear Medicine, Masaryk University, Central European Institute of Technology, Brno, CZ

Purpose: To evaluate survival benefit in patient undergoing transarterial chemoembolization for hepatocellular carcinoma by national registry data analysis and comparison of regions with unequal usage of interventional radiology procedures.

Material and methods: 4343 patients with primary diagnosis of HCC between 2010-2016 were extracted from the databases of The Czech National Cancer Registry. The analysis was supported by data from the National Registry of Paid Health Services and the Death Records Database. Primary treatment option was categorized as liver resection, ablation, TACE and chemotherapy. The regional data analysis provided information of IR procedures frequency for primary treatment of HCC. The 14 main regions were symmetrically divided to group with well-developed IR service and low-developed IR service according to the frequency of stage-adjusted IR procedure usage (<15%, >15%). Kaplan-Meier and Cox regression were used for survival and hazard ratios analyses.

Results: Only 1730 patients had assessed any primary treatment option, 16.5% (285) were treated by TACE. Median of survival were significantly different in regions with well and low developed IR service for whole study population (13.2 months vs 6.5, $p < 0.001$), patients treated in regions with well developed IR service had lower risk of death during treatment (HR=0.73 (0.66-0.81)). The patient treated by TACE had median of survival 15.8 months (13.5-18.1), while the survival was not significantly different in region groups.

Conclusion: The usage of anticancer therapies based on IR procedures is a huge factor influencing the survival of HCC patient according to population-based data. Studies gathering data from cancer register databases can provide further information on treatment effectiveness.

2004.5

Transarterial chemoembolization with degradable starch microspheres (DSM-TACE) vs. selective internal radiation therapy (SIRT) in multifocal hepatocellular carcinoma (HCC)

T.A. Auer¹, M. Jonczyk¹, F. Collettini¹, B. Hamm², B. Gebauer³

¹Department of Radiology, Charité - University Medicine Berlin, Berlin, DE, ²Institut für Röntgendiagnostik, Med. Fakultät d. Humboldt-Universität, Berlin, DE, ³Klinik für Strahlenheilkunde, Charité Universitätsmedizin Berlin, Berlin, DE

Purpose: To compare outcome of trans-arterial chemoembolization (TACE) with degradable starch microspheres (DSM-TACE) vs. selective internal radiation therapy (SIRT) in multifocal hepatocellular carcinoma (HCC).

Material and methods: In this single-center study, 36 patients without portal vein invasion, treated between 05/2014 and 05/2018, were enrolled retrospectively. 18 consecutive patients received DSM-TACE and were matched by age, gender, BCLC-stage, Child-Pugh-status and tumor-volume with 18 patients undergoing SIRT. Overall survival (OS), progression free survival (PFS) and local tumor control (LTC) were evaluated.

Results: In the entire collective median OS was 9.5 months (m), PFS 5.0m and LTC 5.5m. Subgroup analysis revealed an OS of 9.5m in both groups ($p=0.621$). PFS was 6m for the SIRT- and 4m for the DSM-TACE-cohort ($p=0.065$). Although not significantly, LTC was lower (4m) in the SIRT- compared to the DSM-TACE-cohort (7m; $p=0.391$). When DSM-TACE

was performed 3 times or more ($n=11$) OS increased, however, without statistical difference compared to SIRT, to 11m, PFS to 7m and LTC to 7m. When DSM-TACE was performed less than 3 times ($n=7$) OS, PFS and LTC decreased significantly (5m, $p=0.333$; 2m, $p=0.047$; 2m, $p=0.47$).

Conclusion: Repetitive DSM-TACE might be an alternative to SIRT in multifocal HCC patients as OS, PFS and LTC did not differ significantly.

2004.6

Multimodality quantitative volumetric and metabolic assessment of early tumor response and survival in patients with uveal melanoma liver metastases undergoing Y^{90} -radioembolization

F. Tabotta¹, S. Gnesin², A. Ponti¹, A. Denys¹, A. Hocquelet¹, A. Digkila³, J. Prior², J.-F. Knebel⁴, N. Schaefer², R. Duran¹

¹Radiodiagnostic and Interventional Radiology, CHUV University Hospital, Lausanne, CH, ²Nuclear Medicine and Molecular Imaging, CHUV University Hospital, Lausanne, CH, ³Medical Oncology, CHUV, Lausanne, CH, ⁴Centre for Biomedical Imaging, Centre Hospitalier Universitaire Vaudois, Lausanne, CH

Purpose: To determine early tumor response and survival predictors using quantitative volumetric and metabolic parameters in patients with uveal melanoma liver metastases (UMLM) treated with Y^{90} -radioembolization.

Material and methods: Ten patients with 25 lesions (mean, 63-year-old) of a prospectively collected cohort were retrospectively included. Patients underwent MRI/CT, F^{18} -FDG PET/CT before and 3-6 months after Y^{90} -radioembolization, and Y^{90} -PET/CT immediately post-radioembolization. Image analysis included: 1) lesion intensities/attenuations, 2) size and tumor volume (Response Evaluation Criteria in Solid Tumors (RECIST) and volumetric RECIST, respectively), 3) volumetric tumor enhancement (quantitative European Association for the Study of the Liver [qEASL]), and 4) quantitative metabolic parameters (total lesion glycolysis (TLG), standardized uptake value (SUV), volumetric dosimetry of the treated lesions). Paired-t-test was used to compare pre- and post-therapy measurements. Spearman's rank-order correlation and Pearson's chi-squared test were used to correlate the dose to the different measurements. Survival was evaluated by using Kaplan-Meier analysis with the log-rank test.

Results: Lesions' size (RECIST), volumetric enhancement (qEASL) and metabolic activity (TLG, SUV) decreased significantly post-therapy ($P<.05$). Mean absorbed dose was 139Gy (range, 15–594Gy). Interestingly, all lesions responded even with low absorbed dose. However the absorbed dose was not correlated with response. Baseline and post-treatment TLG and SUV parameters were predictive of survival ($P<.05$), while qEASL demonstrated a clear trend for survival prediction ($P=.058$).

Conclusion: Quantitative metabolic parameters may be used as a surrogate biomarker for early survival prediction in UMLM after the first Y^{90} -radioembolization. A wide range of absorbed doses achieved response, suggesting that similar outcomes might be reached with low-dose protocols.

Free Paper Session Prostate artery embolisation

2206.1

A CT protocol for 4D angiography and perfusion imaging of the prostate for embolization planning: proof of concept study

A. Kobe¹, G. Puippe², E. Klotz³, H. Alkadhi², T. Pfammatter²

¹Interventional Radiology, University Hospital Zurich, Zurich, CH, ²Division of Diagnostic and Interventional Radiology, University Hospital Zürich, Zurich, CH, ³CT R&D, Siemens Healthineers, Forchheim, DE

Purpose: To evaluate the visibility of the prostatic artery (PA) prior to prostate artery embolization (PAE) in benign prostatic hyperplasia using a novel CT protocol providing 4D-CT angiography (4D-CTA) and quantitative perfusion information.

Material and methods: 22 consecutive patients (mean age 67 ± 7 years) underwent a dynamic CT scan of the pelvis (scan range: 22.4cm, cycle time: 1.5s, scan time: 44s, 25 scan cycles, 70kVp, 100mAs, 70ml iodinated contrast media, flow rate 6ml/s, 10s delay). Image post-processing consisted of noise reduction, motion correction, and fusion of multiple arterial time points resulting in time-resolved 4D-CTA. Intraprocedural cone-beam CT was performed with microcatheter in the PA. In both modalities the CNR of the right internal iliac artery and PA were calculated. Visibility of the PA was scored using a Likert scale (score 1=not seen, score 4= intraprostatic PA branches seen).

Results: The average $CTDI_{vol}$ and DLP of CT was 35.7 ± 6.8 mGy and 737.4 ± 146.3 mGycm, respectively. CNR in 4D-CTA and cone-beam CT were 45 ± 19 and 69 ± 27 , respectively ($p<0.01$). The mean visibility score of the PA was 3.6 ± 0.6 for 4D-CTA and 3.97 ± 0.2 for cone-beam CT ($p<0.001$). The PA was visualized in 100% of 4D-CTA examinations, with one PA being visible only proximally. Prostate CT perfusion analysis showed blood flow, blood volume, mean transit time and flow extraction product values of 27.9 ± 12.5 ml/100ml/min, 2.0 ± 0.8 ml/100ml, 4.5 ± 0.5 , 12.6 ± 5.4 ml/100ml/min, respectively.

Conclusion: We introduced a CT protocol for PAE planning providing excellent visualization of the PA at reasonable dose and low contrast volume. The additionally available quantitative perfusion information might potentially be useful for outcome prediction after embolization.

2206.2

Prostatic artery embolization with HydroPearls: safety and efficacy

A. Kovács, P. Bischoff, A. Schaefer, A. El Mansouri

Radiology and Neuroradiology, MediClin Robert Janker Klinik, Bonn, DE

Purpose: Prostatic artery embolization (PAE) has been described as a new, effective and safe procedure for the treatment of patients with lower urinary tract symptoms (LUTS), secondary to benign prostatic hyperplasia (BPH). To date, several studies have reported outcomes of PAE with different bland embolic agents, but the safety and efficacy of new bland embolic microspheres, HydroPearl, has not been reported. Our aim was to study the outcome of patients with BPH treated with HydroPearl.

Material and methods: 174 patients (mean age 69.7 years) with BPH treated with 200 μ m HydroPearls for PAE in a single German institution were assessed. Preinterventional and follow-up imaging was carried out in MRI and US. Clinical follow-up included post-void residual volume (PVR), prostatic volume (PV), International Prostate Symptom Score (IPSS), quality of life (QoL) and peak urinary flow (Qmax) recorded at 2, 6 and 12 months.

Results: Clinical and imaging follow-up revealed a significant improvement at any time point after PAE. No major complications were reported.

	prae PAE	2 month	6 month	12 month
PV (ml)	131.7	82.4	78.1	75.3
PVR (ml)	176.7	68.5	52.2	53.7
Qmax (ml/s)	6.7	11.8	12.3	12.1
IPSS	21.3	9.6	7.8	8
QoL	4.7	1.5	1.3	1.3

Conclusion: PAE with HydroPearls is an effective, safe and well-tolerated alternative for the treatment of BPH. Final results will be reported at the time of Congress.

2206.3

Prostatic artery embolization for benign prostatic hyperplasia: anatomical, technical and radiation exposure considerations in 168 cases

M. Shaker, E.Y. Hashem, A.A.M.B. Okba, R.T.M. Khafagy, K. Abd El Tawab
Radiology, Ain Shams University, Cairo, EG

Purpose: Prostatic artery embolization (PAE) has been established as a safe and effective treatment option for benign prostatic hyperplasia. We aim to provide important anatomical and technical considerations extracted from our case series of 168 patients who underwent PAE.

Material and methods: We performed PAE for 168 consecutive patients from January 2013 to January 2019. Most commonly used tools were cobra-head 5-French angiographic catheter and 2.7-French microcatheter. Preoperative CT angiography and intraoperative cone-beam CT were not utilized. Anatomy, radiation dose and procedure duration were recorded and analyzed.

Results: In the 168 patients, 331 prostatic arteries (PAs) were angiographically identified. Median procedure duration was 69 minutes. Mean radiation dose was 562 mGy. In 3 patients (2%), only unilateral PA was identified; while the rest had bilateral supply. 9 patients (5%) had 3 PAs. No PAs could be identified in 2 patients (1%). The frequencies of origins of PAs were found to be as follows: 132 (40%) from superior vesical artery, 97 (29%) from internal pudendal artery, 70 (21%) from obturator artery, 29 (9%) originated directly from anterior division of internal iliac artery and only 3 (1%) originated from inferior gluteal artery. PA origins were symmetrical in 46% of bilateral cases. Intraprostatic anastomosis between contralateral PAs was observed in 31 patients (18%). Penile, rectal or vesical anastomoses were angiographically identified with 59 PAs (18%).

Conclusion: Thorough anatomical and technical knowledge is essential to guarantee successful PAE, avoid potential complications of non-target embolization and optimize radiation exposure.

2206.4

PAE provides a proportionately greater change in storage symptoms compared with surgery: multivariate analysis of the UK-ROPE database

G. Vigneswaran¹, D. Maclean¹, S. Modi², M.R. Harris³, T.J. Bryant⁴, N. Hacking⁵

¹Interventional Radiology, University Hospital Southampton, Southampton, UK, ²Radiology, University Hospital Southampton, Southampton, UK, ³Urology, University Hospital Southampton, Southampton, UK, ⁴Radiology, Southampton General Hospital, Southampton, UK, ⁵Clinical Radiology, University Hospital Southampton, Southampton, UK

Purpose: Studies have shown storage symptoms are a particularly bothersome subset of lower urinary tract symptoms (LUTS) and are commonly a patient's most severe complaint. PAE is known to reduce storage symptoms effectively, but no comparative studies against surgery have

examined the International Prostate Symptom Score (IPSS) breakdown. We aimed to identify which procedure reduced storage symptoms to a greater extent relative to the overall IPSS score.

Material and methods: Analysis of the UK-ROPE database identified 146 patients (121 PAE, 25 TURP/ HoLEP) with the IPSS breakdown score recorded at baseline and 12 months (mean age 66.2, mean prostate volume 102 mls, mean Qmax 9.9 ml/s). Analysis of Variance (ANOVA) and t-test was performed to assess for differences in reduction of voiding symptoms, storage symptoms and the ratio between the two.

Results: No significant difference was seen in overall IPSS reduction between the two groups, although there was a trend towards a greater reduction in the surgery cohort vs PAE (13.4 vs 10.9, $p=0.13$). Surgery reduced voiding symptoms to a greater extent although this was not significant compared with PAE (8.4 vs 6.7, $p=0.1$). The reduction in storage symptoms was similar between the treatments (4.9 vs 4.2, $p=0.34$), but the proportionate change in storage symptoms relative to overall IPSS reduction was significantly greater in PAE group (-0.1) vs surgery (-0.3, $p<0.001$).

Conclusion: PAE is a good option for patients with bothersome storage symptoms as it forms a larger proportion of total IPSS reduction compared with surgery. This suggests a different mechanism of symptom relief to surgery.

2206.5

Correlation between peri-procedural prostate enhancement and the number of prostatic arterial targets during prostate artery embolisation

T. Barge¹, A. Macdonald², P. Boardman³, C.R. Tapping⁴

¹Department of Radiology, Oxford University Hospitals NHS Foundation Trust, Oxford, UK, ²Radiology, John Radcliffe Hospital, Oxford, UK, ³Radiology, Churchill Hospital, Oxford, UK, ⁴Radiology Department, Churchill Hospital, Oxford University Hospitals NHS Foundation Trust, Oxford, UK

Purpose: To assess whether the degree of hemi-prostatic parenchymal enhancement on cone-beam CT (CBCT) predicts the number of prostatic arteries (PAs) for potential targeting during prostate artery embolisation (PAE).

Material and methods: During PAE, CBCT was performed prior to embolisation to confirm correct catheter placement, using the same contrast injection parameters. The degree of parenchymal enhancement of each hemi-prostate on CBCT was scored, where 0 was no enhancement, 1 was partial and 2 was complete. The number of PAs supplying each hemi-prostate was assessed on a pre-procedural CT angiogram and also during embolisation. Differences between groups were analysed using Fisher's exact test.

Results: Results are shown in Table 1. Complete hemi-prostatic enhancement predicts the absence of further PAs ($p=0.02$). Where enhancement was incomplete, but only a single PA was identified, extra-prostatic branching was demonstrated in 5 of 15 patients (33%).

Table 1: Hemi-prostatic enhancement vs number of PAs			
		Enhancement score	
		1	2
Number of prostatic arteries	1	15	20
	2	6	0

Conclusion: Complete enhancement of a hemi-prostate negates the need to search for further embolic targets. However, where hemi-prostatic enhancement is incomplete, the presence of proximal segmental branches or additional PAs should be considered. This may be particularly of significance when pre-procedural imaging of the prostatic arterial

supply is unavailable or inadequate to determine whether multiple vessels should be targeted during PAE.

2206.6

Outcome of prostatic artery embolization for benign prostatic hyperplasia: 1550 patients follow up to 10 years

J.M. Pisco ^{†1}, T. Bilhim², N.V. Costa³, L.C. Pinheiro⁴, D. Torres¹, J. Pisco⁵, A.G. Oliveira¹

¹Interventional Radiology, Saint Louis Hospital, Lisbon, PT, ²Interventional Radiology, CHLC, Saint Louis Hospital, Lisbon, PT, ³Radiology, St Louis Hospital, Lisbon, PT, ⁴Urology, Hospital Curry Cabral, Lisbon, PT, ⁵Angiography, Hospital St. Louis, Lisbon, PT

Purpose: To evaluate the outcome of prostatic artery embolization (PAE) for symptomatic benign prostatic hyperplasia (BPH) patients with moderate to severe lower urinary tract symptoms (LUTS).

Material and methods: Between March 2009 and February 2019, 1550 patients with symptomatic BPH and severe LUTS underwent PAE. The prostate was larger than 100 cm³ in 312 patients and 156 patients were in acute urinary retention (AUR).

Results: There was a statistically significant ($P < 0.001$) change from baseline to observed value in the evaluated parameters. The cumulative clinical success rates at short, medium and long term follow up were 88.1% (95% CI, 77.6% - 92.4%), 85.1% (95% CI, 71.3% - 93.1%), and 76.8% (95% CI, 69.1 - 84.6%), respectively. From the 156 patients in AUR, 140 (89.7%) had the bladder catheter removed between 2 days and 3 months; 10 had repeated successful PAE and 6 had surgery. From the 312 patients with prostate larger than 100 there was clinical success in 252 (80.7%) (95% CI 78.2% - 93.1%) at short term, in 242- 77.6% (95% CI, 74.8% - 84.9%) at medium and in 235 (75.3%) (95% CI, 72.4% - 82%) at long term. There were 3 major complications, a bladder wall ischemia, a perineal pain for 3 months without sequela and a patient had expelled prostate fragments and AUR treated by TURP without sequela.

Conclusion: Due to the good clinical results of PAE for symptomatic BPH patients with moderate to severe LUTS at short, mid and long term follow up, PAE may become the standard procedure for BPH.

2206.7

The proStatic aRtery EmbolizAtion for the treatMent of benign prostatic hyperplasia (STREAM) study: two-year results from a prospective cohort

A.C. Macdonald¹, T. MacKinnon², J. El-Sheikha¹, D. Kearns¹, R. Macpherson³, J. Crew³, M.W. Little⁴, P. Boardman⁵, C.R. Tapping³

¹Radiology, Oxford University Hospitals, Oxford, UK, ²Interventional Radiology, Oxford University Hospitals, John Radcliffe, Oxford, UK, ³Radiology Department, Churchill Hospital, Oxford University Hospitals NHS Foundation Trust, Oxford, UK, ⁴Interventional Radiology, Royal Berkshire NHS Foundation Trust, Reading, UK, ⁵Radiology, Churchill Hospital, Oxford, UK

Purpose: The STREAM study was initiated to assess the safety and efficacy of prostate artery embolisation in the short to medium term. Pre and post-operative imaging with multi-parametric MRI was concurrently performed.

Material and methods: Patients were referred from a benign prostatic hyperplasia clinic for consideration of PAE based on factors including personal preference for minimally invasive treatment or contraindications to surgery. International prostate symptom score (IPSS), International Index for Erectile Function (IIEF), and a quality of life assessment (EQ-5D) were recorded along with MRI pre-PAE, at three months, one year and two years. Embolisation was performed at a single centre via a femoral approach using 300-500um particles and the assistance of cone beam CT in all cases.

Results: A total of 50 patients were recruited. Mean gland volume was 63mls (21-171) and mean age 68 (56-91). There were two technical

failures. Overall, the good outcomes seen at one year were maintained into the second year of follow up with only a two-point reduction in the cohort average IPSS from year one to year two. MRI appearances continued to correlate with clinical outcomes at two years and may provide some insights into identifying those who will respond well to PAE.

Conclusion: Prostate Artery Embolisation remains an effective and durable treatment at two-year follow up. MRI has provided useful correlates between physiological/radiological features and symptomatic relief.

Free Paper Session

Transarterial approaches for liver tumours

2207.1

Spectral CT-based iodized oil quantification to develop a tumor response prediction model for chemoembolization of hepatocellular carcinoma

W.S. Choi¹, B. Kang², Y.H. So³, Y.S. Jeong², J.W. Chung², J.W. Choi², S. Hur²

¹Radiology, Seoul National University Bundang Hospital, Seongnam, KR, ²Radiology, Seoul National University Hospital, Seoul, KR, ³Radiology, Seoul National University Boramae Hospital, Seoul, KR

Purpose: To develop a tumor response prediction model of chemoembolization using post-procedural spectral CT imaging in patients with hepatocellular carcinoma (HCC).

Material and methods: From September 2017 to December 2018, 50 HCCs in 41 patients underwent chemoembolization as the initial treatment of HCC. All patients underwent a spectral CT scan to address iodized oil retention in index tumors at the same day of the chemoembolization. Absolute iodine density (mg/mL) and Hounsfield unit (HU) values were measured on images, and tumor responses were evaluated on 3-month 6-month follow-up CT images. Receiver operating characteristic (ROC) curve analysis was utilized to calculate and compare the performances of tumoral iodized oil density and HU measurements to predict a 6-month complete response (CR).

Results: Thirty-nine of 50 tumors (78%) had shown a complete response (CR) for 6-month of follow up. The lower 10 percentile of iodine density and HU were selected as representative values of each measurement. The area under the curves of iodine density and HU measurements in predicting a 6-month CR were .907 and .923, respectively ($p = .319$). The iodine density cut-off value of 7.64 mg/mL, which corresponded to a 1.6 vol% of a tumor, yielded a 79.5% of sensitivity and a 90.0% of specificity in predicting a 6-month CR ($p < .001$).

Conclusion: Post-chemoembolization iodized oil retention in HCC can be quantified using spectral CT imaging, which facilitates developing a tumor response prediction model in patients with HCC.

2207.2

Efficacy and feasibility of temporary protective embolization of non-target liver vessels in Y90-radioembolization

P.F. Sieben¹, M. Schulze-Hagen¹, A. Tschinaev¹, F. Pedersoli¹, M. Liebl¹, C.K. Kuhl¹, P. Bruners¹, P. Isfort¹, A. Heinzel²

¹Department of Diagnostic and Interventional Radiology, RWTH Aachen University Hospital, Aachen, DE, ²Department of Nuclear Medicine, RWTH Aachen University Hospital, Aachen, DE

Purpose: To evaluate the feasibility of temporary protective embolization (TPE) using degradable starch microspheres (DSM) of non-target (non-tumor-supplying) branches of the tumor-feeding artery during Y90-RE treatment. Aim of this procedure is to prevent non-target deposition of Y90-microspheres in the normal liver.

Material and methods: Lobar Y90-RE was performed in 7 female minipigs in standard fashion. In 4 animals, vessel branching was considered

to be too close to the microcatheter's embolization position. These vessels were selectively embolized using DSM (Embocept™) prior to radioembolization. Afterwards, PET-CT using the positron-decay of Y90 as PET-signal source was performed to evaluate intrahepatic activity distribution. Volumes of interest of target-volume and non-target-volume were calculated using cone-beam CT obtained during intervention. PET-activity was used as a metric for Y90 deposition and thus, for intrahepatic radiation dose, and was compared between the group with TPE vs. without TPE.

Results: Comparison between target- and non-target-volumes shows a reduced PET-activity in the non-target-areas in all subjects. Similar PET-activity was achieved in the target-volume of both groups (121.3 ± 29.01 vs. 147.1 ± 28.44 counts/ccm with vs. without TPE). By way of contrast, in the non-target-volume, there was a much lower PET-activity in the group with vs. without TPE (8.36 ± 1.08 vs. 40.7 ± 6.18 counts/ccm). Accordingly, TPE led to a reduction of PET-activity in the non-target liver volume by a factor of 4.9 without compromising the Y90-dose in the target volume. **Conclusion:** Selective temporary protective DSM-embolization of non-target branches prior to hepatic radioembolization markedly reduces PET-activity in the non-target-volume and thus radiation exposure to the normal liver.

2207.3

Comparison of the efficacy of hypertrophy induction by unilobar ⁹⁰Y radioembolisation vs portal vein embolization: a prospective animal study

F. Pedersoli¹, A. Tschinaev¹, M. Liebl¹, M. Zimmermann¹, M. Schulze-Hagen¹, P.F. Sieben¹, V. Van den Bosch¹, E. Barzakova¹, A. Heinzel², C.K. Kuhl¹, P. Bruners¹, P. Isfort¹

¹Department of Diagnostic and Interventional Radiology, RWTH Aachen University Hospital, Aachen, DE, ²Department of Nuclear Medicine, RWTH Aachen University Hospital, Aachen, DE

Purpose: To compare the hypertrophy induction of the contralateral liver lobe achieved by unilobar radioembolisation (RE) with ⁹⁰Y resin microspheres vs portal vein embolization (PVE) in a swine model.

Material and methods: After approval by the animal care authorities, we conducted a prospective trial on 20 pigs. After a dose escalation study in the first 4 animals, 16 consecutive pigs were treated by either unilobar ⁹⁰Y-RE, or unilobar PVE using lipiodol/cyanoacrylate. Liver volume was measured on contrast-enhanced CT/MRI before treatment and one, three and six months thereafter. After euthanasia, livers were evaluated histopathologically. Independent t-test ($p < 0.05$) was used to compare the hypertrophy rate.

Results: At one month after the intervention, a significantly different degree of hypertrophy was observed for the PVE-group vs the ⁹⁰Y-RE group, with a volume gain of +51% (IQR: +47%; +69%) for PVE, compared to +29% (IQR: +20%; +50 %) for ⁹⁰Y-RE. At follow-up after three and six months, degrees of hypertrophy in the two different groups converged, with a volume gain of +103% (IQR: +86%; +119%) for PVE, vs +82% (IQR: +70%; +96%) for ⁹⁰Y-RE after three months, and of +115% (IQR: +70%; +146%) for PVE, vs +86% (IQR: +58%; +111%) for ⁹⁰Y-RE, after six months.

Conclusion: Hypertrophy-inducing effects of unilobar ⁹⁰Y-RE and of PVE follow a different time course. PVE causes a fast and strong volume gain within 4 weeks after the procedure, followed by a steady-state. Effects of ⁹⁰Y-RE are slower, but persist until 3 months after the procedure, at which time the hypertrophy is similar to PVE.

2207.4

Transarterial chemoembolization of hepatic neuroendocrine metastases: the effect of fatty liver on treatment response

K. Jumaa, D. Wiseman, A. Mujoomdar

Interventional Radiology, Schulich School of Medicine and Dentistry, Western University, London, ON, CA

Purpose: To compare treatment response in patients with and without fatty liver at the time of TACE for hepatic neuroendocrine metastases

Material and methods: Retrospective single-institution cohort study involving 197 TACE procedures performed for hepatic neuroendocrine metastases between May 2006 and January 2017. Pre- and post-embolization contrast-enhanced computed tomography (CT) examinations were reviewed. Tumour response was characterized using both Response Evaluation Criteria In Solid Tumors (RECIST) and Modified Response Evaluation Criteria In Solid Tumors (mRECIST) models. A Chi-squared test was used to determine statistical significance.

Results: Of the 197 TACE procedures, 42 were excluded due to incomplete imaging. Of the remaining 155 TACE procedures, 72% (n=112) were performed in non-fatty livers and 28% (n=43) in fatty livers. When using the RECIST model, there was no difference in the rate of either complete response (CR) or partial response (PR) between non-fatty and fatty livers. When using the mRECIST model, there was a higher observed rate of either CR or PR in the non-fatty liver group compared to the fatty liver group (93% and 79%, respectively $P=0.03$). Sub-analysis of the individual PR and CR rates demonstrated a higher rate of PR in the non-fatty liver cases (27% and 19%, respectively, $P=0.04$).

Conclusion: Metastatic neuroendocrine patients with fatty liver demonstrate diminished complete or partial response to TACE by mRECIST criteria compared to patients without fatty liver. We hypothesize that alterations in arterial microcirculation in fatty livers impair uptake of the chemoembolic agent by the tumour thereby attenuating the response relative to non-fatty livers.

2207.5

A phase II open-label, single centre, non-randomised trial of Y90-radioembolization in combination with nivolumab in Asian patients with advanced hepatocellular carcinoma: an interim analysis

F. Irani¹, A. Gogna¹, N.K.K. Venkatanarasimha¹, T. Hennedige², D. Ng³, K. Loke³, H.L. Huang³, C. Tham⁴, S.-L. Koo⁴, S.H. Tan⁵, H.S. Chong⁵, X.W. Lee⁵, P. Chow⁶, B. Goh⁶, K.H. Lim⁷, J. Yeong⁷, E.W. Newell⁸, H.C. Toh⁴, D. Tai⁴, S.P. Choo⁴

¹Department of Vascular and Interventional Radiology, Singapore General Hospital, Singapore, SG, ²Division of Oncologic Imaging, National Cancer Centre Singapore, Singapore, SG, ³Department of Nuclear Medicine, Singapore General Hospital, Singapore, SG, ⁴Division of Medical Oncology, National Cancer Centre Singapore, Singapore, SG, ⁵Clinical Trial and Epidemiology, National Cancer Centre Singapore, Singapore, SG, ⁶Division of Surgical Oncology, National Cancer Centre Singapore, Singapore, SG, ⁷Department of Pathology, Singapore General Hospital, Singapore, SG, ⁸Singapore Immunology Network, Singapore, SG

Purpose: To evaluate response rates, safety and tolerability of Y90-radioembolization (RE) and nivolumab combination treatment in HCC patients.

Material and methods: Single-arm, two-stage Phase II IRB approved trial. Primary efficacy endpoint is best overall response (BOR) (CR+PR) at 18 weeks. In Stage I, 11 patients were recruited. Progression to Stage II (25 patient), only if 3 or more Stage I patients achieve BOR. All patient eligible for Y90 RE and who met inclusion criteria were enrolled in the study after passing Tc99 MAA study. Following administration of Y90 RE (Day 1), Nivolumab 240mg IV infusion over 1 hour was started on Day 21 and continued every 2 weeks. Liver biopsies were performed prior to Y90 RE

and after first Nivolumab infusion. Response rates (imaging evaluation) and adverse events were monitored.

Results: 11 patients in Stage 1 are reported on. Median age was 63 years, with 10 patients being male. 9 patients were ECOG 0, with 7 (63.6%) and 4 (36.4%) being BCLC B and C respectively. 6 patients had terminated treatment and the remaining 5 were still on nivolumab. BOR was 45%. In 5 responders, median duration of response was 29 weeks (longest 36 weeks). 6 patients who terminated study, time-to-treatment progression was 9.1 to 36.6 weeks. Adverse events were Steven Johnson syndrome (n=1), Grade 3 fever (n=1) and Grade 3/4 ALT/AST rise (n=1). There were no treatment related deaths.

Conclusion: Y90-radioembolization with nivolumab combination treatment in HCC patients appears safe and tolerable with encouraging activity. Recruitment into stage 2 of this Phase II trial is ongoing.

2207.6

LifePearl® Anthracyclin registry in selective chemo-embolization of patients with unresectable hepatocellular carcinoma: safety, tolerability and efficacy (PARIS study)

T. de Baère¹, L. Tselikas¹, G. Verset², B. Guiu³, M. Ronot⁴, P. Chevallier⁵, G. Sergent⁶, P.P. Goffette⁷

¹Interventional Radiology, Institut Gustave Roussy, Villejuif, FR,

²Interventional Radiologist, Gastroentérologie Médicale, Hôpital Erasme, Brussels, BE, ³Department of Radiology, St-Eloi University Hospital – Montpellier School of Medicine, Montpellier, FR, ⁴Service de Radiologie, Hôpital Beaujon, Clichy, FR, ⁵Radiologie, CHU Archet, Nice, FR, ⁶Radiologie & Imagerie Digestive, CHRU Lille, Lille, FR, ⁷Radiologie Interventionnelle et Vasculaire Neuroangiographie Thérapeutique, Cliniques Universitaires Saint-Luc-UCL, Brussels, BE

Purpose: To assess systemic and liver specific toxicity and efficacy of LifePearl® microspheres loaded with anthracyclines for Transarterial Chemoembolization (LP-TACE) in patients with unresectable hepatocellular carcinoma (HCC).

Material and methods: Multicenter, prospective, single arm study of HCC patients treated with LifePearl® loaded with doxorubicin or idarubicin. Tumor response was evaluated according to mRECIST using CT or MRI following hospital standard practice.

Results: Out of 102 patients, 92.8% were males, with mean age of 65.9±10.4 years and 81.4% with cirrhosis (95.3 % Child Pugh A and 4.7% B). The mean number of HCC lesions was 2.5±1.9 and mean sum of tumor diameters was 71.6±42.0mm.

Among 182 LP-TACE procedures, 77.3% were doxorubicin-LP-TACE and 22 (22.6%) idarubicin-LP-TACE with a mean dose of 74.4±22.0mg and 11.7±4.0mg, respectively.

Adverse events were reported in 60 patients, serious adverse events in 18 patients, including 4 possibly or probably related to LifePearl®. Different levels of post- LP-TACE liver/biliary toxicities were detected on follow-up imaging, including bile ducts dilation (n=6), portal vein narrowing (n=1), portal vein thrombosis (n=9) and biloma (n=4)

Best objective response and disease control rates were 79.1% and 97.7% respectively in 86 patients for whom at least one imaging control was available. No difference in response rate were found for doxorubicin and idarubicin.

Conclusion: TACE with doxorubicin or idarubicin loaded LifePearl® for the treatment of patients with unresectable HCC is well tolerated with low liver/biliary toxicity and high tumor response rate.

2207.7

HepaSphere (30–60 µm) transarterial chemoembolization vs. conventional transarterial chemoembolization for the treatment of hepatocellular carcinoma: propensity score matched analysis of early clinical outcomes

H.H. Chu, C. Park, J.Y. Kim, M. Park, J. Hur, J.W. Kim, J.H. Kim, J.H. Shin, D.I. Gwon

Radiology, Asan Medical Center, Seoul, KR

Purpose: To compare the safety and efficacy of transarterial chemoembolization (TACE) using HepaSpheres of 30–60 µm with that of conventional TACE (c-TACE) in the treatment of unresectable hepatocellular carcinoma (HCC).

Material and methods: From April 2017 to April 2018, 607 patients who underwent HepaSphere (30–60 µm) TACE (n = 119) or c-TACE (n = 488) as a first-line treatment for unresectable HCC were included in this study. Using a propensity model to correct for selection bias, 118 patients were selected from each treatment group to compare the effectiveness of HepaSphere TACE and c-TACE.

Results: In the entire study population, the rates of major complications (1.7% vs. 1.8%, $P > 0.999$), objective tumor response (80.7% vs. 79.7%, $P = 0.899$), and time to progression (TTP; $P = 0.828$) were not significantly different between the HepaSphere TACE and c-TACE groups. However, the HepaSphere TACE group showed significantly higher objective tumor regression rates in subgroups with BCLC stage C ($P = 0.033$) and a maximal tumor size > 5 cm ($P = 0.011$). After adjustment with propensity score matching, the rates of major complications, objective tumor response, and TTP remained similar between the two groups.

Conclusion: Both TACE using HepaSpheres of 30–60 µm and c-TACE were safe and effective for treating unresectable HCC, and gave similar clinical outcomes. In BCLC C stage patients or patients with large (> 5 cm) HCC, TACE using 30–60 µm HepaSpheres showed a higher probability of an objective tumor response than c-TACE.

Free Paper Session

Peripheral vascular disease intervention 2

2208.1

Risk factors of distal edge stenosis after stenting for isolated mesenteric artery dissection

Z. Jia

Department of Interventional and Vascular Surgery, The Affiliated Changzhou No. 2 People's Hospital of Nanjing Medical University, Changzhou, CN

Purpose: To retrospectively analyse factors associated with distal edge stenosis after stenting for isolated mesenteric artery dissection (IMAD).

Material and methods: Patients with IMAD who underwent stenting between February 2010 and July 2018 were included in this study. Univariate and multivariate analyses were used to assess factors that may be associated with distal edge stenosis.

Results: A total of 45 patients (42 men and 3 women) were included in this study. Of those patients, a total of 52 self-expandable metal stents were used. Technical success was achieved in 100% (45/45). No procedure-related major complications occurred. During 26.7 ± 17.3 months of follow-up, CT angiography demonstrated good distal edge patency in 25 cases (55.6%) and evidence of distal edge stenosis in 20 cases (44.4%). Distal edge stenosis was correlated significantly with stent-to-vessel (S/V) diameter ratio (OR: 3.36; 95% CI: 1.41-7.99; $P < 0.01$) and angulation at the distal edge (OR: 1.12; 95% CI: 1.01-1.23; $P = 0.03$). Receiver operating characteristic (ROC) curve analysis indicated the area under curve of S/V diameter ratio, angulation at the distal edge, and combined of them were 0.87, 0.70, and 0.95, respectively.

Conclusion: Distal edge stenosis after stenting for IMAD was common. S/V diameter ratio and angulation at the distal edge were independent risk factors for distal edge stenosis in patients with IMAD who underwent stenting therapy.

2208.2

The peripheral bleeding score: a novel easy-to-use preprocedural score to predict bleeding complications of endovascular peripheral arterial interventions

M. Boulougouri¹, L. Reppas², S. Spiliopoulos¹, A. Tsochatzis¹, G. Festas¹, F. Christidi³, K. Palialexis¹, E. Brountzos²

¹2nd Department of Radiology, Interventional Radiology Unit, Attikon University General Hospital, Athens, GR, ²2nd Department of Radiology, Attikon University General Hospital, Athens, GR, ³Medical School, National & Kapodistrian University of Athens, Athens, GR

Purpose: To investigate the bleeding complications of endovascular peripheral arterial interventions (EPAI) and develop an easy-to-use peripheral bleeding score (PBS).

Material and methods: This prospective, single center, study included all therapeutic EPAI performed between August 2016 and July 2018, for the treatment of chronic peripheral arterial disease. Primary endpoints were: (i) evaluation of the incidence of periprocedural (30-day) bleeding complications (PBC), (ii) the identification of factors associated with bleeding events and (iii) the development of a PBS to include in the pre-procedural checklist. Secondary outcome measures included the comparison between the HAS-BLED score and the PBS.

Results: In total 530 procedures were included (mean age 67.6±9.8 years; male:74.7%). The overall PBC rate was 3.77% (20/530 procedures). Major PBC rate was 3.2% [17/530 procedures; retroperitoneal active bleeding (0.75%); pseudoaneurysms (2.45%)]. The annualized incidence of overall and major PBC was 1.88% and 1.6%; respectively. According to multivariable regression analysis an age≥75 was correlated with a significantly increased bleeding risk [HR:3.32; 95%CI:1.12-9.80;p<0.02], while male gender [HR:0.19; 95%CI:0.07-0.49;p<0.001] and statin therapy [HR:0.24; 95%CI:0.08-0.71;p=0.01] were correlated with a significantly decreased bleeding risk. Based on the regression analysis findings an eight-point PBS was developed, demonstrating 75.0% sensitivity and 78.4% specificity. The HAS-BLED score failed to identify PBC.

Conclusion: The annual incidence of bleeding complications of EPAI was low. Advanced age and female gender were correlated with increased bleeding risk. PBS demonstrated satisfactory statistical performance and could be considered for inclusion in the pre-procedural endovascular checklist in order to contribute in the optimization of patient care.

2208.3

Can legflow improve treatment of long femoropopliteal lesions: the REFLOW outcomes

J. Wauters, M. Bosiers

Vascular Surgery, AZ Sint-Blasius, Dendermonde, BE

Purpose: To evaluate the performance of the Legflow Paclitaxel-Eluting Peripheral Balloon Catheter for the treatment of long femoropopliteal lesions (TASC C&D).

Material and methods: To investigate this, we set up a prospective, single-arm, multicenter study in 120 patients enrolled in 5 centers in Belgium and 2 centers in Germany. Patients with Rutherford classification 2 to 5 that had a de novo lesion in the femoropopliteal arteries (>150mm), suitable for endovascular therapy could be enrolled in the study. Enrolled patients that were enrolled in the study were expected to come back on follow-up at 1,6 and 12-month.

Results: Most important patient demographics were hypertension (77.50%), nicotine abuse (56.67%) and hypercholesterolemia (53.30%). Treated lesions were very challenging with an average lesion length of

216.08mm, with 67.50% calcified and 45.00% occluded lesions. Bail-out stenting was performed in only 35.00% of the cases.

6-month primary patency and freedom from target lesions revascularization was 81.00% and 89.70% respectively. Preliminary 12-month survival rate in 90 patients was 94.00%. 4 patients died, from which none was device of procedure related.

Preliminary 12-month primary patency rate and freedom from TLR in 90 patients was 70.50%, and 78.80% respectively.

At CIRSE, we will have the final 12-month data ready and if accepted, they will be first presented at CIRSE.

Conclusion: These preliminary results suggest that the Legflow DCB is a valid and effective alternative to treat "real-life" long, complex and calcified femoropopliteal lesions. Awaiting for the final 12-month results, which will be available at CIRSE.

2208.4

BIO4AMB: a multicenter, controlled trial evaluating ambulatory endovascular treatment of PAD for 4 French and 6 French femoral access strategies

M. Brodmann¹, J.C. van den Berg², K.R. Deloose³, E. Steinmetz⁴

¹Clinical Division of Angiology, Medizinische Universität Graz, Graz, AT,

²Interventional Radiology, Ospedale Regionale di Lugano, sede Civico, Lugano, CH, ³Vascular Surgery, AZ St. Blasius, Dendermonde, BE,

⁴Chirurgie Cardio-Vasculaire et Thoracique, CHU Le Bocage, Dijon, FR

Purpose: The purpose of this multicenter, prospective, controlled trial is to compare the rate of access site complications (ASC) in 6French (6F) vs. 4French (4F) femoral access for endovascular treatment of peripheral artery disease (PAD) in an ambulatory setting.

Material and methods: In total 792 patients suffering from infrainguinal PAD are planned to be treated endovascular in an ambulatory setting. The patients will be assigned to either a 4F or 6F group per physician's discretion. The primary endpoints are peri- and post-procedural ASC (1 month post-intervention). The endpoints will be adjudicated by a clinical event committee.

Results: First time presentation of up to 792 patients will be included in the evaluation. So far 549 subjects have been evaluated, 249 patients in the 4F group and 293 patients in the 6F group. A low event rate with so far no significant difference in MAE (0.4%/1.7%), ambulatory success (93.5%/93.2%) and ASC (3.2%/2.0%) between 4F and 6F procedures was seen.

Conclusion: The low event rate indicates that the ambulatory setting is a viable option for peripheral endovascular treatment. 4French compatible products show similar results when compared to the well-established 6French devices and are a valid alternative, while avoiding the need of a vascular closure device.

2208.5

The Ulysse prospective single center registry: midterm angiographic and clinical outcomes of ultrasound plasty associated to plain angioplasty for below the knee lesions in patient with critical limb ischemia

C. Del Giudice¹, R. Gandini²

¹Vascular and Oncological Interventional Radiology, Hôpital Européen

Georges Pompidou, Université Paris Descartes, Paris, FR, ²Diagnostic and Interventional Radiology, Policlinico Tor Vergata, Rome, IT

Purpose: To evaluate the safety and efficacy of low energy, high intensity ultrasound using a new dedicated ultrasound catheter associated to a conventional balloon angioplasty to treat calcified below the knee (BTK) vessels lesions

Material and methods: The ULYSSE registry was a prospective, nonrandomized single center registry that enrolled 12 critical limb ischemia (CLI) patients (mean age 72.2 ±5.3, 8 males). 9 patients (75%) had a Rutherford category ischemia 5, and 7 patients had severe below-the-knee arterial

calcification. Patients were treated with the KAPANI catheter (Apani Corporation, Rome, Italy) associated to a conventional PTA and followed for 6 months. The primary efficacy endpoints in this study were primary patency at 6-month FU. The primary safety endpoint was a composite of major adverse events through 30 days defined as death, myocardial infarction, need for emergency surgical revascularization of the target limb, or amputation of the target limb.

Results: Technical success was reported in all patients. 19 lesions were treated during the registry. Primary patency at 6 months FU was 94.7% (18/19). No procedural device-related adverse effects were reported. No acute vessel occlusion was observed at 1-month DUS. No death, MAE, target lesion revascularization and amputation were reported at 6-month follow-up.

Conclusion: Midterm angiographic and clinical outcomes of this single center prospective registry demonstrated that calcified, infrapopliteal arteries lesions can be safely and successfully treated with low frequency, high intensity ultrasound using a new dedicated ultrasound catheter following a conventional balloon angioplasty

2208.6

Final 1-year outcomes of the KANSHAS 1 study of the novel KANSHAS drug-coated balloon for treatment of femoropopliteal occlusive disease: the first-in-human study

M. Lichtenberg¹, G. Tepe², S. Müller-Hülsbeck³, K.R. Deloose⁴, J. Verbist⁵, P. Goverde⁶, T. Zeller⁷

¹Vascular Center, Klinikum Arnsberg, Arnsberg, DE, ²Diagnostic and Interventional Radiology, Medical Centre of Rosenheim, Rosenheim, DE, ³Department of Diagnostic and Interventional Radiology / Neuroradiology, Ev.-Luth. Diakonissenanstalt zu Flensburg, Flensburg, DE, ⁴Vascular Surgery, AZ St. Blasius, Dendermonde, BE, ⁵Department of Cardiovascular and Thoracic Surgery, Imelda Hospital, Bonheiden, BE, ⁶Vascular & Endovascular Surgery, Vascular Clinic ZNA, Antwerp, BE, ⁷Angiology, Herz-Zentrum Bad Krozingen, Bad Krozingen, DE

Purpose: Our study aims at investigating safety and efficacy profile of the novel KANSHAS DCB in treatment of patients with de novo lesions in femoropopliteal arteries.

Material and methods: KANSHAS 1 is an on-going prospective, single-arm, multicenter, first-in human study performed at seven hospitals in Germany and Belgium, which follows up 50 patients (Rutherford category 2-4), who were treated with KANSHAS DCB (evaluation at 1, 6, 12, and 24 months). The primary outcome measure of this study is a composite endpoint of freedom from device- and procedure-related deaths through 30-day, freedom from target limb amputation, and clinically driven target lesion revascularization through 6 months.

Results: Mean patient age is 69.0 ± 10.5 (32% females). Study comprises mainly claudicants (14% Rutherford category 2, 80% category 3 and 6% category 4 cases) with mean ankle-brachial index (ABI) at baseline 0.67 ± 0.14 (48/50). The mean cumulative lesion length was 88.6 ± 36.5 mm and mean diameter stenosis (DS) $91.0 \pm 9.4\%$, with 20.0% of moderately-severely calcified lesions, spanning both SFA and popliteal regions. 28% of interventions required bailout stenting. Mean residual DS was $11.2 \pm 7.8\%$. The primary composite safety end-point was reached in 100% of patients. At 6-month follow-up, from 45/50 patients 93% displayed an improvement in Rutherford class and a mean increase in ABI of 0.28 ± 0.24 (43/50).

Conclusion: In the studied population, KANSHAS DCB displays excellent safety and efficacy performance through 6 months follow-up. Final 1-year outcomes will be available for presentation at CIRSE 2019 congress.

2208.7

Tackling challenging infrainguinal arterial recanalization through retrograde use of the Outback re-entry catheter: a multi-centre cohort experience

B. Dharmarajah¹, L. Patrone², S. Theivacumar², E. Blessing³

¹Imaging, Hammersmith Hospital, Imperial College Healthcare NHS Trust, London, UK, ²West London Vascular and Interventional Centre, London North West University Healthcare NHS Trust, London, UK, ³Abteilung Innere Medizin und Angiologie, SRH Klinikum Karlsbad-Langensteinbach gGmbH, Karlsbad, DE

Purpose: The Outback re-entry catheter is a well described adjunct for antegrade recanalization in infrainguinal arterial chronic total occlusion (CTO). We present our experience of retrograde, infrainguinal recanalization using the Outback re-entry catheter in challenging CTO.

Material and methods: This was a retrospective, multicentre, cohort study. Eligibility included retrograde, infrainguinal use of the Outback re-entry catheter where both conventional antegrade and retrograde recanalization had been unsuccessful. Procedural outcomes included successful targeted re-entry and complications including bleeding and distal embolisation. Post-procedural outcomes included patency and amputation free survival.

Results: 21 patients underwent retrograde, infrainguinal recanalization with the Outback re-entry catheter between February 2015 and November 2018. 17 (80%) patients had a past history of open vascular surgery. Targeted recanalization was achieved in 20 (95%) patients. The retrograde access site was distal superficial femoral artery in 15 (71%) patients and tibial vessel in 6 (29%) patients. The re-entry target was common femoral artery in 19 (90%) patients, proximal superficial femoral artery in 1 (5%) patient and proximal anterior tibial artery in 1 (5%) patient. The Outback re-entry catheter was inserted over an 0.018 support wire via a 6-French sheath in 13 (62%) cases and sheathless in 7 (38%) cases. There were 2 (10%) instances of distal embolisation and no bleeding complications. 2 (10%) patients demonstrated >50% stenosis at follow-up but all patients (100%) remained amputation free.

Conclusion: Retrograde use of the Outback re-entry catheter in infrainguinal CTO provides a feasible and valuable endovascular option where open surgery is challenging and conventional antegrade and retrograde recanalization procedures have failed.

Free Paper Session TIPS and portal vein intervention

2304.1

Indications for transjugular portosystemic shunts (TIPS) at a US liver transplant center: trends during the last 10 years

K.J. Moore, P.F. Laeseke, M.A. Woods, O. Ozkan
Radiology, University of Wisconsin-Madison, Madison, WI, US

Purpose: To determine trends in TIPS utilization during the last 10 years at a major US liver transplant center that performs >100 liver transplants per year.

Material and methods: TIPS patients (n=201) performed at a single center between January 2009 - December 2018 were retrospectively studied. Indications for TIPS were grouped into (1) refractory ascites including hepatic hydrothorax, (2) emergent bleeding after failed endoscopic treatment, (3) elective TIPS for recurrent variceal bleeding despite endoscopic intervention, and (4) portal venous thrombosis (PVT) for either for preserving venous inflow for transplant candidacy or management of bowel ischemia. Line functions were calculated for each group using least squares method with slope comparisons to determine trends.

Results: One-hundred and six (52.74%) patients had ascites refractory to medical management, 41 (20.4%) underwent emergent TIPS for variceal bleeding, 32 (15.92%) underwent elective TIPS for recurrent variceal

bleeding, and 22 (10.95%) had PVT. TIPS performed for ascites (Group 1, slope=-0.72) and non-emergent variceal bleeding (Group 3, slope=-0.04) decreased; however, TIPS for emergent variceal bleeding and PVT (Groups 2 and 4) increased (slopes = 0.61 and 0.11, respectively). Total number of TIPS also had a slight downward trend (slope=-0.03).

Conclusion: In the last 10 years, the number of TIPS performed for refractory ascites at a major US liver transplant center decreased in frequency. Emergent TIPS for variceal bleeding increased whereas elective TIPS for non-emergent variceal bleeding decreased despite evidence suggesting improved outcomes from early TIPS. PVT as an indication for TIPS constituted a relatively high proportion of patients in our cohort.

2304.2

Percutaneous transhepatic creation of intrahepatic portosystemic shunt with a combination of tip-angled guiding needle and coaxial straight needle

Y. Takeuchi¹, N. Sakamoto², H. Morishita³, Y. Arai⁴

¹Radiology, Fukuchiyama City Hospital, Kyoto, JP, ²Radiology, Kakogawa Central City Hospital, Hyogo, JP, ³Diagnostic Radiology, Japan Red Cross Kyoto Daiichi Hospital, Kyoto, JP, ⁴Department of Diagnostic Radiology, National Cancer Center Hospital, Tokyo, JP

Purpose: Percutaneous transhepatic access has been reported as an alternative procedure in difficult cases for TIPS. We report percutaneous transhepatic creation of intrahepatic portosystemic shunt with a combination of tip-angled guiding needle and coaxial straight needle.

Material and methods: We attempted this procedure for three patients who were not indicated for conventional TIPS procedure because of postsurgical deformity of the liver, narrowed portal vein or hepatic venous hypoplasia. A right jugular vein accessed angiographic catheter was placed in the right hepatic vein or the intrahepatic vena cava as a marker. A handmade 17-G 15cm-long tip-angled blunt metal needle was inserted into the intrahepatic portal vein through a transhepatic sheath. A coaxially inserted 21-G 20cm-long straight needle was used to puncture the target vein through the guiding needle whose angled tip was steered toward the marker. The transhepatic guidewire was captured by a transjugular snare to establish a pull-through route. Using the pull-through guidewire, a transjugular catheter was advanced to the main portal vein and metal stents were placed to complete the shunt creation. Finally, the transhepatic sheath was removed with coil embolization of the tract.

Results: The required number of puncture was 1, 1 and 4. The procedures were completed in all cases without any severe complications.

Conclusion: The technique may be a new option in difficult cases for TIPS. Farther investigation is required.

2304.3

Stability over time of global and intra-stent pressure gradients in under-dilated TIPS placed for refractory/recurrent ascites in cirrhotic patients

F. Prampolini¹, G. Musacchia¹, S. Pizzuto¹, F. Casari¹, C. Caporali¹, P. Torricelli¹, L. Turco², F. Schepis²

¹Department of Radiology, Azienda Ospedaliero-Universitaria Policlinico di Modena, Modena, IT, ²Department of Gastroenterology, Azienda Ospedaliero-Universitaria Policlinico di Modena, Modena, IT

Purpose: Transjugular intrahepatic portosystemic shunt (TIPS) is the treatment of choice in cirrhotic patients with refractory/recurrent ascites. Recently, we have shown that under-dilated (<8 mm) PTFE-covered nitinol stents do not self-expand to nominal diameter at the level of portal and hepatic vein walls. Our aim was to investigate short- (48-hours) and long-term (3-months) stability of post-TIPS portosystemic pressure gradients (PSPG) and long-term stability of pressure gradients across the expected intra-stent strictures in patients with refractory/recurrent ascites.

Material and methods: Retrospective cohort study. PSPG was determined as the difference between portal vein (PV) and inferior vena cava (IVC) pressures; PSPG components across the stents were measured between a) PV and intraparenchymal tract (ΔP_1), b) intraparenchymal and hepatic vein tracts (ΔP_2), and c) hepatic vein tract and IVC (ΔP_3).

Results: Data from 43 patients were analyzed. Mean post-TIPS PSPG resulted comparable between the after-deployment, the 48-hour and the 3-month checks (12.83 ± 0.48 mmHg vs. 13.64 ± 0.65 mmHg vs. 13.02 ± 0.86 mmHg, $p=0.252$ by ANOVA). Table_1 shows the evaluation of long-term presence and stability of post-TIPS components of PSPG. A decrease in ΔP_1 is partially compensated by an increase in ΔP_2 : this guarantees the long-term stability of PSPG.

Table_1. Long-term assessment of post-TIPS components of PSPG (n=43)

	48-hours	3-months	p
ΔP_1	7.78 ± 0.92	5.74 ± 0.59	0.001
ΔP_2	2.48 ± 0.48	3.89 ± 0.61	0.045
ΔP_3	3.41 ± 0.58	3.42 ± 0.59	0.977
PSPG	13.64 ± 0.65	13.02 ± 0.86	0.375

Data are presented as mean $\pm$ SE and compared using paired T test

Conclusion: This study confirms the long-term presence and hemodynamic relevance of intra-stent strictures in under-dilated TIPS placed in cirrhotic patients with ascites.

2304.4

Transjugular intrahepatic portosystemic shunt versus endoscopic therapy for the treatment of variceal bleeding with hepatocellular carcinoma meeting the Milan criteria: a propensity score-matching analysis

J. Luo, M. Li, Z. Jiang, M. Huang

Interventional Radiology, The Third Affiliated Hospital of Sun Yat-sen University, Guangzhou, CN

Purpose: The aim of the study is to compare the clinical outcomes of transjugular intrahepatic portosystemic shunt (TIPS) and endoscopic therapy (ET) for the treatment of variceal bleeding with hepatocellular carcinoma (HCC) meeting the Milan criteria.

Material and methods: We retrospectively reviewed the data of 98 consecutive patients with HCC meeting the Milan criteria who had received TIPS (34 patients) or ET (64 patients) because of variceal bleeding between June 2010 and December 2017. A matched cohort composed of 30 patients from each group was selected after adjustment with propensity score matching. The outcome measures including the overall survival, the rebleeding rate, and the incidence of hepatic encephalopathy were evaluated and calculated by using the Kaplan-Meier method and were compared by using the log-rank test.

Results: No significant differences were observed in the baseline characteristics between groups after propensity score matching adjustment. The median follow-up time was 33.5 months (range, 5.6-96.0 months). The overall survival, the rebleeding rate, and the incidence of hepatic encephalopathy were similar in both groups ($p=.120$, $p=.06$, $p=.496$, respectively). In stratification analysis, MELD ≤ 11 or Child-Pugh A patients could get a survival benefit from ET ($p=.021$, $p=.026$, respectively). Compared with ET, TIPS reduced the risk of rebleeding for patients with ascites ($p=.017$).

Conclusion: There were no significant differences between TIPS and ET for variceal bleeding with HCC meeting the Milan criteria. However, ET was associated with improved survival and TIPS reduced the risk of rebleeding in selected patients.

2304.5

Association of sarcopenia and growth rate of the future liver remnant after portal vein embolization

M. Schulze-Hagen¹, D. Truhn², F. Duong², F. Pedersoli¹, C.K. Kuhl¹, G. Lurje³, P. Isfort¹, P. Bruners¹, M. Zimmermann¹

¹Department of Diagnostic and Interventional Radiology, RWTH Aachen University Hospital, Aachen, DE, ²Institute of Imaging and Computer Vision, RWTH Aachen University, Aachen, DE, ³Department of Surgery and Transplantation, RWTH Aachen University Hospital, Aachen, DE

Purpose: Portal vein embolization (PVE) of the right liver lobe is an established method to induce hypertrophy of the future liver remnant (FLR) before major liver resection. It has been shown that sarcopenia correlates with morbidity and mortality after major liver surgery. Aim of this study was to correlate patient's psoas muscle volume (as a surrogate for total muscle mass) with the growth rate of the FLR after PVE.

Material and methods: 48 patients who underwent PVE of segments V–VIII before major liver resection were included in the study. Liver volumetry was performed based on contrast-enhanced CT-scans before and one month after PVE using a semi-automated segmentation tool. In addition, both psoas muscles were segmented in the baseline CT-scans using a fully automated 3D machine learning algorithm with a GAN-type convolutional neuronal network in combination with a 3D multi-atlas based segmentation. Data were analyzed using descriptive statistics and a linear regression model.

Results: Mean volume of the left liver lobe was $585 \pm 217 \text{ cm}^3$ before and $768 \pm 243 \text{ cm}^3$ one month after PVE. Mean volume of the major psoas muscle was $304 \pm 87.6 \text{ cm}^3$ (range: $104\text{--}463 \text{ cm}^3$). There was a strong correlation between psoas muscle volume and volume increase of the FLR with a correlation coefficient of $r=0.78$ ($p=0.003$).

Conclusion: We identified a strong association between psoas muscle volume – as an indicator of sarcopenia – and growth rate of the FLR after PVE. Sarcopenia may thus serve as an important marker to predict FLR growth, and may be useful to identify patients who might be poor candidates for PVE for FLR augmentation.

2304.6

HCC complication by PVT – percutaneous management by image-guided endoport RFA, followed by metal stent implantation

M. Mizandari¹, T. Azrumelashvili¹, N. Habib²

¹Diagnostic and Interventional Radiology, New Hospitals LTD, Tbilisi, GE, ²Surgery, Imperial College London, London, UK

Purpose: The novel technique of PV malignant thrombus recanalization is presented

Material and methods: 36 patients underwent percutaneous endoport RF treatment attempt. PV tributary is accessed under US guidance; manipulation by 5 Fr diameter guiding catheter is used to conduct the guidewire across the blocked segment and portography is performed. 15 Watts power was applied for 2 minutes using bipolar endoluminal RF device (Habib™ EndoHPB, EMCision Ltd., London, UK), placed in PV blocked segment according to the guidewire. The number of RF application sessions depends on tumour thrombus extent as shown on portography. After RF application self-expanding 14 mm diameter vascular stent is positioned and PV patency restoration is documented by final portography. Procedure is completed by procedure track RF ablation and/or embolisation by coil/gel-foam.

Results: Procedure was completed in 28 (77.8%) cases; 6 (16.7%) cases - wire conduction failure; 2 (5.5%) cases - RF device conduction failure (finished by stenting only). Portal vein obstructed segment showed the restored blood flow in 29 (96.7%) all 30 completed stenting cases as documented by postprocedure portography, follow-up Doppler and CT studies; this resulted in liver function improvement in 22 (73.3%) of procedure technical success cases. Procedure was complicated by intra-peritoneal bleeding in 3 (8.3%) cases; 1 of them (2.8%) died because of

polyorgan failure. Recanalized PV patency varied from 3 weeks to 22 months; in 9 cases patients underwent successful TACE procedure after PV recanalization.

Conclusion: PV thrombus percutaneous recanalization by endoport RFA & stenting is effective and should be suggested as a possible treatment option for HCC patients with PVT.

2304.7

Primary tumor location is an independent prognostic factor for time-to-progression in patients with colorectal liver metastases undergoing portal vein embolization and subsequent right hepatectomy

L. Hitpaß, F. Pedersoli, M. Schulze-Hagen, P. Isfort, C.K. Kuhl, P. Bruners, M. Zimmermann

Department of Diagnostic and Interventional Radiology, RWTH Aachen University Hospital, Aachen, DE

Purpose: To identify prognostic factors affecting intrahepatic time-to-progression, in patients with colorectal liver metastases (CRLM) undergoing portal vein embolization (PVE) and subsequent right hepatectomy.

Material and methods: This prospective study included 60 patients (mean age: 62.3 ± 10 years) who underwent PVE in preparation for right hepatectomy at our institution, between 2011 and 2018. Intrahepatic tumor progression was defined as the presence of new metastases, either in the future liver remnant (FLR) after PVE or the liver remnant after surgery, as seen on postinterventional contrast-enhanced CT and/or MRI. Using a Cox proportional-hazards model, primary tumor location (right- vs. left-sided colon cancer), timing of hepatic metastasis (synchronous vs. metachronous), number of metastases, size of metastases (smaller or greater than 3 cm) and metastatic involvement of the future liver remnant before PVE were assessed as independent predictors of time-to-progression.

Results: Median follow-up after PVE was 8.5 months (range 1–63). 6 patients (10%) developed new metastases in the FLR and did not proceed to surgery, whereas another 25 patients (42%) developed intrahepatic metastatic recurrence after resection. Primary tumor location was the only independent predictor of time-to-progression after PVE and right-sided colon cancer was associated with shorter time-to-progression than left-sided colon cancer (median 5.7 ± 2.4 months vs. 9.4 ± 1.0 months; hazard ratio = 2.934; 95% confidence interval: 1.219, 7.066; $P = 0.016$).

Conclusion: Patients with hepatic metastases from right-sided colon cancer develop earlier intrahepatic metastatic progression/recurrence after PVE and right hepatectomy than those with left-sided colon cancer.

Free Paper Session Musculoskeletal interventions

2305.1

Utilization of motor and somatosensory evoked potentials for neural thermoprotection in ablations of musculoskeletal lesions

J.T. Yoon¹, J. Nesbitt², B.L. Raynor², M. Roth², C.C. Zertan², J.W. Jennings²

¹Mallinckrodt Institute of Radiology, Washington University School of Medicine, St. Louis, MO, US, ²Radiology, Washington University/Mallinckrodt Institute of Radiology, Saint Louis, MO, US

Purpose: To characterize the utility of monitoring motor evoked potentials (MEPs) and somatosensory evoked potentials (SSEPs) for neural thermoprotection during ablation of musculoskeletal lesions.

Material and methods: Patients from 2015 to 2018 who underwent either tumor cryoablation or radiofrequency ablation procedures with intraprocedural transcranial electrical stimulation MEP and SSEP monitoring were retrospectively identified. Data regarding demographics,

tumor characteristics, pain, ablation technical details, and MEP/SSEP activity was reviewed. For procedures in which an abnormality in MEPs or SSEPs was identified, the characteristics and duration of the diminished or lost activity, associated sensory and/or motor deficits, and symptom duration and/or recovery were also reviewed.

Results: 30 procedures, including cryoablation (n=20) and radiofrequency ablation (n=10), were identified in 29 patients. In 12 (40%) of the procedures, an activity loss in MEPs (n=9) and/or SSEPs (n=5) was charted, and in five cases the activity loss did not recover intraprocedure. Three patients (60%) with unrecovered activity losses and two patients with recovered activity losses (29%) had charted new motor (n=1) or sensory symptoms (n=4) post-procedure (RR 2.10, 95%CI 0.53-8.29). No patients without activity losses (n=17) had new motor or sensory symptoms post-procedure. SSEP activity losses were 75% (95%CI 19-99%) sensitive for new post-procedure sensory symptoms and 92% specific (95%CI 74-99%). MEP activity losses were 100% (95%CI 2.5-100%) sensitive for new post-procedure motor symptoms and 71% (95%CI 51-87%) specific.

Conclusion: Activity losses of MEPs/SSEPs during ablative procedures can be predictive of post-procedural neurological sequelae. Its use should be considered in musculoskeletal ablations in which there is concern for neural thermal injury.

2305.2

Ablation-osteoplasty-reinforcement-internal fixation (AORIF) for osteolytic skeletal metastases

I. Latich¹, F. Lee²

¹Department of Radiology, Yale New Haven Hospital, New Haven, CT, US,

²Orthopaedic Surgery, Yale University, New Haven, CT, US

Purpose: Presence of metastatic cancer cells in bone initiate bone destruction by promoting osteoclastic bone resorption and inhibiting osteoblastic bone repair. Local control of cancer cells is very important to prevent progressive bone loss after surgical stabilization. Surgical reconstruction of pelvic bone defects and periarticular lesions requires large skin incisions and deep surgical dissections, which are associated with high incidences of muscle weakness, infection, prolonged morbidity, transfusion, and delayed pharmacologic cancer therapies. It is most ideal if an open surgery can be avoided. The purpose of this study is to determine the efficacy of Ablation-Osteoplasty-Reinforcement-Internal Fixation (AORIF) for osteolytic skeletal metastases.

Material and methods: We have developed a minimally invasive AORIF as a novel surgical strategy for management of radiation-resistant osteolytic metastatic cancers in the pelvis. 19 patients with osteolytic metastatic lesions to pelvis (N=16), femoral head & neck (N=3), proximal tibial plateau (N=2), and calcaneus (N=1) underwent AORIF. Primary cancers were from lung (lung cancers), breast (breast cancers), kidney, skin (melanoma), oral cavity, and bladder (endocrine cancer).

Results: None of patients required transfusion or hospital admissions related to post-AORIF. Infection, delay in chemotherapy, and prolonged morbidity from surgical dissections were avoided while functional improvement and decreased pain were observed in all patients. Pain and function improved.

Conclusion: Skeletal defects secondary to metastatic cancers in deep anatomic locations are effectively managed through a very small skin incision while avoiding extensive open surgeries. AORIF is indicated for large osteolytic defects around or near the acetabulum, sacroiliac joints, pelvic ring, proximal tibia, and calcaneus.

2305.3

Cryoablation as second line treatment for fibro-adipose vascular anomaly (FAVA)

C. Kaufman¹, A.E. Frodsham², R. Arnold³

¹Radiology, University of Utah, Salt Lake City, UT, US, ²Radiology, Comprehensive Interventional Care, Salt Lake City, UT, US, ³Department of Radiology, Primary Children's Hospital, Salt Lake City, UT, US

Purpose: FAVA is a recently described intramuscular lesion that replace normal skeletal muscle with fibrofatty proliferation and phlebotasia. There is dense fibrosis surrounding the nerves which may attribute to the classic symptoms of severe pain and contractures. Cryoablation has recently emerged as a means of treating FAVA with favorable outcomes. The purpose of our study was to examine FAVA patients at our institution who failed prior interventions and underwent cryoablation as second line treatment.

Material and methods: A retrospective review was performed of all cases of cryoablation for FAVA (diagnosed on imaging or biopsy) who had undergone prior treatment from 10/2014 to 5/2018 at the adult and children's hospital. Pre-procedure, intra-procedural, and, when available, follow-up imaging was reviewed. EMR review was performed to determine demographics, indication, prior treatments both interventional and surgical, symptoms, and clinical response.

Results: There were 8 patients with 10 ablation procedures; 2 underwent staged procedures. Seven out of eight patients had prior surgical intervention. Two patients had prior embolization procedures. One patient had prior sclerotherapy and EVLT. Seven out of eight patients had significant decrease in pain with return of normal activities or cessation of pain medication. The one patient with diffuse FAVA had worsening pain after ablation and was subsequently treated with Sirolimus. 6/8 patients had no further procedures. 1/8 required a nerve block for residual pain.

Conclusion: FAVA can be difficult to treat with sclerotherapy, or surgical resection. Cryoablation has recently emerged as a promising treatment. Our experience suggests cryoablation can be successful to treat FAVA even after failed prior interventions.

2305.4

Magnetic resonance-guided high intensity focused ultrasound (MRgFUS) for the treatment of oligometastatic prostate cancer bone metastases: non-invasive use of sound waves can down-stage cancer spread

C. Marroccchio, A. Napoli, R. Scipione, S. Dababou, H.-P. Erasmus, C. Catalano

Radiological, Pathological and Oncological Sciences, Sapienza - University of Rome, Rome, IT

Purpose: To evaluate efficacy and safety of MR-guided Focused Ultrasound (MRgFUS) in down-staging patients with oligometastatic bone disease from prostate cancer.

Material and methods: This prospective study was designed following an intention-to-treat protocol. From 2010 to 2016, 11 patients with five or less bone metastases from prostate cancer were enrolled and underwent MRgFUS ablation. Treatment success was evaluated measuring the non-perfused volume ratio (NPVR) on MRI. Patients underwent follow-up at 12 months assessing lesion dimension, mean Standardized Uptake Value (μSUV) on 18F-choline PET/CT, and Prostate Specific Antigen (PSA) levels. Pain response at 12 months and survival were secondary outcomes. Analyses were conducted on a per-protocol basis.

Results: No adverse events were reported. NPVR was 100% in 9/11 patients; 2 patients had a partial response. At 12 months follow-up, lesion dimension did not change significantly (p=0.093). μSUV values were reduced from a baseline mean (SD) of 10.5 (2.3) to 1.0 (2.7) (p=0.003) with 9/11 patients achieving a value of 0. Similarly, PSA levels decreased from 12.8ng/ml (6.0) to 1.7ng/ml (5.4) (p=0.003). Pain reduction was also observed with a reduction of VAS score from a mean (SD) of 6.9 (1.5) to

0.4 (1.2) at 12 months ($p=0.003$). Kaplan-Meier analysis estimated a cancer-specific survival mean (SE) of 63 months (5.9) and a progression-free survival of 53 months (3.4).

Conclusion: MRgFUS is an incisionless procedure that might obtain nearly complete ablation of bone lesions in oligometastatic prostate disease. This radiation-free approach may be of incremental value in long-survivor subset of cancer patients.

2305.5

Feasibility, safety and efficacy of genicular artery embolization for relief of knee pain related to osteoarthritis

S. Sharma¹, R. Rajagopal¹, S. Kumar¹, V. Verma², R. Malhotra²

¹Cardiovascular Radiology & Endovascular Interventions, All India Institute of Medical Sciences, Delhi, IN, ²Orthopedics, All India Institute of Medical Sciences, Delhi, IN

Purpose: Knee osteoarthritis (OA) is a major cause of pain and disability with estimated prevalence of >20% in the elderly. Treating patients with intermediate disease severity is a challenge due to poor response to conservative treatment. Surgery is not warranted in them due to absence of severe deformity. This pain is postulated to be related to osteochondral neoangiogenesis with low grade inflammation. The feasibility, safety and efficacy of genicular artery embolization for relief of symptoms in this subgroup was studied

Material and methods: Thirteen patients (age range, 48–71 years) who failed conservative therapy were recruited after an informed consent. All patients underwent selective angiography and super selective embolization of abnormal periarticular neoangiogenesis, using PVA particles. Patients were evaluated at baseline and 1 month post procedure using the VAS and WOMAC scales. Complications were assessed at all time intervals.

Results: Angiography demonstrated hypervascularity with abnormal subchondral blush in 11 patients. Embolization was technically successful in all of them. No angiographic abnormality was found in the remaining two patients. No major complications occurred. Median baseline radiographic OA grade was KL 1. VAS improved from baseline (mean 7.6/10) to 1 month (mean 3/10). WOMAC decreased by an average of 18 points from baseline to 1 month.

Conclusion: Genicular artery embolization is feasible, safe and effective for short term pain relief in patients with knee OA of intermediate severity

2305.6

MR-guided focused ultrasound (MRgFUS) in the treatment of osteoid osteoma: a safe, effective and durable therapeutic option

S. Dababou, A. Napoli, C. Marrocchio, R. Scipione, G. Alfieri, D. Fierro, C. Catalano

Radiological Sciences, University of Rome La Sapienza, Rome, IT

Purpose: To demonstrate the significant therapeutic role of the completely non-invasive, radiation-free, MRgFUS in the management of osteoid osteoma.

Material and methods: Patients with typical clinical and radiological diagnostic findings of osteoid osteoma (non-vertebral), suitable for MRgFUS and anaesthesia, were enrolled in this dual-centre prospective observational study. Safety (rate of complications), clinical effectiveness (reduction in Visual Analogue Scale [VAS]) and durability of MRgFUS were evaluated as primary outcomes; tumour control (nidus ablation) at dynamic contrast enhanced MRI was considered as secondary outcome. All patients underwent a minimum follow-up period of 4 years.

Results: 45 out of 50 patients screened were enrolled and treated with MRgFUS. No treatment-related complications were observed. A complete and durable response was achieved in 80% of cases. Median VAS pain score dropped from 8 (IQR 7-9) to 0 at 1-week, maintained at all

subsequent follow-up (1 month, 6, 12, 24, 36 and 48 months). Scores evaluating interference of pain with sleep, physical and daily activities showed similar improvement after treatment. Among subjects with partial response (20%), 4 received a second treatment (3 with CT-guided Radiofrequency Ablation, 1 with MRgFUS), and 5 did not need any other treatment. All re-treated patients achieved 0 VAS score. Overall, 87% of patients after MRgFUS reached and maintained a stable 0 VAS score during follow-up. At 3-year the MRI of the osteoid osteoma showed no vascularization in 32/42 patients (76%).

Conclusion: MRgFUS is a safe, effective and durable option in the treatment of non-spinal osteoid osteoma. This technique provides relevant advantages in the treatment of this impairing disease affecting mostly young population.

2305.7

Evaluation of the role and feasibility of radiofrequency ablation for chondroblastoma: experience from tertiary care centre in India

N.S. Shetty, S.S. Kulkarni, K.B. Gala, S. Mohd, A. Puri, A. Gulia
Interventional Radiology, Tata Memorial Hospital, Mumbai, IN

Purpose: To evaluate the safety and efficacy of radiofrequency (RF) ablation in the treatment of selected cases of chondroblastoma.

Material and methods: A retrospective analysis of 26 patients with chondroblastoma treated by RF ablation since 2009–2018 in our institution was included in the study. Institutional ethical committee approval was obtained and need to obtain informed consent was waived for retrospective review of patient records. The diagnosis was based on histopathological and recognised radiological criteria. RF ablation was performed under computed tomography guidance. Symptoms were assessed before, post procedure day 1, and then every 3–6 months. Clinical and imaging follow-up was obtained to rule out local recurrence, complications, cartilage and growth plate damage while functional assessment was done using revised Musculoskeletal Tumor Society (MSTS) scoring system.

Results: Of the total 26 patients there were 20 males and 6 females ranging 8–31 years in age. The mean lesion volume was 8.75 mL. All patients reported complete relief of symptoms post procedure with return to all activities except two patients, one with femoral head lesion suffered subchondral collapse and another involving lunate had partial collapse of lunate with mild osteoarthritic changes. One patient had residual disease after ablation and underwent curettage.

Conclusion: Percutaneous RF ablation is a safe and effective treatment option for chondroblastoma. Large volume lesions in weight-bearing surfaces should be treated with caution due to possible risk of articular collapse. Dynamic MRI and radiographs can be used for follow up imaging. PET-CT can be used patients with persistent or recurrence of symptoms after treatment to visualize residual/recurrent lesion.

Free Paper Session Embolotherapy

2306.1

Geniculate artery embolisation in patients with osteoarthritis of the knee (GENESIS): preliminary results from the first European prospective study

M.W. Little, M. Gibson

Interventional Radiology, Royal Berkshire NHS Foundation Trust, Reading, UK

Purpose: Knee OA is an extremely common and debilitating condition. Recent work has elucidated the role of angiogenesis, which is increased in the synovium, osteophytes and menisci, leading to degenerative

change. The GENESIS study is the first prospective European study to investigate the role of GAE in the treatment of mild to moderate knee OA.

Material and methods: Participants have knee MRI, which is repeated 1-year post procedure. Prior to embolisation, patients complete KOOS, and VAS questionnaires. These are repeated at 6weeks, 3months, 1&2 years post procedure. Participants also undergo brain fMRI and behavioural assessments pre embolization. GAE is performed as a day-case procedure.

Results: The study opened in June 2018, and as of abstract submission has recruited 25 of 50 patients. We will present the most up-to-date data. Thus far (n=10), the mean total KOOS score pre intervention was 42.5 (22-64). At mean 3month follow up (to date of abstract), the mean total KOOS score post intervention is 70 (62-78). Thus far GAE in patients with mild to moderate knee OA significantly improves pain, function, and quality of life by 39% (p<0.05). We have had one complication of skin discoloration over the embolised territory that resolved spontaneously. The technique of GAE and cases will be discussed.

Conclusion: Mild to moderate OA of the knee resistant to conservative treatment, but not yet severe enough to merit joint replacement represents a specific challenge. If GAE is shown to provide a clinical benefit, this will change the way in which we view the pathophysiology and treatment of this common disease.

2306.2

Clinical outcomes of transcatheter arterial embolization for chronic knee pain: severe versus mild to moderate knee osteoarthritis

T. Kim¹, S.-H. Lee², Y.H. So³

¹Department of Radiology, Armed Forces Capital Hospital, Seongnam-si, Gyeonggi-do, KR, ²Interventional Radiology, H+ Yang-Ji Hospital, Nambusunhwan-ro, Gwanak-gu, Seoul, KR, ³Radiology, Seoul National University Boramae Hospital, Seoul, KR

Purpose: To compare the clinical outcomes of transcatheter arterial embolization (TAE) for chronic knee pain in patients with severe vs mild to moderate knee osteoarthritis (OA).

Material and methods: This study included 41 knee OA patients, refractory to conservative treatments, who underwent TAE between June 2017 and July 2018. Clinical outcomes were compared in two groups: severe OA (n = 12) and mild-to-moderate OA (n = 59). Visual analog scale (VAS) scores were used to assess pain at the baseline and post-treatment (1 d, 1 wk, 1, 3, 6 mo, and 12 mo).

Results: There were no significant differences in age, body mass index or baseline VAS scores between the two groups. The mean VAS scores in the mild-to-moderate OA group were significantly decreased at one-day, one-week, one-month, three-months and six-months (5.5 at baseline versus 3.2, 3.1, 2.9, 2.2, and 1.9 after treatment; all P = .00). These improvements were maintained at a mean of 10 ± 3 months (range, 6–19 months) post-treatment. The VAS scores were significantly decreased in the severe OA group for one-month post-treatment (6.3 as baseline versus 4.1, 4.1, and 4.4 at one-day, one-week, and one-month; all P < .01). However, the decrease was not statistically significant from three to six-months (5.4 and 5.9 at three-months and six-months, respectively).

Conclusion: TAE effectively relieved pain in patients with mild-to-moderate osteoarthritis. In patients with severe osteoarthritis, pain was decreased for one-month. However, in these patients, pain was increased after three-months.

2306.3

Effects of transcatheter arterial embolization for persistent trapezius myalgia refractory to conservative treatment

M. Shibuya, Y. Okuno

Musculoskeletal Intervention Center, Okuno Clinic, Yokohama, JP

Purpose: Trapezius myalgia (TM) is the most frequent type of neck-shoulder pain among office worker, characterized by pain, stiffness and tightness of the upper trapezius muscle. TM is a problem faced by people who do highly repetitive work and static contractions all day on the job. The effect of conventional treatment for this condition is limited. Transcatheter arterial embolization (TAE) of small abnormal vessels has appeared to be a method for the treatment of chronic painful conditions.

Material and methods: This study comprised in 10 patients (7 women; mean age, 61y; range, 30-75y; mean duration of symptoms, 7.1 years) with TM that was resistant to conservative treatments for more than 1 year. Patients with cervical radiculopathy, cervical spinal stenosis, thoracic outlet syndrome, shoulder joint pathology, polymyalgia rheumatica, cervical osteoarthritis, or rheumatoid arthritis were excluded. TAE was performed for transverse cervical, suprascapular, and the scapular circumflex arteries according to the region of pain between Oct 2017 and July 2018.

Results: No major or minor adverse events were related to the procedures. The mean brief pain inventory (BPI) pain intensity score before TAE significantly improved at 1 and 6 months after TAE (8.8±1.3 vs. 6.3±3.5 and 5.8±3.5, respectively; P < 0.01). The mean pain BPI interference scores significantly decreased at 1 and 6 months after TAE (5.2±1.4 vs. 3.6±3.0 and 3.6±3.0, respectively; P < 0.01).

Conclusion: TAE could be a potential treatment option for the persistent TM. Further evaluation with a control group is needed to confirm the effects of TAE.

2306.4

Impact of uterine fibroids embolization on uterine contractility and female quality of life

V.A.V. Fornazari¹, D. Szejnfeld¹, S.M. Goldman¹, J. Szejnfeld¹, T.F. Nunes², G.M. Salazar³, S.A. Vayego⁴

¹Department of Diagnostic Imaging, Federal University of São Paulo, São Paulo, BR, ²Radiodiagnostico, UFMS, Campo Grande, BR, ³Vascular Imaging and Intervention, Massachusetts General Hospital, Boston, MA, US, ⁴Department of Statistical, Federal University of Parana, Curitiba, BR

Purpose: To assess uterine contractility using ultrafast magnetic resonance imaging (cine MRI) before and after uterine fibroid embolization (UFE) and therefore evaluate the impact of uterine contractility patterns on the quality of life of women undergoing to uterine artery embolization for the treatment of symptomatic fibroids.

Material and methods: This is a prospective study of uterine contractility in 26 patients (age 30–41 years) undergoing UFE for symptomatic uterine fibroids. Cine MRI was performed before and 6 months after UFE. The uterine contractility was classified as absent, ordered, or disordered. Patients were then grouped into three distinct patterns of progression: unchanged contractility (group A), modified contractility (B), and loss of contractility (C). The health-related quality of life questionnaire was applied in person on first MRI exam day and one year after UFE.

Results: Of the 26 patients included, 38% had no change in contractility after UFE (group A), 50% had a positive change (group B), and 11% lost contractility (group C). All patients presented reduced in the mean score for symptoms and increase in mean scores on quality of life. Group B significant reduction in the mean symptom score and increase in the mean quality of life subscale score. Group A showed significantly higher average scores of activity and self-confidence than Group B.

Conclusion: In women of reproductive age with symptomatic fibroids, uterine contractility improved significantly after UFE. The functional

recovery of uterine contractility after UFE may be one of the factors of positive interference under improvement of the quality of these patient's life.

2306.5

Comparison of embolization of the superior rectal arteries with conventional surgical correction in the treatment of internal hemorrhoidal disease: initial results

P.M. Falsarella¹, S.E.A. Araujo², F. Nasser³, A.S. Portilho², B.B. Vailati², F.L. Galastri⁴, B.B. Affonso³, J.M. Da Motta Leal Filho⁵, R.G. Garcia¹, M. Katz⁶

¹Interventional Radiology, Hospital Israelita Albert Einstein, São Paulo, BR,

²Department of Coloproctology, Hospital Israelita Albert Einstein, São Paulo, BR,

³Radiologia Vascular Intervencionista, Hospital Israelita Albert Einstein, São Paulo, BR,

⁴Radiologia Vascular, Hospital Israelita Albert Einstein, São Paulo, BR,

⁵Radiology, Hospital das Clinicas, University of São Paulo Medical School, São Paulo, BR,

⁶Department of Cardiology, Hospital Israelita Albert Einstein, São Paulo, BR

Purpose: To compare embolization of the superior rectal arteries and surgical correction in the treatment of internal hemorrhoidal disease

Material and methods: Single-center, prospective, randomized in progress study approved by institutional review board with 22 included patients with indication for surgical treatment for internal hemorrhoidal disease (grades 2 and 3) started in April 2018.

Patients were randomized into two groups: embolization group with microcoils and conventional surgery group (ferguson technique), composed by 10 men and 12 women.

Postoperative symptoms were evaluated at 2, 7 and 30 days of posttreatment in both groups at a medical visit and through telephone evaluation (90 and 180 days).

Results: 22 patients were included (11 in the embolization group and 11 in the surgery group). Until now 9 patients were submitted to embolization of the superior rectal arteries and 7 to the conventional surgical treatment until the moment. Among the patients in the embolization group the pain in the first 7 days ranged from 0 to 3, without need for analgesic and anti-inflammatory use. And in surgery group, pain varied from 0 to 10, requiring the use of analgesics and anti-inflammatories (2 to 3 daily doses) for pain control.

Regarding the control of symptoms (bleeding and hemorrhoidal prolapse), in the postoperative period of up to 10 months, all patients presented remission, without need for a new approach in both groups.

Conclusion: the initial results of treatment of hemorrhoidal disease through embolization of the superior rectal arteries demonstrate clinical improvement of symptoms, with less pain and need for analgesic use when compared to conventional technique.

2306.6

Assessment of angiographic outcome using 2D parametric parenchymal blood flow (2D-PPBF) technique in patients with hypersplenism undergoing partial spleen embolization (PSE)

T.C. Meine¹, S.K. Maschke¹, M. Kirstein¹, T. Werncke¹, J. Baumgart², C.L.A. Dewald¹, F. Wacker¹, B.C. Meyer¹, J.B. Hinrichs¹

¹Department of Diagnostic and Interventional Radiology, Medizinische Hochschule Hannover, Hannover, DE,

²Fluoroscopic and Radiographic Systems, Siemens Medical Solutions USA, Chicago, IL, US

Purpose: To analyze the feasibility of 2D-PPBF for the assessment of angiographic outcome following PSE.

Material and methods: Overall, 15 PSE procedures in 14 patients were included in this study (2015/2018). Outcome was the platelet response (PR), calculated as the percentual increase of platelet count (PLT) following PSE. To assess angiographic outcome via perfusion quantification following PSE, the acquired digital subtraction angiography (DSA) series were post-processed. A reference region-of-interest (ROI) in the

splenic artery and a target ROI outlining the splenic embolization territory were placed in corresponding areas on DSA pre- and post-PSE. The ratios to the reference ROI were calculated for the Wash-In-Rate (WIR), the Time-To-Peak (TTP) and the Area-Under-the-Curve (AUC). Comparisons between pre- and post-embolization data were made using a Wilcoxon signed-rank test and correlated to the outcome parameter using Spearman's rank correlation coefficient (r). Additionally, the study population was subdivided according to the median of the most significant 2D-PPBF parameter. PR between subgroups was compared using Mann-Whitney U test. Level of significance was $p < 0.05$.

Results: Following PSE, PLT increased significantly from $41.200 \pm 19.468 / \mu\text{L}$ to $111.133 \pm 69.286 / \mu\text{L}$ with a PR of $+209\% \pm 237\%$ ($p = 0.002$). In the embolized splenic territory, the pre-/post-embolization 2D-PPBF parameter changed significantly: $\text{WIR}_{\text{pre-PSE}} 1.05 \pm 2.18 / \text{WIR}_{\text{post-PSE}} 0.09 \pm 0.07$ ($p = 0.03$), $\text{TTP}_{\text{pre-PSE}} 4.28 \pm 0.93 / \text{TTP}_{\text{post-PSE}} 5.98 \pm 1.86$ ($p = 0.012$) and $\text{AUC}_{\text{pre-PSE}} 0.81 \pm 0.79 / \text{AUC}_{\text{post-PSE}} 0.13 \pm 0.08$ ($p = 0.01$). Correlations of the 2D-PPBF parameters with PLT were: $\text{WIR}_{\text{pre-PSE}} / \text{PLT}_{\text{pre-PSE}} r = 0.236$ ($p = 0.396$), $\text{TTP}_{\text{pre-PSE}} / \text{PLT}_{\text{pre-PSE}} r = -0.585$ ($p = 0.022$) and $\text{AUC}_{\text{pre-PSE}} / \text{PLT}_{\text{pre-PSE}} r = -0.39$ ($p = 0.889$). PR between patients with $\text{TTP}_{\text{pre-PSE}} \leq 4.065$ vs. > 4.065 was significant different with $+80\% \pm 87\%$ [$n = 8$] and $+358\% \pm 273\%$ [$n = 7$] ($p = 0.040$).

Conclusion: 2D-PPBF is an objective approach to assess angiographic outcome via perfusion quantification following PSE. Further, TTP derived from 2D-PPBF has the potential to predict response to PSE.

2306.7

Identifying active extravasation on arteriograms using artificial intelligence

M. Shen¹, M. Ozturk², P.-L. Loh³, V. Jog⁴, P.F. Laeseke⁵, D. Morgan¹, M. Kleedehn⁵

¹Materials Science and Engineering, University of Wisconsin-Madison,

Madison, WI, US, ²Department of Radiological Sciences, Ondokuz

Mayis Universitesi, Samsun, TR, ³Department of Statistics, University

of Wisconsin-Madison, Madison, WI, US, ⁴Electrical and Computer

Engineering, University of Wisconsin-Madison, Madison, WI, US,

⁵Radiology, University of Wisconsin-Madison, Madison, WI, US

Purpose: To use artificial intelligence to identify extravasation on arteriograms.

Material and methods: Forty-seven positive and 23 negative digitally subtracted arteriogram series, containing 548 positive and 577 negative images, were used as a ground truth data set. Arteriogram series from consecutive embolization procedures with definitive sites of bleeding and findings concordant with final dictations were selected for the positive images. An attending interventional radiologist with 3 years of experience placed bounding boxes around the sites of extravasation using ImageJ 1.52a. A two-stage method was used to solve the extravasation detection problem, where the first stage was used to classify whether a bleed was present and the second stage where an object detector was trained to identify the site of bleeding. ResNet-152 was used as the first stage classifier and Faster R-CNN was used as the second stage object detector. Eighty percent of the data was used for training and twenty percent was used to validate the first stage of the algorithm. Ten unique positive arteriogram images from new series were used to test the second stage of the algorithm.

Results: The first stage of the algorithm was 86% accurate. The second stage of the algorithm correctly identified 5 of the 10 sites of bleeding.

Conclusion: The algorithm was able to correctly classify if a bleed was present on 86% of the validation images and was able to identify the site of extravasation on 50% of the test images. These preliminary results show significant promise for detection of bleeding on arteriograms using deep-learning methods.

News on Stage

From science to practice

2802.1

Perfusion imaging with 320-slice spiral computed tomography and color-coded digital subtraction angiography for assessing acute skeletal muscle ischemia-reperfusion injury in a rabbit model

C. Li

Interventional Radiology and Vascular Surgery, The First Affiliated Hospital of Jinan University, Guangzhou, CN

Purpose: To explore the value of CT perfusion and color-coded DSA in assessing acute ischemia-reperfusion injury (IRI) of skeletal muscle in a rabbit model.

Material and methods: 50 New Zealand white rabbits were randomly assigned to the IR group (n=40) or sham group (n=10). After 3 h of surgically-induced hindlimb ischemia, the IR group underwent reperfusion and were assessed at 0, 6, 12, or 24 h post-reperfusion using CT perfusion imaging (CTPI) and color-coded DSA. The data from CT and DSA in the right and left hindlimbs, blood flow (AF-R/L), blood volume (BV-R/L), contrast clearance rate (C-R/L) and the maximum contrast enhancement values (peak-R/L) were obtained. Using blood samples, lactic dehydrogenase (LDH), creatine kinase (CK), malondialdehyde (MDA), and superoxide dismutase (SOD) were measured. The statistical correlation between the above parameters (CT perfusion, color-coded DSA, and biochemical markers) was analyzed.

Results: The mean value of AF-R/L, BV-R/L, C-R/L and peak-R/L decreased linearly from 1.07 ± 0.08 to 0.75 ± 0.11 , 1.03 ± 0.06 to 0.85 ± 0.14 , 0.93 ± 0.15 to 0.71 ± 0.18 , and 1.07 ± 0.01 to 0.47 ± 0.04 , respectively. The correlation coefficients between AF-R/L and LDH, CK, MDA, SOD were -0.60, -0.44, -0.62, and 0.57, respectively ($P < 0.05$). The correlation coefficients between Peak-R/L and LDH, CK, MDA, SOD were 0.68, 0.71, 0.66, and 0.59, respectively ($P < 0.05$). The correlation coefficient between AF-R/L and Peak-R/L was 0.70 ($P < 0.05$).

Conclusion: Both CTPI and color-coded DSA could dynamically assess skeletal muscle IRI in rabbits.

2802.2

Radiation exposure during transarterial chemoembolization: angio-CT versus cone-beam CT

L. Piron¹, J. Le Roy², C. Cassinotto¹, J. Delicque¹, A. Belgour¹, C. Allimant¹, J.-P. Beregi³, J. Greffier³, N. Molinari⁴, B. Guiu⁵

¹Radiology, St-Eloi University Hospital, Montpellier, FR, ²Medical Physics, University Hospital, Montpellier, FR, ³Service de Radiologie et Imagerie Médicale, CHU Carémieu, Nîmes, FR, ⁴IMAG, CNRS, University of Montpellier, Montpellier, FR, ⁵Department of Radiology, St-Eloi University Hospital – Montpellier School of Medicine, Montpellier, FR

Purpose: Cone-beam computed tomography (CBCT) has been developed to improve reliability of many interventional radiology (IR) procedures performed with Angio system, such as transarterial chemoembolization (TACE). Angio-CT has recently emerged as a new imaging technology that combines a CT-scanner with a flat panel Angio system in the same IR suite. The purpose of our study was to compare Angio system with CBCT capability and Angio-CT in terms of patient radiation exposure during TACE procedures.

Material and methods: Consecutive TACE procedures performed between January 2016 and September 2017 with the two imaging modalities (Artis Zeego defining the CBCT group and Infinix-i 4D-CT defining the Angio-CT group) were reviewed. TACE and patient's characteristics and patient radiation exposure parameters were collected. Dose-area products (DAP) and dose-length products (DLP) were converted into

effective doses (ED) using conversion factors. Accuracy of tumor targeting and response was retrospectively assessed.

Results: 114 TACE procedures in 96 patients were included with 57 procedures in each group. The total ED in the Angio-CT group was 2.5 times lower than in the CBCT group (median 15.4 versus 39.2 mSv, $p < 0.001$). Both 2D ED and 3D ED were lower in the Angio-CT group than in the CBCT group (5.1 versus 20 mSv, $p < 0.001$, and 7.4 versus 17.9 mSv, $p < 0.001$, respectively). There was no significant difference in terms of classes of tumor targeting ($p = 0.509$) neither in terms of classes of tumor response ($p = 0.070$) between both groups.

Conclusion: Angio-CT provides significant decrease in patient effective dose during TACE procedures compared to Angio system with CBCT.

2802.3

A randomized and controlled study comparing patient controlled and radiologist controlled intra-procedural conscious sedation, using midazolam and fentanyl, for patients undergoing insertion of a central venous line

W. Clements¹, D. Sneddon¹, H. Kavnoudias¹, T. Joseph¹, G.S. Goh¹, J. Koukounaras¹, T.M. Snow²

¹Department of Radiology, Alfred Hospital, Melbourne, VIC, AU,

²Queensland Diagnostic Imaging, Holy Spirit Northside Hospital, Brisbane, QLD, AU

Purpose: Interventional Radiology procedures can provoke anxiety and may be painful. Current practice, Radiologist Controlled Sedation (RCS), involves titrating aliquots of midazolam and fentanyl to patient response but underdosing and overdosing may occur. This study tests a new method of titrating sedation/analgesia during the procedure, Patient Controlled Sedation (PCS), in which a combination of fentanyl and midazolam are administered using a patient-controlled analgesia pump. This allows the patient to self-control their sedation/analgesia during the procedure.

Material and methods: We performed a randomised control trial comparing the effects of pain, sedation, amnesia, and overall patient satisfaction between PCS and RCS, by enrolling forty patients undergoing insertion of a tunnelled central line.

Results: Our results showed that PCS was safe, with no adverse events. PCS was effective in providing sedation, amnesia, and overall pain relief comparable to RCS. There was no significant difference in dose given to patients using PCS or RCS. There was a tendency for patients in the PCS group to begin sedation later than those in the RCS group, but both were equally sedated during the procedure. We show that patients in the PCS group were very satisfied with the procedure.

Conclusion: We show that PCS is non-inferior to RCS in terms of dosage given and degree of sedation. To the authors' knowledge, this is the first study to show intra-procedural PCS in an Interventional Radiology setting using midazolam and fentanyl as a randomised comparative trial. It has wide applicability in a procedural setting for very low cost and with minimal additional training required.

2802.4

Left distal Percutaneous Radial hEmostasis using a Truncated dEflation Algorithm; IdPROTEA: safety and nursing impact assessment

D. Klass¹, L. Cardarelli-Leite², A. Hadjivassiliou², J. Chung², D.M. Liu³, S. Ho²

¹Interventional Radiology, University of British Columbia, Vancouver, BC, CA, ²Department of Radiology - Interventional Radiology, University of British Columbia, Vancouver, BC, CA, ³Interventional Radiology, Vancouver General Hospital, Vancouver, BC, CA

Purpose: Evaluate the safety, efficacy and nursing impact influence of a modified rapid hemostasis protocol (left distal Percutaneous Radial

hemostasis using a Truncated deflation Algorithm; IdPROTEA) in patients undergoing left distal radial access (IdTRA)

Material and methods: Prospective single-center observational study from April 2017 to December 2018. All patients undergoing IdPROTEA were included. Following treatment, hemostasis was obtained using a proprietary hemostatic disc (Statseal, Biolife, FL) and a hemostatic band (Safeguard radial, Sync distal, Merit Medical, S Jordan, UT). The balloon was inflated with 3-4mL of air and completely deflated at 10 minutes. The band was removed 15 minutes later if no bleeding was observed.

Results: 402 procedures were performed in 282 (70.15%) males and 120 (29.85%) females. Overall mean age 63.89 ± 13.02 years. Reaccess procedures included 63 (31.34%) patients, two punctures, 18 (13.4%) patients, three punctures, 4 (3.98%) patients four punctures and 1 (1.24%) patient, 5 punctures. Mean PTT 33.59 (26-44), mean INR 1.16 (0.9-2.4), mean platelets was 244.24 (37 to 552). Mean nursing intensity 25.19 min (25-40 min). In 262 patients evaluated post procedure, no radial artery occlusions were observed. 7 patients (1.74%) developed a small hematoma and were treated conservatively.

Conclusion: IdTRA using a modified rapid hemostasis protocol (IdPROTEA) is a safe procedure, with a significant decrease in nursing intensity post procedure.

2802.5

Women in interventional radiology: Australia's gender gap

M. Foo¹, J. Maingard², M. Wang¹, K. Phan³, R. Lim⁴, H.K. Kok⁵, R. Chandra⁶, M.J. Lee⁷, H. Asadi⁸, M. Brooks⁹

¹Department of Radiology, Austin Health, Heidelberg, VIC, AU, ²Department of Radiology, Monash Health, Clayton, VIC, AU, ³Department of Neurosurgery, Liverpool Hospital, Liverpool, NSW, AU, ⁴Department of Surgery, Peninsula Health, Frankston, VIC, AU, ⁵Radiology, Northern Health, Melbourne, VIC, AU, ⁶Interventional Radiology Service - Department of Radiology, Monash Health, Clayton, VIC, AU, ⁷Radiology, Beaumont Hospital, Dublin, IE, ⁸Neurointervention, Monash Health, Clayton, VIC, AU, ⁹Interventional Neuroradiology Service, Austin Hospital, Heidelberg, VIC, AU

Purpose: Worldwide, women are grossly underrepresented in interventional radiology (IR). Consistently, the latest Australian workforce census reported no women practicing IR. Given that gender equality amongst healthcare professionals can lead to a safer workplace, more equitable healthcare, and better patient outcomes, it is important to identify factors leading to this gender gap. As such, we aim to assess gender differences in exposure, knowledge, interest, and impressions of IR amongst medical students and junior doctors.

Material and methods: Multicentre cross-sectional study using in-person and web-based distribution of a voluntary anonymous survey to junior doctors (interns and residents). 333 complete responses were received from 11 health services across 2 states. Results were compared to those of our previous study, ASPIRE-1, which employed a similar survey completed by 236 medical students.

Results: Amongst medical student and junior doctors, both males and females reported low levels of exposure, teaching, knowledge and career awareness about IR, but strong appreciation and interest in learning IR. Despite no significant gender differences in these aspects, females were significantly less likely to consider a career in IR as medical students (24.8% vs 41%, $p=0.008$) or junior doctors (13.1% vs 29.7%, $p<0.001$).

Conclusion: From medical school to residency, females express significantly less interest in pursuing IR compared to males. This is not explained by disparities in opportunities or knowledge in IR, therefore, it is likely that sociocultural factors or radiation concerns underpin the current lack of female interventional radiologists. In order to ensure growth of IR through greater female representation, we must further investigate this gender bias and actively encourage female involvement through advocacy, mentorship, and policy.

2802.6

Platform for preclinical MRI-guided focused ultrasound hyperthermia

U. Roy¹, M. Fournelle², S. Greiser³, R.V. Gorkum⁴, D. Speicher², T. Grunwald³, S. Kozerke⁴, S. Tretbar², L. Landgraf⁵, A. Melzer⁵

¹Innovation Center for Computer Assisted Surgery (ICCAS), Universität Leipzig, Leipzig, DE, ²Fraunhofer IBMT, St. Ingbert, DE, ³Department of Immunology, Fraunhofer-Institute for Cell Therapy and Immunology, Leipzig, DE, ⁴Institute for Biomedical Engineering, ETH Zurich, Zurich, CH, ⁵University Leipzig, Innovation Center Computer Assisted Surgery (ICCAS), Leipzig, DE

Purpose: Magnetic resonance imaging guided focused ultrasound (MRigFUS) allows precise and non-invasive 3D positioning hyperthermia treatment at 41-46°C which may allow to radio-sensitize tumor cells. The purpose of this study was validation of FUS hyperthermia including the implementation of a preclinical FUS system and MRI based thermometry into a MRI scanner.

Material and methods: A novel MRI compatible FUS array transducer for preclinical treatments has been developed and produced (11x11 elements, copper shielding, aperture size of 10x10 mm, frequency 960 kHz). Installation of the transducer was realized at 7 Tesla MRI (Bruker). The transducer was placed on top of an agar-milk tissue phantom coupled via gel and fixed inside the rat body coil (Bruker). For PRF thermometry FLASH sequence was used to image the phantom during FUS heating. Hyperthermia was started at intensity of 4.8 W/cm² for 60 seconds. Real temperature monitoring was confirmed by using fiber optic (Luxtron) inside of the phantom.

Results: Images showed zipper artifact of 0.7 mm thickness through the center of the phantom oriented in the phase-encoded direction in presence of the transducer and 2.4 fold reduction of the signal-to-noise ratio. The temperature of the phantom was increased by 6°C during sonication with $\leq 0.8^\circ\text{C}$ temperature discrepancy in comparison to MRI thermometry.

Conclusion: The transducer presented in this study showed that hyperthermia and MRI based temperature control is feasible and small animal MRigFUS can be achieved at 7 Tesla. In vivo experiments in xenografted mice will be performed in the future combining MRigFUS hyperthermia and radiation therapy.

Free Paper Session Super Tuesday

3008.1

Impact of combined coiling and liquid sclerotherapy compared with coiling only on symptoms of pelvic congestion syndrome: a randomised controlled trial

M.I. Soliman

Vascular Surgery, Mansoura Medical School, Mansoura, EG

Purpose: Pelvic congestion syndrome (PCS) is a condition occurring in multiparous premenopausal women causing chronic pain in the pelvis and lower abdomen. Interventional treatment involved coiling, sclerotherapy and embolisation with variable degrees of success.

Material and methods: Ninety-eight patients diagnosed with PCS were randomised to combined coiling and liquid sclerotherapy (group A) or coiling only (group B). Patients were assessed following treatment by Doppler ultrasound or computed tomography venography for verifying residual or recurrent reflux and pain scores in the lower limbs at 3-, 6- and 12-month intervals.

Results: Symptom relief was achieved in 94% of patients in group A compared with 83% in group B. There was a statistically significant improvement in the venous clinical severity score of group A with a drop from 8.4 to 3.3, whereas in group B, the score dropped to 5.6. No residual

reflux or recanalisation was evident in group A but was observed in 13% of group B.

Conclusion: Both methods showed a considerable degree of improvement in pelvic and lower limb pain; however, this was remarkable only in the group with liquid sclerotherapy. This difference can be explained by a more diffuse effect of the sclerosant occluding a wider territory of the pelvic veins in addition to obliterating the communication sites to the lower limb. Reflux is not the only mechanism of symptoms, but the multilevel communication to pelvic and limb veins.

3008.2

Randomised controlled trial comparing drug eluting balloon versus conventional balloon angioplasty for below the knee arteries in patients with critical limb ischemia

B.S. Tan¹, A. Patel¹, F. Irani¹, U. Pua², T.T. Chong³, S. Leong¹, G. Tan⁴, E. Chan⁵, K. Damodharan¹, N.K. Karaddi¹, L.H.H. Quek², K.D. Zhuang¹, S.X.J.M. Chan¹, A. Gogna¹, C.W. Too¹, L. Toh⁶, M.C. Burgmans⁷, K. Gummalla², D. Matchar⁸, S.P. Chng³, H.H. Win¹, Y. Wei⁵, S. Chandramohan¹, P. Kumar¹, J.M.E. Chua¹, R.H.G. Lo¹, K.-H. Tay¹

¹Department of Vascular and Interventional Radiology, Singapore General Hospital, Singapore, SG, ²Department of Diagnostic Radiology, Tan Tock Seng Hospital, Singapore, SG, ³Department of Vascular Surgery, Singapore General Hospital, Singapore, SG, ⁴Department of General Surgery, Tan Tock Seng Hospital, Singapore, SG, ⁵Singapore Clinical Research Institute, Singapore, SG, ⁶Diagnostic Imaging and Intervention, KK Women's and Children's Hospital, Singapore, SG, ⁷Department of Radiology, Leiden University Medical Center, Leiden, NL, ⁸Health Services & Systems Research Programme, Duke-NUS Medical School, Singapore, SG

Purpose: To report final results of a randomised controlled trial comparing drug eluting balloon (DEB) versus conventional balloon (CB) angioplasty for below the knee (BTK) arteries in patients with critical limb ischemia (CLI).

Material and methods: In this investigator-initiated, multicentre, blinded, randomised controlled trial (NCT02129634), 138 patients (93 males) with mean age of 62.6 years (std=9.9), were randomised 1:1 to either DEB group (n=70) or CB group (n=68). 94.2% of the patients were diabetics and 52.9% had end stage renal failure (ESRF). The primary endpoint was 6-month angiographic primary patency rate of target lesions. Efficacy was analysed by generalised linear model adjusted for ESRF status in intention-to-treat population.

Results: Patient demographics and mean lesion length treated (DEB: 90.3mm (std=73.9), CB: 81.8mm (std=71.8)) were similar between the two groups. There was no statistical difference in the 6-month angiographic patency rates (DEB 41.9% vs CB 37.8%, risk difference (rd)= 6.2%, 95% CI= (-11.0%, 23.4%), p=0.479). The limb salvage rates at 12 months (DEB 75.0% vs CB 84.6%, rd=11.4%, 95% CI= (-24.7%, 2.5%), p=0.097) were similar. Amputation free survival (AFS) was better in the CB group and the difference was statistically significant (log-rank test p=0.030, 12-month AFS DEB 62.3% vs CB 77.3%). The serious adverse event rate was similar between the two groups.

Conclusion: There were no statistically significant differences in the 6-month angiographic target lesion patency or 12-month limb salvage rates between DEB and CB groups in BTK angioplasty for CLI. AFS was significantly different between the two groups, in favour of CB group.

3008.3

Totally percutaneous deep foot veins arterialization: a single centre experience

B. Migliara

Vascular and Endovascular Surgery, Pederzoli Hospital, Peschiera Del Garda, IT

Purpose: In this study we analyse the results of an alternative and standardized technique, using an IVUS-guided needle catheter to create the AV fistula during totally percutaneous deep foot vein arterialization.

Material and methods: From May 2017 to August 2018, we performed totally percutaneous deep foot vein arterialization in 16 limbs, 14 male and 2 female, median age 70,9±5,8 years, with this technique. All patients are with "no-option CLI". TcpO2 before treatment was 9,2 mmHg (1-24).

Results: We were able to create the AV fistula in 15/16 limbs, so the procedure success rate is 93,7%. During follow-up (132,2 days) we had 4 deaths not related with the procedure; we had 6 occlusions. In all patients we were able to obtain immediate resolution of pain and good progression of healing. We obtained complete healing in 4 limbs (26,7%). The TcpO2 increased from 9,2 mmHg to 37,4 mmHg. Amputation free survival is 66,7%.

Conclusion: Our experience suggests that this technique can be considered an alternative treatment in patients with "no-option CLI". The advantages are: to create the AV fistula with only one antegrade femoral access and to have direct ultrasound view of the tibial vein.

3008.4

Viable allograft intervertebral disc augmentation: preliminary results and safety data in the first 24 patients

E. Yoon¹, D.P. Beall², D. Wagoner¹

¹Interventional Pain, Clinical Radiology of Oklahoma, Edmond, OK, US,

²Radiology, Clinical Radiology of Oklahoma, Oklahoma City, OK, US

Purpose: To determine whether a cellular allograft disc matrix could be used to augment and restore disc tissue lost to degeneration.

Material and methods: Following IRB approval, safety and efficacy of disc augmentation was evaluated at 6 and 12 months. 24 subjects were prospectively randomized to receive supplemental allograft (cellularized nucleus pulposus), placebo, or conservative care. Those subjects who continued conservative care were offered the option to cross over to the allograft at 3 months. Distribution of the subjects were active allograft(16), placebo(4), and conservative care(4). The outcome of the study evaluated Oswestry Disability Index and the Visual Analogue Scale of Pain Intensity at 6 and 12 months. Safety was assessed by the incidence and severity of adverse events and clinically relevant changes in laboratory tests.

Results: No subjects left the study, no adverse events were reported, all conservative care patients crossed over. VAS was reduced in all subjects treated. Allograft pain scores decreased from 58.3 to 9.85; placebo decreased from 60 to 27.0; and conservative care cross over to allograft decreased from 55.0 to 6.0. Oswestry Disability Index improved in all subjects in the study. The allograft patients decreased from 54.67 to 12.85; placebo patients decreased from 50.40 to 17.50; and conservative care cross over patients decreased from 65.5 to 20.0.

Conclusion: Allograft was well tolerated and demonstrated the greatest improvement in ODI and VAS, and following crossover was able to achieve comparable symptomatic relief despite the initial conservative care. Allograft augmentation offered a safe and effective percutaneous treatment to decrease pain and improve function in DDD.

3008.5

Intra-operative and post-operative pain management of conventional transarterial chemoembolization (cTACE) for hepatocellular carcinoma (HCC) by different route of intraarterial lidocaine administration: a randomized controlled trial

Y.-D. Xiao

Department of Radiology, The Second Xiangya Hospital of Central South University, Changsha, CN

Purpose: To investigate the efficacy and safety of intraarterial lidocaine administration in controlling pain after TACE.

Material and methods: This randomized controlled clinical trial was approved by institutional review board. Ninety patients with HCC who received TACE were randomized divided into three groups. Group A was intraarterially bolus injection of 5ml 100mg lidocaine hydrochloride prior to TACE (n=30), Group B received 5ml 100mg lidocaine hydrochloride mixed with 60mg epirubicin and 10ml lipidol using water in oil technique (n=30), Group C intraarterially received a placebo of 5ml 0.9% sodium chloride (n=30). Pain intensity was recorded at intra-operatively (T_0), and 1 hour (T_1), 2 hours (T_2), 4 hours (T_3), 8 hours (T_4), 24 hours (T_5), 48 hours (T_6), and 72 hours (T_7) after the procedure. Pain intensity, adverse events, hospital stays, analgesic consumption, and quality of life were evaluated and compared within the three groups.

Results: The pain intensity at T_0 did not differ between Group A and Group B ($P>0.05$), while both significantly lower than Group C (all $P>0.05$). However, at T_1 , T_2 , T_3 , T_4 , and T_5 , the pain intensity was significantly lower in Group B than those of Group A ($P<0.05$) and Group C ($P<0.05$). At T_6 and T_7 , the pain intensity did not differ within three groups (all $P>0.05$). Analgesic consumption were significantly lower in Group B than those of Group A ($P<0.05$) and Group C ($P<0.05$).

Conclusion: Intraarterial lidocaine administration using water in oil technique is better in controlling post-operative pain than pre-TACE intraarterial bolus injection of lidocaine.

3008.6

A comparison of retrievability and indwelling complications of Celect and Denali infrarenal vena cava filters: a randomized controlled trial

S.H. Baek¹, K. Han², G.M. Kim¹, J.H. Kwon², J.Y. Won², M.D. Kim², D.Y. Lee³, J. Lee²

¹Radiology, Yonsei University Severance Hospital, Seoul, KR, ²Radiology, Severance Hospital, Yonsei University College of Medicine, Seoul, KR,

³Radiology, Yonsei University College of Medicine, Seoul, KR

Purpose: To compare the Celect and Denali filters in terms of complicated filter retrieval and indwelling complications after a 2-month indwelling time.

Material and methods: Between May 2016 and July 2018, 153 subjects were assessed for eligibility and 17 patients were excluded. A total of 136 patients were randomly assigned to receive either Celect (n=68) or Denali (n=68) filter placement in the infrarenal inferior vena cava. Overall filter retrieval, indwelling complication, and complicated retrieval rates were compared.

Results: 24 (17.6%) were excluded due to lost to follow-up after a mean indwelling time of 60.4 ± 7 days. Filter retrieval was successful in all patients (112/112, 100%). Significantly higher rates of filter tilt $> 15^\circ$ (n=8) and strut penetration (n=14) were found with the Celect filter than with the Denali filter (tilt n=1, penetration n=1) ($p=0.033$ and 0.001 , respectively). No significant differences in tip embedment, filter fracture, filter migration, or mean fluoroscopy times were noted. There were 3 cases of complicated retrieval (1 for Denali vs. 2 for Celect, $p=0.619$), for which the loop-snare technique was used.

Conclusion: Denali filters demonstrated significantly lower rates of tilt angles $> 15^\circ$ and strut penetration. However, there were no significant differences in the complicated filter retrieval rate.

3008.7

MR-guided focused ultrasound (MRgFUS) versus external beam radiation therapy (EBRT) for the treatment of painful bone metastases: a multicenter, phase III, randomized case-control trial

S. Dababou, A. Napoli, C. Marrocchio, R. Scipione, G. Alfieri, D. Fierro, C. Catalano

Radiological Sciences, University of Rome La Sapienza, Rome, IT

Purpose: To assess and compare the clinical impact of MR-guided Focused Ultrasound (MRgFUS) and External Beam Radiation Therapy (EBRT) for pain palliation in patients with symptomatic non-spinal bone metastases.

Material and methods: Patients with solid malignant tumors and one or more bone metastases were enrolled in the study. Included patients were ≥ 18 years of age, presented with symptomatic bone metastases (defined by pain score ≥ 4 at Visual Analogue Scale) confirmed at imaging, without contraindications to both MRgFUS and EBRT. Vertebral locations were excluded since they were not accessible to the ultrasound beam. Participants were randomly assigned (1:1 ratio) to receive MRgFUS or EBRT. Outcomes were compared at 1, 3, 6 and 12 months. The primary outcome was the reduction in pain with treatment response defined as a decrease of ≥ 2 points in worst pain by 1 month with stable or reduced opioid dose. Secondary outcomes included average pain, interference of pain with activity, mood, quality of life, and procedure-related adverse events.

Results: 281 patients (M: 151; F: 130) were enrolled and randomly assigned to MRgFUS (140) and to EBRT (141). Treatment response was achieved by 109 patients (77.9%) and 112 patients (79.4%) in the MRgFUS and EBRT arm respectively (adjusted odds ratio, 1.04; $p = 0.728$). No statistically significant differences were observed among the secondary outcomes between the two treatments. Results were stable along the whole follow-up period.

Conclusion: Pain palliation of symptomatic bone metastases achieved with MRgFUS was comparable to EBRT. This technique does not require radiation exposure and is performed in a single session. MRgFUS is limited to non-spinal locations.

Free Paper Session Neurointerventions

3104.1

Interim 30-day safety outcomes of Roadsaver dual-layer micro-mesh carotid artery stent: evidence from a large multicentre European study

S. Müller-Hülsbeck¹, S.A. Kedev², R. Langhoff³, K.R. Deloose⁴, R. Beelen⁵, O. Francois⁶, Z. Vajda⁷, A. Szolics⁸, B. Faurie⁹, J.-L. Banos¹⁰

¹Department of Diagnostic and Interventional Radiology / Neuroradiology, Ev.-Luth. Diakonissenanstalt zu Flensburg, Flensburg, DE,

²Medical Faculty, University Clinic of Cardiology, Skopje, MK, ³Vascular Center, Sankt Gertrauden-Krankenhaus, Berlin, DE, ⁴Vascular Surgery, AZ St. Blasius, Dendermonde, BE, ⁵Department of Cardiovascular and Thoracic Surgery, OLV Hospital, Aalst, BE, ⁶Interventional Radiology, AZ Groeninge, Kortrijk, BE, ⁷Neurovascular, Moritz Kaposi Teaching Hospital, Kaposvár, HU, ⁸Neurosurgery (Neurovascular Division), University of Pécs, Pécs, HU, ⁹Cardiology, Groupe Hospitalier Mutualiste of Grenoble, Grenoble, FR, ¹⁰Cardiology, Centre Hospitalier de la Côte Basque, Bayonne, FR

Purpose: Our study aims to validate clinical performance of dual-layer micro-mesh carotid stent Roadsaver in carotid artery stenosis (CAS) patients considered eligible for elective stenting procedure.

Material and methods: Roadsaver is an ongoing, prospective, single-arm, multicenter, observational study, aiming to enrol 2000 patients

across 12 European countries. Consenting adults with a non-occlusive/non-thrombotic CAS eligible for elective stenting with Roadsaver stent and a life expectancy of >12 months were included in the study. The primary outcome is the cumulative incidence of death or stroke up to 30 days after the procedure. Currently, 248 patients are enrolled in the study. An independent Data Monitoring Committee and Clinical Event Committee identifies safety issues and adjudicates major adverse events, respectively.

Results: 37.3% out of 248 patients were symptomatic with mean age of 71.4 ± 9.0 years and 33.5% females. The mean lesion length was 17.2 ± 10.2 mm, percent stenosis (NASCET) $81.6 \pm 14.3\%$, with 55.6% calcified, 43.8% eccentric and 18.2% ulcerated lesions. 88.4% of the lesions were localized in ICA. Pre-dilatation was performed in 26.2% of patients, embolic protection was used in 60.2% of which 90.8% being distal. Stenosis post-stenting was $6.5 \pm 9.4\%$. The mean pre- and post-procedure NIHSS was 0.5 ± 1.3 and 0.4 ± 1.3 , respectively. Preliminary data at 1 month shows 1 stroke related death, 2 deaths non-related to the procedure or device and 5 transient ischemic attacks.

Conclusion: Preliminary data confirms a safe profile and shows clinical benefit evidenced by decreased stenosis and low NIHSS score. By CIRSE2019 congress, we estimate to have adjudicated 30-day follow-up analysis in 400 patients.

3104.2

Initial clinical results and in-vitro testings of the new CGuard™ MicroNet® covered carotid-stent: one size fits all

C. Wissgott¹, C. Brandt-Wunderlich², C. Kopetsch¹, W. Schmidt², R. Andresen³

¹Institut für Diagnostische und Interventionelle Radiologie, Westküstenklinikum Heide, Heide, DE, ²Institute for Biomedical Engineering, University Medicine, Rostock, DE, ³Institute for Diagnostic and Interventional Radiology/Neuroradiology, Westküstenklinikum Heide, Academic Teaching Hospital of the Universities of Kiel, Luebeck and Hamburg, Heide, DE

Purpose: Evaluation of a new MicroNet® covered stent (InspireMD™) designed for the carotid artery with the ability of self-adjusting to different vessel diameters: Mechanical properties assessment in respect to expansion radial forces and clinical safety and effectiveness.

Material and methods: 30 consecutive patients with symptomatic high-grade stenosis of the internal carotid artery (ICA) were treated with the new self-adjusting stent and the technical success and clinical follow-up were analyzed. The only stent used was the MicroNet® conformable layer One-Size-Fits-All-CGuard™-stent with lengths of 30 or 40 mm. The chronic outward force was determined with a segmented head radial force test device (Blockwise Engineering LLC, Tempe, USA). The stent was deployed directly into the test device at a diameter of 5.0 mm, and the chronic outward force was measured up to 10.0 mm for complete expansion.

Results: The average stenosis rate was $86.3 \pm 6.4\%$ (NASCET). In all 30 patients the stent was successfully implanted. No peri- or post-procedural complications, including minor or major stroke occurred within 30 days follow-up.

The chronic outward force normalized by stent length demonstrates a near-equivalent radial force outcome: Between the minimal radial force at 9.0 mm (0.195 N/mm) and the maximal radial force at 5.5 mm (0.330 N/mm) the stent presented only a minor difference.

Conclusion: The new MicroNet® covered stent, is characterized by its structure with high conformability combined with an almost equivalent radial force between 5.5 to 9.0 mm expansion diameter. Our first clinical results demonstrate that the One-Size-Fits-All-stent can be implanted very safe and effective with respect to the vessel architecture.

3104.3

Selective transvenous embolization combined with balloon angioplasty of occluded inferior petrosal sinus for the treatment of cavernous sinus dural arteriovenous fistulas

H. Kiyosue¹, S. Ide¹, K. Tokuyama², Y. Hori¹

¹Department of Radiology, Oita University, Faculty of Medicine, Yufu, JP,

²Department of Radiology, Nagatomi Neurosurgical Hospital, Oira, JP

Purpose: Abgioplasty of the dural sinus has been rarely performed for the treatment of cavernous sinus dural arteriovenous fistulas. We evaluate efficacy of selective transvenous embolization (TVE) combined with balloon angioplasty of the occluded inferior petrosal sinus (IPS) for the treatment of cavernous sinus dural arteriovenous fistulas (CSDAVFs).

Material and methods: Consecutive 5 patients with CSDAVFs with occlusion of the IPS treated by selective TVE with balloon angioplasty of the IPS from July 2018 to January 2019 were retrospectively review. There were 3 females and 2 males with age average 74 years. All patients showed ocular symptoms. Angiography showed cortical venous reflux in 4 cases, and localized shunted pouches at the medial portion of the cavernous sinus, intercavernous sinus, or the laterocavernous sinus. Selective TVE was performed via the occluded IPS with bilateral femoral venous approaches, and the occluded IPS was reconstructed by angioplasty with 2-3mm diameter balloon during or after selective TVE.

Results: CSDAVFs were disappeared immediately after treatment and the occluded IPSs were successfully reconstructed with re-establishment of normal antegrade venous flow in all cases. No complication was observed, and symptoms resolved within 2 weeks after treatment. During 1-6 months follow-up periods, no cases showed recurrence of CSDAVFs.

Conclusion: Selective TVE combined with balloon angioplasty of the occluded IPS is safe and effective for the treatment of CSDAVFs with re-establishment of normal venous circulation in selected cases with localized shunted pouches.

3104.4

Safety and efficacy of transvenous embolization of ruptured brain arteriovenous malformations as a last resort: a prospective single arm study

Y. He¹, W. Bai¹, L. Tianxiao²

¹Zhengzhou University, Henan Provincial People's Hospital, Zhengzhou, CN,

²Department of Interventional Therapy, Henan Provincial Hospital, Zhengzhou, CN

Purpose: Due to limited data reported up to now, the transvenous embolization for brain AVMs is still considered an unproven salvage therapy. Our aim was to explore the safety and curability of transvenous embolization treatment.

Material and methods: Between November 2016 and November 2018, 21 consecutive patients with ruptured brain AVMs who underwent transvenous embolization were prospectively followed. Safety was evaluated by observing the procedure-related complications occurred within 1 month, and the primary outcome of efficacy was complete angiographic obliteration of the AVMs nidus on the 6-month follow-up angiography. Functional outcome was established using the mRS.

Results: The procedure was technically feasible in 19 of 21 (90.5%) cases. Procedure-related complications were 6 (28.6%), including 5 hemorrhages and 1 infarction, which caused 1 (4.8%) disability and 1 (4.8%) death. Sixteen (84.2%) patients had immediate angiographic obliteration in technically feasible patients. The median angiographic follow-up for 14 surviving patients was 5.5 (range, 3 – 15) months, and in 13 (92.9%) patients complete obliteration of the nidus conformed. Among them, 1 patient in whom immediate angiographic obliteration was not achieved showed spontaneous obliteration at the 13-month follow-up. There were no recurrences during the follow-up period. The good functional outcome (mRS≤2) ratios improved from 57.1% (12/21) at preoperation, to

66.7% (14/21) at 1-month follow-up and 100% (19/19) at 6-month follow-up respectively.

Conclusion: This prospective study demonstrates that transvenous embolization for brain AVMs may have a high rate of complete angiographic obliteration but also a high rate of procedure-related morbidity and mortality.

3104.5

Breaking new ground – flow diversion beyond the circle of Willis: endovascular aneurysm treatment in peripheral cerebral arteries employing a novel low-profile flow diverting stent

S. Schob

Department for Neuroradiology, University Hospital Leipzig, Leipzig, DE

Purpose: Flow diversion (FD) has emerged as superior minimally-invasive therapy for cerebral aneurysms. However, especially aneurysms of small peripheral vessel-segments have not yet been sufficiently treatable. More specifically, currently established devices necessitate large micro-catheters, which impede atraumatic maneuvering. The Silk Vista Baby (SVB), a novel flow diverter offers the yet unique feature of deliverability via a 0.017" microcatheter. Our study reports our first experience with the SVB in challenging intracranial vessels employing a vessel-specifically tailored microcatheter strategy.

Material and methods: 25 patients (27 aneurysms) were prospectively included. A total of 30 SVBs were employed, predominantly targeting demanding aneurysms of the AcomA-complex. Efficacy of FD was estimated using 2D-vector based perfusion and conventional digital subtraction angiography after implantation as well as in the first follow-up (FU) at 3 months. The 1stFU was available in 22 patients.

Results: All devices were implanted without technical or clinical complications. Eleven treatments were performed using the recommended Headway17. In fourteen interventions the even more maneuverable Excelsior-SL10 was used, which was priorly tried and tested for safety 'in-vitro' as alternative delivery system. Aneurysmal influx was strongly reduced after implantation. All parent vessels remained patent. 17/27 aneurysms were completely occluded at 1st FU (≈ 2.7 months). 6/27 aneurysms showed decreased influx or delayed washout, one remained unchanged. In 3 cases FU was unavailable.

Conclusion: SVB provides enhanced controllability in vulnerable segments beyond the circle of Willis. Smaller variants (2.25mm, 2.75mm) can safely be implanted via the superiorly navigable Excelsior-SL10. Hence, the SVB represents the next evolutionary step in minimally-invasive treatment of cerebral aneurysms.

3104.6

Early cerebral vein opacification as imaging marker for hemorrhagic reconversion in ischemic stroke: a retrospective study

A. Ferrari, F. Schirru, F. Fusaro, P. Enne, C. Ganau, S. Corraïne, S. Comelli

Neuroradiology and Interventional Radiology, Azienda Ospedaliera Brotzu, Cagliari, IT

Purpose: Infarcted brain tissue is at risk of developing hemorrhagic reconversion (RE), and this risk increases after recanalization with mechanical thrombectomy. The purpose of this study is to explore the efficacy of early cerebral vein appearance (ECV) in the mechanical post-thrombectomy angiogram to predict symptomatic cerebral hemorrhage event after reperfusion.

Material and methods: A retrospective analysis was performed on 78 patients undergone endovascular recanalization procedure of the intracranial circle between January 2016 and April 2018. The appearance of ECV after thrombectomy was evaluated by two observers in the control angiogram. The presence of hemorrhagic reconversion was evaluated in the control CT at 24 hours. A Chi-square test was used to discriminate

the two population (hemorrhagic and non hemorrhagic one) and the ECV opacification.

Results: In patients who developed hematoma a higher percentage of ECV was observed compared to patients without symptomatic hematoma (90.0% Vs 25.0%, $p < 0.0005$). Patients with positive ECV showed an higher percentage of Hematoma compared to patients with negative ECV (52.9% vs. 4.0%, $p < 0.0005$). The presence of ECV showed positive predictive value of 52.9% and a negative predictive value of 96% ($p < 0.001$) in predicting symptomatic hemorrhage. Sensitivity was estimated to be 90%, with a specificity of 75% and an accuracy of 78.6% (odds-ratio = 27; $p < 0.001$).

Conclusion: The appearance of early cerebral veins is highly predictive in developing symptomatic parenchymal haemorrhages, as their absence is a highly predictive factor for a better outcome.

3104.7

Preliminary results of the GPX embolic in a rabbit aneurysm model

R. Mühl-Benninghaus, F. Fries, U. Yilmaz, A. Simgen, T. Tomori, W. Reith

Neuroradiology, Saarland University Hospital, Homburg, DE

Purpose: In recent years liquid embolic agents have emerged for endovascular treatment of cerebral aneurysm. Our aim was to report the in vivo performance of a novel embolization agent (GPX).

Material and methods: Elastase-induced aneurysms were created in 10 rabbits. Each aneurysm was embolized with GPX under balloon assistance. DSA was performed pre-deployment; 5, 10, and 30 minutes post-deployment in 10 rabbits and at 1 month in 8 rabbits. Early post-deployment intra-aneurysmal flow was graded as unchanged, moderately diminished, or completely absent. At 1-month the status of aneurysm occlusion was graded by using a 3-point scale (complete, near-complete, or incomplete occlusion). Adhesion to catheter material and migration of GPX was assessed.

Results: The mean aneurysm neck diameter, width, and height was 3.6 ± 1.0 mm, 3.0 ± 0.8 mm and 7.4 ± 1.4 mm. The mean dome-to-neck ratio was 0.9 ± 0.2 . Nine (90%) of 10 aneurysms showed complete stagnation of intraaneurysmal flow within 30 minutes of device deployment. One aneurysm showed moderately diminished intraaneurysmal flow within 30 minutes due to distal migration of GPX that still was connected to intraaneurysmal embolic. At 1-month follow-up, 8 aneurysms were completely occluded. No evidence of GPX adhesion to catheter material was noted. Upon gross examination at 28-days, tissue appeared normal.

Conclusion: This is the first preclinical study reporting the performance of GPX embolic in a rabbit aneurysm model (including wide-neck aneurysm). The embolic showed promising results by achieving and maintaining high rates of complete angiographic occlusion.

Free Paper Session

Gynaecology and urogenital interventions

3105.1

Thermal ablation of renal tumors in patients with a solitary kidney: evaluation of renal function in patients with single tumor and with multiple tumors

P.B. García Jurado¹, M.E. Perez Montilla², J.J. Espejo Herrero², S. Lombardo Galera², I.D. Domínguez Paillacho¹, L.J. Zurera Tintero³
¹Vascular Intervencionismo, Hospital Universitario Reina Sofía, Córdoba, ES, ²Interventional Radiology, Hospital Reina Sofía, Córdoba, ES, ³Serv. Radiodiagnóstico, Hospital Universitario Reina Sofía, Córdoba, ES

Purpose: To evaluate the effect on renal function of percutaneous thermal ablation (TA) of renal tumors in patients with a solitary kidney (SK),

comparing patients with a single tumor (ST) and with multiple tumors (MT). The secondary objective was to evaluate the technical efficacy and complications.

Material and methods: Single-centre retrospective study of patients with a SK and renal tumors treated with TA between April-2004 and February-2018.

Results: 27 patients with 44 tumors were analyzed (9 with MT and 18 with ST), with a mean age of 62,7($\pm$ 15,4) years, being 54,5% women. The mean follow-up was 48,2($\pm$ 42,9) months. 81.8% of the procedures were performed by radiofrequency and 18.2% by microwave. In 13.6%, pielo-perfusion was performed and in 11.4%, hydrodissection. 93.2% of the tumors were T1a, with an average of the RENAL score and the PADUA score of 6.4 and 8 points, respectively. Serum creatinine one year after the procedure increased 0.4mg/dl in patients with a ST, while in patients with MT it increased 1.5 mg/dl($p=0.07$). In 11.4% of the cases, residual tumor remained after the first procedure with 100% technical efficacy after retreatment. In 13.6% of the cases there were grade 2 complications of the Clavien-Dindo classification and in 4.5%, grade 3. In 6.8% of the cases there was tumor recurrence with an average recurrence time of 31 months.

Conclusion: The TA of renal tumors in patients with SK presents excellent efficacy with a low rate of complications, although in patients with MT renal function seems to be more impaired than in patients with a ST.

3105.2

Benign prostatic hyperplasia treated by an ultrasound guided transperineal laser ablation, in local anaesthesia, by interventional radiologists: outcome in 81 patients with at least 6 months follow-up

G. Patelli¹, S. Paganoni², G. Mauri³, C.M. Pacella⁴

¹Department of Interventional Radiology, Ospedale Pesenti Fenaroli, Alzano Lombardo, IT, ²Interventional Radiology, ASST - BERGAMO EST, Seriate, IT, ³Interventional Radiology, IEO European Institute of Oncology IRCCS, Milan, IT, ⁴Interventional Radiology, Ospedale Regina Apostolorum, Albano Laziale, IT

Purpose: To report results, after at least 6 months follow up, of Ultrasound-guided (US-g) Transperineal Laser Ablation (TPLA) in patients with Benign Prostatic Hyperplasia (BPH).

Material and methods: Eighty-one patients (mean age 72.3 $\pm$ 10.4 years, range 58-93) with obstructive syndrome secondary to BPH, were treated by TPLA using continuous wave (CW) diode laser source at 1064nm (Echolaser Soractel Lite, Elesta s.r.l., Calenzano (FI), Italy). Under transrectal US-g, one or two 21G introducer needles for each lobe, according to the prostate volume, were inserted with transperineal approach. Each ablation was performed at 3W power for 1800J energy. A pull back was done case by case according to the prostate volume. Major and minor complications were recorded. The efficacy was evaluated on the changes of means of International Prostate Symptoms Score (IPSS), Quality of Life (QoL), post-void residual (PVR), prostate volume and the ejaculatory function. The mean hospital stay was measured.

Results: At a mean follow-up time of 16 months (range 6-51), IPSS improved from 22.9 to 9.5 ($P<0.001$), QoL from 4.5 to 1.2 ($P<0.001$), PVR from 162.3 ml to 64.0 ml ($P<0.001$) and prostate volume from 73.5 ml to 50.8 ml ($P<0.001$). Of 34 patient evaluated for ejaculatory function, 32 (94%) maintained a satisfactory ejaculation. No major complications occurred. The mean operation time was 42.3 $\pm$ 8.7min, ablation time 15.6 $\pm$ 3.4min, energy deployed 11,540.0 $\pm$ 3,680.5J, hospital stay 1.7 $\pm$ 0.4days.

Conclusion: TPLA is a mini invasive treatment for BPH. This therapeutic approach was safe, efficacious and with a satisfactory outcome.

3105.3

Correlation of transabdominal contrast-enhanced ultrasound and magnetic resonance imaging for evaluation of prostate artery embolization procedures

A. Massmann¹, C. Niklas², R. Kubale¹, P. Fries¹, G.K. Schneider¹, A. Buecker¹

¹Diagnostic and Interventional Radiology, Saarland University Medical Center, Homburg, DE, ²Urology and Pediatric Urology, Saarland University Medical Center, Homburg, DE

Purpose: Prospective evaluation of transabdominal contrast-enhanced ultrasound (CE-US) and MRI (CE-MRI) of the prostate prior and after prostate artery embolization (PAE).

Material and methods: After examination and dose optimization of CE-US in five patients, 20 patients (mean age 68; range 51-88 years) underwent pre- and postinterventional dynamic CE-US (Siemens Acuson S2000 Helix: 9L4, 4C1 and 6C1) using twice-time bolus sulphur hexafluoride microbubble (Bracco SonoVue) injection for evaluation of midgland prostate and Gadolinium-BOPTA CE-MRI including multiparametric prostate imaging (Siemens Magnetom Aera 1.5 T) one day before and after PAE. Perfusion characteristics (time-to-peak intensity TTP; mean transit time, MTT) of regions-of-interest (ROI) placed in PI-RADS region 3, 4, 10, 14, prostate capsula, and iliac artery were measured. Planimetry after PAE of ischemic areas in CE-US and CE-MRI were analyzed. Spearman's correlation, Bland-Altman and intraclass correlation coefficient (ICC) were analyzed.

Results: Best imaging quality was achieved using 6C1 and 2 ml SonoVue in full bladder technique. In 13/20 patients sufficient, homogeneous contrast was achieved for evaluation with significant correlation of CE-US and CE-MRI perfusion (Spearman $r=0.77$, $p<0.01$; ICC=0.831, $p<0.01$). Extension of infarction after PAE correlated highly with CE-MRI and diffusion restriction on MRI (Spearman $r=0.79$ $p<0.01$; ICC=0.831, $p<0.01$).

Conclusion: This is a first proof-of-concept study for determining prostate tissue infarction after PAE by transabdominal CE-US perfusion imaging with excellent correlation to CE-MRI.

3105.4

Endometrial assessment prior to uterine artery embolisation

M.K. O'Reilly¹, M.J. Lee², T. Geoghegan¹

¹Department of Radiology, Mater Misericordiae University Hospital, Dublin, IE, ²Radiology, Beaumont Hospital, Dublin, IE

Purpose: Uterine artery embolisation (UAE) / uterine fibroid embolization (UFE) has established itself as a minimally invasive procedure for reducing symptoms, including menorrhagia, from uterine fibroids and or adenomyosis. Premenopausal abnormal uterine bleeding is common and estimated to affect more than one-fifth of women. In a recent systematic review, the prevalence of endometrial cancer in premenopausal women with menorrhagia has been estimated at 0.11%. In clinical practice, there is little consensus on how or even the need to evaluate the endometrium prior to UAE/UFE. Our aim was to investigate current clinical practice trends in this regard.

Material and methods: A 3 question anonymous survey was sent to all current CIRSE members ($n=7608$) via electronic mail and administered using SurveyMonkey software (SurveyMonkey Inc., California, USA). A reminder email was sent 1 month later. The questions dealt with the necessity for endometrial biopsy, use of imaging and to assess the perceived risk of endometrial cancer in premenopausal women with menorrhagia.

Results: We received 406 complete surveys; a response rate of 5%. Endometrial biopsy in premenopausal women prior to UAE/UFE was considered a necessity by 6% of CIRSE members, with 68% leaving this to the discretion of the referring gynaecologist. 61% advocated contrast-enhanced MRI as the preferred imaging modality to assess the

endometrial cavity prior to treatment. 61% of respondents overestimated the risk of endometrial cancer in premenopausal women with menorrhagia.

Conclusion: This is the first survey of its kind to investigate current clinical practice in endometrial assessment prior to UAE/UFE in a worldwide cohort of practicing interventional radiologists.

3105.5

Uterine artery embolisation for women with giant versus non-giant uterine fibroids: a systematic review & meta-analysis

O. Llewellyn¹, N.R. Patel², D. Mallon³, M.S. Hamady²

¹Department of Radiology, Royal Infirmary of Edinburgh, Edinburgh, UK,

²Interventional Radiology, Imperial College Healthcare NHS Trust, London, UK, ³Radiology, Imperial College Healthcare NHS Trust, London, UK

Purpose: Uterine artery embolization (UAE) is an established minimally invasive treatment for symptomatic uterine fibroids. Evidence supporting UAE for giant (>10cm and/or uterine volume >700CC) fibroids remains sparse. We performed a systemic review and metanalysis of outcomes from comparative studies of UAE for symptomatic giant versus non-giant fibroids.

Material and methods: This study was registered online (PROSPERO ID: CRD42019118989) and conformed with PRISMA standards. We systematically reviewed the literature, searching bibliographic lists. Studies not using peri-operative MRI to characterise fibroids, and pre-surgery UAE studies were excluded. Primary outcomes were complication and reintervention rates, fibroid and uterine volume reduction, procedure time, length of stay, patient symptoms and satisfaction.

Results: Four observational studies totalling 839 patients were included (giant=163; non-giant=676). Our analysis showed that when compared with non-giant fibroids, UAE for giant fibroids is associated with a significantly higher rate of major complications (OR 4.71 95% CI 1.51-14.64, p=0.007) and reintervention (OR 3.57 95% CI 1.70-7.49, p=0.0008). Giant fibroids were also associated with longer operative time (MD 5.58 95% CI 2.58-8.57, p=0.0003) and length of stay (MD 4.84 95% CI 1.06-8.61, p=0.01); [2 studies, 365 patients]. There was greater dominant tumour volume reduction for non-giant fibroids (MD -5.28 95% CI -9.93-0.64, p=0.03) but uterine volume reduction was equivocal (MD 0.78 95% CI -3.07-4.63, p=0.03). Systematic review found no comparable patient symptom/satisfaction data to include in the meta-analysis.

Conclusion: The available limited evidence shows UAE is safe and effective for giant fibroids but carries a higher risk of complications and reinterventions. Patients should be selected, counselled and managed accordingly.

3105.6

A new approach: unilateral UFE in women with symptomatic fibroids

S.O.J.H. Adriaansens¹, A. Mohamad¹, A. Venmans², A.J. Smeets², P.N.M. Lohle¹

¹Radiology, ETZ Tilburg, Tilburg, NL, ²Radiology, St. Elisabeth Hospital, Tilburg, NL

Purpose: To evaluate the effectiveness of elective unilateral uterine fibroid embolization (UFE).

Material and methods: A review of the most recent 1491 uterine artery embolization (UAE) at a single institution identified 38 patients who underwent unilateral UAE. Three patients were excluded. The minority underwent unilateral fibroid embolization (UFE) due to anatomic variants (n=12). The vast majority had intentional unilateral UFE (n=23) because of unilateral disease on magnetic resonance imaging (MRI) with supply from only the ipsilateral uterine artery confirmed by angiography. These intentional unilateral UFE case-group patients were compared with a control group of patients with unilateral disease who underwent bilateral

UFE. Outcome measures included the validated standardised uterine fibroid symptom and health related quality of life (UFS-QOL) questionnaire, chief symptom resolution score, patient satisfaction, fluoroscopy time, tumour infarction rate and volume reduction.

Results: Three-month clinical follow-up and post procedure MR imaging were available for all patients from both groups. Overall results demonstrated significant improvement compared to baseline for both groups regarding UFS-QOL. 27 patients, whereof 17 intentional unilateral UFEs showed an infarction rate >80%. There was no significant difference between groups regarding UFS-QOL, chief symptom resolution score, or patient satisfaction. Final results regarding fluoroscopy time, uterine and fibroid volume reduction will be provided.

Conclusion: In properly selected patients unilateral UFE provided similar clinical and imaging results as in patients who underwent the standard bilateral UFE.

3105.7

Radial artery approach: a new opportunity

N. Romero¹, A. Alguersuari¹, E. Criado Paredes², J. Guitart³, J.F. Falco-Fages⁴, M. Teixidor Vinas¹

¹Interventional Radiology, University Hospital Parc Taulí, Sabadell, ES,

²UDIAT (Interventional Radiology), Corporació Sanitària Parc Taulí,

Sabadell, Barcelona, ES, ³Radiology - Interventional Radiology, Hospital Clínic Barcelona, Barcelona, ES, ⁴Radiology, Parc Taulí, Sabadell, ES

Purpose: Uterine artery embolisation (UAE) has shown very good results in patients with fibroids. Unfortunately, severe abdominal pain related to percutaneous procedure and lack of interventional radiology (IR) hospital beds have restricted its chances to become the gold standard technique. Radial access (RA) allows patients to mobilize immediately after the procedure and helps improving pain control. Also, Domiciliary hospitalization service (DHS) and IR clinics allows IR services to become more independent.

The aim of this study is to describe our UAE experience, comparing outcomes before and after introduction of RA and DHS.

Material and methods: A new UAE treatment protocol based on direct GP referred patient to IR, IR clinics, day case RA UAE and DHS follow up was developed in our hospital in 2017. Comparative retrospective study between RA UAE treatment (Study Group) vs femoral access UAE treatment (Control Group) was performed. Patient's age, time gap between patient's diagnose and UAE performed, patient's radiation dose, degree of pain and patients' satisfaction was recorded.

Results: 31 patients with fibroids underwent to UAE in our department from January 2017 till December 2018. 13 patients were included in the Study Group. Demographic characteristics were similar in both groups. Patient's pain control and patient's comfort were better in the Study Group (p>0.05). Even patient's radiation dose and length of the procedure were smaller in the Study Group, no statistically significant differences were noted.

Conclusion: IR treatments using radial access approach seems to improve clinical and radiological outcomes. RA in conjunction with DHS can determine the future of our speciality.

Free Paper Session Biopsy and drainage

3106.1

Minocycline hydrochloride as a soft sclerotizing agent for symptomatic simple renal and hepatic cysts: our experience

A. Paladini¹, A. Borzelli², G. Guzzardi³, G.E. Vallati⁴, G. Pizzi⁴, A. Carriero⁵, D. Negroni¹, A. Galbiati¹

¹SCDU Radiologia Diagnostica ed Interventistica, AOU "Maggiore della Carità" - Novara, Novara, IT, ²U.O.C. Neuroradiologia, AORN, Naples, IT, ³Institute of Diagnostic and Interventional Radiology, Ospedale Maggiore, Novara, IT, ⁴Interventional Radiology, IFO Istituto Regina Elena National Cancer Institute, Rome, IT, ⁵SCDU Interventional Radiology, "Maggiore della Carità" Hospital, Novara, IT

Purpose: The aim of this work is to retrospectively evaluate our ten years experience on the sclerosing procedure of simple hepatic and renal cysts. We used Minocycline Hydrochloride, an antibiotic drug from the Tetracycline family, as sclerosing agent. Through ultrasound guided percutaneous access, it was injected in the cysts. In conclusion we evaluated efficacy and safety of the procedure.

Material and methods: We analyzed 75 Patients (54 Patients with 60 renal cysts and 21 Patients with 24 liver cysts) with symptomatic cysts. Patients were treated with ultrasound percutaneous drainage of cystic formation and subsequent injection of Minocycline Chloride into the cyst itself. In larger cystic formulations, the treatment was repeated twice. We performed follow-up with ultrasound 6 and 12 months after procedure.

Results: The success rate of this treatment is 100% - in case of liver cysts - and 86% for renal cysts. Among minor complications, 5 Patients reported fever (<38 °) in the 24 h following treatment, treated with Paracetamol.

Conclusion: In conclusion, sclerosing treatment with Minocycline Hydrochloride is effective and safe, with a low level of complications. Symptoms disappeared in all Patients with liver cysts (100% success rate) and 93% of Patients with renal cysts.

3106.2

Efficacy of the tract embolization technique with gelatin sponge slurry to reduce pneumothorax and chest tube placement after percutaneous CT-guided lung biopsy

F. Cousin¹, H. Renier¹, L. Gérard¹, P. Lamborelle¹, R. Hustinx²

¹Radiology, CHU of Liège, Liège, BE, ²Nuclear Medicine, CHU of Liège, Liège, BE

Purpose: To assess the efficacy of the tract embolization technique using gelatin sponge slurry after CT-guided lung biopsy to reduce pneumothorax and chest tube placement rates.

Material and methods: We retrospectively compared 231 CT-guided lung biopsies performed with the tract embolization technique using gelatin sponge slurry (treated group) with 213 biopsies performed without embolization (control group). All procedures were performed at our institution between 2014 and 2018 by one of three experienced interventional radiologists with a 19-gauge coaxial needle. Multivariate analysis was performed between groups for risk factors for pneumothorax and chest tube placement.

Results: In the two groups, there was no significant difference concerning age, sex, emphysema, lesion size, lesion location, lesion morphology, needle tract depth and biopsy side down patient positioning. Only patient position was found to be statistically different between the two groups: the number of lateral positions was greater in the control group. Compared to the control group, patients with gelatin sponge slurry tract embolization had statistically lower rates of pneumothorax (10% versus 25.8%; p<.0001) and chest tube placement (3.5% versus 12.2%; p=.0005). Using multiple logistic regression analysis, the only variable that had an

influence on the pneumothorax rate was the group (OR=0.32, 95% CI: 0.18 - 0.56, p<.0001) and the variables that had an influence on chest tube insertion rates were the group (OR=0.23, 95% CI: 0.10-0.54, p=0.0006) and the presence of emphysema (OR=3.50, 95% CI: 1.53 - 8.03, p=0.0031). **Conclusion:** Tract embolization technique using gelatin sponge slurry after percutaneous CT-guided lung biopsy significantly reduces pneumothorax and chest tube placement rates.

3106.3

Percutaneous image-guided drainage of the main pancreatic duct: what for and how

M. Mizandari¹, T. Azrumelashvili¹, G. Asatiani², O. Kepuladze³, N. Habib⁴

¹Diagnostic and Interventional Radiology, New Hospitals LTD, Tbilisi, GE, ²Surgery, Tbilisi State Medical University, Tbilisi, GE, ³General & Minimally Invasive Surgery, Clinic "Caraps Medline", Tbilisi, GE, ⁴Surgery, Imperial College London, London, UK

Purpose: To present the rationale and technique of percutaneous image-guided pancreatic duct (PD) drainage

Material and methods: 65 patients (pancreatic tumor – 37, pancreatitis – 23, papilla of Vater tumor – 3, pancreatic head metastasis – 1, pancreatic fistula – 1) underwent PD percutaneous image-guided drainage. In 54 of them the indication was PD obstruction related clinical symptoms (pancreatitis, recently revealed or rapidly advancing diabetes); non-dilated PD was drained in only pancreatic fistula case.

PD drainage was performed under combined image-guidance - US&fluoroscopy (38) or CT&fluoroscopy (27 cases). Puncture was performed by 18 G (30 cases), 22 G needle (16 cases) or co-axially used 18 and 22, 17 and 18 or 14.5 and 18 G needles (19 cases), allowing to conduct the guidewire in PD. Finally 6 to 8.5 Fr diameter locking-loop drainage catheter was placed under the real-time fluoroscopy guidance over the wire.

Results: Drainage was successful in 63(96.9%) cases, including non-dilated PD in post-biopsy pancreatic fistula case. Clinical improvement was documented in all successful drainage cases (elimination or alleviation of pancreatitis, dramatic improvement of glycemic control in recently revealed/advanced diabetes cases). Pancreatic fluid discharge varied between 300 -900 ml/day.

Conclusion: The percutaneous PD drainage appears to be a safe and effective procedure and should be considered in symptomatic patients with obstructed PD, especially in cases when endoscopic retrograde cannulation fails or impracticable. Mature drainage track might be used for further low-invasive treatment procedures.

3106.4

Preliminary study on the catheter-based endoluminal radiofrequency sealing of pancreatic duct

E. Ewertowska¹, A. Andaluz², X. Moll², A. Aguilar², F. Garcia², D. Fondevila², R. Quesada³, M. Trujillo⁴, E. Berjano¹, F. Burdío⁵

¹BioMIT, Electronic Engineering, Universitat Politècnica de València, Valencia, ES, ²Departament de Medicina i Cirurgia Animals, Facultat de Veterinària, Universitat Autònoma de Barcelona, Barcelona, ES, ³Localized Hyperthermia Therapy, Fundació IMIM, Barcelona, ES, ⁴Matemàtica Aplicada, Universidad Politécnica de Valencia, Valencia, ES, ⁵Surgery, Hospital del Mar, Barcelona, ES

Purpose: To develop a novel catheter-based technique for endoluminal radiofrequency (RF) sealing of pancreatic duct for the management of a pancreatic stump after pancreaticoduodenectomy that could offer advantage over the currently used sutures and glue.

Material and methods: We developed a novel RF ablation technique based on impedance-guided catheter pullback. First, the technique was analyzed using bench tests on ex vivo models; after this, an in vivo study on 8 Lagrange pigs was conducted. For in vivo endoluminal RF sealing of non-transected pancreatic duct, the 3Fr bipolar RF catheter was

inserted through the pancreatic papilla and a ~10 cm-long ablation was performed. Sealing effectiveness was evaluated 30 days after with permeability test (saline injection through the pancreatic papilla) and histological analysis of exocrine atrophy.

Results: The impedance-guided bipolar RF technique was accomplished in all cases delivering ~4 W of power to initial ductal impedance of $308 \pm 91 \Omega$. Similar pattern of electrical impedance progress could be recognized and was used to modulate pullback speed to avoid tissue overheating and provide a continuous lesion. During the follow up there was no postoperative complications, except signs of exocrine atrophy and animals presented significant reduction in weight increase ($p < 0.05$). Failed attempts to reinsert the catheter or syringe needle for permeability test suggested that effective sealing occurred. Histological analysis revealed a homogeneous exocrine atrophy along the entire ablated segment in all animals.

Conclusion: Catheter-based RF bipolar ablation seems to be an effective and safe technique for endoluminal sealing of pancreatic duct.

3106.5

Feasibility of non-invasive MR-based characterization of pleural effusions and ascites in patients with suspected lymphatic leakage using the 6-point mDIXON fat quantification method

C.C. Pieper, A.M. Sprinkart, D. Kütting
Radiologie, Universitätsklinik Bonn, Bonn, DE

Purpose: To assess whether MR-based fat quantification (mDIXONquant) allows for non-invasive differentiation of chylous (rich in triglycerides [TG]; e.g. chylothorax) and non-chylous effusions.

Material and methods: In-vitro, ex-vivo and in-vivo MR-examinations were performed using the commercially available mDIXONquant on a 1.5T MR-scanner. Proton density fat-fraction (PDFF) was measured ROI-based on parameter maps.

For in-vitro experiments eight solutions with known TG-content (145-19000 mg/dl) were examined. For ex-vivo evaluation 14 chylous and 6 non-chylous clinical fluid samples were examined. In-vivo testing was performed in 29 patients with chylous ($n=16$) and non-chylous ($n=13$) effusions. All clinical samples underwent laboratory testing. Laboratory values were correlated with PDFF and ROC-analysis was used to determine the optimal PDFF threshold to differentiate chylous and non-chylous fluids.

Results: In-vitro PDFF-values highly correlated with TG-content ($r=0.998$). Ex-vivo PDFF showed significant differences between chylous ($2.5\% \pm 1.2$) and non-chylous fluids ($0.8\% \pm 0.2$) ($p=0.0013$). Ex-vivo PDFF highly correlated with TG-content ($p < 0.0001$; $r=0.88$).

In-vivo PDFF also significantly differed between chylous ($6.2\% \pm 4.3$) and non-chylous fluids ($0.6\% \pm 0.6$) ($p < 0.0001$). In-vivo PDFF correlated strongly with TG-content ($p < 0.0001$; $r=0.96$), and moderately with protein levels ($p=0.0054$; $r=-0.66$).

Using PDFF cut-off values of either $> 1.2\%$ or $> 1.8\%$ yielded a sensitivity of 86% or 79% and specificity of 91% or 100%, respectively, for in-vivo differentiation of chylous and non-chylous effusions.

Conclusion: MR-based non-invasive differentiation of chylous and non-chylous effusions is feasible. This can be helpful in complex cases with suspected chylous leakages, especially with combined pleural/pericardial effusions and ascites in which diagnostic paracentesis of all compartments may lead to an increased risk of complications.

3106.6

Novel use of guiding device for CT-guided transoral biopsies of challenging retropharyngeal lesions

H.Y. Tan¹, S. Leong¹, C.W. Too²

¹Department of Vascular and Interventional Radiology, Singapore General Hospital, Singapore, SG, ²Diagnostic Radiology, Singapore General Hospital, Singapore, SG

Purpose: EUS guided FNA of challenging retropharyngeal lesions can have limited diagnostic yield. We describe the use of a commercial guiding device in performing CT guided transoral biopsies of retropharyngeal lesions in four patients. Our aim is to show that CT guided transoral biopsy of retropharyngeal lesions using a guiding device is safe, feasible and warrants exploration with further clinical trials.

Material and methods: From April 2018 to September 2018, four patients aged 65 to 72, underwent a CT guided core needle biopsy or fine needle aspiration cytology of retropharyngeal lesions with a guiding device (SeeStar, AprioMed, Uppsala, Sweden) under local anaesthesia or mild sedation.

Results: All the patients tolerated the procedure with no major complications. The four cytohistopathological specimens were diagnostic for various malignant conditions of the neck. CT guided transoral biopsy of retropharyngeal lesions using a guiding device provides simple and economical method with several advantages. The exquisite resolution of CT allows for the biopsy of deep retropharyngeal lesions while the guiding device holds the needle stationary. This method allows the procedurist to avoid important neurovascular structures in the neck while at the same time respecting the different compartments to reduce the chance of seeding. Although the use of the transoral technique has limitations of non-sterility and poor soft tissue contrast, our preliminary experience shows that this approach is feasible and safe without major complications.

Conclusion: CT guided transoral biopsy of retropharyngeal lesions using a guiding device is safe, feasible and warrants exploration with further clinical trials.

3106.7

Transvenous biopsy of native kidneys and renal transplants

A. Schmid¹, S. Svandrlík², K.F. Hilgers³, K. Amann⁴, M. Uder¹

¹Radiology, University Hospital Erlangen, Erlangen, DE, ²Radiology, University of Erlangen, Erlangen, DE, ³Nephrology, University of Erlangen, Erlangen, DE, ⁴Nephropathology, University of Erlangen, Erlangen, DE

Purpose: Transjugular renal biopsy is an established alternative biopsy technique of native kidneys in cases in which the standard percutaneous approach is not feasible or associated with elevated risks. In 2006 the first transvenous biopsy of a renal transplant via a transfemoral approach was performed by our group. The aim of this study was to compare the indications, the effectivity and the complication rates of transfemoral renal transplant biopsies (TFRTB) and transjugular renal biopsies (TJRB) of native kidneys.

Material and methods: We conducted a retrospective analysis of 264 transvenous biopsies from 2006 to 2016 (128 TFRTB, 136 TJRB).

Results: The most common indications for the transvenous approach were elevated risks of bleeding (45.3% of TFRTB, 47.8% of TJRB) or limited percutaneous access to the organ (50.8% of TFRTB, 36.8% of TJRB). In 14.8% of TFRTB and in 0.7% of TJRB the biopsy cannula could not be advanced to the kidney due to relevant vascular kinking. If specimen were obtained, a sufficient histological diagnosis was achieved in 99.1% of TFRTB and 100% of TJRB. BANFF criteria were completely fulfilled (≥ 10 glomeruli) in 60.7% of TFRTB and 71.9% of TJRB and partially fulfilled (1-9 glomeruli) in 38.3% of TFRTB and 28.1% of TJRB. Procedure-related major complications occurred in 2.8% of TFRTB and 2.9% of TJRB, minor complications in 23.4% of TFRTB and 25.2% of TJRB.

Conclusion: TFRTB cannot be performed in approximately 15% of cases because of relevant vascular kinking. If possible, the effectivity and complication rates are comparable to the established TJRB of native kidneys.

Barcelona, Spain
September 7-11
CIRSE 2019

PART 3

**Abstracts of
Posters
sorted by presentation
numbers**

Aortic Intervention

P-1

Acute outcomes of endovascular treatment of stenosis of the aorta and renal arteries in management of uncontrolled hypertension and left ventricular dysfunction in Takayasu's arteritis

S. Sharma, M. Sinha, S. Kumar, G.S. Gulati, P. Jagia
Cardiovascular Radiology & Endovascular Interventions, All India Institute of Medical Sciences, Delhi, IN

Purpose: To evaluate results of percutaneous transluminal angioplasty (PTA) in treatment of stenosis of aorta and renal arteries for control of uncontrolled hypertension, pulmonary oedema or left ventricular (LV) dysfunction caused by Takayasu's arteritis, in active or inactive stage

Material and methods: Informed written consent was obtained. Activity was assessed by measurement of ESR, C-reactive protein and carotid intimal-medial thickness. Active disease was treated by medical therapy prior to endovascular treatment, except in pulmonary oedema or LV dysfunction, when PTA was performed irrespective of clinical activity. PTA was done by femoral, brachial, carotid or trans-septal route using previously reported technique. Paired t-test was used to evaluate outcomes.

Results: 126 patients (66 females, mean age, 11 years) underwent PTA, for aorta in 54 and renal artery in 72 (bilateral in 6) and in both locations in five patients. Technical success was achieved in 116 patients, without complication. Clinical success was achieved in 112 at 1 month; ejection fraction improved from 23+8% to 52+9% ($p<0.001$) and blood pressure from 178+22/ 102+6 mm Hg to 138+20/ 86+8 mm Hg ($p<0.01$). Clinical improvement was seen irrespective of disease activity (active disease in 54).

Conclusion: PTA is safe and effective in control of uncontrolled hypertension, pulmonary edema and LV dysfunction in the immediate term, irrespective of disease activity.

P-2

Endovascular balloon aortic occlusion - does it have a role within the emergency departments of a geographically spread trauma network?

A. Eccles¹, P.E. Jenkins¹, T. Nutbeam²

¹Radiology, Peninsula Radiology Academy, Plymouth, UK, ²Emergency Department, Derriford Hospital, Plymouth, UK

Purpose: Resuscitative Endovascular balloon aortic occlusion (REBOA) is an endovascular technique which temporarily occludes the aorta providing haemorrhagic control. Its primary indication is trauma resuscitation in patients with non-compressible torso haemorrhage (NCTH)¹. NCTH has a significant mortality of approximately 45%².

The Peninsula trauma has challenges with pre-hospital care due to its large geographic area. We aim to identify patients who have presented to the emergency department (ED) with NCTH within the Peninsula that may have benefitted from REBOA being available within the resuscitation room.

Material and methods: Trauma and Audit Research Network database identified severely injured patients attending ED between September 2013-September 2017.

Patient demographics, traumatic mechanism, management including timings and outcomes were collated. Injury codes were reviewed to exclude non-NCTH with the remaining patients imaging reviewed.

Results: Over 4-years 580 patients attended severely injured. Review of trauma codes and CT imaging identified 92 adult patients had injuries appropriate for REBOA.

This cohort had a Median age 42 (Range 16- 93) and a median Injury Severity Score of 32 (Range 5-75). 55 of 92 (60%) presented to the MTC with 25% of all presentations via helicopter. 59 patients would have benefited from REBOA location 1 and 33 for location 3. 40 out of 86 cases in which presentation time was recorded, presented between 0800 and 1800.

Conclusion: The analysis shows a small patient population of young, severely injured patients with NCTH who could benefit from REBOA within ED. This patient population present infrequently and in order to maintain competence the group inserting the device would need to be small, with transferrable competence.

P-3

Endovascular treatment of traumatic blunt aortic injury: a single center experience

J.H. Won, J.M. Lee, Y. Kwon, J. Kim

Department of Radiology, Ajou University Hospital, Suwon, KR

Purpose: This study aims to address the utility of TEVAR in traumatic blunt aortic injury (TBAI).

Material and methods: The retrospective analysis was conducted in this single center study of consecutive patients presenting with TBAI. We reviewed thirty-four consecutive patients treated for TBAI from October 2014 to December 2018, and used the TBAI classification to classified them into four grades based on their CT findings. Treatment modalities were categorized as non-operative management (NOM), TEVAR, and surgical repair (OR). Medical records and follow-up imaging acquired 1 and 3 month after the procedure were reviewed.

Results: A total of forty-two patients were diagnosed with TBAI. Locations of involvement were as follows: ascending in 3 patients (7%), arch in 2 (4%), isthmus in 24 (57%) and descending in 11 (26%). Thirty-five patients (83.3%) were classified above BAI grade two. The number of patients for each BAI grade were 7, 11, 15, and 9, respectively. Overall mortality was 21% (9/42), while the mortality directly related to TBAI was 10% (4/37). Nineteen patients (45.2%) underwent TEVAR for TBAI, among which the number of patients per grade was 0, 2, 10, and 7, respectively. Mortality for the TEVAR group was 0%, while it was 17% for the NOM group and 40% for the OR group. There were two major complications, type Ia endoleaks.

Conclusion: Our results suggest the safety and efficacy of TEVAR for all grades of TBAI. Additional prospective studies and longitudinal follow up are needed to confirm its long-term effectiveness.

P-4

Evaluation of complementary endovascular procedures for the treatment of progressive aortic dissections

P. Revel-Mouroz, A. Petermann, M. Jaffro, P. Otal, H. Rousseau

Radiology, CHU Rangueil, Toulouse, FR

Purpose: In some cases of chronic aortic dissection (AD), conventional treatments are insufficient to provide an effective aortic repair. The aim of this study was to evaluate complementary endovascular procedures in progressive AD.

Material and methods: Between August 2005 and December 2017, 35 consecutive patients were treated for aneurysmal expansion, aortic rupture or malperfusion syndrome. Sixteen patients (45.7%) presented an initial type A AD treated by conventional aortic surgery, and 19 (54.3%) presented an initial type B AD, treated by conventional TEVAR when complicated. Aortic remodeling was evaluated on the preprocedural and on the most recent computed tomography angiography follow-up for each patient.

Results: At a median follow-up time of 60,7 months [44,4-76,8], 59 ancillary endovascular procedures were performed. At the end of the follow-up, thoraco- abdominal transaortic diameters were reduced or stable (<5 mm increase) in 21 patients (60,0%) and 9 patients (25,7%) experienced complete thoraco-abdominal false lumen thrombosis. The mean total false lumen thrombosis score before the first ancillary procedure was 0,97 (+/-0,90) vs. 2,54 (+/-0,98) at the end of the follow-up, $p<0,0001$. One patient died of a retrograde dissection, 2 days after a proximal aortic stent graft extension.

Conclusion: Complementary endovascular procedures seem to be effective and safe to promote aortic remodeling in progressive chronic AD.

P-5

Efficacy and safety of different prosthesis aortic valve replacement in patients with aortic stenosis: a systematic review and meta-analysis

S. Salahia¹, M. Riffai¹, M. Shehata², A.S. Hassaballa³

¹Faculty of Medicine, Ain Shams University, Alain, AE, ²Faculty of Medicine, Zagazig University, Alain, EG, ³Cardiothoracic Institute, Ain Shams University, Alain, EG

Purpose: The aim of this systematic review and Meta-analysis was to assess the efficacy and safety while comparing variable prostheses after aortic valve replacement.

Material and methods: We searched PubMed, MEDLINE in Process, Scopus and Web of Science (previously ISI) for relevant studies, published up to January 2018. We included randomized controlled trials (RCTs) that compared different types of prostheses valves. Data were pooled as odds ratios (OR) or mean differences (MD) with their 95% confidence intervals (CI) between compared groups in a random meta-analysis model. Subgroup and sensitivity analysis were conducted. We assessed heterogeneity by a Chi square test and I2 statistic.

Results: Regarding efficacy outcomes, transvalvular mean gradient at 1 year was significantly lower in Cryolife O'Brien than Toronto (MD= -4.50 mmhg, 95% CI [-6.64, -2.36]), lower in Edwards Perimount Magna (EPM) than Medtronic Mosaic (MM) (MD= -6.42 mmhg, 95% CI [-8.11, -4.72]), and lower in ROSS than MIRA (MD= -6.70 mmhg, 95% CI [-8.38, -5.02]). Regarding safety outcomes, CarboMedics was associated with significantly higher cardiac valve not related deaths (OR= 2.04, 95% CI [1.04, 3.97]), higher early mortality (OR= 2.72, 95% CI [1.18, 6.32]), and lower hemorrhage (OR= 0.41, 95% CI [0.17, 0.98]) compared to St. Jude Medical.

Conclusion: Our findings showed that Cryolife O'Brien had lower transvalvular mean gradient at 1 year than Toronto. CM had higher early mortality, cardiac valve not related deaths, and lower haemorrhage than SJM.

P-6

Post-market surveillance study of the technical success of Zenith Alpha™ abdominal endovascular graft

D. Joshi, Y. Gupta, B. Ganai

Radiology, Brighton and Sussex University Hospitals NHS Trust, Brighton, UK

Purpose: The 2nd generation Zenith abdominal stent-graft has been very successful in the treatment of infrarenal AAA. However, its delivery system has a larger profile and a troublesome top cap. Zenith Alpha abdominal stent graft (3rd generation) has a lower profile and it is designed without a top cap. Currently, there is no post-market surveillance study to assess its effectiveness in a clinical setting. The aim of this audit is to determine its technical success in the treatment of infra-renal abdominal aortic aneurysm.

Material and methods: Retrospective analysis of a prospectively collected data was performed in 100 consecutive patients who underwent standard infrarenal EVAR in a single institution. The patient selection and the procedure technique was strictly based on the instructions for use. Technical success was defined as greater than 97.7% successful access of the aneurysm site and placement of the Zenith Alpha abdominal Endovascular Graft in the desired location. The endovascular graft must be patent and there should be no type-1 or type-3 endoleak at the time of positioning in greater than 97.7% of the patients.

Results:

1. There was 100% success in accessing the aneurysm site and placement of the graft in the desired location.
2. Type-1a endoleak occurred in 7 (7%) patients. However, all of them were rectified (6 with Palmaz stent and 1 with cuff extension).
3. There were no type-3 endoleaks and none of the patients required a surgical conversion.

Conclusion: The post-market surveillance study determined the Zenith Alpha™ Abdominal Endovascular Graft deployment to be technically successful.

P-7

Interventional angiography damage control

N. Vasinotis Kamarinos¹, S. Spiliopoulos², L. Reppas¹, K. Palialexis², E. Brountzos¹

¹2nd Department of Radiology, ATTIKON University General Hospital, Athens, GR, ²2nd Department of Radiology, Interventional Radiology Unit, ATTIKON University General Hospital, Athens, GR

Learning objectives: The management of vascular trauma has changed dramatically over the last decade. This poster aims to highlight the role of interventional angiography in modern trauma care.

Background: Trauma is the leading cause of death in people under 40 and the third cause of death in all age groups. Traumatic vascular injuries caused by high-velocity weapons, stab wounds and blunt trauma, can lead to hemorrhagic shock and fatal exsanguination. Traditionally, hemodynamically unstable patients with vascular lesions have been taken straight to the operating room.

Clinical Findings/Procedure Details: Today, hemodynamically unstable patients receive endovascular treatment in the angiography suite, especially in cases in which surgery entails a high mortality risk. The evolution of endovascular technology has brought innovative strategies to manage complex vascular injuries by temporizing or providing definitive therapeutic intervention. Transarterial embolization, stent graft deployment, and balloon occlusion can expeditiously control bleeding and prevent exsanguination in a patient in extremis. These minimally invasive methods avoid the additional physiological stress of the traditional surgical approach and can be performed under moderate sedation. Trauma centers are increasingly endorsing a multidisciplinary approach to trauma care that involves surgeons and interventional radiologists. Operating rooms with imaging devices and endovascular equipment are implemented across the world, and severely ill patients can be treated at the same time that resuscitation and trauma evaluation takes place.

Conclusion: Non-operative management of vascular injury is possible by means of interventional angiography, avoiding the risks of open surgery. This poster will describe the treatment algorithms, available toolkit, and techniques for vascular trauma.

P-8

Use of a balloon-expandable sheath for transfemoral complex endovascular aortic repair

C.L. Furlough

Department of Surgery, Northwestern University, Chicago, IL, US

WITHDRAWN

P-9

What could possibly go wrong? Imaging findings of non-endoleak EVAR complications and their management

A. Eccles, P.E. Jenkins, N.F. Gafoor

Radiology, Peninsula Radiology Academy, Plymouth, UK

Learning objectives:

1. Appreciate the importance of recognising potential nonendoleak related EVAR complications on imaging modalities.
2. Appreciate the possible endovascular and non endovascular management options available to treat complications.
3. Recognise the radiological appearances of subsequent treatments for complications.

Background: Aortic aneurysm continues to be an important source of morbidity and mortality, with a prehospital mortality of ruptured abdominal aortic aneurysm of 50%. Endovascular aortic aneurysm repair (EVAR) is a percutaneous technique to treat unruptured and ruptured abdominal aortic aneurysms. With its increasing use, complications are becoming more widely seen. Appreciation of endoleaks and treatment options is well established, however other complications are less well recognised and understood by trainees. An understanding of the appearances of non endoleak complications and their management is essential for both interventional and general radiologists.

Clinical Findings/Procedure Details: We present a pictorial review of complications and their subsequent management encountered in our practice. In our institution patients undergo follow up CT angiogram at 6 weeks and 1 year post EVAR with subsequent yearly ultrasound followup or imaging triggered by patient symptomatology. Complications can include groin related complications, access vessel related complications, infection, thoracic aortic dissection flap, pseudoaneurysm formation, end organ ischaemia, limb thrombosis and aorto-enteric fistula.

Conclusion: This poster reviews the non endoleak EVAR complications encountered within our unit demonstrated on post-operative imaging. These patients may present through general oncology, in centres that do not perform EVAR. Trainees must be aware of the appearances of non endoleak EVAR complications and have an awareness of the treatments to appropriately direct patient management.

P-10

Complex endovascular interventions of the abdominal aorta

M. Hadi¹, S. Anthony², D. Howard³, R. Patel¹, J. Perkins⁴, E. Sideso⁴, R. Uberoi⁵

¹Interventional Radiology, John Radcliffe Hospital, Oxford, UK, ²Interventional Radiology, Oxford University Hospitals Trust, Oxford, UK, ³Vascular Surgery, Oxford University Hospitals Trust, Oxford, UK, ⁴Vascular Surgery, John Radcliffe Hospital, Oxford, UK, ⁵Radiology, John Radcliffe Hospital, Oxford, UK

Learning objectives:

1. To understand the anatomical constraints of endovascular abdominal aortic repair (EVAR).
2. Become familiar with the different types of stent-grafts and their application in EVAR with unfavourable anatomy.

Background: Three decades on, EVAR for aortic pathologies has evolved to include more complex anatomies. New devices have been developed to overcome anatomical limitation, in particular, short and angulated necks. Devices with smaller profile and more flexibility allow better maneuverability during delivery. Percutaneous access demonstrates high success rate, shorter operation time, shorter length of stay, and fewer wound complications. There is a range of options for juxtarenal aneurysm repair including custom-made fenestrated devices, and in emergency situations, off-the-shelf fenestrated devices and parallel graft techniques. Endovascular thoracoabdominal aortic aneurysm repair with fenestrated and branched stent grafts have also established its role with excellent short-term results and promising long-term durability.

Clinical Findings/Procedure Details: We present a series of complex aortic pathologies that have undergone endovascular repair in our institution with emphasis on pitfalls and lessons learned. The cases include juxtarenal, thoracoabdominal, and infrarenal aortic aneurysms with hostile neck anatomy. We report our experience with custom made fenestrated versus parallel stent-grafts, as well as our early experience with conformable devices and EndoAnchors.

Conclusion: Endovascular management of complex abdominal aortic pathologies has become more common and is likely to increase with an ageing population who are likely to be poor candidates for open repair. This is aided by ongoing technical development, introduction of new devices, and the continuing success of experienced operators performing procedures outside the instruction for use recommendation.

P-11

Segmental artery coil embolization for arteriogenic preconditioning of the spinal cord network before thoracoabdominal aortic aneurysm repair: our early experience

A. Sidhu, T.Y. Chan, S. Mafeld, G. Annamalai, K.T. Tan

Joint Department of Medical Imaging, University of Toronto, University Health Network, Toronto, ON, CA

Learning objectives:

1. Increase awareness of SACE as safe and feasible with aim to reduce risk of post-EVAR spinal ischemia.
2. Increase knowledge of preprocedural steps to optimize success:
 - 1) Stop anti-hypertensive meds 3d prior to procedure.
 - 2) Obtain CTA for planning of target vessel embolization likely to be covered by EVAR.
 - 3) Perform SACE on inpatient basis to monitor neurologic status.

Background: Segmental artery coil embolization (SACE) for arteriogenic spinal cord precondition before thoracoabdominal aortic aneurysm (TAAA) repair has been recently described (1,2) and adopted at our institution. We share our early experience in 3 cases occurring between Mar 1-Sept 30, 2018 prior to elective EVAR. Preoperative CTA performed. Anti-hypertensive held 3d before. Patients admitted to monitor neurologic status.

Clinical Findings/Procedure Details: Case 1: 79 YOM with type 2 TAAA measuring 7.5 cm. Had 1-vessel SACE using microcoils. Discharged POD#1. EVAR with spinal drain done 4 wks later. Discharged POD#4. No neurologic sequelae on clinic visit 31 days(d) later.

Case 2: 71 YOM with history of type B dissection post TEVAR in 2011, presents with sac expansion. 2-vessel SACE done using microcoils. First stage EVAR with spinal drain performed 6d later, with 2nd stage 2-vessel branch repair 27d later. Postop transient AKI needing temporary dialysis. Discharged POD#25. No neurologic sequelae.

Case 3: 65 YOM with history of PAD, HTN and type 4 TAAA. Six-vessel SACE using microcoils. 4-vessel EVAR with spinal drain done 15d later. Discharged POD#7. No neurologic sequelae on 45d clinic visit.

Conclusion: SACE before EVAR appears safe in our early experience of minimizing risk of spinal cord ischemia.

P-12

Traumatic aortic injury and major PE

N.A. Alghareem¹, E.M. Alsaed²

¹Radiology Department, King Khalid Hospital, Najran, SA, ²Rehabilitation Department, King Khalid Hospital, Najran, SA

Clinical History/Pre-treatment Imaging: 28 Years old bomb blast injury victim with aortic injury, spinal injury and other scattered injuries treated in a local hospital and was referred to my hospital for aortic pseudoaneurysm management.

Upon receiving the patient in our ER he was deteriorating, O2 demand increases, became more hypoxic and restless. CT was done and confirmed the descending thoracic aorta pseudoaneurysm and Pulmonary embolism

(PE). Thereafter the patient was shifted to ICU where he got arrested and coded. CPR was done for 2 minutes and he revived.

Treatment Options/Results: Thoracic endovascular aortic repair (TEVAR) was performed using bifemoral access with right common femoral artery as primary access and left CFA for the angiogram. The descending thoracic aorta pseudoaneurysm was stented by 26mm x 10cm TAG stent-graft. Proglide was used as closure devices.

Using Left CFV approach; pulmonary angiogram was done and confirm Left major PE and Rt lower lobar PE.

Using balloon fragmentation of the left pulmonary artery embolus was done and followed by thrombolysis using 6 I.U. of reteplase.

Post thrombolysis showed improved left pulmonary revascularization.

Discussion: Successful stenting of the descending thoracic aorta was achieved.

Successful revascularization of the left pulmonary artery was achieved. Venous pressure improved and oxygen saturation was improved.

The patient underwent an uneventful recovery after and extubated the second day and was discharged from ICU third day.

Take-home points: Aortic Stenting save patient for complicated surgeries. PE carry a high risk and its management in this special case carry a risk of bleeding from the stented aorta and from arterial access.

P-13

Subclavian artery recanalisation complicated by type B aortic dissection: a grating day in the IR suite

N.R. Patel¹, B. Pitrola¹, S. Rostampour¹, C.D. Bicknell², M.S. Hamady¹

¹Interventional Radiology, Imperial College Healthcare NHS Trust, London, UK, ²Department of Vascular Surgery, Imperial College London, London, UK

Clinical History/Pre-treatment Imaging: An 89-year-old male patient was admitted with embolic skin lesions in the left hand, a necrotic left index finger and left hand pain at rest. CT angiography confirmed occlusive thrombus at the origin of the left subclavian artery.

Treatment Options/Results: Access was gained via the right common femoral and left brachial arteries. The left vertebral artery was protected using a 4mm balloon catheter (Figure 1). The subclavian occlusion was transgressed retrogradely, snared and brought out through the right common femoral artery. This was subsequently exchanged for a stiff wire. An 8mm x 32mm balloon mounted covered stent was deployed. Towards the end of the procedure the patient complained of severe chest pain. CTA demonstrated type-B aortic dissection and active bleeding into the periaortic space (Figure 2).

A 31mm x 15cm Gore C-tag thoracic stent graft was deployed across the left subclavian artery and an Amplatzer plug was deployed within the left subclavian artery origin. The patient made a good recovery.

Discussion: On reflection, during the initial procedure, the stiff wire was at one point pulled bare against the aortic arch to obtain a longer length at the groin side. This created a "grating" phenomenon against the aortic wall which ultimately resulted in dissection.

Take-home points:

- Always keep stiff wires protected within a catheter at sites of vulnerability, e.g. aortic arch, particularly if using a through-and-through stiff wire platform.
- When stenting subclavian artery occlusions, temporarily occluding the vertebral artery will prevent embolic showering of the intracranial posterior circulation.

P-14

A novel approach for emergency hybrid repair of ruptured aortic pseudoaneurysm associated with aortic coarctation in a pregnant female

X. Pu¹, X. Huang¹, L. Huang²

¹Intervention Diagnosis and Therapy, Beijing Anzhen Hospital, Beijing, CN, ²Interventional Department, Beijing Anzhen Hospital, Capital Medical University, Beijing, CN

Clinical History/Pre-treatment Imaging: A 28-year-old female patient with 20-weeks pregnancy, presented with suddenly chest pain and dyspnea. She had a history of hypertension for 14+ years without treatment. The HR was 106/min, BP was 80/50mmHg in upper limbs, couldn't detected in lower extremities. Pelvis ultrasound confirmed intrauterine fetal death unfortunately. Aortic CT angiography demonstrated ruptured pseudoaneurysm in descending aorta associated with CoA, aortic hypoplasia, and left hemothorax.

Treatment Options/Results: A novel approach was performed. First, axillary-femoral bypass grafting at right side, then, 2 domestic PDA occluder devices (16/18mm) were placed at the proximal and distal of the ruptured segment, respectively. Post-operative angiography demonstrated ruptured segment was occluded successfully. Forward blood flow with sufficient volume was reviewed on abdominal aorta. The post-operative period and 1 year CTA follow-up showed a good result without any complications.

Discussion: Initially, emergency endovascular repair was planned. Because of severe aortic hypoplasia (4mm in femoral and 8mm in descending aorta), neither covered-stent graft nor covered CP stent could be implanted unfortunately. What worse, open repair was almost impracticable, because CPB couldn't establish due to arteries' diameter. So in this hybrid approach, PDA occluder was aim to occlude the ruptured segment, and the bypass was aim to ensure the visceral perfusion. Otherwise, if transcatheter occlusion failed, the bypass vessel could used to establish CPB for further open repair.

Take-home points: 1. Measure upper and lower limbs BP respectively in severe hypertension patient is the easy but key point to exclude aortic CoA in adult.

2. The treatment of CoA in adults is complicated sometimes.

P-15

How one stent turns into two and a half?

M. Gyánó, C. Csobay-Novák, B. Nemes

Heart and Vascular Center, Semmelweis University, Budapest, HU

Clinical History/Pre-treatment Imaging: 54-year-old patient with subclavian-steal-syndrome (SSS) was treated by stent implantation in the left subclavian artery origin. One year later she was presented with recurring symptoms. CT scan revealed a stent malposition; the piece being in the aorta was partially broken and in-stent-restenosis (ISR) was in both pieces.

Treatment Options/Results: The reintervention could be carried out only from the left brachial artery. First a balloon dilatation (PTA) was used on the subclavian part of the stent. During PTA the bent piece in the aorta was broken; drifted in the aortic bifurcation, and was pushed and dilated in the right common iliac artery. Due to extended ISR, a second stent was implanted to obtain the optimal lumen diameter.

Discussion: significant stenosis of the subclavian artery can be treated with interventional radiology methods. The stenosis can be approached from both femoral and brachial artery on the affected side. PTA of the stenosis may be sufficient, but balloon-expandable stent implantation required in heavily calcified lesions. When longer parts are affected self-expanding stent may be needed. Rarely the two methods needs to be combined, even to cover the origin of the vertebral artery.

Take-home points: It is not always necessary to implant a stent in SSS intervention. Malpositioned stent had higher ISR rate, so closer monitoring

needed. In case of reintervention when strut-fracture is known we prepare the migration of a stent fragment and to treat the complication immediately.

P-16

Percutaneous embolization of postoperative refractory bile leak with n-butyl cyanoacrylate

J.S. Shin

Radiology, Hallym University Dongtan Sacred Heart Hospital, Seoul, KR

Purpose: To assess the effectiveness and safety of percutaneous embolization with n-butyl cyanoacrylate (NBCA) for postoperative refractory bile leak

Material and methods: From January 2013 to December 2017, percutaneous embolization of postoperative refractory bile leak using NBCA was performed in 10 patients (M:F = 6:4; mean age, 61.7 years). Five patients underwent hepatic lobectomy, two patients underwent cholecystectomy, two patients underwent pancreatoduodenectomy, and one patient underwent liver transplantation. All patients had previously had the traditional non-surgical treatment for postoperative bile leak; percutaneous catheter drainage (PCD) of biloma and percutaneous transhepatic biliary drainage (PTBD). After cholangiography to confirm the site of bile leak, percutaneous embolization with NBCA was performed using microcatheter system through the PTBD route. In patients with combined biliary strictures, biliary balloon dilation was also performed.

Results: Technical success was achieved in all 10 patients. All bile leaks were initially closed immediately. However, one patient showed recurrent small bile leak 6 days later and underwent repeated NBCA embolization with successful result. Three patients showed biliary strictures and underwent biliary balloon dilation. The unintentional spillage of NBCA into the CBD was observed in two patients, which does not cause flow disturbance and ultimately clinically insignificant. There were no other procedure-related complications.

Conclusion: In the postoperative bile leak patients who failed treatment with PCD of biloma and PTBD, percutaneous embolization with NBCA is a safe and effective therapeutic method as a minimally invasive treatment alternative to surgery.

P-17

Percutaneous biliary tract biopsy using choledochoscopy

A. Leoncini¹, M. Maffei², J.C. van den Berg³, R.C. Balzarotti Canger⁴, S. Cappio⁵

¹Diagnostic and Interventional Radiology, Ospedale Regionale di Lugano, Lugano, CH, ²Gastroenterologia, Ospedale Regionale di Lugano, Lugano, CH, ³Interventional Radiology, Ospedale Regionale di Lugano, sede Civico, Lugano, CH, ⁴Chirurgia Generale, Ospedale Regionale di Lugano, Lugano, CH, ⁵Radiologia, Ospedale Regionale di Lugano, Lugano, CH

Purpose: To evaluate the use and diagnostic yield of percutaneous choledochoscopic biopsy in patients with positive imaging findings for tumoral lesions in the biliary ducts and a negative endoluminal forceps biopsy.

Material and methods: Over a 2-year period, 5 consecutive patients (4 women, 1 man; mean age 70, range 68-81 years) underwent percutaneous choledochoscopy in general anesthesia using the 'Spyglass' (Boston Scientific, Marlborough, USA) after obtaining standard percutaneous biliary access using an 11F sheath. All the patients had a negative endoluminal forceps biopsy. The choledochoscope uses HD view-technology. During the procedure the lesion was localized visually and a biopsy was performed at the level where pathologic tissue was seen. This technique allows direct examination of the biliary ducts (as opposed to the indirect visualization of radiologically guided biopsy). The procedures were performed by a team consisting of interventional radiologists, a gastroenterologist and a hepato-pancreatic surgeon.

Results: In all 5 patients a definitive diagnosis was obtained. Four patients had neoplastic disease, while 1 patient was diagnosed with chronic inflammatory disease and cholesterol apposition in a previously placed stent. Fluoroscopy mean time was 12.27 minutes (range 8'-25'). No periprocedural complications were seen.

Conclusion: Percutaneous choledoscopic biopsy is feasible and safe in patients with an uncertain diagnosis of biliary disease and can help avoiding unnecessary major surgery in this patient population.

P-18

A feasibility study of percutaneous transhepatic gall bladder filling (PTGBF) in a swine model

Y. Ogawa¹, M. Kubota², A. Kotoku¹, T. Iraha³, S. Wada¹, K. Hashimoto⁴, S. Hamaguchi⁴, M. Takagi², H. Mimura⁵

¹Radiology, St. Marianna University School of Medicine, Kawasaki, Kanagawa, JP, ²Pathology, St. Marianna University School of Medicine, Kawasaki, Kanagawa, JP, ³Radiology, Okinawa Prefectural Chubu Hospital, Urumashi, JP, ⁴Radiology, St. Marianna University of Medicine, Kawasaki, JP, ⁵Department of Radiology, Kawasaki Hospital, Kawasaki Medical School, Okayama, JP

Purpose: Treatment of acute cholecystitis includes cholecystectomy or percutaneous drainage, but some patients have a high risk for operation and prolonged drainage may decrease their quality of life. The purpose of this study is to investigate the feasibility of percutaneous transhepatic gall bladder filling (PTGBF) with n-butyl-cyanoacrylate (NBCA) in a swine model.

Material and methods: This procedure was performed under general anesthesia. A swine (49kg) underwent percutaneous transhepatic gall bladder puncture using 20G-PTCD needle under ultrasound guidance. 2.1F-microcatheter was inserted through the outer needle of PTCD needle and then cystic duct was coil embolized. After embolization, the microcatheter was removed and gall bladder was filled with 25% NBCA (5ml). The PTCD needle was removed. The swine underwent blood test and CT examination immediately after the procedure and 7 days later, and then gall bladder was evaluated microscopically.

Results: No apparent complications were encountered during the procedure. Vital signs were stable during follow up. CT showed gall bladder filling with NBCA without obvious complications. Hepatobiliary enzyme was not significantly elevated. Microscopically, H-E stain demonstrated partial necrosis of the mucosa and the muscle layer was intact.

Conclusion: This technique would be a feasible, but further studies are needed to conduct safety and long-term efficacy.

P-19

Comparative analysis of antegrade side-by-side stenting and Y-stenting in patients with unresectable malignant biliary hilar obstruction

S.S. Lebedev¹, G. Chechenin²

¹Surgery, Russian Medical Academy of Postgraduate education, Moscow, RU, ²Department of Surgery, The State Budget Educational Center of Postgraduate Education «Russian Medical Academy of Postgraduate Education of Roszdrav», Municipal Clinical Hospital named by S. P. Botkin, Moscow, RU

Purpose: There is no clear information in the literature about which method of bilobar stenting is preferred

Material and methods: In Botkin Hospital (Moscow) from 2008 to 2018 performed bilateral biliary stenting in 43 patients with unresectable malignant biliary hilar obstruction. The patients were divided into 2 statistically homogeneous groups: 28 side-by-side stenting (G1) and 15 Y-stenting (G2). Characteristics of patients: age G1 71.2 ± 5.1 years, G2 74.3 ± 5.5 years; sex (m / f) G1 18/10, G2 9/6; G1 Bismuth IIIa / IIIb 17/11, G2 Bismuth IIIa / IIIb 11/4; average bilirubin G1 284 ± 8.2 μmol / l, G2 311 ± 7.4 μmol / l

Results: Technical success was 100%. Clinical success G1 26 (92.8%) and G2 13 (86.7%) ($p = 0.043$). 19 patients from the G1 and 10 patients from the G2 died from the progression. Survival median: G1 (12 patients - 50 days, 7 patients - 100 days, 9 patients are alive at the time of writing the results of the study); G2 (7 patients - 50 days, 4 patients - 100 days, 4 patients are alive at the time of writing the study results). 6 (21.4%) patients from G1 and 4 (26.7%) patients from G2 showed stent dysfunction ($p = 0.041$). The average period of functioning of the stents in G1 was 78 ± 4.5 days, and in G2 - 63 ± 4.8 days ($p = 0.036$).

Conclusion: On the basis of the obtained results, it is recommended to use bilobar stenting using the side-by-side method.

P-20

Percutaneous biliary derivation in cholangitis secondary to perihilar cholangiocarcinoma: should it be the second approach?

R. García Buen-Abad¹, I.E. Casanova Sanchez¹, M. Guerrero Hernandez¹, A.J. Vázquez Mézquita², B. Riveros Gilardi¹

¹Radiology, Instituto Nacional de Ciencias Médicas y Nutrición Salvador Zubiran, Mexico City, MX, ²Radiology & Molecular Imaging, The American British Cowdray Medical Center, Mexico City, MX

Purpose: There is scarce evidence to support endoscopic biliary drainage (EBD) as superior to percutaneous biliary drainage (PBD) for patients with cholangitis secondary to perihilar cholangiocarcinoma. This study pretends to establish the therapeutic success and early complications of PBD and compare it to EBD, in such particular and critical scenario.

Material and methods: Consecutive patients from January 2016 through October 2018 ($n = 32$) with perihilar cholangiocarcinoma and acute cholangitis managed with EBD or PBD were detected, followed by a retrospective review of their clinical histories. The primary outcome was the therapeutic success, defined as resolution of cholangitis followed by hospital discharge within the first 28 days after the first successful biliary drainage, early complications were studied.

Results: PBD was the first approach for biliary drainage in 17 patients, and EBD in 15 patients. Technical success was 100% in PBD and 93.3% (1 failure) in EBD. Therapeutic success was significantly lower in EBD than in PBD (26.7% vs 70.6%; $p = 0.015$). There were 6 cases of early mortality (within 30 days of procedure), 4 in the PBD group and 2 in the EBD group (26.7% and 11.8% respectively; $p = 0.28$). Regarding early complications, ranging from refractory cholangitis to hemorrhage, 10 patients in the PBD group presented one or more of them, and 13 in the EBD group (68.8% and 86.7%; $p = 0.085$).

Conclusion: PBD for the management of cholangitis in patients with perihilar cholangiocarcinoma offers higher rate of therapeutic success than EBD, thus it should be considered as the first method for biliary drainage.

P-21

Radiation exposure in percutaneous transhepatic biliary drainage (PTBD): comparison between right and left approach

C. Gozzo¹, D.G. Castiglione¹, M.C. Calcagno², C. Desiderio², P.V. Foti², S. Palmucci², A. Basile²

¹Di.Bi.Bi.Med., AUOP P. Giaccone, Palermo, IT, ²U.O. Radiodiagnostica e Radioterapia, University of Catania, Catania, IT

Purpose: PTBD is an interventional procedure performed for malignant/benignant biliary obstruction under fluoroscopy or combined ultrasound/fluoroscopic guidance. Therefore, radiation protection for physicians and patients is an important issue. The choice of the side of PTBD approach is debated. The aim of our study was to verify the difference between right and left approach in terms of operator and patient exposure.

Material and methods: From March 2018 to September 2018, 20 patients with obstructive jaundice were randomized to undergo right or left access. Complete dilatation of biliary tree was an inclusion criteria in order to make both access feasible. During the procedure APD-Mk2 dosimeters positioned at neck height allowed us to read operator exposure values

(Hp(10)). We collected data of fluoroscopy time and DAP for evaluate patient exposure. We used two-tailed Ttest for statistical analysis.

Results: PTBD were performed through right access in 10 cases (GroupA) and through left access (GroupB) in other 10 cases. "GroupA" showed lower operator radiation dose compared to "GroupB" with a statistically significant difference ($p < 0.05$). As regard patient exposure, we observed no significant difference between two groups, in terms of fluoroscopy time and DAP. GroupA showed better postprocedure QoL.

Conclusion: Both right and left access are similar in terms of technical success and resolution of jaundice. Considering the major physician's radiation exposure and lower patient's compliance in the right approach, we warmly suggest to mind that in cases of feasibility of both access, it could not be the same for physician, in terms of radiation exposure, and for patient, considering QoL.

P-22

Clinical outcomes in patients who had delayed cholecystectomy or percutaneous biliary endoscopy following percutaneous cholecystostomy for acute cholecystitis: ten-year, single-center retrospective review

B.J. Amos¹, R. Artrip², A. Burdette³

¹Department of Radiology, Penn State Health, Hershey Medical Center, Hershey, PA, US, ²College of Medicine, Penn State, Hershey, PA, US, ³Division of Cardiovascular & Interventional Radiology, Penn State Health, Hershey Medical Center, Hershey, PA, US

Purpose: Compare clinical outcomes in patients who had delayed cholecystectomy (DC) or percutaneous biliary endoscopy (PBE) as secondary intervention following percutaneous cholecystostomy (PC) for acute cholecystitis.

Material and methods: PC placements for acute cholecystitis from January 2008 to January 2017 were retrospectively reviewed. 234 patients had PC with a minimum 30-day follow-up. Median follow-up was 359-days. Patients were divided into three groups: patients who had DC (group I, $n = 74$), PBE (group II, $n = 26$), or no secondary intervention (group III, $n = 134$). Mortality rates, tube-independence rates, major complication rates, demographics, and clinical characteristics including American Society of Anesthesiologists Class (ASA-Class) were compared for statistical significance.

Results: Demographics and clinical characteristics were not significantly different between groups I and II. Mortality rates, median times-to-death, overall tube-independence rates, and major complication rates were not significantly different between groups I and II. Median times-to-tube-independence were significantly longer in groups II and III compared to group I (group I: 62-days, II: 241-days, III: 107-days; $p < 0.05$). Group III had a significantly higher percentage of ASA-Class 4 and 5 patients at last follow-up, higher mortality rates at 30, 180, and 365-days, shorter median time-to-death, lower tube-independence rates, and higher major complication rates compared to groups I and II.

Conclusion: Clinical outcomes were similar between the delayed cholecystectomy and percutaneous biliary endoscopy groups following percutaneous cholecystostomy, and were significantly better than the group with no secondary intervention. Patients who underwent percutaneous biliary endoscopy experienced a significantly longer time-to-tube-independence compared to delayed cholecystectomy.

P-23

Percutaneous transpapillary placement of biliary metallic stent in patients with malignant extrahepatic biliary obstruction: outcomes of double bare stent versus PTFE-covered stent

H.H. Chu, C. Park, J.Y. Kim, M. Park, J. Hur, J.W. Kim, J.H. Kim, J.H. Shin, D.I. Gwon

Radiology, Asan Medical Center, Seoul, KR

Purpose: To investigate the outcomes of percutaneous transpapillary placement of biliary metallic stent in patients with malignant extrahepatic biliary obstruction and to compare the outcomes of uncovered double bare stent and PTFE (polytetrafluoroethylene)-covered stent

Material and methods: From April 2015 to December 2018, 83 patients (50 men, 33 women; mean age, 64.3 years; age range, 36-89 years) with malignant extrahepatic biliary obstruction were enrolled in this retrospective study. All patients underwent percutaneous transpapillary stent placement: uncovered double bare stent placement in 40 patients, PTFE-covered stent placement in 43 patients.

Results: There was no significant differences in technical success ($p > .999$), successful internal drainage ($p = .473$), complications ($p = .217$), patient survival ($p = .107$), and stent patency ($p = .103$). Overall patient survival were 90 days in double bare stent group and 219 days in covered stent group, respectively. Stent occlusion occurred in seven patients (20%) at a mean of 114 days in double bare stent group (food reflux [$n=5$] and tumor ingrowth [$n=2$]) and in 16 patients (41%) at a mean of 170 days in covered stent group (food reflux [$n=8$], tumor overgrowth [$n=5$], stent migration [$n=1$], blood clot [$n=1$], and stent collapse due to subsequent duodenal stenting [$n=1$]) ($p = .153$). Median stent patency were 74 days in double bare stent group and 135 days in covered stent group, respectively.

Conclusion: Percutaneous transpapillary placement of biliary metallic stent seems to be effective and safe in patients with malignant extrahepatic biliary obstruction. Stent type may not significantly affect technical and clinical outcomes.

P-24

Comparison of TROcar versus SELdinger technique for percutaneous cholecystostomy: the multicenter TROSELC study

D. Konstantopoulos¹, L. Reppas², N. Arkoudis¹, M. Theofanis³, S. Spiliopoulos¹, P.M. Kitrou³, D. Fillipiadis⁴, K.N. Katsanos³, K. Palialexis¹, A.D. Kelekis⁴, D. Karnabatidis⁵, E. Brountzos²
¹2nd Department of Radiology, Interventional Radiology Unit, Attikon University General Hospital, Athens, GR, ²2nd Department of Radiology, ATTIKON University General Hospital, Athens, GR, ³Interventional Radiology, Patras University Hospital, Patras, GR, ⁴2nd Department of Radiology, National and Kapodistrian University of Athens, ATTIKON University General Hospital, Athens, GR, ⁵Department of Diagnostic and Interventional Radiology, Rion University Hospital, Patras, Patras, GR

Purpose: To compare bed-side ultrasound (US)-guided, Trocar versus US/fluoroscopy-guided, Seldinger, percutaneous cholecystostomy (PC).

Material and methods: This is a two-center, prospective, controlled, non-inferiority study, comparing bed-side US-guided, Trocar PC (group T; 53 patients, mean age: 74.31±16.19 years, male: 28) versus US/fluoroscopy-guided, Seldinger PC (group S; 52 patients, mean age: 79.92±13.38, male: 26) in consecutive patients undergoing PC in two large tertiary University Hospitals. Primary endpoints were technical success, and procedure-related complications rates. Secondary endpoints included procedural duration, peri-procedural pain assessment and clinical success at 3 months follow up.

Results: PC was successfully performed in all 105 patients (100%). Clinical success was similar between the two study groups (86.8% group T vs. 76.9% group S; $p=0.09$). Significantly more procedure-related complications were noted in group S compared to group T (11.5% vs. 1.9%; $p=0.02$). In group S, bile leak was 7.7%, abscess formation 1.9% and gallbladder rupture 1.9%. No procedure-related death was noted. Minor bleeding

occurred in one patient (1.9%) in group T, which auto-resolved. Pain score during the procedure was significantly lower in group S (3.2 ± 1.77 vs. 4.76 ± 2.17 ; $p=0.01$). At 12 hours, pain score was significantly lower for patients in group T (0.78 ± 1 vs. 3.12 ± 1.36 ; $p=0.0001$). Mean procedural time was significantly lower in group T (1.77 ± 1.62 min vs. 4.88 ± 2.68 min group S; $p<0.0001$).

Conclusion: In this study, bed-side, US-guided, Trocar PC, was equally effective, required less procedural time and resulted in less procedure-related complications and decreased post-procedural pain, compared to fluoroscopically-guided PC with the Seldinger technique.

P-25

Is leaving a safety drain post percutaneous biliary stenting necessary? A retrospective analysis

F. Alabdulghani, C. Farrelly, S. Brennan, A. Stirling
 Radiology, Mater Misericordiae University Hospital, Dublin, IE

Purpose: The purpose of this study is to compare patient outcomes with and without placement of a safety drain.

Material and methods: A retrospective analysis was performed by searching for all patients who had percutaneous bile duct stenting in 8 years. This resulted in two cohorts, one in which a safety drain was placed and the other without. Patient outcomes were evaluated in terms of minor and major complications, lab tests, and requirement for re-intervention.

Results: A total of 6 complications were observed in 4 cases. There was no significant correlation between primary or staged/secondary stenting and the complication rate ($p = 0.995$) and no significant correlation between placement of a covering biliary drain post procedure and the complication rate ($p = 0.432$). Sub-group analyses revealed no statistical relationship between cases of stent occlusion and covering drain placement ($\chi^2=0.975$, $p = 0.807$). 1 of 31 metallic stents occluded compared to 2 of 8 plastic stents but correlation between stent occlusion and type of stent ($\chi^2=4.077$, $p = 0.106$) was not statistically significant. All cases of stent occlusion occurred in patients with perihilar or proximal common bile duct (CBD) obstruction. Association between overall occurrence of complications and level of obstruction ($p = 0.123$) did not reach statistical significance.

Conclusion: In patients with distal CBD obstruction it is not necessary to place a safety external drain after percutaneous biliary stenting. Further studies are warranted to evaluate if patients with central or peri-hilar tumours and patients with percutaneously placed plastic biliary stents would benefit from placement of a safety external biliary drain.

P-26

Cystic duct stenting

A. Hussain¹, T. Fotheringham¹, M.R. Akhtar², I. Renfrew³
¹Interventional Radiology, The Royal London Hospital, London, UK, ²Diagnostic Imaging Department, BartsHealth NHS Trust, The Royal London Hospital, London, UK, ³Radiology, Royal London Hospital (Barts NHS Trust), London, UK

Purpose: To assess technical success, complications and long term outcomes following percutaneous placement of a cystic duct stent, in patients deemed unfit for cholecystectomy.

Material and methods: Retrospective review of patients who had a cystic duct stent placed as part of their management for acute cholecystitis between July 2009 – Dec 2018. 16 patients who were deemed unfit for cholecystectomy after cholecystostomy were referred for a cystic duct stent. The cystic duct and common bile duct were crossed and a plastic JJ stent was placed from the gallbladder to the duodenum. Majority of our patients did not have any covering drains. Electronic review of patient records was undertaken to look for complications, deaths and rate of reintervention. Follow up period was for a mean of 454 days (Range 124 – 948).

Results: Technical success achieved in 15 patients (94%) with one failure. No major complications or deaths recorded in the first 30 days. There were a total of 5 unrelated deaths in the follow up period. The main complication of delayed stent migration was seen in 4 patients (25%), with further intervention required in 3 patients (19%) due to biliary obstruction. Two of the latter, were treated by placing another percutaneous stent and in the third patient the obstructing stent was removed endoscopically. The fourth patient passed the stent per rectum without causing any complications.

Conclusion: Cystic duct stenting is an effective technique for managing acute cholecystitis in patients too unfit for cholecystectomy. However, stent migration can occur and frequently requires further intervention.

P-27

Comparing outcomes of percutaneous cholecystostomy tube placement between patients within and outside of diagnostic criteria for acute cholecystitis

A. Lionberg¹, T.G. Tullius¹, T. Jiang², C. Okafor², T. Wassermann², T.G. Van Ha¹

¹Radiology, Section of Vascular and Interventional Radiology, University of Chicago Medicine, Chicago, IL, US, ²Pritzker School of Medicine, University of Chicago, Chicago, IL, US

Purpose: To compare outcomes following percutaneous cholecystostomy tube (PCT) placement between those who met official diagnostic criteria and those who did not.

Material and methods: Previous studies on PCT placement have compared outcomes for patients with calculous versus acalculous cholecystitis. However, diagnostic criteria outlined by the Tokyo Guidelines (updated in 2018) does not recognize this distinction in determining surgical management versus percutaneous drainage for treatment of acute cholecystitis (AC). We performed chart review to identify the presence or absence of Tokyo Guidelines criteria in 146 patients who underwent PCT placement between 2012 and 2015. Those who met criteria were compared to those who did not in terms of demographics, laboratory values, drain indwelling time, eventual surgical management, and 30-day mortality.

Results: 60 patients (41%) met diagnostic criteria for AC, while 86 did not (59%). Patients within diagnostic criteria were older (64.6y vs 59.8y [p=0.04]), had a shorter mean length of stay (12.2d vs 17.7d [p=0.04]), were more likely to have a positive gallbladder fluid culture (72.9% vs 36.6% [p=0.001]), and lower 30-day mortality (6.7% vs 25.6% [p=0.003]). There was no significant difference in terms of ICU requirement (38.3% vs 51.2% [p=0.12]), mean indwelling time (62.0d vs 59.1d [p=0.35]), eventual laparoscopic cholecystectomy (43.3% vs 29.1% [p=0.08]), or open cholecystectomy performed (16.7 vs 7.0%).

Conclusion: A significant portion of patients who undergo PCT placement are outside of Tokyo Guidelines criteria for acute cholecystitis. This group tends to be sicker with worse outcomes. Further research may be indicated to better define the indications for PCT placement in this group.

P-28

Percutaneous extraction of residual post-cholecystectomy gallstones through the T-tube tract

J. Sobstyl, M. Sojka, M. Kuczyńska, Ł. Światłowski, E. Kuklik, K. Pyra, T. Jargiełło

Department of Interventional Radiology and Neuroradiology, Medical University of Lublin, Lublin, PL

Purpose: In the present study, the effectiveness and safety of minimally invasive percutaneous extraction of residual post-cholecystectomy gallstones through the T-tube tract were assessed.

Material and methods: Between 2000 and 2015, 12 patients (seven women and five men, mean age 78 ± 8 years) after open cholecystectomy with common bile duct exploration and T-tube drainage underwent percutaneous extraction of residual gallstones through the T-tube tract.

Results: The intervention was successful in 92% (11/12). In seven patients complete extraction of the retained gallstones was achieved, and in four cases partial extraction combined with passage of small residual fragments to the duodenum was obtained. In one case the extraction attempt was ineffective. Mild haemobilia was observed in two patients. No mortality or major complications were observed.

Conclusion: Our findings are consistent with literature data and confirm that percutaneous extraction of residual post-cholecystectomy gallstones through the T-tube tract is an effective and safe treatment method. Although the presented technique is not a novel approach, it can be beneficial in patients unsuitable for open surgery or laparoscopic intervention when ERCP attempt occurs ineffective or there exist contraindications to ERCP.

P-29

Biliary complications and percutaneous radiological interventions in 436 pediatric patients with liver transplantation: single center experience

R. Kutlu¹, M.S. Buruk¹, S. Karatoprak¹, B. Işık², S. Yılmaz²

¹Radiology, Inonu University School of Medicine & Liver Transplantation Institute, Malatya, TR, ²Surgey, Inonu University School of Medicine & Liver Transplantation Institute, Malatya, TR

Purpose: Liver Transplantation is an important treatment option in chronic and severe acute liver failure but it may cause many complications. Although ERCP is the first method in the treatment of post-transplant biliary complications, percutaneous radiological interventions are an important and effective diagnostic and treatment option. In this study, we aimed to demonstrate the importance and efficacy of percutaneous radiological interventions in the management of biliary complications in pediatric liver transplantation.

Material and methods: 130 (29,8%) patients who developed biliary complications in 436 (231 Male, 205 Female) children who underwent liver transplantation between the 2002 and 2019 years in our center were included in the study. We evaluated demographics, indications, ERCP procedures, indications and the efficacy of percutaneous radiological interventions.

Results: Biliary complication occurred in 130 (29,8%) of the pediatric transplant patients. 59 (13,5%) of these patients underwent percutaneous radiological intervention, 34 (7,8%) had ERCP, and 37 (8,5%) underwent both percutaneous radiological intervention and ERCP. 96 patients who underwent percutaneous biliary intervention were treated with various indications including biliary stricture. These patients received 111 times PTC, 201 times biliary drainage (101 external, 100 internal), 94 times balloon dilatation, 28 times percutaneous biliary stenting, 142 times catheter revision, 14 times stone or debris removal. Planned operation was successfully performed in 90 patients. Initially ERCP was performed in 71 (54,6%) patients who had biliary complications. 28 patients (39,4%) underwent PTK procedure because of ERCP procedure failure.

Conclusion: Although ERCP is the preferred treatment modality in post-transplant biliary complications, percutaneous biliary interventions are a highly successful and problem-solving treatment.

P-30

Percutaneous treatment of biliary complications in adult left lobe living donor liver transplantations

R. Kutlu¹, S. Karatoprak¹, M.S. Buruk¹, B. Işık², S. Yılmaz²

¹Radiology, Inonu University School of Medicine & Liver Transplantation Institute, Malatya, TR, ²Surgey, Inonu University School of Medicine & Liver Transplantation Institute, Malatya, TR

Purpose: Biliary complications develop with a higher rate in living donor liver transplantation (LDLT) compared with cadaveric liver transplantation (CLT). In LDLT, biliary complications have been reported up to %30. But almost all studies related to biliary complications after LDLT have been

made in right lob LDLT. In this study, our aim is to evaluate the efficacy of percutaneous treatment of biliary complications in adult left lobe LDLT.

Material and methods: 6 adult patients who underwent percutaneous treatment because of biliary complications after left lobe LDLT between 2008-2019 in our center were included in this study. Patient demographics, transplantation indications, ERCP procedures before percutaneous treatment, percutaneous treatment indications and efficacy were analyzed.

Results: Between 2008-2019, 49 adult patients underwent left lobe LDLT in our center. Among them, biliary complications developed in 18 patients (36%). In these patients, the first diagnostic and treatment method was ERCP. 6 patients referred to us for percutaneous treatment because of the failure of the ERCP procedure. In diagnostic percutaneous transhepatic cholangiography (PTC) 2 patients had leaks and 4 patients had an anastomotic stricture and intrahepatic bile duct dilatation. In 4 patients, strictures were treated with balloon dilatation. In all 6 patients, drainage catheters were placed. After drainage procedure percutaneous biliary stents were placed in 2 patients.

Conclusion: Although ERCP is the first choice for biliary complications in adult left lobe LDLT, percutaneous treatment is a successful and effective method when ERCP fails.

P-31

Biliary tract lithiasis treatment with anterograd papiloplasty - multicentric study

C. Szulman¹, P.J. Menendez², G. Parquet Villagra³, R. Sanchez³, L. Ciciliani⁴, J.A. Doderá⁵, **F.J. Suarez Anzorena Rosasco**⁶

¹Interventional Radiology, Clínica Nuestra Señora del Rosario, San Salvador De Jujuy, AR, ²General Surgery, Clínica Nuestra Señora del Rosario, San Salvador De Jujuy, AR, ³General Surgery, Instituto Previsional de Salud, Asunción, PY, ⁴General Surgery, Hospital del Centenario, Rosario, AR, ⁵General Surgery, Hospital Naval Pedro Mayo, Buenos Aires, AR, ⁶Diagnostic Imaging, Fundación Triada Mininvasiva, Buenos Aires, AR

Purpose: Analyze the experience in sphincteroplasty as a method for choledocholithiasis treatment through percutaneous and laparoscopic access and evaluate results.

Material and methods: Retrospective study of cross-section, two groups of patients, in which sphincteroplasty with balloon was used as a therapeutic method, were evaluated.

Series A: 556 patients, performed by percutaneous access papillary dilatation and biliary tract clearance.

Series B: 38 cases, performed by sphincteroplasty during laparoscopic cholecystectomy to resolve concomitant choledocholithiasis.

Results: Choledocholithiasis in series A was solved in 536 (96.4%), 458 were solved in 1 time, 76 needed 2 sessions and other 2 patients needed 3 sessions. The diameter of the stones was between 4-18mm. 448 patients had less than 4 stones and 88 patients had more than 4 stones (range 5-25mm).

Choledocholithiasis in series B was removed by laparoscopic papiloplasty in 38 cases (100%). The diameter of the stones was between 3-5mm, 36 cases had only one stone.

In series A, 20 cases (3.6%) developed complications with the loss of the transistillar path and development of coliperitoneum in 15 patients. There were no pancreatic events registered.

Conclusion: Treatment of choledocholithiasis through the sphincteroplasty is a highly effective method, independent of the route of percutaneous or laparoscopic access. It is a method of technical simplicity, low cost and low morbidity.

P-32

Cholecystostomy free life after acute cholecystitis: precarious cholecystoscopy and cholelithotripsy are the key

N. Nezami¹, T. Schlachter², J.C.L. Perez Lozada², I. Latich¹

¹Radiology and Biomedical Imaging, Yale University School of Medicine, New Haven, CT, US, ²Radiology and Biomedical Imaging, Yale School of Medicine, New Haven, CT, US

Purpose: Once diagnosed with acute calculus cholecystitis and had cholecystostomy tube placement, a significant number of this population have to live with this catheter till end of their life, given contraindication for cholecystectomy. We aimed to report the technique and clinical outcomes of cholecystoscopy and laser/mechanical cholelithotripsy for the management of symptomatic cholelithiasis.

Material and methods: This is a retrospective analysis of 16 cases with acute calculus cholecystitis, who underwent cholecystostomy tube placement. Single use flexible 9.5 F cholecystoscopy was used in combination with laser cholelithotripsy and basket assisted stone extraction to clean the gallbladder and biliary ducts from stones. Seven cases were male, while 9 were female. The mean age was 76.44 years. Surgical contraindications were cardiac or pulmonary disease, and cirrhosis. Timing of cholecystostomy, cholecystoscopy, basket stone extraction, complications, time interval between the first cholecystoscopy and removal of cholecystostomy were obtained.

Results: All patients had transhepatic cholecystostomy tube placement. The mean time interval from cholecystostomy to cholecystoscopy and cholelithotripsy was 58 days, after average of two tube check and exchange sessions. Stone free gallbladder and cholecystostomy tube removal were achieved in all patients. In average, 3 sessions of laser and mechanical cholelithotripsy were required for complete gallstone extraction. The mean time interval between the first cholelithotripsy session and removal of cholecystostomy was 61 days. All patients tolerated the procedure well, without procedure related complications.

Conclusion: Percutaneous cholecystoscopy in combination of laser/mechanical cholelithotripsy is a feasible and safe treatment option to remove the cholecystostomy tube in the patients with contradiction to cholecystectomy.

P-33

Liver puncture model simulator

T.A. Reyes del Castillo, R. Lopez-Benitez, D.M. Benz

Radiology & Nuclear Medicine, Luzerner Kantonsspital, Luzern, CH

Purpose: To present a liver puncture model simulator which can be used without radiation exposure during practice, which is light and easy moveable and which reflects precisely the anatomy of biliary ducts and its vicinity structures.

Material and methods: An anatomic model of the biliary tree was developed with a system of nylon strings into a wooden frame, simulating the basic anatomy of 8 liver segments and the main biliar duct. On the right side of the system we placed a 2cm thick styrofoam panel to simulate intercostal muscles and subcutaneous tissue. To simulate ribs we fixated some bended plastic tubes and covered the whole panel by a thin layer of sponge mimicking the skin. The right pleura was simulated by placement of an air pad. For the puncture we use 20 Gauge Chiba needles over which we are able to introduce a marking wire which is used to troll a cord simulating the successful puncture of a bile duct.

Results: 45 Participants were included to test our PTC-Simulation model. After a short introduction and explanation of the system, all participants were able to perform a well simulated PTC puncture with real time visualisation of the needle trajectory on the monitor. After several attempts, all participants were able to catch a "biliary" cord.

Conclusion: We believe its important for medical training to give options and new alternatives to students so they can practice and perform

rationalization of the minimally invasive procedures in a ethic environment and conditions without putting patients on risk.

P-34

Newly modified plastic stent for transhepatic placement above the sphincter of Oddi in treatment of biliary anastomotic stricture after liver transplantation: preliminary report of 7 patient

W. Choi, H.J. Shim

Radiology, Chung-Ang University Hospital, Seoul, KR

Purpose: Treatment of biliary anastomotic stricture after liver transplantation (LT) has been widely accepted with balloon dilation followed by long term large bore catheter indwelling, or a retrievable metallic stent or plastic stent via PTBD or endoscopic routes. However, the long-term indwelling catheter reduces the patient's quality of life, and failure of treatment due to migration of retrievable stent or plastic stent is a remained problem. The present study is to evaluate the technical feasibility and efficacy of our newly modified biliary plastic stent

Material and methods: A total of 7 patients (age range, 49-62 years) underwent newly modified biliary plastic stent for biliary anastomotic stricture after LT between July 2018 and October 2018 at our institution. To prevent migration, we placed 7Fr plastic stent above the sphincter. At the distal end of the plastic stent, a small piece of angiographic catheter was connected through a prolene thread. The angiographic catheter piece was placed in the duodenum through the sphincter for easy retrieval by endoscope. Plastic stent position and function were followed up

Results: The technical success was achieved in all patients (100%) and clinical success was achieved in 6 of 7 patients (85%) after initial plastic stent placement. One patient underwent reintervention due to the additional stricture of another duct. In two patients with symptomatic improvement, plastic stents were easily removed using a prolene thread.

Conclusion: Our newly modified plastic stents for transhepatic placement above the sphincter can be used safely and effectively for biliary anastomotic stricture after LT.

P-35

Treatment of benign lesions of the bile duct via absorbable stents: multicenter BIELLA study

E. Criado Paredes¹, J.A. Guirola², M. Barrufet³, M. Pérez Lafuente⁴, M.D. Ferrer⁵, C. Lanciego⁶, M.D. Ponce-Dorrego⁷, A. Aguinaga⁸, A. Capel Alemán⁹, A. Gregorio¹⁰, J. Urbano¹¹, M.A. de Gregorio¹²

¹UDIAT (Interventional Radiology), Corporació Sanitària Parc Taulí, Sabadell, Barcelona, ES, ²Interventional Radiology - GITMI, Hospital Clínic Universitario Lozano Blesa, Zaragoza, ES, ³Unidad de Cirugía Mínimamente Invasiva Guiada por Imagen, Hospital Clínic, Barcelona, ES, ⁴Interventional Radiology, Hospital Vall d'Hebrón, Barcelona, ES, ⁵Interventional Radiology, Hospital Universitario de la Ribera, Alcira, Valencia, ES, ⁶Radiología Intervencionista, Hospital Virgen de la Salud, Toledo, ES, ⁷Interventional Radiology, Hospital Universitario La Paz, Madrid, ES, ⁸Interventional Radiology, Hospital Universitario Cruces, Baracaldo, Vizcaya, ES, ⁹Interventional Radiology, "Virgen de la Arrixaca" University Hospital, Murcia, ES, ¹⁰Radiology, Hospital Marina Alta, Denia, ES, ¹¹Vascular & Interventional Radiology, Alfonso X el Sabio University, Madrid, ES, ¹²Interventional Radiology, University of Zaragoza, Zaragoza, ES

Purpose: Determine the feasibility and efficacy of a biodegradable biliary stent in the treatment of benign strictures of the biliary tract by the implantation of ELLA type stent with medium and long term follow up in a Spanish Multicenter registry.

Material and methods: The study was approved by the Ethics Committee of Aragon Acta 19/2004. A total of 137 patients were recruited for the treatment of benign biliary strictures. The most frequent causes were surgical complications of the biliary tree and bile duct (49.6%). In the

100% of the cases, the ELLA DV Biliary prosthesis was implanted with a custom built-in polydioxanone of different sizes and lengths according to each case Stent patency, clinical symptoms, relevant laboratory data, and complications during followup were analyzed. The mean followup was 53.5 ± 27.8 months (range 6-123 months).

Results: The clinical success was 100% and in only 1 case the stent migrated distally and could be replaced using an angioplasty balloon. The mean stent patency was of 84.55 months at 12 months, 81.2% at 24 months, 78.5% at 36 months and 73.3% at 42 months. The GGT, bilirubin and alkaline phosphatase decreased significantly after 1-month follow-up. There 26 (23%) cases consulted of high fever, and cholangitis but only 6.5% of them required hospital-admission.

Conclusion: The implantation of the ELLA absorbable stent is a feasible and safe and effective treatment for benign biliary strictures refractory to standard treatments.

P-36

Assessing risk of percutaneous trans-hepatic biliary drainage (PTBD): preliminary results from a multi-centred prospective cohort study

A.C. Macdonald¹, T. Barge¹, H. Corrigan², G.C. Makris³, A.K. Allouni⁴, R. Ubero⁵

¹Department of Radiology, Oxford University Hospitals NHS Foundation Trust, Oxford, UK, ²Radiology Department, Churchill Hospital, Oxford University Hospitals NHS Foundation Trust, Oxford, UK, ³Interventional Radiology, Oxford University Hospitals, Oxford, UK, ⁴Radiology, Oxford University Hospitals, Oxford, UK, ⁵Radiology, John Radcliffe Hospital, Oxford, UK

Purpose: Percutaneous biliary drainage is a valuable intervention for the management of biliary obstruction. Whilst this procedure is known for high overall mortality, the heterogeneous nature of the patient cohort makes individual risk stratification and hence patient selection and consent challenging.

A multi-centred prospective cohort study was performed in order assess the impact of several risk factors as part of a scoring system for determining perioperative morbidity and mortality following biliary drainage.

Material and methods: Seven centres prospectively recruited patients for the study across three-year period. Along with procedural details, the preoperative Albumin, Prothrombin Time, Haemoglobin, Bilirubin, White Cell Count and functional status (Karnofsky Score) were recorded. Patients underwent biliary drainage +/- stent insertion as per routine practice at their local institution.

Post-procedural Bilirubin, symptom score, morbidity and mortality were subsequently assessed on days 7 and 30.

Results: A total of 250 patients were recruited. Overall 7 day mortality was 4%, 30-day mortality was 14%. Whilst no individual risk factor was predictive for a poor outcome, a combination of risk factors using a modified scoring system allows stratification into high and low risk for post-procedural mortality.

Conclusion: Provisional results show promise for the validation of a risk scoring system based on preprocedural risk factors. This will hopefully lead to improvements in patient selection, consent and monitoring.

P-37

Percutaneous bilio-gastric anastomosis for biliary strictures in living donor liver transplant recipients

A.K. Kapoor, S.S. Bajjal

Radiology, Medanta-the Medicity, Gurgaon, IN

Purpose: To achieve internal biliary drainage for biliary obstruction due to non-salvagable benign biliary strictures in living donor liver transplant (LDLT) recipients

Material and methods: Five patients (4 male and 1 female) presented with deranged liver enzymes suggestive of biliary obstruction, 1-24 months

post transplant (Right lobe graft with right hepatic duct to common bile duct anastomosis).

Endoscopic attempts failed to recanalise occluded biliary duct to duct anastomosis. Two patients had separation of anterior and posterior ductal systems. Seven percutaneous transhepatic biliary drainages were done. Multiple attempts to achieve internalisation failed. Dynamic CECT Abdomen was done in all cases to plan the path of puncture. Using fluoroscopic and Ultrasonographic guidance, communication between the obstructed bile ducts and stomach was achieved. The track was bridged using 10 mm diameter fully covered stents in 3 patients. Two 8 mm diameter stents were deployed in two patients each to prevent isolation of side branches/segmental ducts. Internal-external drainage catheters were placed through the stents into stomach. Stents were retrieved endoscopically within 6 months of deployment. Internal-external catheters were deployed for further 6 months after which they were removed

Results: Technical success was achieved in all cases. All stents were successfully retrieved endoscopically. The longest follow-up is of 3 year and all patients are asymptomatic on follow-up. None of the patients show any biliary dilatation.

Conclusion: Initial results show percutaneous bilio-gastric anastomosis to be safe and effective procedure for treating patients with non salvagable biliary strictures in LDLT recipients

P-38

Tips and tricks of the percutaneous trans-hepatic intra-biliary biopsy of biliary obstructive lesion, using biliary drainage access

U.G. Rossi¹, F. Petrocelli², A.M. Ierardi³, P. Rigamonti⁴, M. Femia⁴, L.C. Pescatori⁵, G. Carrafiello⁶, M. Cariati⁷

¹Diagnostic Imaging Department - Interventional Radiology Unit, E.O. Galliera Hospital, Genoa, IT, ²Radiology, San Martino, University Hospital, Genoa, IT, ³Radiology, University of Milan, San Paolo Hospital, Milan, IT, ⁴Radiology and Interventional Radiology, San Carlo Borromeo Hospital, Milan, IT, ⁵Postgraduation School in Radiodiagnostics, University of Milan, San Donato Milanese, IT, ⁶Diagnostic and Interventional Radiology, University of Milan, Milan, IT, ⁷Diagnostic Sciences, San Carlo Borromeo Hospital, Milan, IT

Learning objectives: To describe percutaneous trans-hepatic intra-biliary biopsy technique of biliary obstructive lesions. This technique applies to lesions of the hepatic ducts, of the common hepatic duct and of all extension of the common bile duct.

Background: Malignant obstructions of the bile ducts are part of the routine pathology of abdominal surgery and gastroenterology services. In the high lesions (intra-hepatic and para-hilar) it is extreme difficulty to have a cytological or histological diagnosis. But a certain diagnosis is essential for the correct treatment especially in possible oncological malignant bile ducts obstructions. Through the percutaneous biliary access is possible to perform cytological and/or histological examination of bile duct obstruction by brushing and forceps biopsy.

Clinical Findings/Procedure Details: The purpose of this poster is to illustrate tips and tricks of the percutaneous trans-hepatic intra-biliary biopsy of biliary obstructive lesion, using biliary drainage access. With particular emphasis, the various steps of the procedure will be analysed with advantages/limitations between brushing and forceps biopsy.

Conclusion: Percutaneous trans-hepatic intra-biliary biopsy of biliary obstructive lesion, using biliary drainage access, guarantees the possibility of having a cytological / histological evaluation of the possible lesion. Therefore, this allows a correct evaluation of the biliary obstructive lesions and allows us to perform the best treatment for each individual patient.

P-39

Single percutaneous access for the stent-in-stent "T-shape" as palliative treatment in malignant hilar biliary obstruction patients

U.G. Rossi¹, P. Rigamonti², A.M. Ierardi³, F. Petrocelli⁴, L.C. Pescatori⁵, M. Femia², G. Carrafiello⁶, M. Cariati⁷

¹Diagnostic Imaging Department - Interventional Radiology Unit, E.O. Galliera Hospital, Genoa, IT, ²Radiology and Interventional Radiology, San Carlo Borromeo Hospital, Milan, IT, ³Radiology, University of Milan, San Paolo Hospital, Milan, IT, ⁴Radiology, San Martino, University Hospital, Genoa, IT, ⁵Postgraduation School in Radiodiagnostics, University of Milan, San Donato Milanese, IT, ⁶Diagnostic and Interventional Radiology, University of Milan, Milan, IT, ⁷Diagnostic Sciences, San Carlo Borromeo Hospital, Milan, IT

Learning objectives: To describe step the implantation of the stent-in-stent with "T-shaped" metallic stent as a palliative treatment of hilar malignant biliary obstruction for establish bilateral hepatic duct patency with single percutaneous access.

Background: Patients with hilar malignant biliary obstruction are a therapeutic dilemma for both ERCP and percutaneous techniques. Various methods have been used for palliative treatment in these patients, but satisfactory technical results and mid/long term patency of bilateral hepatic duct are still limited as percentage.

Clinical Findings/Procedure Details: The purpose of this poster is to illustrate all passages to deploy the stent-in-stent "T-shaped" stent in patients with hilar malignant biliary stenosis/obstruction with single percutaneous access: i) pre-treatment CT planning with MPR images, ii) high resolution fluoroscopy and US guidance for biliary drainage access, iii) "T" stenting with single percutaneous access (advantages and limitations), and iv) post-treatment CT control.

Conclusion: The use of CT as pre-procedural planning, the high resolution fluoroscopy are mandatory for a correct planning and deployment of the stent-in-stent "T-shaped" metallic stent in patients with hilar malignant biliary stenosis/obstruction for establish bilateral hepatic duct patency.

P-40

Percutaneous transhepatic biliary drainage in palliation of malignant hilar biliary obstruction using self-expanding metallic stents with "side-by-side" technique

A. Borzelli¹, A. Paladini², F. Pane³, F. Amodio⁴, E. Cavaglià⁴, R. Niola⁴

¹U.O.C. Radiologia Vascolare ed Interventistica, AORN "A.Cardarelli", Naples, IT, ²SCDU Radiologia Diagnostica ed Interventistica, AOU "Maggiore della Carità" - Novara, Novara, IT, ³Advanced Biomedical Sciences, AOU Federico II Napoli, Naples, IT, ⁴Vascular and Interventional Radiology, Cardarelli Hospital, Naples, IT

Learning objectives: Evaluate feasibility, safety and clinical efficacy of placement of self-expanding metallic stents with "side-by-side" technique in patients with malignant biliary hilar obstruction.

Background: In obstructive jaundice the drainage of both lobe biliary system is mandatory to allow significative reduction of serum bilirubin level, relief from symptoms associated with jaundice and avoid hepatic insufficiency, to let patients start chemotherapy and improve their life quality and mean survival period.

Clinical Findings/Procedure Details: 28 patients (mean age 64 years; 15M, 13F) with jaundice and radiological diagnosis (TC/RM) of malignant biliary hilar obstruction by cholangiocarcinoma (13), gallbladder cancer (6), metastases (2), pancreatic carcinoma (5) and HCC (2). In 19 patients stents were placed in a two-times approach, in 9 patients in a single-step approach. The percutaneous transhepatic approach was performed under fluoroscopic guidance on the right side and under ultrasonographic guidance on the left side, in all cases performed with 21G Chiba-needle and Neff-set, then selective catheterization of biliary ducts with 7Fr-sheaths, 5Fr-catheter and cross-over of the stenosis by .035/.018 guidewires. In

all cases a balloon pre-dilatation was performed before stent release; in all cases self-expanding bare stents were employed. Technical success was achieved in all patients, clinical success in 23 patients; in 5 patients cholangitis occurred and we observed serum bilirubin level between 3 and 5mg/dl. 1 major complication happened, constituted by bleeding into biliary tree due to communication between the latter and portal system, which solved spontaneously. 4 biliary peritoneal effusions occurred, solved by ultrasonographic placement of 8Fr drainage catheter. Mean primary stent patency period was 103 days and mean patient survival period was 150 days.

Conclusion: Percutaneous bilateral stenting "side-by-side" is feasible, safe and effective for palliative treatment of malignant biliary hilar obstruction as it allows a significant improvement of life quality and mean survival period of patients.

P-41

Transcholecystic biliary drainage

C. Liu¹, S. Srinivasan², R. Chung²

¹Medical School, St George's Hospital, London, UK, ²Diagnostic Radiology, Khoo Teck Puat Hospital, Singapore, SG

Learning objectives:

1. The indications for transcholecystic biliary drainage (TCBD) and understand when its preferable to standard techniques of percutaneous transhepatic biliary drainage (PTBD) or cholecystostomy.
2. The technical approach for successful TCBD – tips and tricks.
3. Its clinical effectiveness in severe cholangitis and non-dilated biliary tree.

Background: Critically ill patients with grade 3 cholangitis require rapid haemodynamic stabilisation and parallel treatment of antimicrobial therapy and infective source control. The latter is usually in the form of biliary decompression for which the Tokyo Guidelines 2018 (TG18) principally recommend ERCP or PTBD. However, as acute cholangitis can occur in the absence of biliary dilatation in which the reported technical success rate of PTBD is low at 63%, an alternative route is required to optimise patient care/outcome. TCBD is a less publicised technique, often forgotten by clinicians, but is a viable option for those requiring biliary decompression unsuitable for traditional techniques of ERCP/PTBD.

Clinical Findings/Procedure Details: Using clinical vignettes and schematic diagrams, a guide for successful TCBD is described including:

- Access – approach and stability.
 - Optimal technique for cannulating the often cork-screw and narrow cystic duct, whilst negotiating the spiral valve of Heister.
- Brief report of our single centre experience on indications, technical success and clinical outcome of TCBD in severe cholangitis.

Conclusion: TCBD provides a minimally invasive alternative for high risk cholangitic patients with non-dilated systems requiring biliary drainage. This may also be a bridge towards antegrade cystic biliary stenting or ease endoscopic access during a rendez-vous procedure.

P-42

Advanced enterobiliary interventions in complex post-surgical situations

K. Patatas, N. Charalambous

Interventional Radiology, American Medical Centre, Nicosia, CY

Learning objectives: Novel interventional techniques can allow successful enterobiliary interventions in complex post-surgical situations where often there are no alternative options

Background: Such advanced cases are presented

Clinical Findings/Procedure Details: Case 1

Post extended left hepatectomy complicated by biliary leak due to damage of the proximal CBD, MRCP revealed cutoff of the proximal CBD in keeping with obstruction. PTC could not identify the CBD origin to attempt recanalization therefore biliary drain was sited into the biloma.

Subsequently, rendezvous procedure was performed where via sphincterotomy wire was inserted into the biloma and the wire was snared via the PTC access allowing reestablishment of continuity and stenting of the obstruction.

Case 2

High-grade enteric stricture causing recurrent cholangitis and persisting jaundice post Whipple's was treated via placement of enteric stent through a trans-biliary route via PTC access.

Case 3

High-grade enteric stricture of the blind enteric loop post Whipple's procedure causing recurrent episodes of cholangitis was treated by a combined PTC and percutaneous enterostomy akin a percutaneous gastrostomy where prior to percutaneous puncture the blind loop was continually inflated with air via catheter inserted via the PTC access into the blind loop. Duodenal stent was then placed via the enterostomy access.

Case 4

Segmental biliary obstruction due to stricture post extended left hepatectomy was managed via rendezvous procedure through two PTC accesses (from the obstructed segment and from patent segment below) and because the obstruction could not be recanalized intraluminally, extra-biliary recanalization was performed with wire snaring prior to stenting of the obstructed segment.

Conclusion: Advanced novel techniques presented.

P-43

Role of interventional radiology in management of complications in post pancreatoduodenectomy patients

P.A. Kotta, M. Elango

School of Clinical Medicine, University of Cambridge, Cambridge, UK

Learning objectives:

1. Review the vascular and non-vascular complications in patients post pancreatoduodenectomy
2. Describe potential interventional radiological solutions to these problems
3. Summarise the risks and benefits of these interventions

Background: A pancreaticoduodenectomy is a major surgery with a high associated mortality rate. It is the only potentially curative option in pancreatic adenocarcinoma yet complications are frequent. Complications include biliary leak, post-pancreatectomy hemorrhage (PPH) (mortality rate up to 50%) and pancreatic fistulae. Redo laparotomies due to complications have mortality rates up to 60% so reducing the need for surgical intervention with radiological procedures is clearly desirable.

Clinical Findings/Procedure Details: The reconstruction of the biliary-enteric connection precludes a normal endoscopic approach to the biliary system; this necessitates the use of percutaneous transhepatic biliary procedures to treat bile leaks. Early onset PPH is a serious complication and requires immediate laparotomy while late PPH can be treated either with transarterial embolisation or surgery. The former is becoming more popular and this poster will present the latest research on IR methods vs surgery in treating late PPH. This poster will also include the indications, a pictorial representation of the different steps involved and the potential complications of each procedure.

Conclusion: Promptly delivered interventional radiological treatments in patients post pancreatoduodenectomy has led to decrease in mortality. It is vital to understand the indications, steps and complications of these procedures to provide excellent clinical care to this patient group.

P-44

Percutaneous transhepatic direct retrograde access and recanalization of occluded TIPS

C.S. Branach

Department of Vascular and Interventional Radiology, University of Michigan, Ann Arbor, MI, US

Clinical History/Pre-treatment Imaging: 76M with history of metastatic cancer with multiple prior TIPS revisions, found to have continued in-stent occlusion and left hepatic vein occlusion with new development of large volume ascites. IR was consulted for stent recanalization and paracentesis.

Treatment Options/Results: Paracentesis was performed. Access of the right internal jugular vein was attempted but was completely chronically occluded. The left IJ vein was accessed but the existing TIPS could not be cannulated despite a combination of a modified Cobra catheter, TJLB stiff catheter, Rosen wire, or stiff angled glide. The decision was made to access the TIPS via direct percutaneous transhepatic access (21G Chiba needle). Through and through access via the LIJ/transhepatic accesses was gained. A sheath was advanced into the proximal TIPS. Using a Quick Cross catheter via the LIJ, the distal TIPS was accessed, and serial balloon dilation was performed with 4x40cm and 6x40cm Mustang balloons via the LIJ. Transhepatic access was removed utilizing Helitene. However, venogram showed preferential flow through the hepatic veins with a small splenic varix noted. Pressure gradient measured 13. The TIPS was replastered with a 4x8cm Mustang balloon; final pressure gradient measured 9. Completion venogram showed preferential flow through the TIPS without any additional collateral flow.

Discussion: Transhepatic access allowed for safe recanalization of the TIPS. The patient had no complications and had relief from his ascites.

Take-home points: Percutaneous transhepatic access is safe and effective when performing biliary interventions in a patient with limited or difficult venous access.

P-45

Percutaneous plastic biliary stents placed by interventional radiologyM. Leyva Vásquez Caicedo¹, C.J. Gonzalez Nieto², J.E. Armijo Astrain², J.V. Méndez Montero³

¹Radiology/Vascular and Interventional Radiology, Hospital Universitario Clínico San Carlos, Madrid, ES, ²Radiology, Hospital Clínico San Carlos, Madrid, ES, ³Vascular and Interventional Radiology, Hospital Universitario Clínico San Carlos, Madrid, ES

Clinical History/Pre-treatment Imaging: Endoscopic biliary plastic stent placement is a well-established technique for unresectable and recurrent biliary obstructive disease, benign biliary stricture, biliary leaks and biliary duct stones and provides significant improvement in the quality of life, however, sometimes endoscopic approaches failed or is not possible and we have to use the percutaneous route to place this kind of stents. We describe a technique of percutaneous placement of biliary plastic stents in three cases of patients with obstructive jaundice secondary to resectable pancreatic cancer, gastric cancer (prior to surgery) and choledocholithiasis after failed stenting by endoscopic retrograde cholangiopancreatography.

Treatment Options/Results: In our hospital the endoscopic team usually inserts plastic stents and the technically unsuccessful ones are referred to interventional radiology for percutaneous stent insertion.

A simple technique for placing a biliary plastic stent percutaneously was performed in patients who require a plastic biliary stent for drainage.

Discussion: We describe a simple technique for placing a biliary plastic stent percutaneously. The procedure can be performed in patients who require a plastic biliary stent for drainage but are not suitable for the endoscopic approach or when endoscopy is unsuccessful

Take-home points: Percutaneous plastic stents can be used safely and effectively in patients who have failed endoscopic stenting.

P-46

Percutaneous biliary ablation with N-butyl cyanoacrylate for intractable bile leak

H. Kuwamura, S. Soga, Y. Suyama, H. Yoshikawa, H. Shinmoto

Department of Radiology, National Defense Medical College, Saitama, JP

Clinical History/Pre-treatment Imaging: Case 1: A 46-year-old male developed an intrahepatic infected biloma following transarterial chemoembolization (TACE) for hepatocellular carcinoma. Although percutaneous drainage of the biloma was performed, persistent bile leakage and repetitive cholangitis hampered the removal of the drainage catheter for more than 11 months.

Case 2: A 57-year-old male developed sustained biliary leakage from isolated biliary ducts because of bile duct injury during laparoscopic cholecystectomy.

Treatment Options/Results: Case 1: Internal drainage and ethanol ablation of bile ducts were attempted but failed. Biliary duct ablation with n-butyl-2-cyanoacrylate (NBCA) was performed via the external drainage catheter, and the bile leakage ceased immediately. Follow-up CT showed complete resolution of the biloma.

Case2: After failed conventional treatments (internal drainage and ethanol ablation), two sessions of NBCA ablations were performed via a balloon catheter advanced through the percutaneous tract. Immediate cessation of the bile leakage and successful removal of the drainage catheter were achieved. No significant complications occurred, and no recurrence of bile leakage was seen in both cases.

Discussion: Bile leakage can occur after TACE or laparoscopic cholecystectomy. Although percutaneous drainage, endoscopic therapy, or biliary ablation using ethanol have been reported as a treatment option for continuous bile leak, the techniques can fail as in the presented cases, requiring surgery or long-term external drainage. Biliary ablation with NBCA seems a safe and straightforward strategy in treating such severe cases.

Take-home points: Biliary ablation with NBCA should be considered as a therapeutic option for intractable bile leakage which is challenging to treat with conventional techniques.

P-47

CT and fluoroscopy guided reconstruction of the common bile duct in the setting of entero-biliary disassociation

O. Jamil, T. Jazmati, S. Contractor

Radiology, New Jersey Medical School, Newark, NJ, US

Clinical History/Pre-treatment Imaging: 61-year-old male, hospitalized for gastric outlet obstruction (secondary to pyloric stricture). Status post partial gastrectomy, D1 resection with Roux-en-Y gastrojejunostomy. The surgery was complicated by injury of the common bile duct, with subsequent formation of biloma.

Treatment Options/Results: IR consulted for cholangiogram and PTC placement. IR was unable to cross antegrade into the duodenum despite multiple attempts in different sessions. Gastroenterology was unable to perform retrograde approach endoscopic interventions due to the altered anatomy. General surgery attempts to perform open repair/hepatojejunostomy were unsuccessful. Multi-disciplinary decision was to attempt IR trans-duodenal retrograde reconstruction of the bile duct. Procedure: The duodenal stump was accessed under CT-guidance. Subsequently, undre fluoroscopy, through the enteric access, and using a long needle from the Rosch-Uchida TIPS set, access from the duodenum into the biliary tree was obtained. A Glidewire was administered from the bowel and snared through the PTC access. 8 French external/internal biliary placed through the newly created fistula. In the following weeks, the patient underwent serial upsizings of the external/internal biliary drain to 16 French, with eventual placement of 10 mm Fluency and Wallstent. The patient is tolerating diet. All the antibiotics are stopped.

Discussion: Construction of new anastomosis through a trans-enteric access with placement of metallic stent have been described only in 2 cases (Lopera, Jorge E., et al GI interventions 2017). This case stands out because of the anatomic complexity and utilizing CT scan for the enteric access.

Take-home points: IR guided enter biliary anastomosis through a trans-enteric access can be safe and feasible in the appropriate settings.

P-48

Acute common bile duct obstruction secondary to rapid onset hepatic artery pseudoaneurysm

D. Hynes¹, P. Aghajafari¹, H. Jalaeian², B. Janne d'Othee²

¹Department of Radiology, UMMS Baystate Medical Center, Springfield, MA, US, ²Division of Interventional Radiology, UMMS Baystate Medical Center, Springfield, MA, US

Clinical History/Pre-treatment Imaging: 21 year old male with Crohns disease who presented with obstructive jaundice, cholecystitis and cholangitis secondary to rapid onset of multiple intrahepatic inflammatory pseudoaneurysms 7 days following hemicolectomy for descending colon perforation. The perilous location of the dominant aneurysm at the portahepatis compressing the common bile duct led to a technically difficult percutaneous internal-external biliary drain placement.

Treatment Options/Results: The purpose of this exhibit is to: review the clinical features, radiological features and complications of hepatic artery aneurysm/pseudoaneurysm; understand the pearls and pitfalls of different imaging techniques; discuss interventional radiology management techniques. Ultrasound, CT, CTA, MRI/MRCP, nuclear medicine hepatobiliary scan and interventional radiology images are presented.

Discussion: Most hepatic pseudoaneurysms are identified when there is a local complication such as mass effect on the CBD or aneurysm rupture. Key management dilemmas occur when these lesions cause obstructive jaundice with cholangitis. Decompression of the biliary system is a priority to manage biliary sepsis. A tenuously weak pseudoaneurysm wall makes manipulation around the aneurysm in the CBD perilous with meticulous technique required to prevent inadvertent iatrogenic aneurysm rupture. Delayed intervention for hepatic artery aneurysm is undertaken when sepsis resolves to prevent hepatic abscess and superinfection of embolization materials or stents.

Take-home points: Therapeutic decisions for hepatic artery pseudoaneurysms in the septic context are challenging. Threefold-therapeutic debate encompasses the; necessity to decompress the obstructed infected biliary system; risk of hemorrhage due to iatrogenic pseudoaneurysm rupture during PTC/PTBD procedure and risk of exacerbating sepsis with abscess formation following insetion of a covered intra-arterial stent in the infected patient.

P-49

Catheter radiofrequency ablation of malignant biliary stenosis

M. Gübitz

Institut für Radiologie und Nuklearmedizin - Zentralröntgeninstitut, LKH Leoben, Leoben, AT

Clinical History/Pre-treatment Imaging: 75 yr male patient, 2016 histologically verified cholangiocarcinoma (6,5cm diameter) in the right liver lobe.

Due to comorbidities the patient received best supportive care and was followed up with MRT exams of the liver which showed no tumor growth or signs of cholestasis for two years.

In 2018 the patient was hospitalized with signs of cholestasis. The CT scan showed a tumor infiltration of the common hepatic duct expanding into both distal intrahepatic ducts, this was confirmed in a cholangiogram (Fig.1).

Treatment Options/Results: Endoscopic stent insertion did not successfully decrease cholestasis, subsequently we inserted biliary drainage

catheters via percutaneous access of the left and the right peripheral biliary tract as internal-/external drainage.

Following an initial decrease of cholestatic parameters, they increased again due to progressive tumorous infiltration of the central biliary ducts. Two weeks later we removed the drainage catheters and performed overlapping catheter radiofrequency ablations (TawWoong Medical, ELRA) from the distal left and right ducts into the common hepatic duct via bilateral access. Following the RFA two biliary stents (TaeWoong Medical, LCD) were inserted in kissing technique reaching from both distal intrahepatic ducts into the common bile duct. Finally a drainage catheter was placed in the right biliary system (Fig.2).

3 weeks later the catheter was removed with now signs of residual cholestasis.

Since our interventions in 09/2018 no recurrence of cholestasis so far.

Discussion: Catheter RFA of the biliary ducts is a feasible and minimal invasive method to delay tumorous re-occlusion.

Take-home points: Biliary RFA can be performed before or after stent placement.

P-50

Interventional biliary reconstruction for the biliary-jejunum anastomosis leak with gun-sight approach

M. Okada¹, K. Ihara², K. Ito¹

¹Radiology, Yamaguchi University Graduate School of Medicine, Ube, JP, ²Radiology, Yamaguchi University Hospital, Yamaguchi, JP

Clinical History/Pre-treatment Imaging: A 72-years-old man underwent left hepatectomy and bile duct jejunum anastomosis for the hilar bile duct cancer, and the suture separation was noted 50 days after operation. Percutaneous transhepatic cholangiography (PTC) and drainage (PTCD) were carried out to reduce the bile leakage (Figure 1).

Treatment Options/Results: Treatment option for separated bile duct-jejunum anastomosis

1) Drainage only (as palliative care)

2) Biliary reconstruction: open or laparoscopic surgical reconstruction, endoscopic technique or interventional procedure using magnet compression or gun-sight technique.

An intestinal drainage tube placed during an operation was changed for a snare-wire (EN Snare: Merit Medical Systems) through the fixed jejunum on abdominal wall, and another snare-wire was also inserted through PTCD tract. To create new anastomosis between biliary tract and jejunum lumen, both snare loops were directly punctured with a needle using gun-sight approach under fluoroscopic guidance. We caught the needle (Figure 2) and drug the guidewire to outside via both PTCD tract and jejunum lumen. Drainage tube was successfully placed along the pull-through guidewire.

Discussion: Postoperative complications of biliary-enteric anastomoses include early postoperative anastomotic leak and delayed biliary stricture. Advances in interventional procedure can repair new biliary-enteric anastomosis even in these severe conditions, using magnet compression or gun-sight technique.

Take-home points: Gun-sight approach can be applied to the reconstruction of bile duct-jejunum anastomosis. However, two snare-wires were needed during procedure.

A snare-loop was not tough enough to be expanded fully in intestinal lumen. En snare with three interlaced loops is recommended as a target during gun-sight approach.

P-51

Percutaneous jejunal access for retrograde approach to transplant choledcho-jejunal stricture

O. Bashir¹, A. Alharbi¹, M. Arabi²

¹Interventional Radiology, King Abdulaziz Medical City, Riyadh, SA, ²Medical Imaging, King Abdulaziz Medical City, Riyadh, SA

Clinical History/Pre-treatment Imaging: 64-year-old liver transplant recipient with known choledcho-jejunal stricture previously treated PTC, balloon cholangioplasty and biodegradable stent placement presented with pruritis and rising serum bilirubin.

Undilated biliary system noted on US. ERCP and PTC were unsuccessful. **Treatment Options/Results:** Percutaneous puncture of Roux-en Y jejunal loop was performed under fluoroscopic and ultrasound guidance. Anchor sutures were deployed to create jejunopexy. Percutaneous jejunal access was upsized to 6Fr sheath followed by traversal of choledcho-jejunal stricture in retrograde fashion using catheter and guidewire which was followed by percutaneous biliary drain placement. Jejunopexy access was subsequently used successfully to treat biliary stricture with drain upsizing and cholangioplasty.

Discussion: ERCP and PTC with drainage, stent placement and cholangioplasty are the mainstay of managing biliary strictures in transplant recipients. However, accessing undilated biliary tract in transplant livers can prove to be challenging on some occasions. Hepatico-jejunal anastomosis can be accessed in retrograde fashion from percutaneous jejunal access even in the absence of a surgical fixation of the afferent Roux limb to the anterior abdominal wall (Hudson loop) as in our case. Creation of jejunopexy using percutaneous technique in this patient allowed subsequent biliary interventions by allowing access to the biliary tree in a convenient and effective manner to treat hepatico-jejunal anastomotic stricture.

Take-home points: Percutaneous jejunal access permits retrograde approach to transplant biliary strictures in challenging cases when conventional techniques using ERCP or PTC are unsuccessful.

P-52

Sharp biliary reconstruction utilizing a steerable sheath for an excluded bile duct leak after hepatic trisegmentectomy for hepatocellular carcinoma (HCC)

A.Z. Vance¹, C. Chedrawy², G. Tiesi³, S. Putnam²

¹Vascular & Interventional Radiology, University of Pennsylvania, Philadelphia, PA, US, ²Vascular & Interventional Radiology, Christiana Care Health System, Newark, DE, US, ³Surgical Oncology, Christiana Care Health System, Newark, DE, US

Clinical History/Pre-treatment Imaging: A 49-year-old male with HIV and HBV developed a large right hepatic lobe HCC. Right portal vein embolization was performed with subsequent hepatic trisegmentectomy. Postoperatively, a bile leak from left the hepatic duct resulted in an abscess requiring percutaneous drainage. Endoscopic, percutaneous, and magnetic resonance imaging confirmed discontinuity of the remnant liver biliary system from the common bile duct, compatible with a Nagano type 4 excluded segmental bile duct leak (ESBDL). An endoscopic CBD stent and an external percutaneous transhepatic biliary drain (PTBD) were placed. Internalization attempts were initially unsuccessful.

Treatment Options/Results: No further endoscopic or surgical options could be offered to bridge the biliary defect. Cholangiography was performed and the indwelling PTBD was exchanged over a wire for a 6.5 French shapeable sheath. With fluoroscopic triangulation the indwelling CBD was targeted for sharp recanalization using a 0.035 inch straight Glidewire and 4 French Bernstein catheter through the shapeable sheath. A gooseneck snare was utilized to snare the indwelling plastic biliary stent and advance it into the bowel. The defect was pre-dilated and successfully reconstructed with a covered stent. The patient's clinical status

stabilized with improvement of his laboratory values and subsequently had his drains removed.

Discussion: Type-4 leaks typically require surgical revision of the liver remnant. We present the use of fluoroscopic imaging providing 3D guidance to percutaneously reconstruct a surgical defect of the biliary tree across the peritoneal cavity in a complex oncologic patient with otherwise limited management options.

Take-home points: Sharp cannulation can be utilized in the construction of nonanatomic conduits throughout the body.

P-53

Percutaneous pancreatic duct stent placement for treatment of transplant pancreatic duct stricture

K.J. Moore¹, M. Ozturk², M. Kleedehn³, M.A. Woods¹

¹Radiology, University of Wisconsin-Madison, Madison, WI, US, ²Department of Radiological Sciences, Ondokuz Mayıs Üniversitesi, Samsun, TR, ³Radiology, University of Wisconsin Madison, Madison, WI, US

Clinical History/Pre-treatment Imaging: A 59-year-old female with ESRD related to insulin dependent diabetes mellitus underwent simultaneous kidney and pancreas transplant complicated by graft pancreatitis and pancreatic ascites with suspected underlying post-operative pancreatic fistula. Cross-sectional imaging demonstrated gradual dilation of the transplant pancreatic duct as well recurrent peri-pancreatic fluid collections.

Treatment Options/Results: Approximately 3 months status post transplantation, the patient underwent percutaneous transplant pancreatic ductography demonstrating a stricture at the level of ampulla and successful transpancreatic stent placement across the stricture into the donor duodenum. Serum amylase and lipase declined following intervention with radiologic improvement in ductal dilation; however, she ultimately died due to bacteremia and sepsis complicating myelosuppression with pancytopenia.

Discussion: Graft pancreatitis and transplant pancreatic duct leak, or post-operative pancreatic fistula, are well-known reported complications following pancreas transplantation. Post-operative pancreatic fistulae and re-laparotomy are associated with significant morbidity and mortality, so alternative approaches to treatment are desirable. This case report establishes percutaneous transplant pancreatic interventions as a novel, minimally invasive approach to the management of post-operative pancreatic fistula associated with pancreatic duct obstruction.

Take-home points:

- Graft pancreatitis and transplant pancreatic duct leak, or post-operative pancreatic fistula, are well-known reported complications following pancreas transplantation.
- Post-operative pancreatic fistulae and re-laparotomy are associated with significant morbidity and mortality.
- Percutaneous placement of a pancreatic duct stent in a transplant kidney for the management of persistent post-operative pancreatic fistula is a feasible management option for transplant pancreatic duct leak.

P-54

Focal intrahepatic bile duct stricture following hepaticojunos-tomy treated with biodegradable biliary stent

G. Damiani¹, M. Tamarin¹, P. Rigamonti¹, M. Femia², P. Spadafora², M. Cariati¹

¹Diagnostic-Therapeutic Advanced Technology Department – Diagnostic and Interventional Radiology Unit, ASST Santi Paolo e Carlo – San Carlo Borromeo Hospital, Milan, IT, ²Postgraduation School in Radiodiagnostics, Università degli Studi di Milano, Milan, IT

Clinical History/Pre-treatment Imaging: We report a case of a 67-year-old woman that referred to our Institution after a long story of focal hepatic abscesses and cholangitis following hepaticojunos-tomy.

TC and MRI demonstrated that the cause was a iatrogenic focal stricture of the biliar duct of the segment 7.

Treatment Options/Results: The Patient was successfully treated with transhepatic drainage positioning, followed by bilioplasty; than a bio-degradable stent was positioned across the stenosis.

The controls at 1, 3 and 6 months demonstrated regular caliber of the biliar duct and no more abscesses, cholangitis or symptoms occurred.

Discussion: Focal intrahepatic strictures following surgery are becoming common complications and are relevant technical and clinical issues requiring a multidisciplinary approach for their optimal management. Imaging is the key for characterizing the injury and planning the proper treatments.

Percutaneous techniques have become the first-line option for the management of these strictures. The most common procedure is to perform a dilatation with balloon, with a success of 70%, but success rate can improve significantly using biodegradable stents.

Take-home points: Intrahepatic bile duct strictures is challenging, due to the difficult technical coefficient and the high complication rate.

Percutaneous procedures allow definitive treatment in selected patients. Biodegradable stent is a safe option, allowing sustained dilatation, without the long-term complications of catheters or metallic stents.

Biopsy and drainage

P-55

A systematic review and meta-analysis of modifiable risk factors during CT-guided lung biopsies to reduce the risk of pneumothorax and chest drain insertion

Y.R. Huo¹, M.V. Chan², A.-R. Habib³, I. Lui², L. Ridley²

¹Faculty of Medicine, University of New South Wales, Sydney, NSW, AU, ²Radiology, Concord Repatriation General Hospital, Sydney, NSW, AU, ³Faculty of Medicine, University of Sydney, Sydney, NSW, AU

Purpose: There are modifiable factors during a computed tomography-guided percutaneous lung biopsy (CT-PTLB) which can reduce pneumothorax rates. This systematic review and meta-analysis aims to identify these factors.

Material and methods: A search of nine databases was done from inception to December 2018. Pooled odds ratios (ORs) and 95% CIs were calculated for the effect of modifiable factors for pneumothorax and chest drain insertion.

Results: A total of 34 articles were included with 17731 CT-PTLB. The risk of pneumothorax was significantly higher if a bulla was crossed (OR:6.13, 95%CI:3.73-10.06), puncture site up compared to down (OR:4.79, 95%CI:2.53-9.09), if a fissure was crossed (OR:3.30, 95%CI:2.60-4.17), more than one pleural puncture (OR:2.22, 95%CI:1.48-5.60) and fine needle aspiration compared to automated core biopsy (OR:1.26, 95%CI:1.03-1.53). Attaining multiple specimens compared to single specimen significantly increased pneumothorax rates in non-coaxial technique (29.7% vs 17.5%, $p=0.006$), but remained similar in co-axial technique (27.8% vs 26.6%). The risk for a chest drain insertion was significantly higher if a bullae was crossed (OR:11.04, 95%CI:5.32-22.90), if a fissure was crossed (OR:2.70, 95%CI:2.00-3.64), puncture site up compared to down (OR:7.84, 95%CI:2.53-24.29) and larger calibre biopsy needles (18G or less) (OR:1.39, 95%CI:1.18-1.62). Factors which did not increase the risk of pneumothorax include operator experience, immediate review of the specimen for adequacy by a cytologist, sedation technique and multiple passes through a co-axial needle.

Conclusion: Knowing these factors can inform the proceduralist about the risks associated with different techniques and provide guidance for the approach that will minimize the risk in an individual patient.

P-56

Which patients and lung lesions have the highest rates of pneumothorax in CT-guided lung biopsies? A systematic review and meta-analysis

Y.R. Huo¹, M.V. Chan², A.-R. Habib³, I. Lui², L. Ridley²

¹Faculty of Medicine, University of New South Wales, Sydney, NSW, AU, ²Radiology, Concord Repatriation General Hospital, Sydney, NSW, AU, ³Faculty of Medicine, University of Sydney, Sydney, NSW, AU

Purpose: This systematic review and meta-analysis investigated patient and lesion risk factors associated with pneumothorax following computed tomography-guided percutaneous transthoracic lung biopsy (CT-PTLB).

Material and methods: A search of nine databases from January 2003 to November 2018 was done. Pooled odds ratios (ORs) and 95%CI were calculated for the effect of patient and lesion factors for pneumothorax and chest drain insertion.

Results: Twenty articles were included with 16240 patients. The overall pooled incidence for pneumothorax was 25.3% and a chest drain was 5.2% following a CT-PTLB. Pneumothorax risk was significantly increased in patients with emphysema (OR: 3.3, 95%CI 2.04-5.33), smaller lesions (<4cm vs 4cm or more: OR 2.09, 95%CI 1.33-3.31), lesions without pleural contact (OR: 1.73, 95%CI 1.17-2.55) and deeper lesions (2cm or more vs <2cm: OR 2.16, 95%CI 1.31-3.57, 5cm or more vs <5cm: OR 8.47, 95%CI 13.44-20.89). Chest drain insertion was significantly higher in patients with emphysema (OR: 6.15, 95%CI 3.73-10.13), lesions in the upper or middle lobe (OR: 1.85, 95%CI 1.56-2.19) and without pleural contact (OR: 1.97, 95%CI 1.21-3.21).

Conclusion: This information can be used to inform consent and balance the benefit against the risk for CT-PTLB.

P-57

Post biopsy manoeuvres to reduce pneumothorax incidence in CT-guided transthoracic lung biopsies: a systematic review and meta-analysis

Y.R. Huo¹, M.V. Chan², A.-R. Habib³, I. Lui², L. Ridley²

¹Faculty of Medicine, University of New South Wales, Sydney, NSW, AU, ²Radiology, Concord Repatriation General Hospital, Sydney, NSW, AU, ³Faculty of Medicine, University of Sydney, Sydney, NSW, AU

Purpose: This systematic review and meta-analysis investigated post biopsy manoeuvres to reduce pneumothorax following computed tomography-guided percutaneous transthoracic lung biopsy.

Material and methods: A search of six databases from inception to November 2018 was done. Pooled odds ratios (ORs) and 95%CI were calculated for the effect of different post biopsy manoeuvres to reduce pneumothorax and chest drain insertion rates following a lung biopsy.

Results: Twenty articles were included with 6627 patients. Chest drain insertion rates were significantly reduced by nine-fold with the normal saline tract sealant compared to controls (OR 0.11, 95%CI 0.02-0.48), three-fold with the rapid rollover manoeuvre to puncture site down (OR 0.34, 95%CI 0.18-0.63), three-fold with the tract plug (OR 0.33, 95%CI 0.22-0.48) and three-fold with the blood patch (OR 0.39, 95%CI 0.26-0.58). The absolute chest drain insertion rates were the lowest in the normal saline tract sealant (0.8% vs 7.3% for controls), rapid rollover (1.9% vs 5.2%), deep expiration and breath-hold on needle extraction (0.9% vs 1.8%) and standard rollover versus no rollover (2.6% vs 5.2%).

Conclusion: These findings highlight post biopsy manoeuvres which could help reduce pneumothorax and chest drain insertions following lung biopsies.

P-59

Pneumothorax and pulmonary hemorrhage after CT-guided lung biopsy: incidence, clinical significance and correlation

U. Russo¹, V. Sabatino¹, F.V. d'Amuri¹, A. Bevilacqua¹, F. Pagnini¹, G. Milanese¹, R. Nizzoli², G. Pedrazzi³, M. De Filippo¹

¹Department of Medicine and Surgery - Unit of Radiologic Science, Azienda Ospedaliero-Universitaria di Parma, Parma, IT, ²Department of Medicine and Surgery - Unit of Medical Oncology, Azienda Ospedaliero-Universitaria di Parma, Parma, IT, ³Department of Medicine and Surgery, Azienda Ospedaliero-Universitaria di Parma, Parma, IT

Purpose: To evaluate incidence and clinical significance of pneumothorax (PTX) and pulmonary haemorrhage (PH) after CT-guided lung biopsy (CT-LB).

To test correlations of PTX and chest tube insertion (CTI) with PH and other imaging and procedural parameters.

Material and methods: Pre-procedural CT and CT-LB scans of 904 patients were examined. Incidence of PTX and of PH (location: type-1 along needle track or type-2, perilesional; severity according to its thickness: low-grade <6mm or high-grade >6mm) were recorded. CTI was assessed by reviewing medical charts.

PTX was considered clinically significant if treated with CTI, PH if treated with endoscopic/endovascular procedure.

Evaluated parameters included: nodule-to-pleura distance (mm), emphysema (subjectively quantified in ≤25%, 25-50%, ≥50%) and procedure time (minutes).

Binary logistic regression analyses tested whether PH and imaging and procedure parameters were associated with development of PTX and CTI.

Results: PTX occurred in 306/904 cases (33.8%); CTI was required in 18/306 (5.9%). PH occurred in 296/904 cases (32.7%), of which 165/296 (55.7%) type-1 high-graded; no case required treatment.

Type-1 high-graded PH showed a protective effect against PTX and CTI ($OR_{PTX}=0.503$; $OR_{CTI}=0.416$). Nodule-to-pleura distance ($OR_{PTX}=1.052$; $OR_{CTI}=1.046$), emphysema ($OR_{PTX}=1.287$) and procedure time ($OR_{PTX}=1.019$; $OR_{CTI}=1.039$) were associated with an increased risk for PTX development or CTI.

Conclusion: Pneumothorax and pulmonary hemorrhage have similar incidence after CT-guided lung biopsy. Treatment was required only for pneumothorax (<6% of cases) while pulmonary hemorrhage was not clinically significant. Pulmonary hemorrhage along needle track >6mm may represent a protective factor against development of pneumothorax and against pneumothorax requiring chest tube insertion.

P-60

Analysis of the factors influencing retrograde double J ureteral stent removal using a simple snare technique in female patients

C. Chen

Radiology, Cancer Hospital, Zhengzhou University, Zhengzhou, CN

Purpose: To determine the factors associated with the easiness of the retrograde double J ureteral stent removal using a simple snare technique in female patients.

Material and methods: Fluoroscopically guided, retrograde double J stent removal with or without replacement were performed using a simple snare technique in 128 female patients from 2012 to 2017. The positions of the double J stent end in the bladder were divided into position types A, B, C, and D with the stent end in the ipsilateral outer, ipsilateral inner, contralateral inner, and contralateral outer quadrants of the urinary bladder, respectively. The factors influencing the fluoroscopy time of the double J stent removal, including the position types or curl numbers of the double J stent, stent indwelling time or obvious incrustation, were analyzed.

Results: A total of 312 procedures were performed and the technical success rate was 97.44% (304/312) and the mean fluoroscopy time was 12.68 ± 7.34 minutes. The position types and the curl numbers had a

significant influence on the fluoroscopy time ($p < 0.05$), although the stent indwelling time or obvious stent incrustation had no significant influence on the fluoroscopy time ($p > 0.05$). Furthermore, multiple regression analysis indicated that the position types and curl numbers of the double J stent were independent, influencing factors for the fluoroscopy time ($p = 0.001$).

Conclusion: The position types and the curl numbers of the double J stent have a significant influence on the easiness of its retrograde double J stent removal using a simple snare technique in female patients.

P-61

Use of a TurboHawk catheter for biopsy of the bile ducts in cholangiocellular cancer

A.B. Varava

Department of Endovascular Diagnostic and Treatment Methods, Vishnevsky Institute of Surgery, Moscow, RU

Purpose: The aim of the study is to share our experience of bile duct biopsy with TurboHawk catheter for cholangiocellular carcinoma complicated by mechanical jaundice and compare our experiences with those of other leading experts.

Material and methods: From 2016 to 2018, we performed 23 bile duct biopsies in 21 patients with cholangiocellular cancer. In 13 cases, a biopsy was performed simultaneously with primary drainage in patients with obstructive jaundice, in 10 cases during replacement of the transhepatic drainage. Earlier 5 in patients had been performed open surgery for cholangiocellular cancer (Klatskin Tumor), in the postoperative period mechanical obstructive jaundice appeared. For differential diagnosis between relapse of cancer and benign stricture of the hepatico-jejunal anastomosis drainage and biopsy were performed at the same time.

Results: In all cases, a sufficient amount of material for histological and immunohistochemical studies was obtained successfully. In all patients with biliary obstruction, when primary cholangiostomy were performed, it was possible to stop the obstructive jaundice. We had 2 hemobilia complications after using of TurboHawk device for biopsy, which stopped through one day on hemostatic therapy. One patient had acute pancreatitis after internal-external drainage was performed, which was cured with infusion therapy and replacing of the PigTail catheter into suprapapillary position.

Conclusion: Using TurboHawk catheter for biopsy in case of cholangiocellular cancer with obstructive obstructive jaundice allows to get safely enough material to perform a histological and immunohistochemical study that affects the choice of further treatment strategy.

P-62

CT fluoroscopy-guided biopsy of lung nodules: comparison of step-wise and real-time techniques

K. Kajiwara¹, K. Murakami¹, R. Yoshimatsu², M. Nishimori³, T. Yamanishi⁴, H. Minamiguchi³, K. Arai⁵, T. Yamagami³

¹Radiology, Medical School, Kochi University, Kochi, JP, ²Radiology, Kochi University, Nankoku, JP, ³Radiology, Medical School, Kochi University, Nankoku, JP, ⁴Radiology, Medical School, Kochi, JP, ⁵Radiology, Hiroshima University Hospital, Hiroshima, JP

Purpose: To compare the step-wise with the real-time technique for CT fluoroscopy-guided biopsy of lung nodules.

Material and methods: Included were 50 consecutive patients (39 men, 11 women; mean age 71.8 years, range 45-89 years) with lung nodules. Between March 2017 and September 2018, they underwent CT fluoroscopy-guided biopsy using a step-wise ($n=30$) or a real-time ($n=24$) technique. The final diagnosis was confirmed by pathological findings or clinical follow-up.

Results: Sufficient samples for histopathological evaluation were obtained in 29/30 (96.7%) treated with the step-wise, and in 23/24 (95.8%) treated with the real-time technique ($p=0.21$). The mean CT dose index and

dose length product were 49.6 ± 17.6 mGy/sec and 2052 ± 733 mGy for the step-wise, and 65.5 ± 26.8 mGy/sec and 2854 ± 1348 mGy for the real-time technique ($p < 0.01$). The mean exposure time was 89 ± 42 sec for the step-wise, and 168 ± 113 sec for the real-time technique ($p < 0.01$). The mean lung nodule size was 31.6 ± 16.9 mm in patients undergoing the step-wise, and 20.4 ± 13.8 mm in patients treated with the real-time technique ($p < 0.01$). The mean depth of the lung nodule was 45.2 ± 18.6 mm for the step-wise, and 43.3 ± 16.9 mm for the real-time technique. Pneumothorax occurred in 10/30 (33.3%) undergoing the step-wise and in 16/24 (66.7%) patients treated with the real-time technique ($p < 0.01$).

Conclusion: The lung nodules were significantly smaller in patients undergoing the real-time technique. There was no significant difference in the diagnostic yield of the two procedures. The CT dose, exposure time, and the incidence of pneumothorax were significantly lower when the step-wise technique was used for CT fluoroscopy-guided biopsy of lung nodules.

P-63

The utility of image-guided core needle biopsy in suspected malignant lymphoma: comparison with surgical excision biopsy

S. Chatani¹, S. Murata¹, S. Kato², T. Hasegawa¹, Y. Sato¹, I. Dejima¹, M. Takahashi¹, H. Tsukamoto¹, M. Kato¹, H. Yamaura¹, H. Onaya¹, K. Yamamoto³, Y. Yatabe², Y. Inaba¹

¹Diagnostic and Interventional Radiology, Aichi Cancer Center Hospital, Nagoya, JP, ²Pathology and Molecular Diagnostics, Aichi Cancer Center Hospital, Nagoya, JP, ³Hematology and Cell Therapy, Aichi Cancer Center Hospital, Nagoya, JP

Purpose: Surgical excision biopsy (SEB) is widely accepted as the gold standard for the diagnosis of lymphoma based on current European Society for Medical Oncology. The purpose of this retrospective study was to assess the diagnostic accuracy and safety of image-guided core needle biopsy (CNB) in the diagnosis of suspected malignant lymphoma in comparison with SEB.

Material and methods: 263 cases of CNB and 108 cases of SEB performed between January 2014 and December 2018 were included in this study. In CNB group, ultrasound-guidance was 174 cases and computed tomography-guidance was 89 cases. Biopsy sites included body surface ($n=123$), retroperitoneum ($n=60$), intra-abdomen ($n=21$), mediastinum ($n=18$), bone and soft tissue ($n=15$), lung ($n=13$), liver ($n=6$), kidney ($n=4$) and others ($n=3$). In SEB group, biopsy sites included body surface ($n=70$), oropharyngeal tissue ($n=29$), intra-abdomen ($n=4$), bone and soft tissue ($n=3$) and others ($n=2$). Technical success, which was defined as obtaining the adequate specimen in diagnosis of lymphoma subtype/grading, and complications were compared between two groups.

Results: Technical success rates of CNB group and SEB group were 88.2% (232/263) and 93.5% (101/108) respectively and there were no significant differences between two groups ($p=0.14$). In CNB group, hematoma ($n=7$), pneumothorax ($n=4$) and vasovagal reflex ($n=2$) were seen as complications and in SEB group, lymphorrhea ($n=2$), bleeding ($n=1$), fever ($n=1$), paresthesia ($n=1$) and pneumoderma ($n=1$) were seen as complications.

Conclusion: CNB provides relatively sufficient diagnostic information of lymphoma and comparable to that of SEB.

P-64

Percutaneous transpulmonary CT-guided liver biopsy: a safe, effective and technically easy approach for lesions located near the diaphragm

H.S.-C. Chan

Department of Radiology, Chang Gung Memorial Hospital, Keelung, TW

Purpose: Liver biopsies done to high liver lesions near the diaphragm using conventional imaged-guided approaches are deemed too technically difficult or unsafe. However, the most serious complications that may arise are pneumothorax and hemorrhage. We performed transpulmonary

CT-guided liver biopsies to high liver lesions near the diaphragm on 14 patients (10 men and 4 women) and were able to demonstrate the feasibility, efficacy, and safety of this approach.

Material and methods: All lesions were done predominantly in the right lobe, which was located near the diaphragm and the biopsy needles had been clearly transpulmonary under CT-guided.

Results: All of the percutaneous biopsies yielded diagnostic specimens and no patients suffered complications. The most common diagnosis was found to be metastatic disease ($n=8$), with hepatocellular carcinoma ($n=4$), dysplastic nodule ($n=1$), cholangiocarcinoma ($n=1$) all following.

Conclusion: A major advantage of the transpulmonary approach is that it often provides the shortest and most direct path to the high liver lesion. However, this approach involves traversing the lung. Therefore, it is necessary to minimize the number of passes for correct needle positioning. A radiologist with enough experience and confidence to place the needle into the target on the first pass is recommended to perform the transpulmonary approach. On the basis of the results in 14 patients, we conclude that a transpulmonary CT-guided liver biopsy to high liver lesion near the diaphragm is a feasible, safe, and effective approach in medicine.

P-65

Ambulatory CT guided lung biopsy (ALB); Nottingham University Hospitals (NUH) experience

A. Ginawi, C. Kennedy

Radiology, Nottingham University Hospitals, Nottingham, UK

Purpose: The pathway for CT guided lung biopsy in Nottingham was radically re-designed in October 2017 moving from away from the traditional day case model to a completely radiology led service with direct discharge from CT.

We describe our patient suitability criteria, describe our new pathway processes and review the impact on revenue savings, including bed days saved. We have reviewed the rate of direct discharge after ALB, complication rate of ALB biopsy and re-admission rate.

Material and methods: A retrospective review of all CT lung biopsies was conducted to determine the rate of ALB biopsy, direct discharge rate and re-admission rate following complications related to ALB in Nottingham between November 2017 to November 2018.

Results: A total of 202 CT guided lung biopsies were performed. 152 procedures were performed under the new ALB pathway. 144 patients were discharged directly from CT (95%). 8 cases required admission due to complications (5%). 46 patients required the more traditional day-case pathway for recovery, social reasons or planned medical admission. 144 bed days saved at approximately £250/day amounts to £36000 per annum with no capital outlay.

Conclusion: Ambulatory lung biopsy is a safe, efficient and cost effective and can be instituted with no capital costs. The new pathway has reduced patient inconvenience, anxiety and time in hospital and led to significant savings to the trust, with associated reduced portering, ward and nursing costs. This pathway has also emphasized the ability to provide holistic care in radiology and improved our job satisfaction.

P-66

Safety of percutaneous biopsy in patients on dual antiplatelet therapy

D. Adamo¹, T.D. Atwell², E. Johnson²

¹Radiology, Mayo Clinic, Rochester, US, ²Radiology, Mayo Clinic, Rochester, MN, US

Purpose: The goal of this study was to identify patients who developed hemorrhage while on dual antiplatelet therapy prior to image guided biopsy.

Material and methods: This HIPAA compliant retrospective review evaluated core biopsies performed at our institution between 2003 and

2018. Data were collected at the time of biopsy, and clinical follow-up was obtained 24 hours and 3 months after the biopsy.

Results: Among the 6083 percutaneous core biopsies performed during the study period, 108 were performed in patients who had taken both aspirin (any dose) and Plavix within 5 days prior to the biopsy. 26 of these patients were female and the average age was 71 (± 10.1). 57 cases were performed with CT guidance and 51 were with ultrasound. 99 biopsies were performed on lesions, 9 were parenchymal biopsies performed on solid organs. 52 of the cases were performed utilizing an 18 gauge needle. Only 1 patient had platelets less than 50 and 2 patients had an INR greater than 1.5. 3 patients were lost to follow-up at 24 hours and 21 were lost to follow-up at 3 months. 1 hematoma was identified at 24 hours and 1 patient required angiography within the 24 post-procedure period. No patients required blood products within 24 hours following biopsy. No additional hematomas, angiographies, or blood product needs were identified at 3 month follow-up.

Conclusion: In this relatively small cohort of patients with recent dual antiplatelet therapy, bleeding complications were very rare. In those patients with imperative indications, percutaneous biopsy may be safer than expected.

P-67

Evaluation of six types of semiautomatic cutting biopsy needles

T. Iguchi¹, T. Hiraki¹, Y. Matsui¹, T. Komaki¹, S. Okamoto¹, S. Fukuma¹, T. Mitsuhashi², S. Kanazawa¹

¹Department of Radiology, Okayama University Medical School, Okayama, JP, ²Center for Innovative Clinical Medicine, Okayama University Hospital, Okayama, JP

Purpose: To evaluate the performance characteristics of six types of semiautomatic cutting biopsy needles.

Material and methods: An 18- and 20-gauge aspiration-type needle (STARCUT aspiration type; TSK Laboratory, Tochigi, Japan) and five non-aspiration-type needles (FINE CORE; Toray Medical, Tokyo, Japan, SuperCore; Argon Medical Devices, TX, MISSION; BARD, AZ, Temno Evolution; Care Fusion, IL, and Quick-Core; Cook, IN) were compared. With each type, 4 biopsies were performed with 2-cm notch for one excised bovine liver, which was repeated for 4 livers using 4 needles. STARCUT was used both with and without aspiration.

Results: Sixteen specimens were obtained with each 18- and 20-gauge needle. The mean weight of specimens obtained with the 18- and 20-gauge needles was 6.32 mg and 1.95 mg for STARCUT with aspiration, 3.56 mg and 1.30 mg for FINE CORE, 5.23 mg and 1.11 mg for SuperCore, 5.43 mg and 1.41 mg for MISSION, 4.56 mg and 1.22 mg for Temno evolution, and 3.24 mg and 1.29 mg for Quick-Core, respectively. In both gauges, STARCUT with aspiration obtained significantly ($P < .05$) heavier specimen than the other 5 needles. In all 6 needles, the specimen weight was significantly different ($P < 0.001$) between 18- and 20-gauge. In STARCUT, it was not significantly different between specimens obtained with and without aspiration (6.32 vs. 5.97 mg in 18-gauge, $P = 0.342$; 1.95 vs. 1.92 mg in 20-gauge, $P = 0.886$).

Conclusion: Although STARCUT with aspiration contributed to heavier specimen, there was no significant difference between biopsy with and without aspiration.

P-68

Management of pneumothorax after percutaneous computed tomography guided lung biopsy with a pigtail catheter: a less invasive and more comfortable method

R. Pekcevik

Interventional Radiology, Izmir Katip Celebi University Atatürk Training and Research Hospital, Izmir, TR

Purpose: The purpose of this study is to evaluate the efficacy of using 8 french (F) pigtail catheter for immediate treatment of the pneumothorax after percutaneous computed tomography (CT) guided lung biopsy.

Material and methods: 124 patients with CT-guided lung biopsy were retrospectively reviewed. Among them patients who developed pneumothorax treated with a pigtail catheter after CT-guided lung biopsy were included the study. 8F Boston Scientific pigtail catheters placed over the 0.035 inch guide wire using the Seldinger technique guided by CT. All air in the pleural space was evacuated and then the catheter was connected to a closed chest drainage system. A chest X-ray follow-up was performed every 24 hours. After the complete regression of pneumothorax, the catheter was closed. The catheter was withdrawn after two chest X-rays, taken 4-hour interval, without air leak.

Results: A total of 26 patients (8 women, 18 men; mean age, 54 years; age range, 18-75 years) were enrolled into the study. Among them, 21 (80.8%) patients was connected to a closed chest drainage system for 24 hours, 4 (15.4%) patients for 48 hours, and 1 (3.8%) patient for 96 hours. All patients were discharged with full recovery.

Conclusion: For the management of pneumothorax after percutaneous CT-guided lung biopsy, small sized pigtail catheters are minimally invasive, more comfortable and safe technique. It is an effective treatment option that is easy to apply.

P-69

Necrotic pancreatic collections - radiological guided solutions: 10 year review of practice at a territory referral hepatobiliary centre

P.E. Jenkins¹, N. Rajaretnam², N.F. Gafoor¹, S. Aroori²

¹Radiology, Peninsula Radiology Academy, Plymouth, UK, ²HPB Sugery, University of Plymouth NHS Trust, Plymouth, UK

Purpose: Pancreatic necrosis is a life threatening complication, which has traditionally been managed with surgical resection. Radiological drainage (IR) is offered as a replacement or adjunct to necrosectomy. We present a 10 year review of patients requiring IR drainage for necrotising pancreatic collection.

Material and methods: We present a retrospective review of patients with biochemical/radiological diagnosis of acute pancreatitis between January 2008 and December 2017. Data was obtained from coding and was referenced with patient records identifying those who received IR drainage. Subsequent data collection and verification from radiological IT system, electronic patient records and letters was performed.

Results: 56 patients were identified with pancreatic necrosis/collection in the context of acute pancreatitis that had at least one radiological drain inserted. Median age was 59 years (range 25-84) (20 female). Median drainages per patients was 2 (1-6). Median number of CT scans was 7 (2-16) excluding drainage CT's. Over 70% of patients spent time on intensive care during their inpatient stay and the median inpatient length of stay LOS was 25 days (4-131). Of 56 patients, 7 (12.5%) required subsequent open necrosectomy with 6 of these surviving to discharge (85.7%). 6 patients (10.7%) did not survive to discharge. At 12 months follow up 46 patients (82.1%) remained alive.

Conclusion: Radiological involvement in acute necrotising pancreatic collections is high with multiple diagnostic CT scans and patients requiring multiple drainages. Radiological drainage can be successfully utilised to reduce the requirement of open necrosectomies with good clinical outcomes and a low mortality rate despite the overall mortality remaining high.

P-70

Accuracy of rapid on-site evaluation in transthoracic lung biopsies

J. Garcia¹, A. Rodriguez¹, J. Barcia²

¹Departamento de Imagenología, Hospital de Clínicas, Montevideo, UY, ²Departamento de Anatomía Patológica, Hospital de Clínicas, Montevideo, UY

Purpose: To address the accuracy of rapid on-site evaluation in transthoracic lung biopsies regarding malignancy and tumor type diagnosis.

Material and methods: This retrospective study included 198 transthoracic lung biopsies performed between 2015-2018 in which rapid on-site cytologic evaluation (ROSE) was performed by experienced pathologists. ROSE results were compared with histological analysis of the transthoracic biopsy or surgical or bronchoscopic samples.

Results: Median age 64 years, 139 males and 59 females. Fifty-five patients had a previously known malignancy. Needles used were trucut (131), franseen (60) and both (7). When correlated with histology, ROSE correctly distinguished malignant from non-malignant lesions in 176 cases (89%), with 10 false-positive and 12 false-negative cases. In 102 cases ROSE distinguished between oat-cell and non-oat cell tumors, with 84% accuracy. Diagnosis of epidermoid and adenocarcinoma subtypes on ROSE had an accuracy of 90% and 76%, with 2 and 4 false-positive cases, respectively.

Conclusion: In transthoracic biopsies ROSE can diagnose malignancy with high accuracy. Regarding tumor classification, ROSE has high accuracy for epidermoid and adenocarcinoma subtypes.

P-71

Image-guided percutaneous adrenal biopsy: 11 years of retrospective analysis

T. Hasegawa¹, M. Sone¹, S. Sugawara¹, C. Itoh¹, N. Umakoshi¹, Y. Onishi¹, S. Kimura¹, S. Fujizuka¹, T. Kubo², Y. Arai¹, M. Kusumoto¹

¹Diagnostic Radiology, National Cancer Center Hospital, Tokyo, JP, ²Radiology, The University of Tokyo Hospital, Tokyo, JP

Purpose: To assess the safety and efficacy of percutaneous adrenal biopsies.

Material and methods: In total, 61 percutaneous adrenal biopsies were performed in 59 patients (median age 61 years), guided with computed tomography (n=38), ultrasonography (n=12) or both (n=11) using coaxial techniques, from January 2008 to December 2018. The median size of the target tumour was 52 mm (range 15–190 mm). The patients were in prone (n=53), supine (n=5), ipsilateral decubitus (n=2) or contralateral decubitus (n=1) positions. In general, 18-gauge (n=58) or 14-gauge cutting needles (n=1) were used in all biopsies except for two unrecorded ones. Adjunct techniques to prevent trans-organ puncture included hydrodissection (n=3), postural change to decubitus position (n=2) and artificial pneumothorax (n=1). For each biopsy, 1–6 specimens (median 3) were considered. Technical success, diagnostic yield, approach routes, and adverse events defined using CTCAE v4.0 were retrospectively evaluated.

Results: All procedures were technically successful, with a pathological diagnosis obtained in 60 biopsies (98%; malignant neoplasms in 48 biopsies [78.7%]), whereas one sample showed the presence of necrotic tissue. Trans-organ puncture was observed in seven biopsies (11.5%) comprising four planned (liver) and three unplanned ones (pulmonary, two; kidney, one). Adverse events occurred in four biopsies (6.6%). Grade 3 haemorrhages were observed in two biopsies, which were successfully embolised. No other major complications were observed.

Conclusion: Image-guided percutaneous adrenal biopsy is a safe and effective method to diagnose adrenal tumour pathology due to its high diagnostic yield and clinically acceptable adverse events.

P-72

The efficacy and safety of ultrasound-guided lung biopsy; correlation between the tumor diameter and pleural contact length

R. Imamine¹, E. Sakata¹, T. Koyama¹, K. Akuta²

¹Radiology, Kurashiki Central Hospital, Kurashiki, JP, ²Department of Radiology, Japanese Red Cross Otsu Hospital, Otsu, JP

Purpose: To evaluate the diagnostic accuracy and complication rates of B-mode ultrasound (US)-guided lung needle biopsy and to investigate the correlation of those with the tumor diameter or pleural contact length.

Material and methods: This retrospective study was evaluated 181 peripheral lung lesions (tumor diameter, median 29.5mm; pleural contact length, median 28mm) in 175 patients who underwent B-mode US-guided lung needle biopsy using needle guidance technique between January 2007 and December 2016 at two institutions. Six patients underwent two US-guided biopsies for another lung lesion on different day. Biopsy results were compared with final diagnosis based on surgical outcomes or clinical follow-up observation. The incidence of pneumothorax and bleeding related to procedure was assessed.

Results: Diagnostic accuracy was 90.1% and final malignant diagnoses were determined for 146 lesions (80.7%). Overall sensitivity and specificity were 87.7% and 100%, whereas positive predictive value and negative predictive value were 100% and 66%. Pneumothorax was observed after first puncture for 7 lesions (3.9%), and bleeding occurred during biopsies for 7 lesions (3.9%). Spearman rank correlation shows no correlation of diagnostic accuracy with the tumor diameter ($r_s=0.11$, $p=0.14$) or pleural contact length ($r_s=0.14$, $p=0.07$). Moreover, no correlations of pneumothorax after first puncture with the tumor diameter ($r_s=0.13$, $p=0.07$) or pleural contact length ($r_s=0.14$, $p=0.05$), and bleeding with the tumor diameter ($r_s=0.09$, $p=0.2$) or pleural contact length ($r_s=0.07$, $p=0.33$) were shown.

Conclusion: US-guided lung needle biopsy may be an effective and safe diagnostic tool for peripheral lung lesions regardless of size diameter or pleural contact length.

P-73

Routine renal tumor biopsy can help avoid unnecessary surgery

A.M. Alduk, E. Kresic, M. Prutki

Department of Diagnostic and Interventional Radiology, University Hospital Centre Zagreb, Zagreb, HR

Purpose: Percutaneous renal tumor biopsy is a safe procedure that is currently being recommended prior to ablation and for inoperable renal tumors in order to obtain tissue diagnosis. The purpose of this study is to investigate the influence of routine biopsy on therapeutic management of patients with renal tumors.

Material and methods: Consecutive patients who underwent percutaneous renal mass biopsy between November 2015 and January 2019, were included in this retrospective study. Patient data, tumor size and morphological characteristics, success rates, complications, and pathohistological diagnosis were analyzed. The impact of pathohistological diagnosis on therapeutic management was evaluated.

Results: During the study period, 84 CT guided percutaneous renal mass biopsies were performed in 83 patients. Median tumor size was 31 mm (range 12-124 mm). 64 (76,2%) tumors presented as solid hypervascular mass. Biopsy was successful in 97,6% (N=82), with no complications requiring treatment or prolonged hospitalization. In 25 (30,1%) patients pathohistological diagnosis showed benign, lymphoproliferative or metastatic lesions which did not require surgical treatment.

Conclusion: Percutaneous biopsy is a safe and effective procedure which can alter therapeutic management in a considerable number of patients with renal tumors, sparing them of unnecessary surgery.

P-74

Types of biliary confluence in hilar cholangiocarcinoma patients

M.A. Shorikov¹, O.N. Sergeeva², D.Y. Frantsev², M.G. Lapteva³, E. Virshke², B.I. Dolgushin⁴

¹Radiology, Interventional Imaging Group, The Federal State Budgetary Institution "N. N. Blokhin National Medical Research Centre of Oncology" of the Health Ministry of Russia, Moscow, RU, ²Interventional Oncology, N.N. Blokhin Cancer Research Center, Moscow, RU, ³Radiology, N.N. Blokhin National Medical Research Center of Oncology, Moscow, RU, ⁴Interventional Oncology, Radiology, N.N. Blokhin Cancer Research Center, Moscow, RU

Purpose: The purpose of the study is to compare distribution of biliary confluence types in hilar cholangiocarcinoma patients and those with unremarkable bile ducts.

Material and methods: Biliary confluence types were retrospectively evaluated in 203 hilar cholangiocarcinoma patients ('study group', male/female=108/95, age range 21-84) and 204 patients with unremarkable bile ducts ('control group', male/female=95/109, age range 17-81) at MRCP (all patients) and direct cholangiography (141 study group patients) by 2 radiologists (Cohen Kappa=0.7, differences were resolved by consensus). Nakamura classification was used for confluence typing: I-right biliary duct is present; II-independent drainage of right sectoral ducts to confluence, III-independent drainage of the right posterior duct into common hepatic duct, IV-drainage of the right posterior duct into left bile duct, V-other, right bile duct is absent. Group differences were evaluated with Chi-square and Pearson exact test criteria.

Results: While control group had confluence type distribution close to one described in literature patients in Klatskin tumor group had a significantly different distribution type ($p < 0.001$). Type I was presented in 75% of the patients in control group and in 30% in Klatskin tumor group, other types respectively: II-9% and 24%, IV-14% and 40%, III-0.5% and 1.7%, V-14% and 40%. Statistical and biophysical models showed: uncommon confluences have a larger area of bile ducts where the tumor may originate (10% of difference) and are under higher pressure that is described in animal models as an oncogenic factor for cholangiocarcinoma.

Conclusion: Uncommon hepatic ducts confluence types are significantly more often present in hilar cholangiocarcinoma patients.

P-75

Ultra low dose radiation protocol (80 kV, 3 mAs) for CT-guided percutaneous needle biopsy of pulmonary lesions: feasibility, efficacy and safety

A. Di Martino¹, D. Morosetti¹, A. Raso¹, F. Salimei¹, A. Bozzi¹, J. Scaggiante¹, R. Gandini²

¹Department of Diagnostic Imaging, Molecular Imaging, Interventional Radiology and Radiation Therapy, University Hospital Policlinico Tor Vergata, Rome, IT, ²Diagnostic and Interventional Radiology, Policlinico Tor Vergata, Rome, IT

Purpose: To prospectively determine the feasibility of Ultra Low Dose (ULD) for computed tomography (CT)-guided percutaneous needle biopsy (PNB) of lung lesions, and to evaluate the efficacy and safety of ULD protocol.

Material and methods: CT-guided needle biopsies of pulmonary lesions were prospectively collected between September 2016 and September 2017, using ultra low-low dose (80 kV, 3 mAs) CT protocol.

Results: For this study, a total of 45 biopsies performed using the ULD protocol were selected: 60% men (27m) and 40% women (18w). The overall technical success rate of these biopsies was 82,22% (i.e. 37 patients). Only two cases presented major complications which required hospitalization (4,44%). Twenty-one cases presented a minor complication (46,67%), however, none of these required a thoracostomy tube placement. In our study we found a significant correlation between complications and nodule size. We confronted our data with a retrospective review of data

obtained from patients who underwent an ultra-low dose CT-guided procedure and found similar results. However, we were unable to find any reference, in similar studies, to a voltage below 100Kv and electric intensity below 7,5mAs.

Conclusion: This study demonstrates, when compared with similar previous studies, that the ultra-low dose protocol is safe, efficient and feasible. Studying the correlations between complications, nodule size and biopsy sites, we have proved their importance when selecting possible candidates for the procedure. These results can help hospitals render the management of patients more efficacious and cost-effective and reduce morbidity.

P-76

Fluoroscopy and video-assisted antero-retroperitoneal debriedement (F-VAARD): an interventional step-up approach for severe necrotizing pancreatitis

A.S. Oggero¹, P. Huespe¹, M. de Santibañes², G. Arbues², O. Mazza², S.H. Hyon¹

¹Image Guided Minimally Invasive Surgery, Hospital Italiano de Buenos Aires, Buenos Aires, AR, ²Hepato Pancreatic Biliary Surgery, Hospital Italiano de Buenos Aires, Buenos Aires, AR

Purpose: To evaluate feasibility and safety of fluoroscopy-video-assisted antero-retroperitoneal debriedement (F-VAARD) for severe necrotizing pancreatitis.

Material and methods: Six patients (5 male; median age 60-yr, 45-80) with infected, severe necrotizing biliary pancreatitis, refractory to initial CT-guided pigtail-multipurpose drainage (8.5 to 14-Fr) were included. Worsening clinical progress and lack of image resolution were indications for F-VAARD. After atraumatic tract dilatation to 30-Fr over an extra-stiff guide-wire, a 12-mm plastic trocar (2 patients) or oesophageal self-expandable metallic stent (18x103-mm, 4 patients) was inserted. Access was antero-peritoneal-epigastric for pancreatic head (1 patient) or left-lateral for mid-distal necrosectomy (5 patients). Fluoroscopy and flexible fibroscope or 5-mm endocamera; with laparoscopy forceps and suction cannula were used. Feasibility was defined as technical/clinical success. Morbimortality was stratified according to Dindo-Clavien (D-C), complications being technical (stent occlusion); haemodynamic (bleeding); infectious; organic (biliary stricture, fistulae); or metabolic (insulin requirement). Treatment finalization and stent extraction was based on clinical, laboratory, image, output and antibiotic resolution.

Results: The mean size of collections was 14.8x3.7x6.4-cm. No F-VAARD access became occluded. Minimal bleeding occurred during necrosectomy (no blood transfusion). Four patients presented fever after first necrosectomy without bacteraemia, being Klebsiella spp. most frequently isolated. Two patients developed intrapancreatic bile-duct stricture, resolving with percutaneous/endoscopic dilatation. One patient presented a jejunal fistula (closed spontaneously). Median time elapsed until F-VAARD was 68-days (23-98); hospital stay, 113-days (104-162); stent permanence, 65.5-days (21-147). No major (D-C>III) immediate or further complications occurred at follow-up, 14-mo (7.9-37.8). All cases achieved technical/clinical success.

Conclusion: Fluoroscopy and video-assisted antero-retroperitoneal debriedement is feasible and safe for treatment of severe, necrotizing pancreatitis.

P-77

A new CT-guided modified trocar technique for drainage of difficult locations abscesses

C.J. Tyng

Imaging, A.C. Camargo Cancer Center, Sao Paulo, BR

Purpose: Computed tomography (CT) is commonly used to guide drainage of deep-seated abdominal fluid collections. However, in some cases, these collections seem to be inaccessible due to surrounding organs

or their being in difficult locations. The aim of this study is to describe a modified Trocar technique to drain collections in difficult locations, especially those in the subphrenic space, without passing through intervening organs.

Material and methods: This retrospective case series study describes twenty inpatients who underwent CT-guided drainage using a modified Trocar technique for abscesses that are difficult to access percutaneously. All patients provided written informed consent prior to the procedure. After placement of a 12–14F catheter inside the peritoneum, the Trocar cutting stylet was removed so that the tip of the catheter became blunt and flexible to avoid injury to organs and structures in the catheter route, and the catheter was slowly advanced towards the collection using CT guidance and tactile sensation. After reaching the target, the cutting stylet was reintroduced to enter the abscess wall.

Results: All procedures were performed using an anterior abdominal wall access with adequate catheter positioning and resulted in clinical status improvement in the days after the drainage. No complications related to the procedure were identified in any of the patients.

Conclusion: The modified Trocar technique for percutaneous CT-guided drainage of abdominal abscesses may be feasible for lesions that are difficult to access with conventional methods.

P-78

Preoperative localization of lung lesions with CT-guided placement of a marker wire: does the shape of the distal-end influence outcome?

C. Mattolin¹, S. Ceccato¹, M. Lazzarin¹, M. Battistel¹, G. Barbiero¹, F. Rea², E. Quaia¹

¹Department of Medicine, University Radiology, Padua, IT, ²Thoracic Surgery, University Hospital of Padua, Padua, IT

Purpose: The aim of the study is to compare success and complication rates of two types of lung-marking wire whose main difference is the shape of the distal-end, respectively with a hook and spiral conformation.

Material and methods: Patients who underwent CT-guided marker positioning for preoperative individuation of lung nodules in the period between January 2017 and January 2019 were prospectively enrolled. Spiral (Somatex Medical Technologies) or hook-shaped (Biopsybell Moon) wire were employed. Correct lesion identification at surgery and complication rates were compared.

Results: Eighteen patients were included in the study (10 male, 8 female; median age 56 years); 7 spiral-shaped and 11 hook-shaped wire were inserted. The demographic characteristics of the two groups were similar. Histological analysis found 10 primary lung neoplasms, 6 metastases and 1 benign lesion. All nodules were identified intraoperatively with the spiral end-shaped wires (7/7, 100%); one hook-shaped wire dislodged preventing the identification of the nodule during surgery (10/11 useful markers, 91%). Complications were more frequent using hook-shaped wires than spiral-shaped one: pneumothorax was observed in 10/11 (91%) cases of the first group and in 5/7 (71%) of the second one. An episode of hemorrhagic pleural effusion occurred with the hook-shaped wire (1/11, 9%) being the patient hemodynamically stable and the bleeding stopped during the surgery.

Conclusion: Findings suggest that spiral-shaped marking wires are more stable while anchoring in the soft tissues of the lung and cause less frequently complications than hook-ending systems. Further data in larger groups are required for strong statistical significance.

P-79

Predictors of technical success and complications of cone beam CT-guided lung biopsy

G. Puntel¹, G. Puppini¹, R. De Robertis¹, M. Infante², S. Montemezzi¹

¹Radiology, Azienda Ospedaliera Universitaria Integrata Verona, Verona, IT, ²Thoracic Surgery, Azienda Ospedaliera Universitaria Integrata Verona, Verona, IT

Purpose: To evaluate the relationship between technical aspects, patients' and lesions' characteristics and technical success and complications in patients undergoing cone beam CT-guided transthoracic lung biopsy.

Material and methods: From January 2018 to January 2019, 43 patients underwent cone beam CT-guided transthoracic lung lesions biopsy using a navigation software. The biopsies were performed by three operators with different experience (20, 10 and 2 years, respectively). A single puncture with coaxial technique using a 18G needle was performed in all cases. The shortest access route to the lesion was chosen for each case. Immediate post-procedural cone-beam CT as well as chest x-ray 3 hours after the procedure were performed in all cases. Technical success was reached when a complete pathological report was performed on tissue samples. The following features were correlated to histopathological findings and biopsy-related complications: age; lesions' size, location and depth; number of samples; chest wall thickness; decubitus position; and operator experience.

Results: A final histological diagnosis, including immunohistochemical staining for malignant lesions, was obtained in 74.4% of cases. Pneumothorax occurred in 12 patients (27.9%) and required drainage in 1 case (2.3%). At logistic regression analysis there were no significant predictive variables for technical success and complications (all $p > 0.05$).

Conclusion: Cone beam CT-guided lung biopsy with coaxial technique is effective and safe; no significant predictors for technical success and complications were identified.

P-80

CT-guided percutaneous chest biopsy: diagnostic efficacy and complications, a real life study

P.C.D.M. Pereira¹, M. Silva², D.M. Rocha³, T. Pereira¹, L. Batista⁴

¹Serviço de Imagiologia, Centro Hospitalar de Vila Nova de Gaia/Espinho, Vila Nova De Gaia, PT, ²Serviço de Pneumologia, Centro Hospitalar de Vila Nova de Gaia/Espinho, Vila Nova De Gaia, PT, ³Radiologia, Hospital São João, Porto, PT, ⁴Serviço de Imagiologia do CHVNG/E, Centro Hospitalar Vila Nova de Gaia / Espinho, Vila Nova De Gaia, PT

Purpose: Evaluate CT-guided percutaneous chest biopsy diagnostic yield and safety.

Material and methods: Retrospective observational study of patients submitted to percutaneous chest biopsy under CT guidance in a one year time period. Core samples were obtained using a 18F dual spring system and analyzed histologically.

Results: The study included 217 patients, with an average age of 66.7 years-old; 67.3% of patients were male. 113 patients were former smokers (113/217) and 41 were smokers. 89 patients had medical history of malignancy; 40 with primary lung tumor and 49 in other locations (breast, gastrointestinal and renal). The majority of the lesions were solid (183/217) and located in the superior left lobe (67/217); lesion mean size was 23.0 ± 18. Diagnosis was achieved in 75.1% (n=163/217) with malignancy being the most frequent diagnosis (n= 129; 59.4%), followed by hamartoma (12/217) and tuberculosis (10/217). Within malignancy, the most prevalent were: lung adenocarcinoma (84/127), epidermoid (20/127) and metastatic carcinoma (7/17). There were no complications in 71.9% of the patients. Pneumothorax occurred in (30/217), self-limited peri-lesional bleeding in (21/217), hemoptysis in (6/217), and paravertebral hematoma in (2/217). 5 patients required chest tube placement. In 217 patients, only 4 needed hospitalization. No relationship was observed between complications and lesion size ($p = 0.292$), between complications and needle caliber

($p=0,344$), and complications and number of punctures ($p=0,948$). The lesion size did not interfere with obtaining the final definitive diagnosis ($p=0,819$).

Conclusion: Percutaneous chest biopsy is a minimally invasive procedure with a high diagnostic yield and it is considered very safe when performed by properly trained and experienced physicians. Furthermore, this study helped confirm that malignancy is the most frequent cause of lung lesions.

P-81

Never cross pulmonary vessel to avoid air embolism after CT guided lung lesion biopsy

M.M. Jelitto-Gorska¹, B. Regent², R. Dziedzic³, T. Gorycki²,

K. Dziadziuszko², E. Szurowska², M. Studniarek²

¹Radiology, Medical University of Gdansk, Gdansk, PL, ²II Department of Radiology, Medical University of Gdansk, Gdansk, PL, ³Thoracic Surgery, Medical University of Gdansk, Gdansk, PL

Purpose: Air embolism is a very rare complication after lung tumor biopsy but could be fatal. The aim of the study is to find direct cause of air embolism and assess possible risk factors of this complication.

Material and methods: Between 2013-2017 in the department of radiology 1041 percutaneous CT-guided lung biopsy were performed. Retrospectively, all control CT scans were checked to find intravascular air and its presence was correlated with the clinical state of the patient. In the case of air embolism, we analyzed the procedures to find direct cause of this complication and to assess possible risk factors.

Results: The intravascular air was found in 3 (0,29%) cases. In all cases, severe neurological outcomes were noticed. All three procedures were performed with the use of core needle, each different gauge. In two cases we noticed that the biopsy needle cut directly the small pulmonary vein, in which we noted air in control CT scan. In one case it was impossible to visualize the direct vein crossing due to advanced interstitial disease, but it was strongly suspected because massive hemoptysis appeared. Additionally, in all three cases, there was a coincidence of pneumothorax in a control CT scan and all the punctured lesions were located in the upper lobe, above the level of the left atrium.

Conclusion: Never cross pulmonary vessel to avoid air embolism after CT guided lung lesion biopsy. Possible risk factors of that complication are the coexistence of pneumothorax and lesion location in the upper lobe, above the level of the left atrium.

P-82

Bleeding risk assessment after percutaneous needle biopsy of lung lesions performed under CT control - the study on the base of 1004 procedures

M.M. Jelitto-Gorska¹, K. Dziadziuszko¹, B. Regent¹, T. Gorycki¹, E. Szurowska¹, M. Studniarek²

¹I Department of Radiology, Medical University of Gdansk, Gdansk, PL, ²Department of Radiology, Medical University of Gdansk, Gdansk, PL

Purpose: Bleeding such as alveolar hemorrhage and hemoptysis are common complications after transthoracic needle biopsy. The aim of the study was to assess independent risk factors of bleeding after lung lesion biopsy.

Material and methods: Between 2013 to 2017, 1004 transthoracic needle biopsies of lung lesions were performed - 603 core and 401 fine needle aspiration biopsies. Variables were divided into related to patient, pathology or procedure. To patient's related variables we included age, gender, smoking history, body mass index and anticoagulant therapy. To pathology related variables, lesion density and its size and depth was taking into account. Type and size of the needle, use of CT fluoroscopy, number of needle passing and puncture of lung fissure or pulmonary vessel were analyzed as procedure related factors. All variables were analyzed using univariate and multivariate logistic regression models to assess independent bleeding risks factors.

Results: Bleeding occurred after 360 procedures (35,8%). Univariate analysis proved that bleeding more often occurred among women. Small size of the lesion and its deep location in lung parenchyma increases bleeding risk. More often hemorrhage or hemoptysis occurred when long core needle was used under the control of CT fluoroscopy and when the lung fissure or lung vessel was crossed. Multivariate analysis proved that independent risk factors for bleeding are female gender (OR 0,64, $p<0,01$), use of CT fluoroscopy (OR 3,07, $p<0,01$), deep lesion location (OR 1,04, $p<0,01$), small lesion size (OR 0,98, $p<0,01$), and lung vessel crossing (OR 3,9, $p<0,001$).

Conclusion: The knowledge of bleeding risks factors could reduce this complication occurrence.

P-83

Previous percutaneous path re-inhabitation: a fluoroscopic catheterisation technique

S. Vidali¹, V. Semeraro¹, V. Da Ros¹, A. Wlderck¹, D. Morosetti¹, R. Argirò¹, M. Nezzo¹, N.M. Lucarelli², M.P. Ganimedè², V. Gisone², N. Burdi², C. Di Stasi³, A. Cina³, A. Contegiacomo³, F. Salimei¹, R. Gandini¹

¹Department of Diagnostic Imaging, Molecular Imaging, Interventional Radiology and Radiation Therapy, University Hospital Policlinico Tor Vergata, Rome, IT, ²Radiology, SS Annunziata Hospital, Taranto, IT, ³Department of Radiological Sciences, Institute of Radiology, "A. Gemelli" Hospital - Catholic University, Rome, IT

Purpose: Previous drainage or fistula patency-restoration represents a known but not yet standardised treatment, that may become a first-line approach in patients requiring multiple catheterisation procedures. Collapsed paths from previous catheterisations may allow both easier access to target sites and, being vessel-free and quite resistant cavities, safer progression of devices until final position.

Material and methods: A 4-years prospective multicentric experience of percutaneous previous drainages (37 nephrostomies, 26 biliary and 36 abscess evacuations) and fistulas (21 spontaneous skin fistulous paths) re-inhabitation procedures, made on 120 consecutive subjects (mean age 73 y.o.) between 2015 and 2018. Hydrophilic standard guide-wires and multi-purpose catheters, inserted in previous drainages cutaneous extremity, were used to attempt patency restoration; in case of difficult navigation, slow contrast-medium injection was performed, to test paths' viability and morphology. When re-inhabitation failed, standard percutaneous puncture and catheterisation were applied.

Results: In 102 cases, re-inhabitations (85% of enrolled patients) were successfully performed (group A); in 18 subjects (15% of enrolled patients), patency of previous paths was not restored and standard technique was applied (group B). In group A, 2 cases of transient haematuria were observed, with an associated overall intra-operative complication rate of 1.9%. In Group B, 3 intra-operative (3 episodes of transient haematuria) and 4 post-operative complications (1 abscess, 2 puncture-site skin inflammations, 1 bleeding) were reported, with a complication rate of 16.6% and 22.2% respectively.

Conclusion: Re-inhabitation appears to be a safer treatment solution to be adopted as a first-line treatment strategy in subjects undergoing second or multiple catheterisation procedures, in order to reduce overall complications' risks.

P-84

CT-guided lung biopsy using a 20-gauge needle biopsy: is it possible to obtain sufficient material for genetic analysis?

C. Lima¹, J. Andrade¹, L.G.M. Valle², P.M. Falsarella², V.O. Carvalho², G.M. Gilberto², R.B. Martins³, L. Lembranca¹, G. Mendes¹, L.R. Socolowski², F.A.C. Vieira², A. Rahal Jr², P.R.B. Silvério², R.G. Garcia²

¹Radiologia Intervencionista, Hospital Israelita Albert Einstein, São Paulo, BR, ²Interventional Radiology, Hospital Israelita Albert Einstein, São Paulo, BR, ³Interventional Radiology, Albert Einstein Hospital, São Paulo, BR

Purpose: To verify if the sample obtained with a 20-gauge needle biopsy is able to provide sufficient material for genetic analysis.

Material and methods: For genetic analysis of the material collected through CT-guided lung biopsy we use the tests Oncoscreen and FoundationONE.

Results: Of the 97 cases biopsied, 75 didn't perform genetic analysis. Of the 22 cases submitted for analysis, 14 were referred to Oncoscreen and 8 to FoundationONE. Of the 14 patients who underwent the Oncoscreen test, 85% had adequate sample, 1 insufficient sample and 1 sub-optimal sample. Of the 8 cases sent to FoundationONE, 4 presented adequate material and the remaining sub-optimal material. The criterion used to classify the material as sub-optimal for the Oncoscreen test was the need to perform more than one extraction of DNA and RNA due to the small amount of material. The extraction of DNA and RNA is performed at the same time with a single kit and, in cases of small samples, DNA extraction may be impaired, requiring further extraction by another technique. The criterion used to classify the material as sub-optimal (Qualified) for FoundationONE was that the quality or quantity criteria of the sample received were not all present but allowed the test to be performed. There was only one case submitted to genetic analysis by the Oncoscreen test that wasn't possible to perform it due to insufficient amount of material.

Conclusion: Despite the small number of cases, we obtained a high success rate and performed the genetic analysis through the fragments obtained with a 20-gauge needle.

P-85

Hemorrhagic complications after image-guided percutaneous core liver biopsy: a single institution experience with 16 and 18 gauge biopsy needles

A. Kubiak¹, J.A. Cieslak¹, H. Bueno², K. Beidas¹, P.A. Shukla¹, P. Kiszka²

¹Department of Radiology, Rutgers, The State University of New Jersey, Newark, NJ, US, ²Division of Interventional Radiology, Department of Radiology, Rutgers, New Jersey Medical School, UH, Newark, NJ, US

Purpose: Hemorrhagic complications after image-guided percutaneous core liver biopsy (IGPCLB) are rare (0.5%) but can cause significant morbidity and mortality. The American Association for the Study of Liver Diseases has stressed the importance of obtaining sufficient liver biopsy specimens. However, the use of smaller-diameter core systems persists in order to minimize perceived complication risks. We sought to compare bleeding rates after 16 and 18 gauge IGPCLB in our institution.

Material and methods: Utilizing retrospective review of IGPCLB performed during 2018, all patients who underwent biopsy with a 16 or 18 gauge needle were included. Demographic data, hematology and coagulation results, aspirin use, the size of the biopsy needle, and the number of needle passes was collected. Bleeding complications were defined using the Common Terminology Criteria for Adverse Events established by the NCI. Followup was 1 month.

Results: 47 patients, (22 males and 25 females, mean age 53.0 +/- 13.3 yrs) met inclusion criteria. 31 patients underwent US-guided core biopsy (66%) and 16 underwent CT-guided core biopsy (34%). 18/47 biopsies (33%) were performed with a 16G needle (13 US-guided, 5 CT-guided) and 29/47 (62%) were performed with an 18G needle (18 US-guided, 11 CT-guided). 3 cores were obtained per patient. One patient had self-limited

bleeding (2.13% overall) after 16G biopsy (1/18, 5.6%) vs no patients with bleeding after 18G biopsy (0/29, 0%); not statistically significantly. No difference between modality of image-guidance was seen. No mortality was observed.

Conclusion: The overall incidence of major bleeding after IGPCLB is low with no safety difference with 16- and 18-gauge needles.

P-86

Morbidity and mortality of iatrogenic hemorrhagic complications after large volume paracentesis in chronic liver failure patients: conservative management vs IR embolization

A. Kubiak, J.A. Cieslak, M. Siddiqi, H. Bueno, S. Contractor, P.A. Shukla, P. Kiszka

Department of Radiology, Rutgers, The State University of New Jersey, Newark, NJ, US

Purpose: Hemorrhagic complications post large volume paracentesis (LVP) in cirrhotic patients are rare but can cause significant morbidity and mortality including abdominal wall hematoma, pseudoaneurysm, and hemoperitoneum after injury to the inferior epigastric artery (60%) or mesenteric varices (20%). Treatments include conservative management, embolization or surgical intervention. No predictive parameters for morbidity and mortality in hemorrhage post LVP have been identified. We aimed to identify predictive factors for patients who would benefit from early IR embolization.

Material and methods: Retrospective review identified 8 patients with cirrhosis who had hemorrhagic complications after LVP. MELD score, platelets, INR, hemoglobin levels, Cr, BUN, GFR, puncture site, volume of ascites removed, management details and mortality were determined.

Results: 4 patients were treated conservatively with IV fluids and blood transfusions and 4 patients were treated with IR embolization of the inferior epigastric and superficial circumflex iliac arteries (Gelfoam (n=3) or 3:1 Ethiodol:Trufill glue (n=1)). Hemostasis was achieved in all patients. One death was observed in each group. No statistically significant difference in any of the parameters was identified. The two mortalities had the highest MELD scores and poorest renal function in their respective groups (MELD $\geq$ 40, Cr $\geq$ 4, GFR $\leq$ 16).

Conclusion: A correlation between post-LVP hemorrhagic complication rates and increasing MELD score and renal dysfunction has previously been made, but no correlation of the likelihood of mortality after post-LVP bleeding has been established. Our series isn't powered to detect such a difference, but suggests that patients with severe liver failure and renal insufficiency should be treated early and aggressively after post-LVP hemorrhage to decrease the risk of mortality.

P-87

CT fluoroscopy-guided drainage for pyogenic spondylodiscitis and iliopsoas abscesses

T. Matsumoto¹, K. Tomita¹, S. Suda¹, S. Kamei¹, S. Yamamoto¹, T. Yamagami², T. Hasebe¹

¹Department of Radiology, Tokai University Hachioji Hospital/Tokai University School of Medicine, Hachioji, Tokyo, JP, ²Radiology, Medical School, Kochi University, Nankoku, JP

Learning objectives:

1. To review the anatomical, clinical and diagnostic features of life-threatening pyogenic spondylodiscitis (PS) and iliopsoas abscesses (PIPA)
2. To illustrate the tips and tricks of CT fluoroscopy-guided interventional procedures for PS/PIPA drainage

Background: PS and PIPA is a relatively rare condition. However, a recent report demonstrated the rapid increase in aged population. Because the patients are often immunocompromised hosts or patients with a poor general condition, a less invasive procedure such as CT-guided drainage is desirable. However, although CT-guided drainage for PS and PIPA offers

an effective alternative to surgery, the majority of literature relating to CT-guided drainage for PS and PIPA is in the form of case reports and short case series. The purpose of this educational exhibit is to review CT-guided drainage for PS and PIPA based on anatomical features and technical tips.

Clinical Findings/Procedure Details: How to select the approach route for safe and effective CT fluoroscopy-guided interventional procedures for PS/PIPA drainage?

1. PIPA located on the lateral wall of the pelvis: An anterior approach from just above the anterior iliac spine.
2. PIPA involving the psoas muscle: An posterolateral approach through paravertebral muscles.
3. Intervertebral drainage for lower cervical PS/ thoracolumbar PS/ PS at the lumbosacral junction (in technically challenging cases): A posterolateral (posterior to the carotid sheath) / posterolateral / transsacral approach.

Conclusion: We, interventional radiologists, should be familiar with the anatomical and technical features to perform feasible and effective CT fluoroscopy-guided drainage for PS and PIPA.

P-88

The phrenic nerve: you can use it or abuse it

J.S. Kriegshauser¹, C.D. Czaplicki¹, J.H. Schildmeyer², N.R. Langley³, M.-G. Knuttinen¹, S.G. Naidu¹, S.J. Alzubaidi¹, I.J. Patel¹, R. Oklu¹

¹Radiology, Mayo Clinic Hospital, Phoenix, AZ, US, ²Anatomy, Mayo Clinic Alix School of Medicine, Rochester, MN, US, ³Anatomy, Mayo Clinic Alix School of Medicine, Scottsdale, AZ, US

Learning objectives:

1. Review the relevant phrenic nerve anatomy in the neck and chest.
2. Know when to use and be able to describe the technique of phrenic nerve block for hiccups and lung nodule biopsy.
3. Understand the ramifications of phrenic nerve damage during ablation procedures and how it might be avoided.

Background: Understanding the course of the phrenic nerve has been important for surgeons and anesthesiologists for many years, so they can avoid damage and nontargeted anesthesia to the nerve. Likewise, interventional radiologists must take great care not to include the phrenic nerve in an ablation area. However, a phrenic nerve block may be beneficial to treat recalcitrant hiccups or decrease respiratory motion during lung nodule biopsy.

Clinical Findings/Procedure Details:

1. Techniques for protecting the phrenic nerve during ablations.
2. Techniques for phrenic nerve block in the neck.
 - a. Etiologic diagnosis and treatment for hiccups.
 - b. Temporary block to decrease respiratory motion during lung nodule biopsy.

Conclusion: Knowing the usual course of the phrenic nerve, and its variations, is important when a proceduralist needs to avoid it or find it. We discuss techniques to avoid the phrenic nerve during ablations, how/when to target the nerve for diagnoses and treatment of hiccups, and how/when to utilize a unilateral local phrenic nerve block to improve outcomes during lung nodule biopsy.

P-89

Rebiopsy of non-small cell lung cancer: a necessity in the era of targeted therapy

A.A. Khankan, M.M. Abdulhaq, I.A. AlHabli, A. Kenawi
Department of Medical Imaging, King Abdulaziz Medical City, Jeddah, SA

Learning objectives: To explain the rationale of rebiopsy of non-small cell lung cancer (NSCLC) in evaluating the tumor therapeutic response, predicting therapeutic resistance and directing the current targeted therapy in addition to its impact on interventional radiology practice

Background: The diagnosis of NSCLC is based on detecting either an epidermal growth factor receptor or anaplastic lymphoma kinase mutation using tissue samples for normal pathological diagnosis. Recent advancements in molecular targeted therapy and immune-checkpoint therapy have evolutionary and revolutionarily impact on management of NSCLC leading to improving the survival of patients with cancer harboring specific genetic alterations. Such therapies require more precise and timely analyses of tissue which result in an increased demand for rebiopsy for personalizing and guiding the therapy although the rebiopsy is still not a common procedure in the current practice.

However, various factors limit the feasibility of rebiopsy for molecular analysis, including the amount of required tissue, best acquisition technique and optimal timing and type of molecular tests applied. To overcome these limits, a multidisciplinary approach is required on a local or institutional level to standardize rebiopsy protocols in order to achieve the best therapeutic outcome.

Clinical Findings/Procedure Details: The poster will provide an overview on the role of rebiopsy in directing targeted therapy of NSCLC. It will focus on the followings:

1. Molecular testing in NSCLC
2. Rebiopsy indications and optimal utilization
3. Potential difficulties and complications

Conclusion: An understanding of the concept of rebiopsy in patients with NSCLC harboring specific genetic alterations is essential for interventional radiologists to be able to facilitate the targeted therapies.

P-90

Hydrodissection assisted CT-guided biopsy – a safe and easy approach

P.T. Wanjari

Interventional Radiology, Seth GS Medical College & Kem Hospital, Mumbai, IN

Learning objectives: Effectiveness of approaching the target in CT guided Biopsy by Hydrodissection with 0.9% saline by causing displacement of the viscera avoiding major complications

Background: 48 years Female, treated case of Ovarian cancer with omental & nodal metastasis came for follow up. Received 8 cycles of Chemotherapy with complete response and underwent TAH+BSO+Omentectomy with concurrent 2 cycles of Adjuvant Chemotherapy for recurrence.

67 years Male, evaluated for haematuria and blood clots in urine, found to have Right renal mass extending in perinephric space with enlarged RP nodes and a nodular lesion on the Lateral limb of adrenal gland. Urine Cytology Negative for malignancy, Right kidney not visualised in DTPA scan. Planned CT guided biopsy of the adrenal lesion followed by Cytoreductive Nephrectomy+Metastatectomy if it comes positive for malignancy.

Clinical Findings/Procedure Details: CT scan in Ca ovary patient reveals 17 x 10 mm Aortocaval lymph node, undergone CT guided biopsy by lateral displacement of the Right Ureter followed by anterior displacement of the Vena cava by injecting 20-30 cc Saline through the 18-15 G Co-axial system, dissecting and expanding the posterior paravertebral space with simultaneously advancing the needle under serial CT control. In the suspected case of metastatic left adrenal mass, biopsy was performed by craniocaudal approach advancing the needle through the left paravertebral space by dissecting and expanding with Saline injection through the 18-15 G Co-axial system causing lateral displacement of the Left Kidney avoiding the pleural puncture.

Conclusion: In oncological patients Hydrodissection assisted CT guided Biopsy gives safe access with high accuracy and minimal complications and the same technique can also be used in CT guided drainage procedures.

P-91

Application of air and hydrodissection in interventional radiology: a pictorial review

R.S. Chivate¹, P. Thakrar², R. Gali¹

¹Interventional Radiology, Jupiter Hospital, Thane, IN, ²Radiology, Nirman Diagnostic Centre, Mumbai, IN

Learning objectives: The spectrum of interventional radiology has been on the rise and now successfully covers percutaneous pigtail catheterisation, image guided biopsy, ablation of anatomically difficult accessible masses. Approach to these masses is often assisted by hydro or air dissection to negotiate and safeguard vital structures in close proximity. Techniques using hydro and air dissection include biopsy of retroperitoneal structures, i.e. adrenals, pancreas, nodal masses; radiofrequency or microwave ablation of liver/renal mass etc.

Background: In some cases even air was used eg. creating controlled pneumothorax for mediastinal node biopsy. 0.9% normal saline was generally used for hydrodissection and creating a path for needle to approach the target. However, 5% dextrose was injected in cases of radio frequency ablations as normal saline tends to conduct heat and cause complications.

Clinical Findings/Procedure Details: Pre-operative assessment of the lesion is done with CT scan or MRI. Procedures are done under CT guidance or fluoro guidance. Depending on type of procedure, biopsy needles/RFA electrode is advanced into the fat planes in close proximity to the lesion and minimum volume of 0.9% saline solution/ dextrose/dilute contrast medium/hydro dissection gel materials/ air etc is injected to displace the adjacent vital viscera or vasculature to allow proper passage of the needle through the space created by hydro and air dissection, which varied from 20 to 50 ml.

Conclusion: Hydro and air dissection offers safe, precise and effective aid to different techniques in field of intervention radiology and has resulted in significant reduction in morbidity.

P-92

Key technical considerations for liver biopsy according to pathology requirements: a review

J. Facas¹, R. Almeida², A. Cipriano², F.C. Alves¹, J.F. Costa¹, P. Donato¹

¹Radiology Department, Centro Hospitalar e Universitário de Coimbra, Coimbra, PT, ²Pathology Department, Centro Hospitalar e Universitário de Coimbra, Coimbra, PT

Learning objectives: To review the technical specifications to perform a diagnostic liver biopsy according to pathology recommendations.

Background: The number of liver biopsies performed by interventional radiologists' (IRs) is gradually increasing (1). Inconclusive biopsies are a major concern attending the potential hazards of a delayed diagnosis, procedural risks and associated economical loss.

Therefore it is mandatory for the IR to closely understand the pathologists' recommendations for liver biopsies as a way to achieve optimal diagnostic yield.

Clinical Findings/Procedure Details: Liver biopsies should be performed differently according to clinical recommendations.

For diffuse parenchymal disease the ideal representativity is achieved with the presence of 11 portal tracts without major fragmentation, translating into a 16-gauge cutting needle, 2-3cm length (2,3). Importantly there are cases where bigger samples are needed, such as assessing ductopenia where 20 portal tracts are recommended (4-6).

Solid hepatic nodules offer a better size/representativity ratio (3), meaning a thinner 18-19 gauge, 1cm length needle is generally sufficient (7). Also, depending on institutional experience, metastatic and biliary malignancies' diagnosis is possible using fine needle aspiration biopsy (9,10). Understanding the remaining liver is considerably helpful for the pathologist, particularly for hepatocellular nodules. So it is good practice to provide an appropriate description of the liver imaging and,

when adequate, biopsying a non-lesional area for morphological and immunohistochemical comparison (e.g. Adenoma) (7).

Conclusion: The technique to perform a liver biopsy is not unequivocal. Thus the best approach is to personalize each biopsy, meaning not only the procedural aspects should tailor the biopsy, but also the clinical and pathological recommendations.

P-93

Complications of CT-guided lung biopsies: detection, prevention and management

M. Cruz, C. Terra Rodrigues, C. Ferreira, P.G. Oliveira, F. Alves, P. Donato
Serviço de Imagem Médica, Centro Hospitalar e Universitário de Coimbra, Coimbra, PT

Learning objectives: The purpose of this article is to discuss:

1. the potential complications of CT-guided lung biopsies and their diagnosis;
2. the technical factors that predispose to the complications and how to prevent them;
3. the management of the patient by the performing physician in each complication.

Background: Percutaneous CT-guided needle biopsy of lung lesions is a well-established technique in modern medical practice, as it allows to obtain tissue for histopathological or microbiological characterization. It is a safe procedure and considerably less invasive than surgical biopsy. However, complications may occur.

Clinical Findings/Procedure Details: The most commonly encountered complications in percutaneous CT-guided lung biopsies are pneumothorax, pulmonary hemorrhage and hemoptysis. Pneumothorax has the highest reported incidence, ranging from 27% to 54% in most of the large series. Pulmonary hemorrhage occurs in 5-16,9% of the cases, with 1,2-5% of these presenting with hemoptysis.

Hemothorax, chest wall hematoma, air embolism, hemomediastinum, cardiac tamponade, vasovagal reaction and tumour seeding are less frequently reported.

When performing a CT-guided lung biopsy, the performing physician is responsible for early detection of complications, appropriate treatment in the acute setting and correct coordination with a multidisciplinary team (namely anesthesiologists, pneumologists and surgeons).

Conclusion: CT-guided lung biopsy is a safe and effective method for histological and microbiological characterization of suspicious lung lesions. However, several complications may result from the procedure and predisposing factors should be prevented. If they occur, correct diagnosis and management by the performing physician is essential in order to provide adequate care.

P-94

Cerebral air embolism after CT-guided lung biopsy: a case of early diagnosis and successful treatment

F. Piccoli¹, E. Lanza², F.R. Lutman²

¹Radiology, Humanitas University, Milan, IT, ²Diagnostic and Interventional Radiology, Humanitas Research Hospital, Rozzano, IT

Clinical History/Pre-treatment Imaging: A 36 years old woman affected by Hodgkin Lymphoma came to our attention for CT-guided biopsy of an FDG/PET-positive pulmonary nodule located in the right upper lobe, which was performed in a single shot using an 18-G Tru-Cut needle guided by CT-fluoroscopy. Immediately after needle removal, the patient experienced hemoptysis and had a tonic-clonic seizure.

Treatment Options/Results: According to the Hare et al. algorithm, the cardiac arrest team was called, 100% oxygen supply was started and both chest and brain CT were performed. The brain CT showed intracranial air in the frontal and parietal lobes, suggesting SAE. The patient was moved to the right lateral decubitus and high flow oxygen was administered. Neurological assessment scored 8 GCS-points, prompting placement of

an external ventricular derivation. A drug-induced coma was maintained for 48 hours. Upon awakening, the patient's vitals normalized, and the deficits improved. The brain CT performed 3 days after showed complete resorption of the cerebral air bubbles. She was discharged 10 days later, after complete recovery.

The biopsy was positive for lymphoma.

Discussion: The Hare et al. algorithm enabled rapid diagnosis and treatment. This case, although single, is important by virtue of cerebral SAE rarity and its life-threatening characteristics. Our treatment course deviated from the recommendations due to the absence of a hyperbaric chamber and to the placement of a ventricular derivation, never reported before to treat SAE. This choice proved however successful.

Take-home points: Physicians performing lung biopsies should be aware of the unpredictable manifestations of SAE and mindful of the usefulness of an emergency algorithm for its management.

P-95

CT-guided percutaneous drainage within intervertebral space for cervical pyogenic spondylodiscitis

K. Tomita¹, T. Matsumoto¹, S. Kamei¹, S. Yamamoto¹, M. Higaki², T. Hasebe¹

¹Department of Radiology, Tokai University Hachioji Hospital, Tokai University School of Medicine, Hachioji, JP, ²Department of General Internal Medicine, Tokai University Hachioji Hospital, Tokai University School of Medicine, Hachioji, JP

Clinical History/Pre-treatment Imaging: A man in his 70s presented worsening neck pain for 2 weeks. He was afebrile, and the other vital signs were normal. The physical examination showed no neurological deficits. The laboratory data on inflammatory reaction was of high value. Contrast enhanced computed tomography (CT) revealed C6/7 pyogenic spondylodiscitis with epidural abscess.

Treatment Options/Results: We performed CT-guided percutaneous drainage within intervertebral space using a posterolateral approach, in which the needle was inserted from the lateral neck and advanced posterior into the carotid sheath towards the intervertebral space. After the needle had reached the intervertebral space, a 0.035-inch guidewire was inserted into the intervertebral space and an 8-French pigtail catheter was positioned within the intervertebral space. Pus culture isolated an extended spectrum beta-lactamase producing *Klebsiella Pneumoniae*. Meropenem was intravenously administered for 4 weeks. The drainage catheter was removed on day 29, and the patient was discharged on day 30.

Discussion: Successful percutaneous CT-guided drainage for pyogenic spondylodiscitis of the thoracolumbar spine and the lumbosacral junction has been reported. However, approaches used in the thoracolumbar spine and the lumbosacral junction cannot be used in the cervical spine because a transverse foramen gives passage to the vertebral artery, and due to the uncinat process on the side edges of the top surface of the vertebral bodies along the route. Thus, we employed the posterolateral approach.

Take-home points: CT-guided percutaneous drainage within intervertebral space for cervical pyogenic spondylodiscitis could be a safe and effective treatment.

The posterolateral approach is feasible for CT-guided percutaneous drainage within intervertebral space for the lower cervical region.

P-96

A case of transfemoral transvenous liver biopsy

K.M.C. Mo, H.M.J. Cheng
Radiology, PYNEH, Hong Kong, HK

Clinical History/Pre-treatment Imaging: A 57-year-old male with history of diabetic nephropathy on hemodialysis was admitted as cholestatic pattern deranged liver function complicated with hepatic encephalopathy

and hepatorenal syndrome. No dilated biliary system or focal hepatic lesion was found at initial CT scan. USG guided percutaneous liver biopsy showed ductal obstruction due to sepsis or Budd-Chiari Syndrome. Patient subsequently had progressive cholestasis for one month and repeat liver biopsy was decided. Transvenous approach was planned in view of deranged clotting profile and ascites. Left internal jugular venous indwelling dialysis catheter was in-situ. Thrombosis presented at contralateral side due to prior catheterisation. Transfemoral transvenous liver biopsy was performed.

Treatment Options/Results: Left femoral vein approach was performed. Right hepatic vein was cannulated by 5Fr Cobra-shaped catheter. Bi-directional steerable guiding sheath was confirmed in right hepatic vein by intra-procedural ultrasound. Cordis 7Fr Endovascular Biopsy Forceps was inserted for sampling. Twelve passes made yielding good cups of tissue uneventfully. Pathology showed cholestasis associated with ductular reaction and diagnosis was drug related liver injury.

Discussion: Transvenous liver biopsy is a well established alternative technique for hepatic tissue sampling for those who are contraindicated in standard percutaneous transabdominal approach. Transfemoral route is considered when transjugular unavailable. Ideal biopsy site and familiar with biopsy instrument are not only important for adequate sampling but also avoid serious potential complication.

Take-home points: Transfemoral transvenous liver biopsy is an effective alternative for hepatic tissue sampling when percutaneous or transjugular routes are not feasible. Despite technically challenging and costly, it is safe and well-tolerate procedure with satisfactory diagnostic yield.

P-97

Intraluminal biopsy of a superior vena cava mass

F. Petrocelli¹, G. Bovio², A. Utili³, N. Camisassi⁴

¹Radiology, San Martino, University Hospital, Genoa, IT, ²Interventional Radiology, San Martino University Hospital, Genoa, IT, ³Radiology and Interventional Radiology, IRCCS San Martino, University Hospital, Genoa, IT, ⁴Radiology, IRCCS San Martino, Genova, IT

Clinical History/Pre-treatment Imaging: A 30-years old woman with superior vena cava syndrome underwent a computed tomography that revealed a soft-tissue anterior mediastinal mass that has invaded into the superior vena cava (SVC). Positron emission tomography (PET)-CT showed increased FDG uptake, with a maximum standardized uptake value SUVmax of 13. Since the bulk of the tumor was within the superior vena cava SVC, it was not technically feasible to obtain tissue using CT-guided percutaneous biopsy.

Treatment Options/Results: After multidisciplinary discussion, intraluminal biopsy of this mass was thought to be the safest approach. In light of the morphology of the intraluminal mass, we decided to use the femoral approach to perform the biopsy. Using a long 8-French introducer sheath we reached the SVC. Under fluoroscopic guidance, the angled sheathed was directed towards the intended biopsy target and endoscopy biopsy forceps were pushed into the mass for tissue retrieval. During the procedure, there was no serious bleeding or other complication. One good specimen was obtained and histology confirmed a primary mediastinal large B-cell lymphoma-WHO 2017.

Discussion: The choice of biopsy method has to balance the potential risks as well as the positive histology. In case of intracaval tumors the major risk is the dissemination. Endoscopy biopsy forceps have been already used in the inferior vena cava (IVC) but they are rarely used in the SVC. Since diagnosis was confirmed pathologically, the patient underwent target anticancer treatment with an excellent clinical response.

Take-home points: Endoscopy biopsy forceps is a valid and safe system to obtain a biopsy of an endovascular mass.

P-98

Coronary air embolism during percutaneous thoracic procedures: recognizing and managing a potentially fatal complication

N.K. Njuguna

Radiology, Radiology and Imaging, Inc, Springfield, MA, US

Clinical History/Pre-treatment Imaging: Patient 1: 60-year-old male undergoing CT-guided biopsy of a lung nodule developed stridor, hemoptysis, acute lower chest pain before going unresponsive in decerebrate posturing. Electrocardiogram showed ST segment elevation in leads II, III and V2-4. CT showed air in the right coronary artery and aortic root and a brain MRI showed diffuse anoxic injury (Figure 1). He died a week later. Patient 2: 62-year-old male with pneumonia and hydropneumothorax reported acute chest pain, became hypotensive, and unresponsive during CT-guided placement of an empyema tube. Cardiac monitor showed ST segment elevations. He was placed in Trendelenburg, treated with fluids, vasopressors, 100% oxygen and made a full recovery. CT of the chest showed air in the right coronary artery, aorta, and left ventricle (Figure 2).

Treatment Options/Results: When intracardiac, coronary, and cerebral air embolism is suspected, the patient should be placed in Trendelenburg/right side down and on 100% oxygen to optimize reabsorption of air.

Discussion: Intraprocedural introduction of air into the pulmonary veins and systemic circulation can occur through a needle lumen or via parenchymal alveolar/bronchial to venous communication. Coronary air embolism may manifest as EKG changes of ischemia in the associated vascular territory. Contemporaneous cerebrovascular air embolism can present with neurological deficits and seizures.

Take-home points: Precordial chest pain, cardiovascular collapse, and EKG findings of myocardial ischemia can indicate coronary air embolism. Prompt recognition and management can be lifesaving.

Bone, spine and soft tissue intervention

P-99

DiscoGel® for management of herniated discs - efficacy and durability over 3-year periodD. Kuhelj¹, I.J. Kocijančič¹, A. Dobrovolec²¹Clinical Radiology Institute, University Medical Centre Ljubljana, Ljubljana, SI, ²Radiology, Celje General Hospital, Celje, SI

Purpose: Percutaneous management of chronic contained herniated discs with DiscoGel® was introduced lately. The efficacy and durability over a 3-year period was assessed.

Material and methods: 47 males and 36 females, 18-79 years (mean 48,9) were treated for 16 cervical and 67 lumbar contained disc herniations between May 2014 and December 2015. Pain was assessed by Visual Analog Scale. Patients' physical activity, the use of analgesics, return to fully productive life, satisfaction with the treatment and willingness to repeat it were also documented by designated questionnaire. The study was concluded on September 30th 2018.

Results: 71% of 83 patients responded. VAS score was significantly reduced in 1 month in 89,8% of patients ($p < 0,001$). It decreased further during 3-year period in patients with lumbar ($p = 0,012$) and remained stable in patients with cervical symptoms. The improvement was seen in 93,5% of patients with lumbar and in 76,9% with cervical symptoms. There was marked reduction in physical disability; moderate and severe disability reduced from 96,6% to less than 30% after 12 months. 78% of patients needed less analgesics and most of active patients returned to their job (71,1%). Most of patients were satisfied with the treatment (86,4%), only 10,2% would not repeat it if needed. A single patient was operated two years after the treatment.

Conclusion: Our results confirmed efficacy of DiscoGel® and a long-term durability that remained stable in patients with cervical symptoms and

even improved in patients with lumbar symptoms. Consequently, the treatment should be proposed to selected patients as the first-line therapy.

P-100

Thermal ablation of bone metastases: which is the most dangerous technique?P. De Marini¹, R.L. Cazzato², P. Auloge¹, G. Koch¹, J. Caudrelier¹, J. Garnon¹, A. Gangi²¹Interventional Radiology, University Hospital of Strasbourg, Strasbourg, FR, ²Imagerie Interventionnelle, Hopitaux Universitaires de Strasbourg, Strasbourg, FR

Purpose: to compare the safety profile of cryoablation (CA) and radiofrequency ablation (RFA) applied for the treatment of bone metastases.

Material and methods: This monocentric retrospective study reviewed the complication rate of bone metastases treated by percutaneous RFA (66 metastases in 53 patients) or CA (300 metastases in 222 patients) between 2008 and 2017. Complications were assessed according to the CTCAE v4 classification.

Results: Compared to patients treated by CA, patients treated by RFA had a poorer performance status (88.7% vs 73.9% with a performance status ≤ 2 , $p=0.02$); were treated more frequently due to spine metastases (60.6% vs 20.7%, $p<0.001$); and presented with smaller tumors (3.0 ± 1.5 vs 4.6 ± 2.2 cm, $p<0.001$) that were less frequently close to critical structures (23.1% vs 66.3%, $p < 0.001$).

Ten metastases (2.7%) showed major (CTCAE v4 grade ≥ 3) complications without any difference between CA and RFA (8; 2.7% treated by CA and 2; 3.0% treated by RFA; $p=0.87$). Forty-one (11.2%) metastases showed minor complications that were more common in the group receiving RFA (33.3% vs 6.3%, $p<0.001$). This difference was related to a significant rate of post-procedural pain after RFA (31.8% vs 4.0%, $p<0.001$).

Conclusion: CA and RFA are safe techniques for the treatment of bone metastases; nevertheless, CA offers significant advantages in terms of post-procedural pain.

P-101

Rapid pain improvement in patients treated for painful bone metastases with the Medtronic OsteoCool RF ablation system: The OPuS One studyS. Bagla¹, J. Levy², T. Hopkins³, F. Massari⁴, A. Vogel⁵, A. Bress⁶, R. Dixon⁷, W. O'Connell⁸, P. Sunenshine⁹, J. Barr¹⁰, N. Tran¹¹, J. Morris¹², E. David¹³, G. Dooms¹⁴, N. Von der Höh¹⁵, A. Gangi¹⁶, K. Schwartz¹⁷, H. Berrier¹⁷, T. Brelje¹⁷¹Cardiovascular & Interventional Radiology, Inova Alexandria Hospital, Alexandria, VA, US, ²Interventional Radiology, Northside Hospital, Atlanta, GA, US, ³Anesthesiology, Duke University Medical Center, Durham, NC, US, ⁴Interventional Radiology, University of Massachusetts Memorial Medical Center, Worcester, MA, US, ⁵Interventional Radiology, Renown Regional Medical Center, Reno, NV, US, ⁶Interventional Radiology, St. Jude Medical Center, Fullerton, CA, US, ⁷Interventional Radiology, University of North Carolina at Chapel Hill, Chapel Hill, NC, US, ⁸Interventional Radiology, Emory University School of Medicine, Atlanta, GA, US, ⁹Interventional Radiology, Banner University Medical Center, Phoenix, AZ, US, ¹⁰Interventional Radiology, University of Texas (UT) Southwestern Medical Center, Dallas, TX, US, ¹¹Neurosurgery, Moffitt Medical Center, Tampa, FL, US, ¹²Radiology, Mayo Clinic, Rochester, MN, US, ¹³Interventional Radiology, Sunnybrook Health Sciences Centre, Toronto, CA, ¹⁴Radiology, Centre Hospitalier de Luxembourg, Luxembourg, LU, ¹⁵Department Orthopaedic Trauma & Plastic Surgery, Universitätsklinikum Leipzig AöR, Leipzig, DE, ¹⁶Imagerie Interventionnelle, NHC, Strasbourg, FR, ¹⁷Clinical Research, Medtronic, Minneapolis, MN, US

Purpose: To report the preliminary outcomes from the prospective, non-randomized, multicenter study of Medtronic's OsteoCool Radiofrequency

Ablation (RFA) system used for the palliative treatment of patients with painful bone metastases (OPuS One Study).

Material and methods: Subjects were prospectively enrolled from October 2017 through August 2018. Inclusion criteria were: 2 or less painful target sites involving the thoracolumbar spine, pelvis and/or sacrum, with a worst pain $\geq 4/10$ measured by the Brief Pain Inventory (BPI) within the previous 24 hours. RFA was performed with the OsteoCool device. Subjects were evaluated prior to RFA and post operatively. Device-, procedure- and/or therapy-related adverse events (AEs) were collected.

Results: Thirty seven subjects at 8 US centers underwent RFA. The mean age was 64 years and 68% were female. Mean baseline BPI worst pain was 8.6. Thirty-one subjects (84%) were treated for lesions involving the thoracolumbar spine, while 6 subjects (16%) were treated for lesions located in the pelvis and/or sacrum. Of the 14 subjects presenting at the 3-month visit, 93% did not undergo radiation therapy at the targeted site(s) between baseline and 3 months. Seventy-four percent (25/34) of subjects at 1 week and 93% (13/14) of subjects at 3 months reported a clinically significant change from baseline in worst pain of ≥ 2 points. One AE, drug hypersensitivity, resolved without intervention. All eleven deaths reported were not related to RFA.

Conclusion: The preliminary results of the OPuS One study show rapid pain improvement at 1 week and sustained long-term relief through 3 months in patients with metastatic bone disease.

P-102

Preoperative transcatheter arterial embolization for metastatic spinal cord compression

S. Chatani¹, Y. Sato¹, S. Haimoto², S. Murata¹, T. Hasegawa¹, I. Dejima¹, M. Takahashi¹, H. Tsukamoto¹, M. Kato¹, H. Yamaura¹, H. Onaya¹, K. Hattori², Y. Inaba¹

¹Diagnostic and Interventional Radiology, Aichi Cancer Center Hospital, Nagoya, JP, ²Neurosurgery, Aichi Cancer Center Hospital, Nagoya, JP

Purpose: Metastatic spinal cord compression (MSCC) is a critical problem. Although palliative decompression surgery (PDS) is effective, it can be associated with massive intraoperative blood loss. The aim of this retrospective study was to evaluate the efficacy and safety of preoperative transcatheter arterial embolization (TAE) for MSCC to reduce intraoperative bleeding.

Material and methods: 11 preoperative TAE was performed in 10 patients (5 males and 5 females; median 64 years; range 48-82 years), who underwent PDS for MSCC from November 2017 to August 2018. The underlying disease was hepatocellular carcinoma (n=3), colon cancer (n=2), lung cancer (n=2), thyroid cancer (n=1), intrahepatic cholangiocarcinoma (n=1), and solitary fibrous tumor (n=1). All 11 spinal metastases (9 thoracic and 2 lumbar vertebrae) showed angiographic contrast enhancement. In TAE procedure, a couple of adjacent unilateral or bilateral segmental arteries were embolized using gelatin sponge particles in combination with coils. If the spinal artery was visualized, the embolization was not performed. Technical success and complications of TAE, and the amount of intraoperative blood loss were assessed retrospectively. The improvement of neurologic status after PDS was also evaluated.

Results: Intended TAE were achieved in all cases. Although slight exacerbation of palsy was seen in 1 patient, it improved after PDS. The mean intraoperative blood loss was 340 ml (range 150-750 ml) and intraoperative transfusion was not required. Neurologic status was improved in 7 patients and stable in 4 patients after PDS.

Conclusion: Preoperative TAE for MSCC could be a feasible procedure.

P-103

Awake real-time monitoring during cryoablation for vertebral tumours in the epidural space with cementoplasty (ARCTIC) shows promise for rapid, sustained pain relief

E. Tan¹, S. Leong¹, C.W. Too²

¹Department of Vascular and Interventional Radiology, Singapore General Hospital, Singapore, SG, ²Diagnostic Radiology, Singapore General Hospital, Singapore, SG

Purpose: Vertebral metastases with epidural extension are challenging to treat due to proximity to neural structures. We report our experience with Awake Real-time monitoring during Cryoablation for vertebral Tumours In the epidural space with Cementoplasty (ARCTIC).

Material and methods: We conducted retrospective review of all patients treated with cryoablation and cementoplasty for vertebral metastases extending into the epidural space from June 2018 to November 2018. Patients were referred after multidisciplinary team input. Procedures were performed under conscious sedation with awake monitoring of lower limb sensorimotor function. Pre-, peri- and post-procedure pain and functional scores were measured using visual analogue scale and modified Oswestry Disability Index respectively. Statistical analysis was with Friedman ANOVA and Dunn-Bonferroni post-hoc testing. Follow-up imaging was analysed for local tumor control when available.

Results: 7 consecutive patients (3 men, 4 women; mean age 61.7 $\pm$ 14.9 years) with metastases at 9 levels (5 thoracic, 4 lumbar) were included. Spinal canal compromise ranged from mild to severe. Technical success was achieved at all levels. 1 patient developed unilateral foot drop the following day (1 major complication, 14.3%). Median usual pain score (7.0, 5.8-8.5) significantly improved peri-procedure (2.5, 1.5-3.5) and post-procedure (1.0, 0-3.0) (p=0.006). Significant improvements were also observed in median worst pain (p=0.023) and functional scores (p=0.003). Follow-up imaging in 3 patients showed local tumour control in all individuals. Re-growth of previously eroded bone was observed in 2 patients.

Conclusion: ARCTIC shows promise for rapid, sustained pain relief in these difficult to treat tumours. It's a potential viable option for palliation, complementary to radiotherapy and surgery.

P-104

Targeted disc decompression using radiofrequency ablation for the treatment of cervical disc herniation

H.-Y. Kang¹, S.-H. Lee²

¹Interventional Radiology, Wooidul Spine Hospital, Busan, KR, ²Neurosurgery, Wooidul Spine Hospital, Seoul, KR

Purpose: To investigate the outcomes of targeted disc decompression (TDD) using radiofrequency (RF) for cervical disc herniation (CDH).

Material and methods: Total 89 patients underwent TDD due to CDH between November 2015 and December 2017 were reviewed retrospectively. Patient were divided into two groups according to preoperative MRI: extruded CDH (Group A) and contained CDH (Group B). Extruded discs combined with myelopathy, cord compression, or sequestered discs were contraindication.

Clinical outcomes were evaluated using visual analog scale (VAS) and MacNab's criteria at pre-operation, 24 hours after the operation and final follow-up (mean 13 months). 38 out of 52 patients in group A and 25 out of 37 patients in group B received MRI postoperatively (range, 4-27 months).

Results: The VAS score was improved from 7.00 $\pm$ 1.66 to 1.73 $\pm$ 1.16 in the group A and from 7.14 $\pm$ 1.55 to 2.43 $\pm$ 1.48 in the group B at the final follow-up. Excellent or good outcomes were achieved in 47 patients (90.3%) in the group A and 29 patients (78.3%) in the group B. On the follow-up MRI, group A showed significantly decreased size of herniated disc compared with group B showed slightly decreased or same size of herniated disc. 5 patients in group A and 4 patients in group B underwent repeated TDD during follow-up period due to recurred CDH. One patient in each of the

two groups underwent surgical treatment because of no improvement after TDD.

Conclusion: Based on careful patient selection, TDD is an effective and safe interventional treatment option for CDH, including extruded disc as well as contained disc.

P-105

Percutaneous cervical coblation as therapeutic technique in the treatment of algo-disfunctional pain of discal erniation

M. Pandolfi¹, F. Galli², M. Gurgitano¹, A. Borelli¹, A. Liguori¹, G. Carrafiello³

¹Università Degli Studi di Milano, Postgraduate School in Radiodiagnostics, Milan, IT, ²Radiologia Diagnostica ed Interventistica, ASST Santi Paolo e Carlo - Presidio Ospedaliero San Paolo, Milan, IT, ³Diagnostic and Interventional Radiology, University of Milan, Milan, IT

Purpose: To confirm the validity of coblation nucleoplasty in pain-reducing of cervical discogenic nature.

Material and methods: In a monocentric prospective clinical observational study recruiting 20 patients, treated with percutaneous coblation for cervical discogenic pain in 16 months in our hospital, we have clinically evaluated 18 patients. The pain was scored with the Visual Analogic Scale (VAS), in a pre-procedural questionnaire and 3/4 monthly-follow-up from treatment.

Results: The mean pre-procedural VAS score was 7.9 ± 1.6 (95%-Confidence Interval 7,198-8,634), while the mean post-procedural score has been 2.5 ± 3.1 (95%- Confidence Interval 1,089-3,965). Among 18 patients, 9 had a completely resolution of pain, 4 had a >50% VAS reduction, 2 a <50% VAS reduction, 3 didn't have any variation of VAS. None peri- and post-procedural complication has been observed.

Conclusion: In spite of a little sample, our results showed coblation as a valid therapeutic option in order to reduce cervical discogenic pain in medicine-refractory patients, as an alternative or a previous choice before a more invasive surgical treatment.

P-106

Cadaveric classification of geniculate artery anatomy

M. Sighary¹, A. Sajan², J.P. Walsh¹, S. Marquez³

¹Diagnostic and Interventional Radiology, State University of New York - Downstate Medical Center, New York, NY, US, ²College of Medicine, State University of New York - Downstate, New York, NY, US, ³Department of Cell Biology and Anatomy, State University of New York - Downstate, New York, NY, US

Purpose: Geniculate Artery Embolization (GAE) has demonstrated efficacy in alleviating knee pain associated with osteoarthritis (OA). A thorough understanding of the classical anatomy and variations in branch patterns are essential in order to optimize target therapeutic selective embolization to hyperemic synovium, and to reduce the risks of non-target tissue embolization. There is a lack of detailed anatomy of the geniculate arteries (GA) in the literature most notably at the cadaveric level. We propose a new classification system for the GA branching patterns.

Material and methods: 92 cadaveric limbs were dissected for gross anatomical appearance and the presence of all 5 main branches off the popliteal artery including the superior lateral genicular artery (SLGA), superior medial genicular artery (SMGA), middle genicular artery (MGA), inferior lateral genicular artery (ILGA) and inferior medial genicular artery (IMGA). The location of origin, diameter of vessels and variation in patterns of the GA were reviewed.

Results: 84 limbs were adequately preserved and reviewed. 7 variations were observed with 3 branching patterns previously not described in the literature. Based on these observations we propose a new classification system for the branching patterns of the GA.

Conclusion: During GAE knowledge of the most common vascular anatomy and variations in branching is essential for safe embolization,

good clinical practice, and optimal outcomes. After a detailed review of the cadaveric anatomy, we propose a new classification system for the GA. Understanding of the variation is essential in targeting embolization and reducing complications associated with non-target embolization. A new classification system will help in reducing these risks.

P-107

Percutaneous image-guided cryoablation of osteoblastoma: a single-centre experience

R.L. Cazzato¹, P. Auloge¹, G. Koch¹, J. Caudrelier¹, J. Garnon¹, A. Gangi²

¹Interventional Radiology, University Hospital of Strasbourg, Strasbourg, FR, ²Imagerie Interventionnelle, NHC, Strasbourg, FR

Purpose: The aim of this study was to assess the clinical efficacy and safety profile of percutaneous image-guided cryoablation (CA) to treat osteoblastomas (OB) at various osseous sites.

Material and methods: This retrospective observational study included all consecutive patients presenting with painful OB, who underwent CA at our Institution between March 2007 and December 2018. Patients were selected following discussion at a multidisciplinary tumour meeting and treated with CT-guidance under general anaesthesia (GA) in all cases.

All relevant patient data, diagnostic imaging of the OB (pre and post ablation), procedure details and clinical outcomes were collected and analysed.

Results: Ten patients underwent treatment: 7 men and 3 women (median age 21 years). Seven OB were located in the spine; and 6 demonstrated a predominantly mineralised central core. In 9 cases, a wide array of thermo-protective techniques were utilised due to the proximity of critical structures (median distance 5mm) to the OB. Technical success was 100%. Two (20%) immediate complications (one major and one minor) were noted.

Median clinical follow-up was 12 months. Primary clinical success was 100% and 77.8% at 1-and 12-months follow-up, respectively, with two patients presenting with recurring pain.

Conclusion: Percutaneous image-guided CA represents an effective therapeutic option for patients affected by painful OB. In our experience, given the frequent proximity of critical structures to the tumours, care and comprehensive protective measures were often needed to maximize the safety profile of the procedure.

P-108

Short-term result of transcatheter arterial embolization using imipenem/cilastatin sodium for non-specific low back pain resistant to conservative treatment: a pilot study

K. Fujiwara, M. Shibuya, Y. Okuno

Musculoskeletal Intervention Center, Okuno Clinic, Yokohama, JP

Purpose: Non-specific low back pain affects people of all age and is a leading contributor to disease burden worldwide. The aim of the present study is to evaluate the safety and short-term clinical outcomes of transcatheter arterial embolization (TAE) using imipenem/cilastatin sodium for non-specific low back pain that is resistant to conservative treatments.

Material and methods: Institutional review board approved this study. Fourteen patients (8 females; mean age, 55.6 years; mean pain duration, 68 months) who were resistant to conservative treatments were included. The changes in brief pain inventory scores, adverse events, and Oswestry low back pain scores were evaluated at baseline, 1 and 3 months after TAE.

Results: No major adverse events were associated with the procedures. One patient was lost to follow-up and remaining 13 patients were available at the final follow-up. Clinical success (defined as pain intensity decreased more than 50% from baseline) was obtained from ten of the 13 patients (76.9%). Mean brief pain inventory scores and Oswestry low back pain scores significantly decreased from baseline to 1 and 3 months after treatment (45.9 vs 24.5 and 20.8; 40.8 vs 21.5 and 20.0, respectively;

all $P < 0.01$). No symptom recurrence or late-onset adverse events were observed during follow-up.

Conclusion: TAE is one possible treatment option for patients with non-specific low back pain who have failed to improve with conservative treatments.

P-109

High-risk vertebral augmentation for pathologic fractures involving the posterior vertebral body wall: is treatment worth the risk?

A.S. Niekamp, R. Sheth, J. Kuban, S. Huang, S.H. Sabir, A. Tam, S. Yevich

Interventional Radiology, MD Anderson Cancer Center, Houston, TX, US

Purpose: To evaluate technical, clinical, and complication outcomes after vertebral augmentation for pathologic fractures with posterior vertebral body wall destruction.

Material and methods: Single-center retrospective review of patients treated 2016-2017 by vertebral augmentation for painful pathologic fractures with >4 mm axial involvement of the posterior vertebral body wall. Peri-procedural imaging and notes were reviewed for fracture extension, technical success, cement leakage, clinical complications, and peri-procedural pain.

Results: 51 pathologic vertebral fractures (21:thoracic, 30:lumbar) in 38 patients (20M:18F, mean 63yo) were treated by vertebroplasty or kyphoplasty (43:8) under CT or fluoroscopic-guidance (37:14). Posterior wall destruction measured 5-9mm (14), 10-19mm (30), and >19 mm (7). Thecal sac was effaced in 21 levels, with 8 demonstrating $>20\%$ focal canal narrowing. All treatments were deemed technically successful. Of 30 patients (79%) with peri-procedure pain records, 29 reported improvement (1 unchanged). Of 10 cement extrusion complications, 9 occurred with posterior wall involvement >9 mm (mean/mode: 16.9/16.5mm) and 7 with thecal sac effacement. Neuroforaminal cement extrusion occurred at 4 levels (7.8%). Spinal canal cement extrusion occurred at 6 levels (11.8%), with 4mm mean radial dimension (range 2-8mm). Only 1 patient with cement extrusion had clinical complication (8mm radial canal extrusion at L4), with laminectomy 1 month post-procedure for combined sequela of cement extrusion and tumor growth.

Conclusion: Although risks are increased, vertebral augmentation for pathologic fractures involving the posterior vertebral body wall can be technically successful and provide pain relief. To minimize cement leakage, CT-guidance is recommended in the setting of posterior wall defects >9 mm and thecal sac effacement.

P-110

Is the anesthesia a key factor for the good outcome of bone ablation procedures? A review of the last two year experience in a MSK interventional center

A. Izzo¹, G. Bianchi², F. Formiconi¹, M. Ruschioni¹, F. Arrigoni³, M. Varrassi⁴, L. Zugaro¹, A.V. Giordano⁵, C. Masciocchi¹

¹Applied Clinical Sciences and Biotechnology, University of L'Aquila, L'Aquila, IT, ²Division of Radiology, Department of Biotechnological and Applied Clinical Science, University of L'Aquila, S. Salvatore Hospital, L'Aquila, IT, ³Emergency Radiology, San Salvatore Hospital, L'Aquila, IT, ⁴Neuroradiology and Interventional Radiology, S. Salvatore Hospital, L'Aquila, IT, ⁵Radiology, Ospedale S. Salvatore L'Aquila, L'Aquila, IT

Purpose: The aim of our study is to retrospectively review the outcomes of different anesthetic approaches in bone ablation procedures in order to choose the best option.

Material and methods: We retrospectively evaluated 98 ablations performed in the period between January 2016 and July 2018. Three different anesthetic approaches were used: general anesthesia, sedation/analgesia and loco-regional anesthesia (Brachial Plexus Block, Spinal Anesthesia). To evaluate the outcomes, three parameters were used: procedural technical success, patient comfort (Scale 1-5) and operator comfort (Scale 1-5)

Results: Of 98 ablation, 50 were benign bone lesions, 48 malignant bone lesions. Overall procedural technical success was 100%. Three cases were of general anesthesia: patient comfort was 5/5 in all cases; operator comfort was in 1 case 5/5, in 2 cases 4/5. Twenty patients underwent sedation: in 3 patients with benign bone lesions, patient comfort was 1/5 and operator comfort 3/5; in 2 patients with malignant bone lesions, patient comfort was 3/5 and operator comfort 4/5. Seventy-five patients underwent loco-regional anesthesia: patient and operator comfort was 5/5 in all cases.

Conclusion: General and loco-regional anesthesia proved itself to be effective, but general anesthesia showed a lower operator comfort (average value 4.3). Sedation/analgesia showed globally a less patient and operator comfort, especially for the treatment of benign lesions (average value respectively 3 and 4), probably due to their important inflammatory component. On the basis of our experience, we believe that loco-regional anesthesia is the best anesthetic approach during bone ablation procedures; so when possible, it should be used. In the treatment of benign lesions a higher level of pain management is required than in the treatment of malignant lesions.

P-111

Intraarticular lumbar facet joint steroid injection vs medial branch block: which technique ensures better clinical outcome for managing lumbar back pain? A single-center experience

F. Cobiainchi Bellisari¹, M. Varrassi², A. Izzo³, G. Bianchi³, F. Formiconi³, M. Ruschioni³, F. Bruno¹, S. Carducci⁴, A.V. Giordano⁵, C. Masciocchi³

¹Radiology, University of L'Aquila, L'Aquila, IT, ²Neuroradiology and Interventional Radiology, S. Salvatore Hospital, L'Aquila, IT, ³Applied Clinical Sciences and Biotechnology, University of L'Aquila, L'Aquila, IT, ⁴Applied Clinical Sciences and Biotechnology, Ospedale San Salvatore, L'Aquila, IT, ⁵Radiology, Ospedale S. Salvatore L'Aquila, L'Aquila, IT

Purpose: To compare the clinical outcome of intraarticular lumbar facet joint (LFJ) steroid injection and lumbar medial branch block (MBB) in the management of LFJ pain.

Material and methods: Fifty-seven patients with LFJ pain were recruited on the basis of clinical evaluation and MR-findings and randomly assigned to one of two groups. Twenty-seven patients (Group A) underwent intraarticular LFJ steroid injection. Thirty patients (Group B) were assigned to lumbar MBB. In both procedures, we injected 1.5mL of Ropivacaine with 2mL of Triamcinolone. We assessed the severity of LFJ pain by VAS Score and the disability grade by RMQ Score, before and at 1, 3, 6 months after the treatment.

Results: Average values of VAS and RMQ before treatment in Group A were 8.1 and 16.6. The treatment was effective (VAS reduction $>50\%$, RMQ score <9) in 85.2% of patients after 1 month, 77.7% after 3 months, 60% after 6 months. Average values of VAS and RMQ before treatment in Group B were 7.8 and 16.1. The treatment was effective in 86.6% of the patients after 1 month, 70% after 3 months, 45% after 6 months.

Conclusion: In this study, both intraarticular LFJ steroid injection and MBB significantly relieved LFJ pain and the positive effects of these techniques persisted for at least 6 months after the procedure. In our experience, both procedures showed similar effectiveness in the treatment of LFJ pain at 1 and 3 months, however, intraarticular LFJ steroid injection guaranteed a better clinical outcome after 6 months. We believe that both the techniques can be performed for the treatment of LFJ pain.

P-112

Prospective randomized evaluation of different devices in percutaneous disc decompression (PDD) to treat lower back pain refractory to conservative medical treatments

G.M. Nicolino¹, R. Di Meo¹, M. Petrillo², S.A. Angileri², A.M. Ierardi², G. Carrafiello¹

¹Diagnostic and Interventional Radiology, University of Milan, Milan, IT, ²Radiology, University of Milan, San Paolo Hospital, Milan, IT

Purpose: To compare the outcomes of percutaneous disc decompression (PDD) performed with different devices using the same fluoroscopic approach to treat lower back pain, due to disk herniation, in patients refractory to conservative medical treatments. Early/acute (1st week) and early/subacute (2nd-4th week) outcomes were compared respectively for: Discogel®, Diskom®, SpineWand® and Forerunner®.

Material and methods: Between 2016 and 2019 twenty patients (20) were enrolled for each one of aforementioned devices using a randomization process. Each patient underwent a lumbar PDD at different levels with the same fluoroscopic approach. After the treatments each patient was invited to answer a questionnaire stated to quantify pain relief at 1st, 2nd-4th and over the 4th week using a NRS (Numerical Rating Scale). Moreover, pre and post surgical functional conditions were assessed through a General Function Score (GFS) questionnaire.

Results: A statistically significative difference in terms of pain relief between Discogel® and the other three techniques was found. In particular for what concerned post-procedure pain and general functional conditions was reported a success rate over 80% for SpineWand®, Forerunner® and Diskom®. A failure was assessed in over 40% of patients treated with Discogel®.

Conclusion: In our experience best results in terms of lower back pain relief and related general functional conditions were obtained with SpineWand®, Forerunner® and Diskom®. More patients are needed to confirm our preliminary experience.

P-113

Spinal blockage under ultrasound guide, validation of the method and comparison with tomographic guide

G. Olondo¹, R.S. Gonzalez Toranzo², P. Juarez Marazzo³, F.L. Moreno¹, F.J. Suarez Anzorena Rosasco¹

¹Diagnostic Imaging, Hospital de Clinicas "Jose de San Martin", Buenos Aires, AR, ²Interventional Radiology, Instituto Quirurgico del Callao, Buenos Aires, AR, ³Interventional Radiology, Hospital de Clinicas, Buenos Aires, AR

Purpose:

1. Diagnose and treat by percutaneous procedures patients with spinal pain and develop ultrasound guided technique.
2. Compare each needle final location with ultrasound guide in relation to CT scan.
3. Evaluate effectiveness, cost, irradiation levels and time.

Material and methods:

1. Descriptive, cross-sectional, prospective and observational.
2. Variables: type of procedure performed in each patient, pain intensity before, immediately after the procedure, and symptomatic evolution.
3. Materials: ultrasound PHILIPS, Alluracetrion x-ray PHILIPS, 16-head TOSHIBA CT.

Results:

1. 78 blockages were performed, identifying different types of pain in the patients. 48 patients suffered lumbociatica, 16 axial low back pain and 7 sacroileitis.
2. The first three months displayed a 50% average failures per needle. The following nine months the needle point was improved, reducing the average failures to 10%.
3. The evolution of pain showed positive results with lower scores on the Oswestry scale immediately after puncture, and after 15, 30 and 60 days.

4. The mean radiation of the procedures in CT was 116.09 mSV.

Conclusion: Although CT is the most proven method, it is expensive, requires more complexity, irradiation levels and patients' stress. The advantages of the ultrasound guide are: lower costs, speed and absence of radiation. It should be considered as a routine instrument when performing therapeutic spinal blockages.

P-114

Transarterial embolisation for recurrent haemarthrosis complicating total knee replacement

N. Karunanithy

Interventional Radiology Department, Guy's and St. Thomas Hospitals NHS Foundation Trust, London, UK

Purpose: Recurrent haemarthrosis is a rare but debilitating complication of knee replacement surgery. When patients develop this complication, the pain and swelling can limit mobility and potentially reduce the longevity of the prosthesis. The pathogenesis of this condition is not fully understood but it is thought the synovitis of the joint capsule leads to friable vessels which bleed in response to minor trauma.

The purpose of this study is to review a tertiary centre experience in managing this condition.

Material and methods: Retrospective review of the records for all cases referred for transarterial embolisation to a single tertiary centre from 2016-2019.

Results: 8 transarterial embolisation procedures were performed on 5 patients (3 male, 2 female). The mean age was 64 yrs (57-79) and the knee replacement was 8-24 months prior to presentation.

3 patients underwent 1 procedure, 1 patient had 2 procedures and 1 patient had 3 procedures. The arteries that contributed to abnormal synovial blush were medial superior genicular (8), lateral superior genicular (8), medial inferior genicular (5) and lateral inferior genicular (2). In one case the lateral inferior genicular artery had an aberrant origin from the proximal anterior tibial artery. The embolic agent used was PVA 300 particles (8) and microcoils (2). The endpoint of embolisation was complete stasis of the feeder vessel(s).

Symptom resolution was achieved in 4/5 patients at 12 month follow up. 1/5 patient continued to experience recurrent low-grade haemarthrosis that did not limit daily activity.

Conclusion: Transarterial embolisation is safe and effective in managing haemarthrosis complicating total knee replacement.

P-115

Retrospective multivariate analysis of the outcomes of percutaneous thermal ablation of painful bone metastasis in oncological patients

G. Bianchi¹, F. Arrigoni², P. Palumbo³, A. Cortellini⁴, L. Zugaro³, K. Cannita⁴, C. Ficarella⁵, A. Barile³, C. Masciocchi³

¹Division of Radiology, Department of Biotechnological and Applied Clinical Science, University of L'Aquila, S. Salvatore Hospital, L'Aquila, IT, ²Emergency Radiology, San Salvatore Hospital, L'Aquila, IT, ³Applied Clinical Sciences and Biotechnology, University of L'Aquila, L'Aquila, IT, ⁴Division of Medical Oncology, Department of Biotechnology and Applied Clinical Sciences, San Salvatore Hospital, L'Aquila, IT, ⁵Division of Medical Oncology, Department of Biotechnology and Applied Clinical Sciences, San Salvatore Hospital, L'Aquila, IT

Purpose: The aim of this study is to assess the effectiveness of interventional radiology procedures on quality of life (QoL) in patients with painful bone metastases.

Material and methods: A retrospective analysis of 27 consecutive advanced cancer patients, who have been treated with ablation (RFA, CA or MWA) for bone metastases (BM) was performed. Pain intensity variation was evaluated with a Visual Analogue Scale (VAS). Median time

to opioid dose escalation, median time to radiological progression of the treated BM and median overall survival (OS) were computed.

Results: 27 patients were evaluated. Axial bones were involved in 22 patients (81.5%) and 17 patients (63%) had a single bone metastasis. Before treatment, 41.1% of patients had a Performance Status (ECOG-PS) of 0-1, while the 51.9% of ≥ 2 ; 40.7% received concomitant bone-oriented treatment (denosumab or zoledronate). 74% of them took concomitant opioid analgesic therapy. Median follow up was 16.5 months. After treatment, 85.2% of patients experienced an improvement in pain intensity (p-value <0.05). Median time to opioid dose escalation was 16.2 months (95%CI: 5.9-26.9; 15 events). Median time to radiological progression of the treated BM was 10.3 months (95%CI: 7.6-16.9; 16 events) and median OS was 27.2 months (95%CI: 8.9-41.2; 15 censored patients).

Conclusion: Percutaneous CT-guided thermal ablation led to a significant improvement of the QoL in particular in terms of time to opioid dose escalation. Also median time to radiological progression of the treated BM and median OS seems to be very promising compared to the outcome data known in literature about medical therapy alone.

P-116

Percutaneous thermal ablation for treatment of osteoid osteoma: a systematic review and analysis

W.S. Lindquister¹, J.J. Crowley¹, C.M. Hawkins²

¹Radiology, University of Pittsburgh Medical Center, Pittsburgh, PA, US, ²Department of Radiology and Imaging Sciences, Emory University School of Medicine, Atlanta, GA, US

Purpose: To perform a systematic review and pooled analysis of radiofrequency ablation (RFA), cryoablation, and microwave ablation of osteoid osteoma (OO) tumors with subset analysis of intra-articular and spinal OOs.

Material and methods: 79 published manuscripts and abstracts were identified. 36 studies met inclusion criteria, comprising 1863 ablations. Inclusion criteria were: (1) retrospective or prospective analysis of RFA, cryoablation, or microwave ablation of osteoid osteomas; (2) included at least 6 months follow-up; (3) 10 or greater ablation procedures; (4) patients were not included in a second study included in this review; (5) English language or English translation available. Success rate was defined as all ablations minus technical failures, clinical failures, and recurrences. A pooled analysis was performed using simple binomial regression. Subset analysis of intra-articular and spinal tumors was performed.

Results: Overall success rate was 91.9% (95% confidence interval: 91-93%). Technical failure, clinical failure, and recurrence rates were 0.3%, 2.1%, and 5.6% respectively. Complications were seen in 2.5% (95% confidence interval: 1.9-3.3%) patients. Success rates were 91.6%, 91.9%, and 100%, for RFA, cryoablation, and microwave ablation respectively. There was no significant difference when comparing RFA and cryoablation (p=0.92). Due to the small sample size, superiority/inferiority comparison with microwave ablations was not possible. Success rates for intra-articular (RFA) and spinal tumors (RFA and cryoablation) were 97% and 91.6% respectively.

Conclusion: Percutaneous thermal ablation of osteoid osteomas was highly successful with a very low complication rate. Efficacy of RFA and cryoablation are similar. Treatment of more challenging intra-articular and spinal lesions demonstrated similarly high success and low complication rates.

P-117

Percutaneous cryoablation of chondroblastoma

L. Leclerc¹, P. Auloge², J. Garnon², G. Koch², J. Caudrelier², R.L. Cazzato³, A. Gangi⁴

¹Alsace, Nouvel Hôpital Civil - NHC, Strasbourg, FR, ²Interventional Radiology, University Hospital of Strasbourg, Strasbourg, FR, ³Imagerie Interventionnelle, Hopitaux Universitaires de Strasbourg, Strasbourg, FR, ⁴Imagerie Interventionnelle, NHC, Strasbourg, FR

Purpose: To assess the safety and efficacy of cryoablation in chondroblastoma.

Material and methods: This retrospective study includes 5 consecutive patients treated with percutaneous cryoablation (CA) between January 2013 and November 2018 due to painful iuxta-articular chondroblastomas. In all cases, surgery was deemed not adapted due to the relevant expected morbidity. Clinical success (i.e. total disappearance of pain after CA) and complications were recorded.

Results: Among the 5 patients there were 4 men (80%) and 1 woman (20%). Median age was 18 years (IQR: 17-23). Of 5 chondroblastomas, 3 (60%) were located in the humeral head and 2 (40%) in the distal femur. None of the case presented with pathological fracture. Median tumor diameter was 23mm (Interquartile range (IQR): 17-23). All procedures were performed under imaging guidance, without additional consolidation after CA. At median 8 months (IQR: 2-17) follow-up, clinical success was obtained in all cases. One patient presented with residual non-inflammatory pain related to contextual rotator cuff tears. One major complication (i.e. focal cartilage necrosis needing surgical curettage and needling of the articular surface of the humeral head) and one minor (i.e. transient pain needing intra-articular steroid injection) complication were noted.

Conclusion: CA of iuxta-articular chondroblastoma is an effective treatment representing a valid alternative to surgery.

P-118

The potential role of intervertebral disc FA (Fractional Anisotropy) value in diffusion tensor imaging (DTI) in selecting patients suffering from low back pain and who may benefit from oxygen-ozone discolysis

M. Perri¹, M. Varrassi¹, A. Di Sibio², L.P. Vazzana³, M.C. De Donato³, M. Martino³, C. Masciocchi⁴

¹Neuroradiology and Interventional Radiology, S. Salvatore Hospital, L'Aquila, IT, ²Radiology, Ospedale S. Salvatore L'Aquila, L'Aquila, IT, ³Applied Clinical Sciences and Biotechnology, University of L'Aquila, S. Salvatore Hospital, L'Aquila, IT, ⁴Applied Clinical Sciences and Biotechnology, University of L'Aquila, L'Aquila, IT

Purpose: To evaluate the intervertebral disc FA value as predictive sign in the clinical outcome after Oxygen-Ozone Discolysis in lumbar disc herniation.

Material and methods: A total of 75 patients suffering from lumbosciatica were selected for prospective randomized blinded trial approved by the Medical Ethical Committee of our Institution. Before treatment they underwent MRI 3 Tesla exams performed with conventional sequences (T2-FSE-WI, T2 fat-sat and T1 FSE-WI) and additional DTI scan respectively for assessing Pfirrmann's grade and Fractional Anisotropy (FA) value of the involved intervertebral disc. Then they were randomly assigned to two groups; Control Group (20 men, 16 women; median age 45 years old) underwent intraforaminal injection of steroid and anesthetic. The remaining 39 patients (Study Group composed by 18 men, 21 women; median age 46 years old) underwent the same treatment with the addition of oxygen-ozone (O2-O3). Oswestry Low Back Pain Disability (ODI) and Visual Analog Scale (VAS) Questionnaires were administered before treatments and at intervals, the last at 6-month follow-up. Results were compared with χ^2 , t test and regression analysis.

Results: O2-O3 discolysis was successful in 16 (41%) study group patients compared with 10 control group patients (27.5 %) (P < 0.01). ODI and

VAS questionnaires showed significant improvement of symptoms in both Groups and cases of Disc Degeneration Grade I, II, III with a mean FA value of 0.29 ± 0.08 in study groups while 0.31 ± 0.11 in the remaining control group.

Conclusion: An FA value congruous with a low-median grade of disc degeneration could be considered as a predictive sign of response to oxygen-ozone treatment.

P-119

Bilateral intradiscal ozone therapy for lumbar disk herniation

J. Scaggiante¹, R. Carpenedo², S. Natoli², M. Nezzo¹, V. Semeraro¹, R. Argirò¹, D. Morosetti¹, V. Da Ros¹, A. Wlder¹

¹Diagnostic and Interventional Radiology, University of Rome Tor Vergata, Rome, IT, ²Anesthesiology, University of Rome Tor Vergata, Rome, IT

Purpose: Low back pain (LBP) is a leading cause of disability. According to the World Health Organization (WHO), its lifetime prevalence is estimated around 60% to 70%, representing the second most common reason for symptomatic physician visits each year.

Despite for non-responders to medications, conventional open surgical techniques provide good results for chronic back pain, unfortunately those are also related with neural adhesion, spinal structural instability, and other complications.

We report our initial experience with minimally-invasive intradiscal O2-O3 therapy for disc herniation, assessing the pain score and satisfaction of patients.

Material and methods: We included in this series, 6 patients with lumbar contained herniated disk and LBP unresponsive to medical treatment for more than 4 weeks. Lumbar spine 3T-MRI was obtained for each patients before the procedure, at 30-days and 6-month follow-up. Primary outcome was to assess the pain before and after intradiscal O2-O3 therapy, using the Numeric Rating Scale (NRS). NRS was assessed by phone interviews at baseline, 7 days after procedure, and then every 15 days for 6 months. Intradiscal injection of O2-O3 (6ml, 3+3ml, 25µg/ml) was performed under fluoroscopic guidance through bilateral Chiba-type needles (20G, 20cm long) introduced with a postero-lateral, extra-articular percutaneous approach.

Results: 30-days MRI demonstrated a reduction in the volume of the disc herniation after intradiscal ozone injection. All patients reported a reduction in the NRS ≥ 2 since 21 days from the procedure.

Conclusion: Intradiscal ozone therapy may represents an alternative solution to surgical intervention, especially for small or contained herniated disk, to reduce the mechanical compression of the nerve root improving low back pain.

P-120

Pre-treatment MRI evaluation of intervertebral disc in patients undergoing O2-O3 chemiodiscolysis: prognostic value of T2 mapping sequences

F. Bruno¹, P. Palumbo¹, G. Bianchi², E. Tommasino¹, A. Splendiani¹, C. Masciocchi¹

¹Applied Clinical Sciences and Biotechnology, University of L'Aquila, L'Aquila, IT, ²Division of Radiology, Department of Biotechnological and Applied Clinical Science, University of L'Aquila, S. Salvatore Hospital, L'Aquila, IT

Purpose: To evaluate the validity of T2 mapping sequences for the pre- and post-treatment evaluation in patients with lumbar disc herniation undergoing O2-O3 chemiodiscolysis

Material and methods: We evaluated 32 patients (17 male, 15 female, mean age 47.6 years,) with sciatica from single-level lumbar disc herniation, eligible for O2-O3 chemiodiscolysis treatment. All patients underwent 3T MR scan with standard morphological and T2 mapping sequences, before and 1 month after treatment. Instrumental imaging evaluation included analysis of intervertebral disc area and analysis of T2 relaxation at the

affected disc level. Clinical evaluation using the VAS scale for pain and the Oswestry Disability Questionnaire for functionality was performed with the same follow-up. Statistical analysis results were compared to a control group of 25 patients with lumbosciatica who were submitted to conservative treatment.

Results: Initial mean disc area was $18.13 \pm 1.54 \text{ cm}^2$. At the follow-up, we found a reduction of the mean disc area with mean value of $15.96 \pm 4.61 \text{ cm}^2$ ($p < 0.005$). Mean pre-treatment T2 values were $74.8 \pm 17.2 \text{ ms}$. 25/32 patients had successful outcomes with significant reduction of mean VAS scores (mean pre-treatment value 8.1, post-treatment 2.6) and ODI (46.3% vs 28.3%). 7/32 patients were classified as non-responders. Correlation analysis showed a significant negative correlation between pre-treatment T2 relaxation times and post-treatment disc area ($r = -0.52$) and a negative correlation with both VAS scores ($r = -0.36$) and ODI scores ($r = -0.44$).

Conclusion: T2 mapping evaluation of intervertebral disc may be a useful indicator to predict procedural outcome and clinical response to O2-O3 chemiodiscolysis

P-121

Mesenchymal stem cell injection for joint cartilage regeneration: one year single center experience

F. Vecchietti¹, E.M. Pandolfi¹, G. Cerone², F. Fasoli¹

¹UOS Radiologia Interventistica Osteovertbrale, Ospedale CTO, Rome, IT, ²UOSD Radiodiagnostica, Ospedale CTO, Rome, IT

Learning objectives: The aim of this work is to illustrate the therapeutic possibilities in the radiological interventional field offered by the minimally invasive techniques derived from one year single center experience of the use of my stem system®.

Background: The progressive aging of the world population leads to an increase in osteo-degenerative diseases such as osteoarthritis; the techniques of regeneration of articular cartilage assume, to date, a role of primary interest in medical practice. Stem cells including various stem cells and pluripotent stem cells are now used in tissue engineering.

Clinical Findings/Procedure Details: The study population consists of 100 patients, selected on the basis of clinical and radiological positivity (MRI and confirmed RX) to multi-segment arthroplasty joint degenerative pathologies (shoulder, hip, knee).

Each patient selected, with written informed consent, underwent local anesthesia, combined radiofrequency joint treatment (42°C for 6 min) and joint grafting under ultrasound guidance and fluoroscopic confirmation of mesenchymal cells previously taken from the subcutaneous adipose tissue and separated through the appropriate MyStem® single-use system.

Conclusion: The combined treatment of articular radiofrequency (42°C for 6 min) and articular grafting of mesenchymal cells previously taken from the subcutaneous adipose tissue and separated by a special MyStem mono-use system shows a clear clinical resolution of the arthritic pain symptomatology allowing 100% of the population to study the return to normal daily activities previously compromised in the clinical follow up to 1 year from treatment.

P-122

Interventional radiology techniques for pain reduction and mobility improvement in knee osteoarthritis: a pictorial review

D.K. Filippidis, G. Haralampopoulos, A. Mazioti, S. Spiliopoulos, E. Brountzos, N.L. Kelekis, A.D. Kelekis
^{2nd} Department of Radiology, ATTIKON University General Hospital, Athens, GR

Learning objectives:

1. To become familiar with the most common minimally invasive imaging-guided techniques for knee osteoarthritis
2. To learn about technical considerations when performing these techniques for knee osteoarthritis
3. To learn about evidenced based practice

Background: Osteoarthritis (OA) of the knee is the most common cause of chronic knee pain being more prevalent in middle-aged and elderly patients. Symptomatic patients complain of pain and mobility impairment. The purpose of this review is to illustrate the technical aspects, the indications and the methodology of all local therapies for knee OA performed by interventional radiologists providing the current evidence.

Clinical Findings/Procedure Details: Therapeutic armamentarium includes physical therapy, oral pharmacologic therapy, intra-articular injections, nerve ablation or modulation, trans-catheter arterial embolization, minimally invasive arthroscopic treatment and partial or total knee arthroplasty. Interventional Radiology therapies for knee OA comprise intra-articular injections, neurotomy and neuromodulation techniques as well as transcatheter intra-arterial therapies; these therapies aim to control pain and inflammation, improve mobility and function whilst the novel cell-based therapies have the potential for bone and cartilage regenerative repair facilitating the delay to surgery.

Conclusion: Interventional Radiology can offer minimally invasive, imaging guided techniques for pain reduction and mobility improvement in knee OA. These techniques are safe, efficacious and constitute attractive alternatives when compared to other conservative a first step prior to surgical treatments. Proper patient selection and imaging guidance are key factors.

P-123

Minimally invasive techniques for musculoskeletal pain syndromes: a pictorial review

D.K. Filippiadis, A. Mazioti, L. Reppas, K. Palialexis, E. Brountzos, N.L. Kelekis, A.D. Kelekis

2nd Department of Radiology, ATTIKON University General Hospital, Athens, GR

Learning objectives:

1. To become familiar with the most common indications for minimally invasive imaging-guided techniques for MSK pain syndromes
2. To learn about technical considerations when performing minimally invasive imaging-guided techniques for MSK pain syndromes
3. To learn about evidenced based practice

Background: Interventional pain management may be employed for patients in whom the analgesic options on the WHO ladder and other adjuvant medications have proven ineffective. MSK pain syndromes in the spine include facet or sacroiliac joint syndromes, Baastrup's disease, coccygodynia, intervertebral disc herniation and vertebral fractures. In the peripheral skeleton pain syndromes include but are not limited to Arnold's syndrome (Greater occipital nerve neuropathy), Alcock's syndrome (pudendal nerve neuropathy), Piriformis syndrome, peripheral joints osteoarthritis and bone lesions or fractures.

Clinical Findings/Procedure Details: The therapeutic armamentarium of Interventional Radiology for painful MSK syndromes includes percutaneous infiltrations (usually a mixture of long acting corticosteroid and local anesthetic), neurolysis (chemical by means of alcohol or phenol and thermal using radiofrequency or cryoablation), neuromodulation (by means of pulsed radiofrequency), intervertebral disc decompression and regeneration techniques, vertebral and bone augmentation techniques. In all the aforementioned techniques imaging guidance increases technical efficacy as well as safety rates whilst proper patient selection is a key factor.

Conclusion: Interventional Radiology can offer minimally invasive, imaging guided techniques for pain reduction and mobility improvement in painful MSK syndromes. These techniques are safe, efficacious and constitute attractive alternatives or first line therapies when compared to other conservative or surgical treatments. Proper patient selection and imaging guidance are key factors.

P-124

Appropriate path selection for biopsy and ablation of bone and soft tissue lesions

M.P. Bolger¹, C.A. Byrne², J.B. Hennebry¹, A.E. Stroiescu¹, L. Greene², A.G. Ryan³

¹Division of Interventional Radiology, University Hospital Waterford, Waterford, IE, ²Radiology, University Hospital Waterford, Waterford, IE, ³Division of Interventional Radiology, Department of Radiology, University Hospital Waterford, Waterford City, IE

Learning objectives:

1. To describe appropriate path selection for biopsy and ablation of bone and soft tissue lesions in the periphery (upper and lower limbs) and centrally (thoraco-abdominal).
2. To become familiar with the concept of not transgressing or contaminating adjacent compartments, whereby potential subsequent surgery is rendered either more aggressive, or worse, necessitating amputation.
3. To recognise that 'intra-compartmental' contamination can also occur, whereby a functionally important structure is traversed, which then must be excised resulting in greater patient morbidity.

Background: Interventional Radiologists (IRs) are often the first port of call for bone and soft tissue lesion biopsy. Some of these lesions will be appropriate for treatment using ablative techniques by Interventional Oncologists (IOs) and IRs. Unfortunately, because of inappropriate path selection, patients are sometimes condemned to overly aggressive surgeries, including amputation, where the initial intention was to perform limb-sparing surgery.

Clinical Findings/Procedure Details: Appropriate path selection in the limbs and centrally will be illustrated with the help of line diagrams outlining the required anatomical knowledge particularly with regards to compartmental anatomy and the most significant neurovascular bundles to avoid.

Conclusion: Appropriate path selection for biopsy and ablation avoids unnecessarily aggressive / ablative surgery and leads to better patient outcomes, especially with regards to functional morbidity. This exhibit aims to teach the IR / IO about optimal path selection depending on the anatomical location of the lesion.

P-125

How to perform deep cervical plexus block to approach cervical traumatic neuromas during fine needle aspiration biopsy

V.N. Marcos¹, M.A.V. Kulcsar², R.B. Domingues³, A.O. Hoff⁴, M.C. Chammas⁵, **R.M.C. Freitas**¹

¹Radiology Unit, Instituto do Cancer do Estado de São Paulo - Universidade de São Paulo Medical School, São Paulo, BR, ²Head and Neck Surgery Department, Universidade de São Paulo, São Paulo, BR, ³Pathology Department, Instituto do Cancer do Estado de São Paulo - Universidade de São Paulo, São Paulo, BR, ⁴Endocrinology Unit, Instituto do Cancer do Estado de São Paulo - Universidade de São Paulo Medical School, São Paulo, BR, ⁵Radiology Institute, Universidade de São Paulo, São Paulo, BR

Learning objectives: This educational abstract describes how to perform ultrasound (US) guided deep cervical plexus block (CPB) to approach cervical traumatic neuroma (CTN) in patients who had undergone thyroidectomy with lateral cervical lymphadenectomy, with the objective to reduce the patient's painful discomfort in fine needle aspiration biopsy (FNAB).

Background: CTN may be misinterpreted as atypical or metastatic lymphadenopathies during post-operative US follow up, and FNAB is markedly painful in this cases.

An US-guided deep CPB was performed in two patients who underwent lateral cervical lymphadenectomy for the treatment of metastatic papillary thyroid carcinoma and whom level III cervical nodules with US characteristics of neuromas were detected.

Clinical Findings/Procedure Details: To perform the deep CPB, the following sequence of procedures was adopted: 1) to identify the cervical node and confirm its continuity with a nerve root by US; 2) follow by US the nerve root until its intervertebral foramen; 3) injection of the local anesthetic around the emergence of the nerve root in continuity to the neuroma at the vertebral foramen under strict US direct visualization. Patients did not present pain discomfort during the puncture, and all punctured nodules had the cytological result compatible with the diagnosis of neuroma.

Conclusion: The deep CPB guided by US technique is safe and can be used in cases where FNAB becomes necessary, reducing a painful experience for the patient.

P-126

10 years challenge: the road map to FURTHER - Focused Ultrasound and RadioTHERapy in patients with bone metastases

S. Dababou, A. Napoli, C. Marrocchio, R. Scipione, G. Alfieri, D. Fierro, C. Catalano
Radiological Sciences, University of Rome La Sapienza, Rome, IT

Learning objectives:

1. Introducing the current therapeutic challenge of bone metastases: brief analysis of the osseous metastatic disease (epidemiology, therapies and quality of life)
2. Learning the basic principles of Magnetic Resonance-guided Focused Ultrasound (MRgFUS)
3. Overview of our 10-year experience in the treatment of metastatic disease with MRgFUS
4. Illustration of the multicenter FURTHER (Focused Ultrasound and RadioTHERapy) project.

Background: Bone metastases challenge almost 65% of patients with advanced cancer impacting significantly their quality of life. Indeed, bone metastases are the most common cause of cancer-related pain often poorly controlled with medications therefore requiring further treatment. The external beam radiotherapy (EBRT) is the standard treatment for symptomatic bone metastases. Although efficient and cost-effective it has some limitations, such as late onset of pain relief (up to 4 weeks), retreatment is not always feasible and is not effective in an important proportion of patients.

Clinical Findings/Procedure Details: MRgFUS is a totally non-invasive technique that uses high-intensity focused ultrasound under magnetic resonance guidance (3T system) to induce an increase of temperature in a sharply defined target, resulting in tissue ablation. Pain resolution results in 60-100% of treated patients, the relief is fast (within 3 days) and long-lasting (>3 months). Tumor control has also been observed and can be attempted in a small subset of patients (oligometastatic disease and/or longer life expectancy).

Conclusion: The multicenter FURTHER projects aims to investigate how MRgFUS can be incorporated into primary therapeutic options with a three-arm randomised controlled trial to assess the efficacy of MRgFUS, radiotherapy and a combination of these two modalities as a primary palliative treatment for bone metastases.

P-127

Gelstix intradiscal injection for intervertebral disc regeneration: one year single center experience

F. Vecchietti¹, E.M. Pandolfi², G. Cerone³, F. Fasoli²

¹UOS Radiologia Interventistica Osteovertebrale, Ospedale Sant' Eugenio - CTO, Rome, IT, ²UOS Radiologia Interventistica Osteovertebrale, Ospedale CTO, Rome, IT, ³UOSD Radiodiagnostica, Ospedale CTO, Rome, IT

Learning objectives: The aim of this work is to illustrate the therapeutic possibilities in the radiological interventional field offered by the minimally invasive techniques derived from one year single center experience of the use of Gelstix® Intradiscal Injection.

Background: The progressive aging of the world population leads to an increase in osteo-degenerative diseases such as Degenerative Disc Disease that is one of the most common spinal pathologies, affecting up to 10-15 % of adults; the techniques of disc regeneration assume, to date, a role of primary interest in medical practice.

Clinical Findings/Procedure Details: The study population consists of 25 patients, selected on the basis of clinical and radiological positivity MRI confirmed. Each patient selected, with written informed consent, underwent intradiscal Hydrogels are water-insoluble hydrophilic polymers under fluoroscopic guidance. All patients follow 1 month sessions of specific physical therapy. Follow-up measures (pain relief VAS and MRI) were performed at 6 and 12 months.

Conclusion: Intradiscal water-insoluble hydrophilic polymers injection under fluoroscopic guidance appears to be a safe and effective treatment for chronic low back pain due to contained lumbar disc herniations in term of life quality gain due to the improvement in leg and back pain, persisting for at least one year.

P-128

Transarterial embolization of bone tumors: a pictorial review

A. Peixoto, J.B. Leitão, A. Gonçalves
Radiology, Centro Hospitalar Lisboa Norte, E.P.E. - Hospital de Santa Maria, Lisboa, PT

Learning objectives: To review and discuss the indications of transarterial embolization in primary and metastatic bone tumors and the selection of the embolic techniques and agents.

Background: Bone tumors, including primary benign and malignant and metastatic neoplasm, are a heterogeneous group disease, which may present with pain, loss of function, pathologic fractures or as an incidental finding.

Treatment selection relies on the type of lesion, but surgical excision, alone or combined with other therapies, is the first-line in most cases.

Clinical Findings/Procedure Details: Transarterial embolization has a wide range of indications, in the context of palliation, definitive treatment or as preoperative adjuvant treatment.

It can simplify the surgery procedure, reduce the intraoperative haemorrhage, help to control the fever, pain or hypercalcemia, and increase the sensitivity of some tumors to chemotherapy and radiotherapy.

Conclusion: Transarterial embolization should be considered as a therapy modality in the treatment of primary and secondary bone tumors, especially in giant cell tumors, aneurysmal bone cysts, vertebral hemangiomas, arteriovenous malformations, osteoblastomas, osteosarcomas and hypervascular metastasis.

There are several embolic techniques and embolic agents available. The operator experience is one of the most important factors influencing their selection.

P-129

Transcatheter arterial embolization: a new means of treating musculoskeletal pain?

S. Patel, A.K. Gupta, I. Ahmed, U. Raja
Interventional Radiology, Guy's and St. Thomas' Hospitals NHS Foundation Trust, London, UK

Learning objectives: Degenerative joint disease is a significant cause of morbidity and mortality, with pain representing the major disabling factor. There is evidence to suggest that musculoskeletal pain may at least in part be attributable to aberrant neovessel and nerve formation.

Limited work conducted in Japan has offered promising early results in the management of this pain through transcatheter embolization, and this could potentially be translated into UK practice.

Validation however is required against other more established musculoskeletal interventions, as well as long-term randomised data.

Background: Neo-angiogenesis and accompanying nerve formation have been described in the literature in the context of arthropathies such as osteoarthritis, a common cause of pain and disability. Recent work undertaken by Japanese research groups have assessed the potential role of transcatheter arterial embolisation in achieving pain relief by targeting these neovessels and associated aberrant nerve fibres.

Clinical Findings/Procedure Details: We conducted a literature search across multiple platforms (including Medline and EMBASE) using the key terms "embolisation" and "osteoarthritis," "enthesopathy" or "capsulitis." The search rendered 3 papers, providing a pool of 77 patients with degenerative joint pathologies. Technical success in identifying and embolising abnormal joint vessels was achieved in all patients, with statistically significantly reduced pain scores seen at maximum 4-year follow-up.

Conclusion: Whilst in its infancy, transcatheter arterial embolisation shows significant promise in the treatment of analgesia-resistant pain, particularly where surgery is not yet deemed appropriate. An Australian single-centre randomised controlled superiority trial is currently being undertaken to assess the impact of transcatheter arterial embolisation in this context, which should prove instructive.

P-130

MRgFUS treatment of desmoid tumor with preparatory nerve protection using MR-guided hydrodissection

H.E. Pärssinen¹, R. Blanco²

¹Radiology Department, Turku University Hospital, Turku, FI, ²Diagnostic and Interventional Radiology, Medical Imaging Centre of Southwest Finland, Turku, FI

Clinical History/Pre-treatment Imaging: A 47 years old female slowly developed radicular pain on her left buttock. MRI showed a large 20cm long tumor with varying zones of enhancement and scar-like signal poor tissue in gluteus maximus and quadratus femoris muscles. The tumor dislocated the ischial nerve. Biopsy confirmed desmoid tumor.

Treatment Options/Results: Surgical treatment was considered but discarded due to large resection area and resulting side effects. MRgFUS treatment with Philips Sonalleve (Amsterdam, Netherlands) was chosen to contain the symptoms. Proximity of ischial nerve to the treatment area was a concern that was dealt with MR-guided hydrodissection, here an injection of a mixture of 20ml Lidocaine 10mg/ml and 50ml of NaCl 9mg/ml with MRI compatible needle (20G, 150mm, Invivo, Gainesville, USA) between tumor and the nerve creating a buffer to avoid heating of the nerve during sonications. The treatment was performed under general anesthesia.

Post-treatment contrast enhanced MRI showed 90% non-enhancing area of the tumor. Following the treatment lower limb sensomotory functions were normal and shrinkage of the tumor volume was observed. Due to significant pain reduction the patient could return to work.

Discussion: Desmoid tumors pose a challenge to current standard treatment. MRgFUS shows potential in treating cases where invasive treatment is not feasible. Hydrodissection can be considered to protect critical structures at risk during the treatment.

Take-home points: Large musculoskeletal tumors can be safely treated using MRgFUS. Sufficient protection of adjacent structures is pivotal and can be achieved utilizing hydrodissection. Its use with MRgFUS should be more widely considered in complex cases to avoid collateral damage.

P-131

Unexpected resolution of POTS after T2-3-4 sympathectomy for hyperhidrosis

C.S. Georgiades

Vascular & Interventional Radiology, Johns Hopkins University, Baltimore, MD, US

Clinical History/Pre-treatment Imaging: 62 y.o. female with history of Postural Orthostatic Tachycardia Syndrome (POTS) and craniofacial/

axillary/palmar hyperhidrosis was referred for CT-guided, T2-3-4 sympathectomy to manage hyperhidrosis. Baseline symptoms included tachycardia (b-blockade), syncopal episodes, shortness of breath (SOB), chronic nausea/vomiting, and hyperhidrosis (Table 1). Karnofsky score was 50%. In addition, the patient carried a diagnosis of Lupus and Sjogren's.

Treatment Options/Results: T2-3-4 sympathectomy was performed under conscious sedation and CT-guidance. With the patient prone, 22g spinal needles (3 each side) were placed with their tips along the anterolateral margin of T2-3-4 vertebral bodies (Fig. 1). Neuro exam after block with lidocaine excluded Horner's or other deficit. Lysis was accomplished with 2 cc of EtOH via each needle. Patient was observed x1 hour and then d/c'd. Follow-up was at one week and then as clinically indicated, up to 2 years. There was complete resolution of hyperhidrosis immediately. In addition the patient reported resolution of nausea/vomiting, SOB, syncopal episodes. Despite ceasing b-blockade, she had no further resting tachycardia. Karnofsky score increased to 90/100.

Discussion: Sympathetic hyperactivity causes both POTS and primary hyperhidrosis. Sympathetic cardiac input arises from the Stellate ganglion, the upper and middle cervical ganglia and the thoracic ganglia at T2-3-4. The overlapping sympathetic anatomy of the heart and craniofacial/axillary/palmar sweat glands explains why T2-3-4 sympathectomy improved the patient's POTS.

Take-home points: This case highlights the role of sympathetic overdrive in patient with POTS. It also opens the possibility of further research and the development of new therapeutic interventions.

P-132

Quadruple threat: Single-session embolization, radiofrequency ablation (RFA), cementoplasty, and transiliac screw fixation for lifestyle limiting pelvic renal cell carcinoma (RCC) metastases

R.A. Pampati¹, N.A. Patel², J.J. Mahn¹, J.J. Gemmete³

¹Radiology, University of Michigan Hospitals, Ann Arbor, MI, US, ²Interventional Radiology, Radiology Imaging Associates, Denver, CO, US, ³Vascular and Interventional Radiology, University of Michigan Health System, Ann Arbor, MI, US

Clinical History/Pre-treatment Imaging: 73-year-old male with remote history of metastatic renal cell carcinoma status and left nephrectomy with new left hip pain and cane-dependent. Imaging demonstrated a large soft tissue and osteolytic mass of the left ilium.

Treatment Options/Results: The patient agreed to undergo embolization, RFA, with screw fixation and cementoplasty for stability. Gelfoam embolization of the left superior gluteal artery. CT-guided placement of two Kyphon (Medtronic) introducer needles and RFA via two Osteocool (Medtronic) probes. Placement of two K wires and 2 transiliac fixation screws. CT-guided injection Confidence (DePuy Synthes) cement. Following physical therapy, he has returned to normal daily activities including climbing ladders to do housework.

Discussion: Many patients with RCC develop metastatic bone lesions, which are associated with fracture, severe pain, and local mass effect. While medical management, radiotherapy, and surgery have been common approaches, embolization, ablation, and cementoplasty has been found to significantly improve patients' pain-related disability. This case is unique as it incorporates this multifaceted approach in a single-session and achieves better stability with percutaneous transiliac screw fixation.

Take-home points: Embolization, ablation, and cementoplasty of metastatic RCC is effective. In cases of severe cortical destruction and instability, percutaneous screw fixation can provide adequate mechanical support.

P-133

Palliative transcatheter arterial embolization for the treatment of metastatic bone tumor from hepatocellular carcinoma: a case report

Y. Matsui, Y. Munetomo, S. Kasaki, Y. Hasegawa, R. Kanou, H. Ashida, H. Ojiri

Radiology, The Jikei university, Tokyo, JP

Clinical History/Pre-treatment Imaging: A man above 80 years of age was admitted to our hospital with progressive left-sided chest pain due to metastatic hepatocellular carcinoma. Enhanced computed tomography revealed multiple bone metastases. Moreover, the metastasis in his left third rib had rapidly grown during the past week. His left-sided chest pain progressed, and the visual analog scale (VAS) score changed from 2 to 4. Hence, we decided to perform transcatheter arterial embolization (TAE) of the metastasis in the left third rib to prevent bleeding and to relieve the pain.

Treatment Options/Results: We punctured the left brachial artery. A cobra catheter was advanced to the left subclavian artery, and digital subtraction angiography (DSA) was performed. The DSA revealed enhancement of the tumor through the superior thoracic artery, lateral thoracic artery, thoracoacromial artery, and internal mammary artery. A micro catheter was inserted into these arteries, and microsphere and absorbable gelatin powder were injected. On the first day after the TAE, his VAS score was 5. However, on the fifth day after surgery, it reduced to 1, and he experienced relief from the severe left-sided chest pain. Following this, the pain relief was maintained.

Discussion: TAE is not usually considered a treatment for bone metastasis; rather, radiotherapy is considered the first option. However, some authors report that TAE provides more prompt pain relief after treatment, whereas radiotherapy provides more permanent pain relief. TAE can be repeated safely and effectively if the pain recurs.

Take-home points: Palliative TAE for bone metastasis from HCC could be effective in relieving bone pain.

P-134

Transoral biopsy of a C2 vertebral lesion in a child

G.M.Y. Ma¹, A. Oussama², M. Shroff³, V. Rea³, B. Papsin⁴, P. Muthusami¹

¹Image Guided Therapy, The Hospital for Sick Children, Toronto, ON, CA, ²Hematology and Oncology, The Hospital for Sick Children, Toronto, ON, CA, ³Diagnostic Imaging, The Hospital for Sick Children, Toronto, ON, CA, ⁴Head and Neck Surgery, The Hospital for Sick Children, Toronto, ON, CA

Clinical History/Pre-treatment Imaging: A 4-year old boy presented with sudden neck pain and decreased range of movement. A radiograph performed in the emergency department showed dens fracture with C1-C2 anterolisthesis. MRI and CT showed replacement of the dens with an enhancing soft tissue mass that extended into the prevertebral soft tissues (figure 1) and laterally displaced the left vertebral artery. Imaging differentials included Langerhans cell histiocytosis (LCH), Ewing's sarcoma and rhabdomyosarcoma.

Treatment Options/Results: Biopsy was performed under fluoroscopic guidance in the interventional radiology suite. Given the location and anatomic relationships, a transoral approach was chosen. Oral access was provided by the otorhinolaryngologist, who placed a tonsillectomy mouth retractor-tongue depressor. Under direct visualization, biopsy was obtained using an 18G biopsy device through a 17 G coaxial needle was advanced into the center of the lesion, and position confirmed with biplane fluoroscopy. Histopathology confirmed LCH.

Discussion: We describe a novel approach in children for safely performing biopsy from the C2 vertebral body. The transoral route has been described in a handful of case reports in the adult population for biopsy and kyphoplasty, but not to our knowledge in children. Additionally, we

show that this procedure, traditionally performed under CT guidance, can be done safely under fluoroscopy, which helps to reduce procedure time and radiation dose.

Take-home points: Pediatric IR procedures often need modification of approach and technique to be performed safely.

The transoral route can provide access to biopsy upper cervical vertebral lesions even in small children.

Multidisciplinary collaboration is key for the success of these procedures.

Clinical practice development

P-135

Esophageal balloon pyloroplasty in the treatment of gastric paralysis after esophageal and cardiac cancer surgery

C. Wang, W. Chen

Interventional Radiology Department, First People's Hospital of Changzhou, Changzhou, CN

Purpose: To explore the mechanism, treatment and prevention of gastroparesis after esophageal and cardiac cancer surgery.

Material and methods: 37 cases of gastroparesis after esophageal and cardiac cancer surgery were analyzed retrospectively from September 2012 to February 2017.

Results: After the treatment of esophageal balloon pyloroplasty, the abdominal distension and vomiting symptoms of these 37 patients disappeared, and the gastrointestinal decompression drainage volume gradually decreased to less than 400ml per day. Upper gastrointestinal radiography confirmed good gastrointestinal peristalsis condition at 19-38 days, and extubation feeding were given. Among these 37 cases, there was only 1 case appeared with gastric juice reflux, which choked into the lung, leading to aspiration pneumonia. The disease is under control and eventually cured after strengthening the anti-inflammatory treatment and timely rescue.

Conclusion: Esophageal balloon pyloroplasty should be performed as soon as the diagnosis of gastroparesis is established. Gastroparesis after surgery can be cured and avoid surgical intervention. Esophageal balloon pyloroplasty can also reduce complications and reduce the economic burden of patients.

P-136

Search engine analysis of interventional radiology directed therapies versus conventional and novel surgical techniques for uterine and prostate pathology in North America and Europe

T.K. Lewis¹, S. Mehta²

¹Radiology, Beth Israel Deaconess Medical Center/Harvard Medical School, Boston, MA, US, ²Vascular and Interventional Radiology, Beth Israel Deaconess Medical Center/Harvard Medical School, Boston, MA, US

Purpose: To analyze search engine results using derived ratios of surgical to interventional radiology-directed therapy for benign uterine and prostate pathology between North America and Europe.

Material and methods: Google was utilized to query data across North America (United States and Canada) and Europe (United Kingdom, Ireland, Germany, France, Italy, Spain, Portugal, Belgium, Netherlands, and Switzerland). Search engine result analysis was performed on keywords pertaining to fibroids and BPH for traditional surgical technique, a newer surgical procedure, and an IR-directed therapy. Ratios were derived for the resultant volumes of surgical to IR term, as well as newer surgical term to IR term to adjust for population differences.

Results: Search volume ratio for hysterectomy:uterine fibroid embolization was 29.8 in North America and 26.4 in Europe. Search volume ratio of myomectomy:uterine fibroid embolization was 4.2 in North America and 3.0 in Europe. TURP:prostate artery embolization search volume ratio was 83.1 in the North America and 103.5 in Europe. HOLEP:prostate

artery embolization search volume ratios were 4.0 in North America and 18.0 in Europe.

Conclusion: At least 26 times more search engine volume was found for surgical techniques versus IR guided therapies. For novel surgical techniques, 3 to 18 times more search engine volume was present when compared to IR-directed therapies. In comparison to Europe, North America searched IR guided therapies at a greater ratio. Our findings suggest a large gap exists between even novel surgical and IR techniques sought out by patients and demonstrates a need for marketing to ensure patients are informed of their options.

P-137

Active surveillance of patients with small renal masses referred to interventional radiology clinic

V.S. Sotirchos, S.W. Stavropoulos

Department of Radiology, Hospital of the University of Pennsylvania, Philadelphia, PA, US

Purpose: Active surveillance (AS) is a viable but often underutilized option for select patients with small renal masses (SRMs). The purpose of this study was to review the outcomes of patients referred to an Interventional Radiologist for SRM management and subsequently followed in an AS program overseen by IR.

Material and methods: An IRB approved retrospective review of IR clinic visits for SRM management between January 2012 and August 2018 was performed. Patient demographics, tumor characteristics, follow-up and survival data were recorded. Comparison of baseline variables was performed using the ANOVA test.

Results: A total of 231 patients with 292 SRMs were evaluated. SRMs were managed as follows: 30.1% (n=88) with AS by IR, 9.2% (n=27) with AS by another specialty, 42.8% (n=125) with percutaneous ablation and 11% (n=32) with surgery. Patients choosing AS were more likely to be older ($p=0.043$), and have smaller (mean size 1.9 cm; $p=0.015$) and multiple SRMs ($p=0.026$). For patients choosing AS by IR, the mean follow-up duration per tumor was 23.5 months (range 2-73 months). During surveillance, 22.7% (20/88) of the tumors demonstrated progression and 13.6% (12/88) ultimately underwent intervention, all with percutaneous ablation. The overall mean tumor growth rate was 1.4 mm/year. 3.3% (2/60) of patients developed new distant metastases presumably from renal cell carcinoma, though not biopsy confirmed. Two-year overall survival was 98.3%.

Conclusion: AS is an effective method for SRM management and can be coordinated by IR. AS can be offered to patients with the understanding that a number of patients will advance to more invasive therapy.

P-138

Are cerebral ischaemic complications more likely to happen in elderly patients undergoing transradial non-coronary intervention – a single-center retrospective review

Y.-W. Wu¹, R.Y. Tan², J. Kwan¹, G.H.T. Lim¹, L.H.H. Quek¹, U. Pua¹, I.K.H. Huang¹

¹Diagnostic Radiology, Tan Tock Seng Hospital, Singapore, SG, ²Yong Loo Lin School of Medicine, National University of Singapore, Singapore, SG

Purpose: Transradial artery access (TRA) is an established technique employed by interventional cardiologists for diagnostic and therapeutic coronary interventions. The use of TRA has gained increasing traction amongst interventional radiologists in recent years. In transradial, non-coronary interventions, the aorta has to be traversed. With increasing age, atherosclerotic changes in the aorta posed a theoretical risk of catheter-related emboli. Currently, there is limited literature available on the cerebral ischaemic complication rates in transradial non-coronary interventions.

Material and methods: Between November 2015 and December 2017, 150 transradial non-coronary interventions were performed on 95 patients. Intra-procedural, in-hospital, 30-day and 6-month complications

(ischaemic stroke, transient ischaemic attack and death, and minor complications, such as puncture site haematoma, pseudoaneurysm, thrombosis, dissection and perforation) were compared between the two age groups (≤ 65 and > 65 years old).

Results: The patients were predominantly male (87.0%) with age ≤ 65 (N=69; 46.0%) and age > 65 (N=81; 54.0%). There were no ischaemic strokes at all time points in both groups, except for one case of ischaemic stroke at 6-months in the age ≤ 65 group (1.4% vs 0.0%; $p=0.462$). On multivariable analysis, age > 65 was associated with lower in-hospital death rates (OR 0.251; 95%CI 0.013-3.09), at 30-days (OR 0.608; 95%CI 0.77-4.805) and at 6-months (OR 0.514; 95%CI 0.169-1.558) with no deaths intra-procedurally in both groups. Minor complications include puncture-site grade I haematoma formation (2.9% vs 2.5%; $p=0.999$) and pseudoaneurysm (2.9% vs 0.0%; $p=0.210$).

Conclusion: Transradial non-coronary interventions is safe in elderly patients, who are likely to have more atherosclerotic disease of the aorta. Of note, no complication of ischaemic strokes within 30 days of the procedure is documented in all patients.

P-139

Improving trainee education and engagement in interventional radiology

T. Gordon¹, C. Hay²

¹Radiology, Royal Infirmary of Edinburgh, Edinburgh, UK, ²Department of Interventional Radiology, Edinburgh Royal Infirmary, Edinburgh, UK

Purpose: Registrars rotating through core-attachments in interventional radiology (IR) often have little prior experience in the subspecialty. Furthermore, the varied array of kit and extensive nomenclature provides a steep learning curve. This can impact on the learning experience, enjoyment and engagement in IR, possibly discouraging pursuing it as a career. In this study, we measured the effect of "primer" sessions on trainee educational output, engagement and enjoyment of IR.

Material and methods: Two seminars covering common IR procedures and basic kit were delivered to trainees beginning their IR attachments. Trainees knowledge and understanding of IR was surveyed prior to these sessions, with a follow-up survey completed at two-weeks.

Results: Twenty-one radiology registrars were surveyed (14 male, 7 female). 62% had little-to-no prior experience in IR. 55% stated they were not considering, or were unsure, on a future career in the subspecialty. With the addition of the primer sessions, the overall mean knowledge and understanding of the surveyed trainees increased from 34% to 76%. Furthermore, trainee familiarity increased with both IR kit and procedures: 2 to 8 and 3.5 to 8 respectively (range: 1-10). Following the primer sessions, all trainees surveyed stated the sessions increased engagement and enjoyment of their IR attachments.

Conclusion: In conclusion, entering IR training can be challenging due to the varied array of procedures and kit. Our results demonstrate how this discourages trainees, limiting their educational experience and enjoyment of IR. By improving education, we have shown that trainees are more likely to enjoy their time in IR and consider further subspecialty training.

P-140

The anatomical variation of prostatic artery in Chinese population: based on contrast-enhanced magnetic resonance angiography

J.L. Zhang, M.Q. Wang, B. Yuan, Y. Wang, J.Y. Yan

Department of Interventional Radiology, Chinese PLA General Hospital, Beijing, CN

Purpose: To evaluate the efficacy of contrast-enhanced MRA (CE-MRA) in identifying the prostatic arteries (PAs) and depict those anatomical variations.

Material and methods: In this single-center, prospective study, 136 consecutive men (mean age, 73.8 $\pm$ 9.9 years; range, 51–89 years) scheduled

to undergo prostatic artery embolization (PAE) for benign prostatic hyperplasia (BPH) between January 2015 and December 2018, preprocedural identification of the PAs were determined using CE-MRA. MRA findings of the PA anatomy, including the number, origin and trajectory, were compared to those of digital subtraction angiography (DSA) which as the reference standard.

Results: In total, 136 patients (272 pelvic sides) with 302 PAs confirmed by DSA. MRA identified PAs with a sensitivity of 94.7% (286/302) and positive predictive value (PPV) of 100% (286/286). The most frequent PA origin was the anterior division of the IIA (30.8%, 88/286), followed by the internal pudendal artery (26.6%, 76/286), the common trunk with the superior vesical artery (20.6%, 59/286), the obturator artery (19.6%, 56/286), the accessory pudendal artery (1.7%, 5/286), and, rarely, the superior gluteal artery (0.7%, 2/286).

Conclusion: CE-MRA could depict reliable PA anatomy with high sensitivity and PPV and provide useful information prior to PAE.

P-141

Transpleural systemic-to-pulmonary artery communications in the absence of pulmonary parenchymal disease: a case-series and review of the literature

B. Pitrola¹, A. Alsaifi¹, J.E. Jackson²

¹Radiology, Imperial College Healthcare NHS Trust, London, UK, ²Imaging, Hammersmith Hospital, Imperial College Healthcare NHS Trust, London, UK

Purpose: To describe the imaging findings, clinical relevance and management of transpleural systemic-artery-to-pulmonary artery shunts occurring in the absence of chronic inflammatory lung disease in the largest series of patients described to date.

Material and methods: All patients referred to a tertiary referral unit between January 2013 and December 2018 diagnosed as having a systemic-to-pulmonary artery communication without underlying lung disease have been included. Presentation, imaging findings, management and follow-up data were reviewed. A literature search was performed.

Results: Eight patients (M:F = 6:2; median age 40 years (range 23-70 years) with systemic artery-to-pulmonary artery shunts without parenchymal lung disease were identified. In six patients there was either a history of accidental or iatrogenic thoracic trauma or of inflammatory disease involving the pleura. All were asymptomatic other than one individual with localised thoracic discomfort that dated from the time of surgery. All patients have been managed conservatively and have remained well with a median follow-up of 5.5 years (2 – 10). A literature search revealed only a few case reports of these abnormalities and varying treatment strategies including surgery, embolization and conservative management.

Conclusion: Systemic artery-to-pulmonary artery shunts in the absence of chronic inflammatory lung disease are unusual and, based upon the current literature, their best management is unknown. This presentation describes the largest series of patients with this condition and concludes that, even when large, management can be conservative.

P-142

Pharmaco mechanical treatment of high risk and intermediate-to-high risk acute pulmonary embolism: long term clinical outcome of a single centre experience

M. Galli

Cardiology, S. Anna Hospital, San Fermo Della Battaglia, IT

Purpose: Pharmaco Mechanical Treatment (PMT) seem to be attractive in acute Pulmonary Embolism (PE) in high or intermediate-to-high risk PE. We sought to retrospectively evaluate patients' clinical outcome who submitted PMT

Material and methods: Between 2011 and 2018, in our Institution, 42 patients with high or intermediate-to-high risk PE were treated with PMT by means of rheolytic thrombectomy (RT) or ultrasound-assisted

thrombolysis (USAT). 26% had absolute contraindication to SF and others had high risk of major bleeding. In RT patients, a thrombectomy catheter was advanced till segmental pulmonary branches and several runs were performed; in USAT treated patients catheters were positioned under fluoroscopy guide in culprit major vessels. Primary endpoints were technical and clinical success. Secondary endpoint was safety in terms of low rates of major bleedings.

Results: Technical and procedural success, defined as significantly reduction of thrombus burden improving and patients' hemodynamic conditions was obtained in 95,3%. In-hospital mortality rate was 7% due to refractory cardiogenic shock, all in high risk PE treated by means of RT; only one major bleeding was experienced due to femoral pseudoaneurysm. In all patients, early improvement in right ventricle systolic function by echocardiographic post-procedural evaluation was documented, regardless of patients' risk status at presentation and interventional strategy adopted. At 36 months median follow-up, 4 patients died because of cancer. All survivors were asymptomatic without right ventricle dysfunction or residual pulmonary hypertension.

Conclusion: Our experience confirms efficacy and safety of PMT in PE, especially when complicated by severe hemodynamic compromise or when SF therapy is contraindicated, even at long term follow-up.

P-143

Evaluation of a novel, cheap and simple silicone based vascular phantom for ultrasound-guided vascular access training

K.S. Sabarwal¹, F.M. Sheehan², G.A. Yogarajah¹, C. Heiss³, A. Pankhania¹

¹Radiology, East Surrey Hospital, Surrey, UK, ²Radiology, Frimley Health NHS Foundation Trust, Camberley, UK, ³Vascular, East Surrey Hospital, Surrey, UK

Purpose: Ultrasound-guided procedures are an essential component of the core radiology training curriculum in the UK. Opportunities to practice these procedures prior to performing them on patients are limited as many times, commercial training models (phantoms) are costly and often not available. Here, we present a novel vascular phantom created from simple inexpensive components and evaluate its use as a training tool.

Material and methods: Using rubber tubing and silicone, three vascular phantoms (models A, B and C) each with progressively more challenging "tissue" density and vessel anatomy were created. Each had a simple mechanism which allowed flashback upon successful puncture. For each volunteer, a timed baseline attempt was made to puncture the intermediate model (B). Following 30-minutes of training, timed attempts to consecutively puncture the three models were performed. A pre- and post-use questionnaire was completed.

Results: Twenty volunteers were recruited from staff at East Surrey Hospital. 62% had little to no experience of performing ultrasound-guided procedures. The mean time taken at the baseline attempt was 72 ± 15s (mean ± SEM). Relative to the baseline, a statistically significant improvement in the time to successfully access all three models following the training session with the vascular phantom was observed - model A: 30 ± 5s (p = 0.017); model B: 30 ± 7s (p = 0.016); model C: 18 ± 3s (p = 0.007). Our questionnaire confirmed that all volunteers felt confident in both performing the procedure and visualising their needle with ultrasound following the training session.

Conclusion: Our novel, affordable silicone-based vascular phantom is an effective training tool for ultrasound-guided vascular punctures.

P-144

Computed tomography guided percutaneous infiltrations for piriformis syndrome: a single center retrospective study

G. Iliadis¹, D.K. Filippiadis¹, G. Christos²

¹2nd Department of Radiology, ATTIKON University General Hospital, Athens, GR, ²Department of Clinical Radiology, Medical School, University of Ioannina, Department of Clinical Radiology, Medical School, University of Ioannina, Ioannina, GR

Purpose: To retrospectively evaluate the effectiveness of Computed Tomography (CT) - guided percutaneous infiltration in a series of consecutive patients with piriformis syndrome with symptoms refractory to conservative therapies.

Material and methods: Institutional database research identified 16 consecutive patients with piriformis syndrome refractory to conservative therapies who underwent CT - guided percutaneous infiltration with a mixture of long acting corticosteroid and local anesthetic. Pre-operational evaluation included physical examination and MRI. The correct position of the needle (22 Gauge spinal needle) was verified with CT scan post contrast medium injection. Pain, prior, one week/one, 6 and 12 months post were compared by means of a numeric visual scale (NVS) questionnaire.

Results: Mean pain score prior to CT-guided percutaneous infiltration was 8.94 ± 1.482 NVS units. This score was reduced to a mean value of 0.81 ± 0.981 units at 1 week after, 0.83 ± 0.983 at 1 month, 1.02 ± 1.284 at 6 months and 1.02 ± 1.284 at 12 months of follow-up ($p < 0.01$). Two (2) patients out of sixteen (12.5%) underwent a second infiltration, which was performed within 7-10 days apart from the first one. No complication was observed.

Conclusion: Computed tomography-guided infiltrations is a feasible, efficacious and safe approach for pain reduction and mobility improvement in patients with symptomatic piriformis syndrome. Computed tomography guidance secures the precise needle placement and minimizes major complications with excellent results upon pain relief.

P-145

"Rookie wall", a phenomenon commonly seen but usually overlooked among junior interventional radiologists

Y. Wang¹, W. Chen¹, Y. Liu², H. Liu¹, L. Jiaping³

¹Interventional Oncology, 1st Affiliated Hospital of Zhongshan University, Guangzhou, CN, ²The Department of Interventional Oncology, The First Affiliated Hospital, Sun Yat-Sen University, Guangzhou, CN, ³Interventional Radiology, 1st Affiliated Hospital of SUMS, Guangzhou, CN

Purpose: We use "Rookie wall" to describe a phenomenon that most junior interventional radiologists would encounter in studying Seldinger technique in the first few months, they found it was difficult to puncture femoral artery. The study aims to explore the possible reasons and solution of Rookie wall (RW).

Material and methods: A survey via internet to explore incidence rate of RW, access the possible reasons, including gender, occur time, duration time, etc. Suitable statistics methods were used to analysis the results.

Results: From three countries, 89 validated questionnaires were collected. All of them used Seldinger technology to puncture Femoral artery. Over 80% doctors encountered the RW in the first months of interventional radiological (IR) career. There was no gender difference. Nearly 60% (59.85%) doctors encountered RW after 10 times of IR procedures. There was no significant difference between classic and modified Seldinger technology. The duration of RW lasted 1-2 weeks mostly. The puncture positions of Femoral artery were 42.68% inner and 45.12% lower when RW happened. Nearly 60% (59.76%) respondents believed the RW was inevitable process. Too little practice was the main reason of RW according 43.9% of respondents. Lack of theoretical knowledge (20.73%), patients' factors (36.59%) and self-doubt (34.15%) were other

reasons. More practice, enhance theoretical study, summarize success could help to pass the RW quickly.

Conclusion: Rookie wall was commonly in the first period of IR career. The main reasons were lack of practice. More practice, enhance theoretical study and self-confidence could break the Rookie wall.

P-146

Continuous versus pulsed mode of microwave ablation: what about pain tolerability during liver ablation?

G. Iliadis¹, D.K. Filippiadis¹, A. Pastroma¹, G. Velonakis¹, A.D. Kelekis², E. Brountzos¹, N.L. Kelekis¹

¹2nd Department of Radiology, University General Hospital ATTIKON, Athens, GR, ²2nd Department of Radiology, National and Kapodistrian University of Athens, ATTIKON University General Hospital, Athens, GR

Purpose: To compare self-reported pain scores of patients undergoing liver ablation with either continuous or pulsed mode of microwave ablation

Material and methods: During the last 6 months 24 patients underwent liver ablation; patients were prospectively evaluated and randomized into continuous mode (CM – 12 patients) and pulsed mode (PM – 12 patients) groups. All ablation sessions were performed under Computed Tomography-guidance and IV analgesia (paracetamol 1g + tramadol 100ml – same anaesthesia protocol in all 24 patients). Group CM included 6 HCC and 14 metastatic [colon (9), pancreatic (1), breast (2), bronchogenic (2) carcinoma] treated lesions; depending on location CM group included 6 sub-capsular and 14 lesions at least 2 cm away from liver capsule. Group PM included 6 HCC and 12 metastatic [colon (8), pancreatic (1), breast (2), bronchogenic (1) carcinoma] treated lesions; depending on location PM group included 8 sub-capsular and 10 lesions at least 2 cm away from liver capsule. Immediately upon completion of the ablation session all patients were asked to complete a pain score questionnaire with a 0-10 numeric pain scale.

Results: The mean pain score was 8.17 ± 1.850 in CM group and 4.50 ± 1.567 pain units in PM group. There was statistically significant difference of 3.667 ± 2.807 pain units ($p = 0.001$). No complications were noted in CM versus two grade I complications according to CIRSE classification system (small peri-hepatic haemorrhagic fluid collections) in PM group.

Conclusion: Pulsed mode of microwave ablation seems to be less painful for patients undergoing liver ablation under IV analgesia, rendering this mode an attractive alternative whenever anesthesiologist is not present.

P-147

Awareness of interventional radiology among patients who attend an interventional radiology outpatient consultation: a survey of patients in a third level Spanish Hospital

D. Ortiz¹, C. Figueroa¹, J. Guerrero¹, C. Moya¹, J.A. Guirrola², M.A. de Gregorio³

¹School of Medicine, University of Zaragoza, Zaragoza, ES, ²Interventional Radiology - GITMI, Hospital Clínico Universitario Lozano Blesa, Zaragoza, ES, ³Interventional Radiology, University of Zaragoza, Zaragoza, ES

Purpose: To quantify the level of knowledge about interventional radiology (IR) among patients who attend an Interventional outpatient consultation (IR-OC).

Material and methods: As an initiative from medical students who were attending the subject of Minimally Invasive Surgery Guided by Imaging of the University of Zaragoza; a paper, self-administered, anonymous, voluntary survey was conducted prospectively to all consecutive patients who attended IR-OC from September 20th until December 31st of 2018 at the Hospital Clínico Universitario Lozano Blesa (Zaragoza, Spain). The study was focused on the relationship between awareness of IR between the place of residence (rural/urban) and the level of studies (basic /medium/university).

Results: A total of 141 patients participated (n = 141), 23% (33 surveys) were discarded due to poor completion. A total of 38% didn't know previously that IR was a medical subspecialty, 62.4% didn't know what procedure the interventional radiologist performed (61% were female, 54% patients came from rural areas), and 12% believed that interventional radiologist were surgeons.

No statistically significant differences were found between awareness of IR and the level of studies in patients ($p > 0.05$) and place of residence ($p > 0.05$).

Conclusion: Currently in our IR-OC showed that 62% of patients knew previously IR, however, it also demonstrated a low patient awareness regarding IR procedures. The findings of this study may help guide future efforts to promote public awareness in IR.

P-148

Utilization trends by specialty for subcutaneous tunneled port placement and revision procedures from 2010 to 2017 amongst Medicare beneficiaries

S. Warhadpande¹, R. Dhangana², W.S. Lindquester³

¹Interventional Radiology, UPMC, Pittsburgh, PA, US, ²Department of Radiology, Division of Vascular & Interventional Radiology, University of Pittsburgh Medical Center, Pittsburgh, PA, US, ³Radiology, University of Pittsburgh Medical Center, Pittsburgh, PA, US

Purpose: To provide an update in utilization of subcutaneous tunneled port placements and revisions amongst Medicare beneficiaries from years 2010 to 2017 in the United States.

Material and methods: Using the publicly-available Medicare Part B Physician/Supplier Procedure Summary Master File (PSPMF) from years 2010 to 2017, national data regarding billing volume and total reimbursement amounts for subcutaneous port placement and revision of subcutaneous port placement procedures were extracted using their respective CPT codes. Utilization trends were subsequently calculated.

Results: Between 2010 and 2017, the total volume of port placements increased by 6.9% (from 127,723 to 136,576), with a similar 6.6% increase in total amount paid (from \$40.4 million to \$43.1 million). Radiologists saw the greatest increase in total port placements performed (27.1% of the total share in 2010 compared to 43.1% of the total share in 2017). The total number of port revisions decreased by 17.5% from 2010 to 2017 (2797 to 2308). Radiologists and general surgeons performed the majority of the port revisions (38.2% and 33.0%, respectively) in 2017.

Conclusion: The decrease in port revisions (despite an increase in the total ports placed) could be related to the preferred choice of venous access (internal jugular vein vs subclavian vein) or improved port-placement technique (increased usage of ultrasound-guided access vs surgical anatomic landmark method), among other factors. Regarding port placements/revisions, the trend in the United States is in radiology's favor: radiologists now lead all specialties in port placements and revisions. Since radiologists taking the lead for port placements, the total number of port revisions has decreased.

P-149

Improving technical success in adrenal vein sampling

B.R. Hawthorn¹, T.J. Cavenagh¹, S. Katsari¹, G. Garzillo², L. Mailli¹

¹Radiology, St. George's Hospital, London, UK, ²Radiology, King's College Hospital, London, UK

Purpose: To determine the technical success rate of adrenal vein sampling (AVS) and compare local results to those reported in literature. To evaluate if technical success can be improved with a single operator and the use of pre-procedural CT adrenal vein mapping and intraprocedural rapid cortisol assay (IRCA).

Material and methods: All AVS procedures performed over a 4 year period in a single tertiary-referral centre were identified retrospectively from the radiology information system. Procedural details were gathered

from radiological reports. Biochemical data obtained from electronic patient records were used to determine technical success. After the initial study period, all procedures were performed by a single operator and routine use of pre-procedural CT and IRCA were introduced. A second study period is currently ongoing (results from the first 3 months are presented in this abstract).

Results: 51 AVS procedures were performed by four operators in the initial study period. The left adrenal vein was successfully sampled in 48 cases (94%) and the right adrenal vein in 31 cases (61%). The quoted success rate in the literature for right adrenal vein cannulation is 74%. Since implementing changes in practise, 7 AVS procedures have been performed and 3 have biochemistry results so far. In this cohort, the left adrenal vein was sampled successfully in 3 cases (100%) and the right adrenal vein in 2 cases (66%).

Conclusion: Local technical success rates have been lower than those reported in literature. Based on preliminary results, the use of pre-procedural CT and IRCA show promise in improving operator confidence and technical success.

P-150

Rorschach psychodiagnostic evaluations in the interventional radiology service: an attempt to improve psychophylaxis

O.B. Sandoval, A.M. Suarez Anzorena, F.L. Moreno, M. Sosa, F.J. Suarez Anzorena Rosasco
Diagnostic Imaging, Hospital de Clinicas "Jose de San Martin", Buenos Aires, AR

Purpose: Identify difficulties in the doctor-patient relationship and provide solutions to it through the Rorschach test to optimize and enhance psychophylaxis in IR patients.

Material and methods: The Pilot study began in October 2018 and concluded in December 2018 with physicians working at the Interventional Radiology Service. This study is descriptive, exploratory, longitudinal and prospective. It uses the Rorschach test due to its diagnostic precision to obtain physicians' psychological characteristics. The sample is composed by 11 voluntary physicians, mixed genders, aged between 27 and 37 years old. All participants were individually evaluated with the Rorschach test. In six months, the same tests will be presented on the same participants.

Results: Preliminary Results:

Analyzed results up to date: the study exhibited a large amount of cases where F+ = 134 shapes prevail. In contrast, there was a very small amount of FC=3. These would imply that participants are trying to control, restrict and hold back emotions in a way that might affect the Doctor-Patient relationship.

Final results will be analyzed according to the "Argentine School for Rorschach Psychodiagnostics". When tests are finished, statistics will be interpreted, taking into account possible changes in each test repetition (quantitative) and speech variations (qualitative) to elaborate hypothesis.

Conclusion: The Rorschach test is an effective tool when analyzing the behavior of a young physician towards his patients. We see that this test is useful to identify changes in a physician's personality and its long term development, strengthening its interpersonal skills. In terms of the patient welfare, this test can improve their psychophylaxis.

P-151

Expected and effective pain in the angio-suite: are words the most powerful drug?

A. Posa¹, R. Iezzi², F. Carchesio², G. Veltri²

¹Department of Radiology, AFaR-IRCCS Fatebenefratelli Hospital Foundation for Health Research and Education, Rome, IT, ²Dipartimento di Diagnostica per Immagini, Radioterapia Oncologica ed Ematologia, Fondazione Policlinico Universitario A. Gemelli - IRCCS, Università Cattolica del Sacro Cuore, Rome, IT

Purpose: To evaluate the levels of patient's expected (pre-procedural) and effective (procedural) pain, fear and stress prior to interventional procedures, and the impact of an accurate and timely informed consent on their control.

Material and methods: We prospectively interviewed 500 adult patients, coming in our angio-suite both from the emergency department and the ward, for interventional procedures, using a dedicated questionnaire to assess their expected and effective pain, using a 5-point scale. We evaluated the demographics of the patients, their level of instruction, their ability to comprehend our explanations, and their previous experience with similar procedures. We recorded clinical and procedural parameters, the quantity of material used, and the time required.

Results: Non-oncological patients coming from the ward, for elective endovascular procedures showed almost no differences between expected and effective pain. Oncological patients, coming from the emergency department for urgent extra-vascular procedures showed the greatest gap between the high expected pain and the low effective pain, with poor stress-control and great level of anxiety throughout the procedure. Patients that received more explanations the day before the procedure had a better stress-control. We found a correlation between comprehension of the procedure and the expected pain, and duration of the procedure.

Conclusion: Mini-invasive interventional procedures require a great level of patient collaboration. Fear and anxiety prior the procedure, often limit the collaboration of the patients, and can transform a relatively painless procedure in a painful experience. A complete and timely explanation of the procedure showed to reduce the anxiety, stress and pain of the patients, increasing their collaboration.

P-152

Awareness and knowledge of interventional radiology by medical students in one of the largest medical schools in France

S. Dbouk¹, P. Auloge¹, R.L. Cazzato¹, C. Kieffer², P.E. Zorn³, J. Sibilia⁴, J. Garnon¹, A. Gangi⁵

¹Interventional Radiology, Strasbourg University Hospital, Strasbourg, FR, ²Medecine, Strasbourg University Hospital, Strasbourg, FR, ³Computer Engineer, Strasbourg University Hospital, Strasbourg, FR, ⁴Rheumatology, Strasbourg University Hospital, Strasbourg, FR, ⁵Imagerie Interventionnelle, NHC, Strasbourg, FR

Purpose: To assess awareness and knowledge of Interventional Radiology (IR) in a large population of medical students in France in 2019.

Material and methods: An electronic survey was sent to all medical students from 1st to 6th year of medical school. The survey contained 13 questions, including two on diagnostic radiology (DR), and artificial intelligence (AI), and 11 on IR.

Responses were analyzed for all students and compared between pre-clinical phase (PCs)(1st to 3th year) and clinical phase (Cs)(4th to 6th year) of medical school. Of 3100 students, 548 students (17.7%) answered the survey (PCs: 275/548 (50.2%); Cs: 273/548 (49.8%)).

Results: On DR questions, 500/548 students (91.2%) answered that radiology have a future (PCs: 252/275(91.6%); Cs: 248/273(90.8%)); 186/548 students (33.9%) thought that AI is a threat for radiology (PCs: 88/275(32%); Cs: 98/273(35.9%)).

On IR questions, 446/548 students (81.4%) have already heard of IR (PCs: 181/275(65.8%); Cs: 265/273(97.1%) with a significant difference ($p=0.005 \times 10^{-24}$); 473/548 students (86.3%) would like more lectures and information on IR (PCs: 240/275(87.3%); Cs: 233/273(85.3%)); 415/548 students (75.7%) considered their knowledge of IR wasn't as good as the other specialties (PCs: 217/275 (78.9%); 198/273 (72.5%)). Finally, 169 (30.8%) would be interested in a career in IR (PCs: 84/273 (30.5%); Cs: 85/275 (31.1%)).

Conclusion: 1/3 of medicals students considered AI as a threat for radiology. More than 3/4 of students are aware of the existence of IR, nevertheless a large majority considers their knowledge to be poor and would like to have more lectures in this field.

P-153

Stereotactic image-guided microwave ablation of hepatocellular carcinoma

M.H. Maurer¹, P. Tinguely², V. Banz², C. Kim-Fuchs², D. Candinas², J. Heverhagen³, A. Lachenmayer²

¹Radiology, Bern University Hospital, Bern, CH, ²Surgery, Bern University Hospital, Bern, CH, ³Radiology, Inselspital, Bern, CH

Purpose: To assess the therapeutic success of CT-based percutaneous stereotactic microwave ablation in patients with hepatocellular carcinoma (HCC).

Material and methods: We retrospectively analyzed a cohort of patients treated with percutaneous stereotactic image-guided microwave ablation for HCC at our institution between 01/2015 and 12/2017. All interventions were performed using CT-based guidance with needle trajectory planning by landmark-based registration and an aiming device for precise needle placement.

Results: In total 163 interventions were performed in 92 patients (mean age 66 (50-84) years, 81 (83.5%) men). Patients presented on average with one tumor (1-6), a maximum of four tumors were ablated per session. Forty-three patients (44.3%) had one or more previous HCC treatments, 14 (14.4%) were transplanted afterwards. Mean tumor size was 16 mm (5-43 mm), mean ablation time per lesion was 5 (1-24) minutes. Within 30 days, no major or liver-specific complications occurred, six (4.6%) patients had minor (grade 1 and 2) complications after a total of 131 interventions. Of the 77 patients with a minimum 6-month follow-up after intervention, mean overall survival was 13.9 months after ablation and 23.7 months after initial diagnosis. Local recurrence occurred in 20/131 (15.2%) lesions, but could successfully be re-ablated in 14 cases (12.2%). Tumor size ≥ 3 cm was significantly correlated to local tumor recurrence ($p=0.005$).

Conclusion: Percutaneous stereotactic image-guided microwave ablation is safe and efficient for the treatment of HCC. It might offer a curative treatment approach especially for inoperable and conventionally unablatable lesions by an accurate and precise needle positioning in a minimally invasive setting.

P-154

Radiofrequency ablation of symptomatic benign thyroid nodules: 600 patients 5-years follow-up

V. Solovov

Interventional Radiology, Samara Oncocenter, Samara, RU

Purpose: The aim of the study was to evaluate the efficacy and safety of ultrasound (US)-guided radiofrequency ablation (RFA) for treating of benign thyroid nodules.

Material and methods: The retrospective analysis included the results of treatment of 600 patients with symptomatic benign tumors of the thyroid gland underwent RFA in the Samara Oncology Center. The inclusive criteria were: reported cosmetic and/or symptomatic problems, solid thyroid nodule (solid portion over 70%), cytologically confirmed benign nodule on two separate US-guided fine needle biopsy (Thirads 2-3, Bethesda 1-3); autonomously functioning thyroid nodules, refusal of or ineligible

for surgery. Among the patients 117 (19.5 %) patients had autonomously functioning thyroid nodules with hyperthyreosis and 413 (81.5 %) had symptomatic ones. The total duration of the study was 5 years.

Results: The therapeutic success (a decrease of not less than 50% of the original volume) was observed in 6 months at 469 patients (78.1%) and in 572 (95.3%) after 1 year. The largest decrease in volume was observed during the first month.

Cosmetic results were evaluated as "excellent" in 566 (94.8%) of patients, in 33 (5.2%), where the initial size was more than 10 ml, as "good".

The function of the thyroid gland with AFN nodules normalized completely in one month after RFA.

No serious complications were observed.

Conclusion: RFA was effective and safe for treating benign thyroid nodules. A wider use of RFA will reduce the number of surgical interventions.

P-155

Left distal transradial access (IdTRA): are we compromising patient comfort for vessel size

D. Klass¹, A. Hadjivassiliou², L. Cardarelli-Leite², J. Chung², D.M. Liu³

¹Interventional Radiology, University of British Columbia, Vancouver, BC, CA, ²Radiology - Interventional Radiology, University of British Columbia, Vancouver, BC, CA, ³Interventional Radiology, Vancouver General Hospital, Vancouver, BC, CA

Purpose: Evaluate the radial artery size in the anatomical snuffbox and wrist and its clinical implications in patients undergoing left distal radial access (IdTRA)

Material and methods: Prospective single-center observational study from November 2016 to October 2018. All patients undergoing distal radial access were included.

An ultrasound evaluation was performed of the radial artery in the anatomical snuffbox and at the site of conventional radial access in the wrist, 1-2cm proximal to the radial styloid, prior to injection of any vasodilator medication. Technical success and complications were documented.

Results: 389 patients (117 female and 272 male patients), aged 18-94 years (median age 64 years) were included. The procedures included hepatic chemoembolization (n=161), Yttrium-90 mapping (n=74), internal radiation therapy with Yttrium-90 (n=48), diagnostic angiography (n=34), gastrointestinal hemorrhage embolization (n=21), vascular or visceral stenting (n=8), abdominal and pelvic embolization (n=37). Mean sonographic measurement of the left radial artery size at the wrist was 2.6 mm (Range 1.4 – 3.3 mm) and 2.4 mm (Range 1.4 – 3.2 mm) at the anatomical snuffbox (p=0.002). Technical success rate was 100%, with no need to downsize a sheath due to a significant decrease in caliber of the vessel in the snuffbox. Single grade 1 hematoma occurred (0.3%). No radial artery occlusions were observed, mean follow up 46 days (25-66 days).

Conclusion: There is a significant difference in the size of the radial artery in the snuffbox compared to the wrist, but this does not translate into a clinically significant difference. No downsizing of sheaths is required if this site is chosen for access.

P-156

Occupational orthopedic health problems in interventional radiology: an online survey

A.M. König, S. Viniol, R. Philip Thomas, A.H. Mahnken
Department of Diagnostic and Interventional Radiology, University Hospital Marburg, Philipps University of Marburg, Marburg, DE

Purpose: Several studies report occupational orthopedic problems among interventional cardiologists. To assess the link between orthopedic health problems and the use of personal radiation protection devices in interventional radiology, an online survey was done.

Material and methods: 1427 invitations to an anonymous online survey that comprised 17 questions were sent via e-mail to interventional radiologists in Germany, Austria and Switzerland. The questions are focused

on the use of personal radiation protection devices and work-related orthopedic health problems.

Results: There were 221 survey responders (15.5% response rate). All responders use personal radiation protection devices. 87.6% of these confirm that the personal radiation protection garments fit well. 53% of the responders declare that their garments were customized to their individual physique. 47.7% suffered more than five episodes of orthopedic problems during their interventional career. In 81.7% of these cases the lumbar spine was involved. Because of orthopedic problems, 15.8% of the responders had to reduce and 2.3% had to stop their interventional practice.

14.2% of all responders use light personal radiation protection devices. Out of this group, 6.7% had to reduce and no one had to stop their interventional practice because of orthopedic problems.

Conclusion: This survey indicates a link between the type and use of radiation protection devices and occupational orthopedic health problems.

P-157

Ablative techniques for lung metastases: baseline characteristics and outcomes of stereotactic radiotherapy versus radiofrequency ablation at The Royal Marsden

J.W.S. Pang¹, U. Bashir², T. Glover², M. Ahmed¹, N.I. Fotiadis²

¹Lung Unit, The Royal Marsden Hospital, Sutton, UK, ²Interventional Radiology Department, The Royal Marsden Hospital, London, UK

Purpose: To determine any differences between outcomes and baseline characteristics of patients treated with radiofrequency ablation (RFA) or stereotactic radiotherapy (SBRT) for lung metastases at our institution.

Material and methods: We retrospectively analysed 86 patients treated with RFA and 33 treated with SBRT. Local control, survival, toxicity and baseline characteristics were compared.

Results: Median follow up was 1.7 and 2.5 years for SBRT and RFA patients, respectively. Tumours treated by SBRT were larger: 21.5mm vs 9.0mm. 42% RFA patients proceeded to further ablative treatment to any lung lesion vs 12% SBRT patients. More RFA patients had systemic therapy either preceding or after ablative treatment: 74% and 71% vs 58% and 46% in the SBRT group, respectively.

The primary diagnoses being treated with either modality differed significantly. All (22) patients with soft tissue sarcoma were treated with RFA, while all (9) melanoma patients were treated with SBRT. Colorectal (62 patients) and renal cell carcinoma (6 patients) were treated with both modalities. Various other primary diagnoses were treated but patient numbers were ≤4 for each diagnosis.

Overall lesional local control was 73.0% for SBRT and 91.1% for RFA. For tumours ≥10mm, lesional local control was 72.2% and 85.4%, respectively. Median OS was 4.2 years for SBRT vs 3.6 years for RFA. Toxicity was comparable to existing literature.

Conclusion: This highlights differences in patient selection and outcomes for RFA or SBRT in the treatment of lung metastases at our institution. Randomised studies are required to determine the optimum treatment modality for these patients.

P-158

Current status of micro-balloon assisted embolization

K. Tanaka, K. Osuga, K. Nagai, Y. Kimura, Y. Ono, H. Higashihara, N. Tomiyama

Diagnostic and Interventional Radiology, Osaka University Graduate School of Medicine, Suita, Osaka, JP

Learning objectives: To describe the evolution and useful cases of micro-balloon (MB) catheter.

Background: MB catheter has tended to be smaller in diameter to provide a good distal accessibility. Recently, further refinement of MB catheter is represented by larger balloon diameter and newly designed catheter with a side-hole. The knowledge of MB catheters is important

to overcome difficult procedures which conventional balloon catheters will not be applied.

Clinical Findings/Procedure Details: As a history, the original MB catheter was launched in 2006. This catheter has 8mm balloon and it can pass through a 6 Fr guiding catheter. In 2013, a 1.8Fr MB catheter with 3-5mm balloon became more flexible and thinner, and can pass through a 4Fr catheter. A 3.8Fr MB catheter with 6mm balloon was launched in 2015. Recently, 2 Fr MB catheter with a side hole was launched.

1. Gastric varices with direct shunt to left gastric vein (LGV): Balloon occluded retrograde obliteration was performed after MB catheter (with large balloon diameter) insertion into the tortuous gastro-renal shunt beyond anastomosis with LGV.

2. Idiopathic esophageal artery rupture: Embolization was performed using NBCA under MB occlusion without reflux to the Aorta (I.E.: B-glue).

3. HCC with massive AP shunt: Under MB occlusion, AP shunt disappeared, while the tumor stain was clearly visualized to be supplied by a fine feeding artery arising from the parent artery near the side hole.

Conclusion: It is important to be familiar with MB features for safer and more reliable interventional procedures.

P-159

Recycling in interventional radiology - steps to a greener department

M.P. Brassil, W. Torreggiani, P. Govender
Radiology, Tallaght University Hospital, Dublin, IE

Learning objectives: We aim to open dialogue on environmental awareness and recycling. Interventional radiology departments need to question their practices and remain open minded to change. With very minimal effort, minor behavioral adjustments and at the expense of neither money nor time, you will see real results and reduce waste.

Background: Interventional radiology has traditionally led the way in patient care and outcomes. When it comes to healthcare waste and recycling, we are in the midst of a green revolution and we are at risk of getting left behind. Having a green policy in IR will make a difference to the quantity of waste we produce and the costs associated with its disposal.

Clinical Findings/Procedure Details: We contacted our hospital environmental services manager and requested a site visit, we learned that virtually all our product packaging was recyclable free of charge to the hospital. Previously this waste had been inadvertently placed in general or risk waste bins. Interestingly, we found an increase 60% of inappropriately segregated waste in cases where the risk bin was physically closer to the interventionalist than the non-risk bin during procedures. Simply having recycling bin readily available at beginning of a procedure and keeping the risk waste bin further away offered instant behavioral results effortlessly. We engaged with industry product representatives to request a more bespoke equipment pack to reduce disposal of unused components.

Conclusion: Improving environmental sustainability in the IR suite has been enlightening, enriching and rewarding. By reducing, reusing and recycling, we not only save money, we can be leaders in the green healthcare revolution.

P-160

Does the use of interventional radiology (IR) safety checklists reduce the incidence of complications associated with IR procedures? A literature review

D. Brennan, D.C. O'Neill, D. Mulholland, M.J. Lee
Radiology, Beaumont Hospital, Dublin, IE

Learning objectives:

1. To review current national and international guidelines on the use of IR safety checklists
2. To review and appraise current literature regarding the use of IR safety checklists and their association with the incidence of periprocedural complications

Background: The introduction of surgical safety checklists has had a significant effect on the morbidity and mortality associated with surgical procedures. In 2011 CIRSE published an IR safety checklist, modified from the WHO surgical safety checklist, with the aim of decreasing the incidence of complications after IR procedures. The checklist is available to download from the CIRSE website and can be modified to fit any IR practice.

As part of the practice-based learning module of the training scheme of the Faculty of Radiologist in Ireland, we performed a literature review to critically appraise best available evidence on the success of IR safety checklists in reducing IR procedure complications.

Clinical Findings/Procedure Details: The use of IR safety checklists is encouraged but not mandated by national and international guidelines. Using an evidence-based framework, we performed a comprehensive literature search. Our search yielded only one article, which was subsequently critically appraised. Although the paper reported a reduction in IR procedure complications following implementation of a safety checklist, it lacked validity and amounted to level 5 evidence.

We will outline in detail our PICO format, search criteria and critical appraisal methods.

Conclusion: The potential efficacy of IR safety checklists has been widely reported but not yet quantified. Further research is required.

P-161

Role of nurse specialists in collaboration between the vascular surgery and IR departments

M.J. Bango Garcia¹, A. Credo², V. Bonne¹, A.L. Feliciano¹, A.M. DeLara¹, A. Pollard¹, N. Thulasidasan³, A. Diamantopoulos²
¹Interventional Radiology, Guy's and St. Thomas' NHS Foundation Trust, London, UK, ²Interventional Radiology, Guy's and St. Thomas' NHS Foundation Trust, King's Health Partners, London, UK, ³Radiology Department, Chelsea & Westminster Hospital, London, UK

Learning objectives:

1. To understand the role of vascular IR clinical nurse specialist (CNS)
2. To understand the challenges of close collaboration with vascular surgeons
3. To present the tasks that IR CNSs fulfil during their daily practice

Background: Interventional radiology in many areas lack the capacity to run ward rounds for patient review. Additionally, streamlining the scheduling of inpatients in big hospitals can be challenging. Especially when it involves working collaboratively with other medical/surgical specialities interdepartmental communication can be a barrier in providing an efficient service.

To overcome the above obstacles, we have developed a role of CNS focusing in collaboration between the vascular surgery and IR departments. Purpose of this project is to present this working model.

Clinical Findings/Procedure Details: We will present our current model which in brief includes the CNS' attending the handover with vascular team, attend the lower limb peripheral arterial and diabetic foot Multidisciplinary meeting in order to identify urgent cases while the vascular CNS also reports to IR any urgent admissions.

The CNS' also provide a bespoke pre-assessment service for all vascular inpatients that involves a number of checks as well as assessment of suitability for nurse led conscious sedation. Based on this assessment patients are scheduled on the first available appropriate slot.

Conclusion: The model has proven to be effective so far by reducing the average waiting times for inpatients, reducing delays caused by unavailable or unsuitable blood results and ensuring that all clinical emergencies are prioritised.

P-162

Effectiveness of automated tumor-feeder detection software (ATDS) using CT images in transarterial embolization (TAE) through extrahepatic collateral vessels for malignant hepatic tumors

T. Kubo¹, M. Sone², S. Sugawara², I. Chihiro², T. Hasegawa², N. Umakoshi², Y. Onishi², S. Kimura², S. Fujitsuka², Y. Arai², M. Kusumoto²

¹Radiology, The University of Tokyo Hospital, Tokyo, JP, ²Department of Diagnostic Radiology, National Cancer Center Hospital, Tokyo, JP

Learning objectives:

1. To explain the mechanism and function of automated tumor-feeder detection software (ATDS) using CT images.
2. To demonstrate how to use ATDS in transarterial embolization (TAE) through extrahepatic collateral vessels for malignant hepatic tumors.
3. To discuss the usefulness of ATDS in TAE through extrahepatic collateral vessels for malignant hepatic tumors.

Background: Identifying tumor-feeders is essential to achieve effective and safe TAE through extrahepatic collateral vessels for malignant hepatic tumors. However, tumor-feeders are sometimes difficult to be detected with digital subtraction angiography (DSA) because of the complexity of tumor location and vasculature. ATDS using cone-beam CT arteriography images is known to be useful in such cases, but there have been no reports about the effectiveness of ATDS using CT images.

Clinical Findings/Procedure Details: We use an ATDS (Embolization Plan, CANON MEDICAL SYSTEMS, Ohtawara, Japan) using CT images to detect tumor-feeders. First, we perform CT arteriography non-selectively (e.g. from celiac artery) or CT angiography. Second, we mark the tumor and the virtual catheter tip on CT images using the software. Then, the software automatically detects the tumor-feeder and visualizes it on VR images. The whole process completes within approximately 5 minutes. Our initial experience showed the promising results of accuracy of detecting tumor-feeders and shortening the procedural time.

Conclusion: The ATDS using CT images is useful for TAE through extrahepatic collateral vessels for malignant hepatic tumors.

P-163

Interventional radiology mortality and morbidity meeting (IRMM) improvement update

A. Nath¹, C. Stove¹, I. Robertson², M. Hennessy¹

¹Interventional Radiology, Queen Elizabeth University Hospital, Glasgow, UK, ²Interventional Radiology Unit, Gartnavel General Hospital, Glasgow, UK

Learning objectives: To examine how and if changes made in 2016 to our Mortality and morbidity (M+M) meeting have improved the impact/functioning and what more we do.

Background: M+M meetings are invaluable in aiding reflective learning and improving procedural performance¹. In 2016, our Institution streamlined referrals and delivery of our M+M meetings. 2 years after these changes, have they improved the process?

Clinical Findings/Procedure Details: The DATIX reporting system was implemented in February 2017 which has streamlined the process further. This provides a single standardised referral form and delivers a standardised output. In 2016, 2017 and 2018 there were 21, 45 and 42 cases discussed respectively. We assume there has been no significant change in mortality or morbidity rates as there has been no change in either practice or operators. Attendances have improved from 99 to 101 to 155 in 2016, 2017 and 2018 respectively.

Conclusion: We assume the underlying complication rate has remained static and the detection/reporting has improved. The improved attendance shows departmental 'buy in', possibly due to the frequency of the meetings and also format. The challenge remains with how best to capture

data. Reporting has improved by encouraging everyone to report cases not just the operator. In IR we do not have 'ownership' of patients which causes further difficulties in follow up and complication detection. We plan to start 6 monthly consolidation meetings.

¹Mok PS, Tan EY, Baerlocher MO, Athreya S. The role of morbidity and mortality meetings in interventional radiology. Eur J Radiol. 2012 Nov;81(11):3344-7. doi: 10.1016/j.ejrad.2012.01.005. Epub 2012 Jan 31.

P-164

Usefulness of the triple coaxial systems using steerable high-flow microcatheter as a second catheter

Y. Munetomo¹, H. Ashida², Y. Matsui¹, Y. Hasegawa¹, S. Kisaki³, R. Kanou¹

¹Radiology, The Jikei University School of Medicine, Tokyo, JP, ²Radiology, Jikei Medical University Hospital, Tokyo, JP, ³Department of Radiology, The Jikei University School of Medicine, Kashiwa Hospital, Kashiwa-shi, Chiba, JP

Learning objectives: Describe the technical tips of steerable high-flow microcatheter as a second catheter for triple coaxial systems.

Background: Progress in catheter devices are remarkable in recent years, especially with balloon catheters and superselective microcatheters, treatment options have expanded more than ever. Since a steerable microcatheter (SwiftNINJA, TERMO, TOKYO) was released in 2016, it has improved vessel selectivity in difficult case.

Clinical Findings/Procedure Details: The steerable microcatheter is greatly improved in vessel selectivity. However, even with the standard (2.4/2.6Fr) or selective (2.0/2.4Fr) steerable microcatheter, we rarely experience the cases that microcatheter cannot be advanced. To solve this problem, we propose a triple coaxial system with a high-flow steerable microcatheter as a second catheter. The highlights of the triple coaxial system is the steerable microcatheter works like a guiding catheter by locking angle of the movable part at the tip, and it is possible to get strong backup. After inserting the guidewire and the third microcatheter to the periphery, releasing the lock improves followability and enables advancement of the steerable microcatheter. By alternately advancing the steerable microcatheter and the third microcatheter, it is possible to intensify the backup in stages and insert catheter even in difficult vessels. It seems to be really useful to advance the catheter reliably.

Conclusion: We propose the triple coaxial system using the high-flow steerable microcatheter as a second catheter is really useful for selecting a branch having steep angle from thick parent vessel.

P-165

Mycotic pulmonary artery pseudoaneurysm: case series of five patients and review of the literature

F. Casero¹, M. Agata Stachno², P. Puyalto De Pablo², J. Sampere Moragues², A. García Gamez², G.A. Tovar Felice², V. Benito Santamaria²

¹Radiology, Germans tries i pujol, Barcelona, ES, ²Radiology, Germans tries i pujol, Badalona, ES

Learning objectives:

1. To review the etiology, clinical presentation and radiographic features of pulmonary artery pseudoaneurysms (PAP).
2. To evaluate its endovascular treatment.

Background: PAP is a very rare entity; although can be caused by any infection, tuberculosis should be considered as its main etiology (Ramussen pseudoaneurysm).

Independently of its cause and whether if it is symptomatic or presents incidentally, always is treated, since can produce a life-threatening haemoptysis.

To our knowledge, only single cases of PAP treated with embolization have been reported and so we present a larger case series based on three Rasmussen aneurysms, one PAP secondary to Aspergillus infection and

another case by *S. pyogenes*. All five were treated with endovascular techniques.

Clinical Findings/Procedure Details: CT chest angiography with multi-planar reconstruction is the modality of choice to evaluate the anatomy and pathology of the pulmonary arterial vascularization, and inflammatory changes of adjacent parenchyma. PAP can be seen as a focal dilatation of the pulmonary artery branch or as a hyperenhanced nodule connected to a pulmonary vessel.

Pulmonary arteriography remains the gold standard for the diagnosis of PAP. As coil embolization, covered stent implantation or synthetic glue injection are less invasive and safer techniques, endovascular treatment has substituted the classic surgical approach in most cases of PAP.

Conclusion: PAP is a very rare pathology, which may arise as a complication of an underlying infectious pulmonary process and can be diagnosed with radiologic techniques such as CT chest angiography or pulmonary arteriography.

Endovascular treatment options offer less invasive alternative to open surgery in the management of PAP.

P-166

Periprocedural anticoagulation management in interventional radiology

M. Hadi¹, C.M. Walker², T. Rand³, S. Müller-Hülsbeck⁴, A. Basile⁵, O.M. van Delden⁶, R. Uberti⁷

¹Interventional Radiology, John Radcliffe Hospital, Oxford, UK, ²Radiology- Urology intervention, John Radcliffe Hospital Oxford University Hospitals NHS Trust, Oxford, UK, ³Dept. of Radiology, KH Hietzing, Vienna, AT, ⁴Department of Diagnostic and Interventional Radiology / Neuroradiology, Ev.-Luth. Diakonissenanstalt zu Flensburg, Flensburg, DE, ⁵Interventional Radiology, Ospedale Garibaldi Centro, Catania, IT, ⁶Department of Radiology, Academic Medical Center, University of Amsterdam, Amsterdam, NL, ⁷Radiology, John Radcliffe Hospital, Oxford, UK

Learning objectives:

1. Review of common and new anticoagulants with emphasis on pharmacodynamics.
2. How to approach periprocedural anticoagulation in elective and emergency settings
3. Provide recommendations for periprocedural management focusing on when to stop and restart anticoagulants.

Background: Periprocedural management of patients on anticoagulation is complex. Suboptimal management often results in cancellations, overtreatment (with blood products) or exposing patients to undue risk such as, severe haemorrhage or even death. Evidence suggests current periprocedural haematological practices are variable and often do not conform to existing recommendations. We present recommendations on how best to manage patients on anticoagulants in the periprocedural setting.

Clinical Findings/Procedure Details: A literature review of medical databases revealed limited level A evidence to inform clinical practice. The majority of evidence is based on local guidelines, manufacturer recommendations, and consensus documents. Evidence was presented based on level-of-evidence for review to a panel of IR, conflicting/weak evidence was resolved by consensus.

Key recommendations include:

- Routine periprocedural coagulation screening to predict postprocedural bleeding in unselected patients is not recommended. Patients should be initially assessed using a structured bleeding history/questionnaire.
- Stopping anticoagulation and starting bridging therapy should be considered in patients with increased risk of thromboembolic complications and who are undergoing an elective procedure with moderate/high risk of bleeding.

Conclusion: Periprocedural anticoagulation management is highly complex more so with the introduction of novel oral anticoagulants. In the emergency setting, intricate haematological pathways to correct

anticoagulation status is usually required. Guidelines should provide more explicit and user friendly periprocedural haematological management recommendations to facilitate improved day-to-day interventional practice for both elective and emergency procedures.

P-167

Adrenal vein sampling: rebuilding a program through quality improvement initiatives

A. Shaikh¹, A. Dunn², S. Khan³, J. Violago³, P. Kiproff²

¹Department of Radiology, Allegheny General Hospital, Pittsburgh, PA, US, ²Department of Radiology, Allegheny Health, Pittsburgh, PA, US, ³Department of Medicine, Allegheny Health, Pittsburgh, PA, US

Learning objectives: Target audience: Trainees to senior IR colleagues, technologists, and nurses.

1. Understand the various hurdles encountered when an Adrenal Vein Sampling (AVS) is ordered from start to finish.
2. Learn about the quality initiative protocols we have initiated to ensure accurate reporting and improvements in patient experience.
3. Pathophysiology of adrenal disorders.
4. Various clinical presentations and treatment.
5. Anatomy of the adrenals and venous system.
6. Understand the technical aspects of procedure.

Background: Rebuilding an adrenal vein sampling (AVS) program requires acknowledgement that there are issues with the current methods. Bringing multiple departments together for a discussion in how to ensure high level care is being delivered is an absolute must. Although having technical expertise in obtaining sampling is a major contributor, this is only one aspect of the entire program. After collection there is a lab analysis and an interpretation.

A quality improvement program was initiated at our institution after frequent lab errors lead to repeat procedures on multiple patients. A collaborative discussion brought out multiple unrecognized issues and we feel that this likely exist in other medical centers around the world. Sharing what we have done to rebuild our program could help the community as a whole.

Clinical Findings/Procedure Details: As discussed in Background.

Conclusion: By sharing our quality improvement initiatives, we hope that other institutions that may have similar problems can take our actions to improve their own programs.

Members of the community not familiar with the procedure can understand the various presentations adrenal disorders and understand the various implications in our reporting with regards to treatment.

P-168

Interventional radiology led pre-assessment model

V. Bonne¹, M.J. Bango Garcia¹, A.L. Feliciano¹, A. Credo², N. Karunanithy³, A. Diamantopoulos²

¹Interventional Radiology, Guy's and St. Thomas' NHS Foundation Trust, London, UK, ²Interventional Radiology, Guy's and St. Thomas' NHS Foundation Trust, King's Health Partners, London, UK, ³Department of Interventional Radiology, Guy's and St. Thomas' Hospitals NHS Foundation Trust, London, UK

Learning objectives:

1. Describe an interventional radiology led pre-assessment service
2. Describe the staff model needed for a interventional radiology led pre-assessment service
3. Explain pre-assessment service benefits for Interventional Radiology department

Background: Referrals to interventional radiology (IR) for complex day case procedures are constantly increasing. As many departments still relay in other clinical teams for patient reviewing and considering that the patient demographic and its complexity needs better screening. To

increase safety and overall patient satisfaction pre-assessment prior to procedure day for this cohort of patient should be a priority.

We present an exclusively interventional radiology lead pre-assessment service set up to address the above issues.

Clinical Findings/Procedure Details: In this new setting, the pre-assessment service is led by a team of 5 nurses. Their role includes amongst others review of clinical and medical notes, review or order of laboratory results and ECG, and identify suitability of patients to undergo IR procedure. They are also running outpatients clinics where all the day cases are reviewed. The pre-assessment service includes an IR pre assessment MDM, where care plans are discussed amongst the interventional radiology consultant and the pre-assessment nurses.

Conclusion: The model has proven to be very effective in our department, with improvements both in the day to day running of the department and the day case pathways. There is early evidence that the patients value having a contact with the radiology team before the procedure. We are also expecting a major financial impact of this new in house service to the department that will allow investment back to the department and further expansion of the service.

P-169

The role of clinical nurse specialist in the ablation pathway

V. Bonne¹, M.J. Bango Garcia¹, S. Ilyas¹, A. Diamantopoulos²

¹Interventional Radiology, Guy's and St. Thomas' NHS Foundation Trust, London, UK, ²Interventional Radiology, Guy's and St. Thomas' NHS Foundation Trust, King's Health Partners, London, UK

Learning objectives:

1. To describe the Role of a Clinical Nurse Specialist with the Ablation pathway
2. To describe our current ablation pathway.
3. To describe the added benefit in terms of the patient experience.

Background: Referrals to Interventional Oncology are constantly increasing. In order to support our existing service, we introduced the role of ablation clinical nurse specialist (CNS) 2 years ago. We present in this abstract the specific role of the ablation nurse and how it helps the pathway and the patient experience.

Clinical Findings/Procedure Details: The role of the clinical nurse specialist involved seeing the ablation patient in Interventional Oncology clinics in conjunction with the ablation consultant. Following the clinic, the CNS will perform a procedure pre-assessment as well as a conscious sedation assessment. If necessary, blood samples will be taken. Information about the procedure and medicine management will be given. The day before the procedure the patient will be admitted under the ablation consultant in the hospital. The CNS will review the patient and facilitate admission. Post operatively, the CNS will coordinate discharge with the interventional radiology team and the receiving ward.

Conclusion: The role of the ablation clinical nurse specialist is well established in our service. Patients do value seeing the same team in clinics as well as during their hospital stay and during the discharge process. The CNS is also key to avoid on the day cancellation due to poor patient preparation. They have essential role to manage the patient pathway from multi-disciplinary meeting, hospital admission and discharge.

P-170

Hepatic artery embolization with indocyanine green-Lipiodol® mixture for intraoperative liver segmentation

R. Tanaka¹, T. Sonomura¹, H. Sato¹, T. Koyama¹, A. Kamisako¹, F. Tanaka¹, A. Ikoma¹, S. Hayami², M. Ueno², H. Yamaue², M. Nakai¹

¹Department of radiology, Wakayama Medical University, Wakayama, JP, ²Second Department of Surgery, Wakayama Medical University, Wakayama, JP

Clinical History/Pre-treatment Imaging: A 69-year-old woman was followed up on for hepatitis C. Blood test showed high values of tumor

markers (AFP:174, PIVKAlI:50). Computed tomography (CT) showed a hepatocellular carcinoma (HCC) in segment VIII. We decided to perform laparoscopic anatomical liver resection.

Treatment Options/Results: On the day before the surgery, hepatic artery embolization (HAE) was performed for marking of the hepatectomy area. After confirming that the feeding artery of the tumor was A8 (hepatic artery for segment VIII) by selective CT-arteriography, A8 was embolized with indocyanine green (ICG)-Lipiodol® mixture and 1 mm gelatin sponge particles containing ICG (Fig.1). The next day, surgeons confirmed the resection segments visually with ICG fluorescence imaging and performed laparoscopic anatomical liver resection (Fig.2).

Fig.1 CT immediately after HAE shows accumulation of ICG-Lipiodol® mixture in segment VIII including the tumor.

Fig.2 The next day, the surgeons confirmed that ICG remained in segment VIII, and performed laparoscopic anatomical liver resection.

Discussion: To accomplish laparoscopic anatomical liver resection, intraoperative liver segmentation is necessary. We reported usefulness of HAE with ICG for liver segment identification at CIRSE 2018. In this presentation, ICG was mixed with a water-soluble contrast medium, and the surgery had to be done on the same day, because ICG washed out in several hours. In this case report, ICG was mixed with a lipid-soluble contrast medium (Lipiodol®), and the surgery could be done the next day. We consider Lipiodol® to have hyperviscosity, and the washout of ICG was prevented by blocking microvessels such as portal vein branches and peribiliary vascular plexus around the tumor.

Take-home points: HAE with ICG-Lipiodol® mixture prevents the washout of ICG, and is effective for liver segment identification during laparoscopic anatomical liver resection the next day.

P-171

Endovascular treatment of a pulmonary artery pseudoaneurysm with a stent graft

E. Petsatodis, C. Giannakoulof, S. Galanis

Interventional Radiology, G. Papanikolaou, Thessaloniki, GR

Clinical History/Pre-treatment Imaging: A 64 year old woman diagnosed with right hilar small cell lung carcinoma 6-months ago, treated with chemotherapy and radiation therapy, was admitted to our hospital with hypoxemia and massive hemoptysis. CT pulmonary angiography revealed a pseudoaneurysm of the common basal trunk of the right pulmonary artery.

Treatment Options/Results: After physical and laboratory assess and considering the underlying malignancy percutaneous transluminal treatment was preferred rather than thoracic surgery. A Stent graft was successfully placed in the common basal trunk of the right pulmonary artery. The Pseudoaneurysm sac or contrast extravasation was no more visualized on CT angiography check. Hemoptysis stopped and the patient was discharged without any known complications. At a 3 month follow up there were no complications regarding the patency of the stent.

Discussion: Pulmonary artery pseudoaneurysm (PAPs) are uncommon and can be congenital or acquired associated with high mortality. Tumor as a cause is relatively rare compared to congenital, infection or trauma. Thoracic surgery as a treatment option can be technically challenging carrying high mortality and morbidity rates. Endovascular treatment as being less invasive is proposed as a valid option. Various embolic agents have been used depending on the size location and the neck width of the pseudoaneurysm. The goal of stenting the pulmonary artery is to exclude the pseudoaneurysm with preservation of the distal flow. CT pulmonary angiography should be always be performed in advance in order to plan the intervention.

Take-home points: Percutaneous transluminal stenting for PAPs is a safe therapeutic option with good clinical outcome

Dialysis intervention and venous access

P-172

Hybrid salvage of thrombosed dialysis access grafts

H. Ali, K. Attallah, K. Awad, B. Thabet

Vascular and Endovascular Surgery Department, Assiut University Hospitals, Assiut, EG

Purpose: To report our experience and evaluate the results of a hybrid procedure comprising of surgical thrombectomy and adjuvant high pressure balloon angioplasty for management of thrombosed arteriovenous grafts (AVGs) with underlying venous anastomotic stenosis.

Material and methods: Between January 2015 and June 2017, 148 patients with first-time thrombosis of AVGs were considered for treatment with surgical thrombectomy followed by high pressure balloon angioplasty of the underlying venous anastomotic lesions. Monitoring and surveillance was subsequently performed using clinical and hemodialysis criteria to detect a failing/failed access. Primary, assisted primary, and secondary patency rates were calculated using Kaplan-Meier analysis.

Results: This hybrid procedure was technically successful in 135 cases (91.2%) and clinically successful in 131 cases (88.5%). The postintervention primary patency rate of the target lesions was 68.2%, 52.4%, and 44.2% at 3, 6, and 12 months, respectively. Endovascular re-interventions increased significantly the postintervention assisted primary patency to 79.1%, 71.9%, and 66.8% ($P = .0004$), and the postintervention secondary patency to 86.5%, 82.2%, and 78.6% ($P < .0001$) at the same time points, respectively.

Conclusion: Hybrid salvage of thrombosed AVGs using high pressure balloon angioplasty of the venous anastomotic stenosis following surgical thrombectomy by Fogarty catheter is a highly successful and safe procedure, with acceptable short-term primary patency. The need for repeated interventions demonstrates the necessity of continuous graft monitoring and surveillance to improve both assisted primary, and secondary patency rates.

P-173

Trends in utilization and physician payments for dialysis arteriovenous fistula and graft maintenance procedures among Medicare beneficiaries: 2010-2016

W.S. Lindquister¹, R. Dhanagana², S. Warhadpande²

¹Radiology, University of Pittsburgh Medical Center, Pittsburgh, PA, US,

²Interventional Radiology, UPMC, Pittsburgh, PA, US

Purpose: To study changing trends in volumes and payments for dialysis arteriovenous fistula (AVF) and arteriovenous graft (AVG) maintenance procedures among Medicare beneficiaries for a recent seven-year period.

Material and methods: Claims from the Medicare Part B Physician/Supplier Procedure Summary Master File (PSPSMF) for 2010 and 2016 were extracted using CPT codes for AVF and/or AVG maintenance procedures. Volumes, physician payments, and trends were analyzed by physician specialty.

Results: From 2010-2016, the volume of dialysis circuit maintenance procedures increased 20% from 308,140 to 369,679 procedures. This was driven by increased volumes for nephrologists and surgeons (34% for each) with only a modest increase for interventional radiology (IR) (5%). Total physician payments increased 19% from \$333.8 million to \$396.7 million. Average per-procedure payment decreased from \$1083 to \$1073 in 2016. In contrast to the marked increase in volume, average per-procedure payment for nephrologists decreased by 13% while payment for IRs and surgeons increased by 8% and 11% respectively.

Central venous angioplasty volumes disproportionately increased by 52% despite a 29% decrease in average per-procedure payment. This was most marked with IR, whose volume increased by 86% compared to nephrology (48%) and surgery (54%).

Conclusion: The volume of dialysis access maintenance procedures and total physician payments increased from 2010 to 2016. Increasing volume relates, amongst other factors, to increased rate of AVF creation, in keeping with Centers for Medicare and Medicaid Services' Fistula First Initiative. Modifications in the Current Procedural Terminology (CPT) bundle codes for dialysis access interventions in 2017 likely will have further impact on these changing trends.

P-174

Picc-port: a better quality of life

F. Incandela¹, D.G. Castiglione², I. Di Gesù¹, C. Genova¹, M. Midiri¹, T.V. Bartolotta³

¹Section of Radiological Science, Di.Bi.Med., University of Palermo, AOUP PAOLO GIACCONE, Palermo, IT, ²Section of Radiological Science, Di.Bi.Med., University of Palermo, AOUP Policlinico Giaccone, Leonforte, IT, ³Department of Radiology, University of Palermo, Palermo, IT

Purpose: To compare the satisfaction of oncologic patients who underwent chemotherapy, by using picc-port (central catheters peripherally inserted via basilic vein with subcutaneous brachial pocket) compared with those who had a central port (inserted via jugular vein with subcutaneous chest pocket).

Material and methods: We prospectively followed up 80 patients requiring chemotherapy, after undergoing implantation of port. The procedures were performed in the angiosuite by the same interventional radiologist team, by using ultrasound-guided venipuncture and fluoroscopic control. We divided patient into two group: A (41 patients underwent central port implantation), B (39 patients underwent picc-port implantation). The evaluation of patient satisfaction was based on a specific questionnaire, which was focused on their personal experience and quality of life.

Results: 10 patients died for disease progression. The questionnaire showed that the patient of A group perceived a more traumatic experience (with pain in the 7 days following the intervention, and complains for aesthetical results); instead of B group which perceived less traumatic experience (with pain after intervention felt only in the 20% of case, and gratifying aesthetical results). Only 50 % of patients of A group would recommend the device to other patients, while the 90% of patients of B group recommend the implantation of picc-port.

Conclusion: Brachial port is a good option to enable delivery of intravenous chemotherapy, since it have been showed low intraoperative risk, low post operative complications which led more satisfied patients, in term of a better quality of life, so that they would recommend the procedure to others.

P-175

Use of covered stents in challenging arteriovenous access complications

A. Spinelli¹, R. Cancellieri¹, S. Marini², G. Sodani¹, N. Maltzef¹, S. Marcia², M. Guazzaroni³

¹U.O.S.D. Interventional Radiology, S. Eugenio, Rome, IT, ²Radiology SS Trinita' Hospital, ATS Sardegna, Cagliari, IT, ³U.O.C. Radiology, S. Eugenio, Rome, IT

Purpose: Evaluate efficacy and safety of covered stent in treatment of Arteriovenous Fistula (AVF) access complication, in challenging cases.

Material and methods: From May 2016 to December 2018, we treated 24 patients with AVF complications, using covered stent. We used covered stents for the treatment of recurrent stenosis (11 cases), post-PTA complications (rupture or dissection, 6 cases), and rescue treatment with thrombosis (7 cases). The preliminary color Doppler (CD) has confirmed the presence of hemodynamically recurrent significant stenosis with flow reduction of the AVF, or occlusion of the vessels. The complication were found intraprocedural at DSA post-PTA control. We implant 31 stents, 22 COVERA (13 flared, 9 straight) and 9 VIABAHN. Follow-up was performed

by CD, to evaluate patency of the stent, flow rate and presence of re-stenoses (range 3-30 months).

Results: We obtained technical success in all the patients except one. In one patient with occlusion of AV Graft we could not recanalize the fistula. In one patient occurred thrombosis of the fistula at 18 months, recanalized by the use of another graft. The flow calculation in patent stents, has confirmed the maintenance of good values. The monitored pressure during dialysis sessions, showed normal pressure which allowed regular sessions.

Conclusion: The use of covered stent is safe and effective in treatment of AVF complication. The covered stents are indispensable devices in a Team that performed endovascular procedures in AVF. With this devices it is possible to solve many problems of vascular access and improvement dialysis parameters, with good primary patency at follow-up.

P-176

Comparison of access patency between balloon angioplasty related venous rupture and non venous rupture in failed hemodialysis patient

S.B. Yang¹, D.E. Goo², H.J. Chun³, Y.J. Kim², J.M. Lee⁴

¹Radiology, Soonchunhyang University Hospital, Gumi, Gumi, KR, ²Radiology, Soonchunhyang University Hospital, Seoul, KR, ³Radiology, Seoul St. Mary's Hospital, The Catholic University of Korea, Seoul, KR, ⁴Radiology, SoonChunHyang University Bucheon Hospital, Bucheon, KR

Purpose: To evaluate the access patency difference between balloon angioplasty related venous rupture and non rupture after PTA

Material and methods: 13506 percutaneous angioplasty, mechanical thrombectomy and thrombolysis procedure in 6732 patients (3685 women, 3047 man; mean age, 58.60±12.84 years; mean hemodialysis access age, 34.32±39.35 mo) were performed.

Rupture rate was obtained and access patency was determined according to rupture status, with/without thrombosis and treatment type (ie, balloon tamponade and stent

Results: Venous rupture was developed in 604 of 13506 procedures (4.5%). Rupture was more frequent in female (5.1% vs 3.6% in male; p=0.001), AVG (4.9% vs 3.9% in AVF; p=0.006) and thrombosis (7.7% vs 3.3% in stenosis; p=0.001).

A balloon tamponade was performed for a total of 604 rupture cases, and stents were deployed on 119 cases where contrast extravasation and flow stasis persisted.

The primary patency time were significantly better in no rupture group rather than rupture group (11.0 months vs 8.9 months; p=0.001). However, the access type (p=0.372) and with/without thrombus (p=0.358) did not significantly differs in patency time. The primary patency time in rupture patients were 8.4 months after prolonged balloon tamponade and 11.2 months after stent placement (p=0.014).

Conclusion: Primary patency is better in non ruptured than balloon angioplasty related ruptured stenotic AVF.

And balloon tamponade and bare metal stent placement are effective treatment methods for treating PTA induced venous rupture. Particularly, stent placement shows similar patency time when compared to non rupture group.

P-177

VIABHAN covered stent for treatment dysfunctional native fistula. Middle-term follow-up

M.E. Perez Montilla¹, P.B. García Jurado², J.J. Espejo Herrero¹, S. Lombardo Galera¹, L.J. Zurera Tendero³

¹Interventional Radiology, University Hospital Reina Sofia, Cordoba, ES, ²Vascular Intervencionismo, Hospital Universitario Reina Sofia, Córdoba, ES, ³Serv. Radiodiagnóstico, Hospital Universitario Reina Sofia, Córdoba, ES

Purpose: Evaluate feasibility and effectiveness of Viabhan covered stent placement for treatment dysfunctional native fistula(n-FAV) and analyze access circuit patency after repeating stent cannulation in hemodialysis session.

Material and methods: Between 2014 and 2018, 29 patients with dysfunctional n-FAV were treated with Viabhan covered stent. Technical and clinical success were achieved. We excluded 5 patient (2n-FAV infection, 1non-related death, 1re-thrombosis< 30 days and 1 was lost). The 24 remaining were retrospectively analyzed. Clinical parameters was used to define functional n-FAV. The stent cannulation was determined with an angiography performed before hemodialysis with the same needle. Patency rates were calculated per Kaplan-Meier method.

Results: 29 dysfunctional n-FAV were treated with Viabhan (2 aneurysm, 1 venous rupture, 7 stenosis+/-aneurysms and 19 acute thrombosis). Technical success was 100%. Clinical success was 24/29. In this 24 patients, the mean follow-up was 19.24months (range1-60months). Twelve repeat interventions were required in 9 patients. At 3, 6, 12 and 24 months, primary patency (PP) rates was 95.8%, 86.3%, 62.3% and 38.9% and secondary patency(SP) was 100%, 100%, 100% and 50%. In non cannulation group (n=9) at 3, 6, 12 and 24 months PP were 88.9%; No patient was retreated. In cannulation group (n=15) at 3, 6, 12 and 24 months PP were 86.7%, 66.7%, 30% and 20%; and at 3, 6, 12 and 24 months SP were 100%, 100%, 100% and 50%.

Conclusion: Viabhan covered stent placement in n-FAV is a safe and useful procedure. Sometimes, it will be cannulated during hemodialysis session, the patency rates are good even though more reinterventions are necessary.

P-178

Mechanical thromboaspiration of acute thrombosis of dialysis arteriovenous fistulae and grafts using the Penumbra Indigo system: preliminary results from a single center experience

E. Soncin¹, M.A. Ruffino², S. Varello¹, M. Fronda¹, A. Discalzi², A. Mancini², D. Righi², P. Fonio¹

¹Radiology Unit, Department of Surgical Sciences, University of Turin, Turin, IT, ²Vascular Radiology, Department of Diagnostic Imaging and Radiotherapy, A.O.U. Città della Salute e della Scienza di Torino, Turin, IT

Purpose: Thrombosis of vascular accesses is most often due to venous anastomotic outflow stenosis or obstruction. Clinical success rates of existing percutaneous mechanical devices to eliminate the clot are usually between 71% and 100%, with low incidence of serious complications. The Indigo Mechanical Thrombectomy System (Penumbra, Inc) consists of vacuum-assisted thrombectomy (VAT), which enables continuous thrombus aspiration. Preliminary results of thrombosed vascular access treatment with this device have been recently reported in literature. We want to report the preliminary findings of our early experience with Indigo System CAT8 and CATD, in the treatment of acute thrombosed dialysis arteriovenous fistulae and grafts (DAVF/DAVG).

Material and methods: Between 11/2017 and 7/2018, 5 patients with acutely thrombosed DAVF/DAVG were treated within 48 hours of the occurrence of thrombosis. Patients (age range, 57–86 y; 60% men) were treated with the Penumbra Indigo System.

Results: Technical and clinical success were both 80% (4 of 5 patients). No technical or device-related complications were reported. Additional

procedures included PTA (60%) and stent graft deployment (40%). Mean follow-up was 163 days (range 59–301). 1-month primary patency was 80%. 3-month primary patency was 60% and 3-month secondary patency was 80% (one patient underwent a second aspiration for recurrent thrombosis on the 37th day of follow-up).

Conclusion: Our preliminary experience confirms the safety and efficacy of Indigo System VAT in the treatment of thrombosed DAVF or DAVG. Our results in terms of clinical success and 3-month patency are in line with what reported by vascular guidelines.

P-179

To demonstrate whether the claim that using the CHLORAG+ARD® impregnated PICC decreases incidence of CLABSI and CR-UEVDT versus polyurethane power injectable (BARD) PICC in oncology patients, to justify its increased price

C.R. Cassim¹, L.-M.N.J. Boucher¹, F. Paquet², D.A. Valenti³, T. Cabrera³, A. Bessissow³, K. Muchantef¹, C. Torres¹

¹Radiology, McGill University Health Centre, Montreal, QC, CA, ²Transition, McGill University Health Center, Montreal, QC, CA, ³Radiology, McGill University, Montreal, QC, CA

Purpose: To demonstrate whether the claim that using the CHLORAG+ARD® Impregnated PICC decreases incidence of CLABSI and CR-UEVDT versus Polyurethane Power Injectable (BARD) PICC in Oncology Patients, to justify its increased price.

Material and methods: Intention-to-treat randomized controlled trial conducted in two academic medical centers from April 2017 to May 2018. All Oncology patients having PICC insertions were considered for the study. Participants were randomized to the CHLORAG+ARD® group or BARD group and were followed until catheter removal. Data collected included: PICC Fr size, type of malignancy, reason for removal, incidence of complications, and total catheter dwell time. Incidence of CLABSI or CR-UEVDT between groups was compared using a Fisher exact test. 127 patients were randomly assigned, totaling 8100 catheter-days; 63 in the BARD group and 64 in the CHLORAG+ARD® group.

Results: Group statistics were equivalent for age, gender, average dwell time, type of malignancy, previous central catheterization, anticoagulation, side of insertion, number of lumen and total catheter days. There were 3 (2.4%) CLABSI events (2 in BARD and 1 in CHLORAG+ARD® group) and 11 (8.8%) CR-UEVDT (7 in BARD vs 4 in CHLORAG+ARD® group). These small differences were not statistically significant ($p=0.271$). Also noted was increased catheter occlusions in the CHLORAG+ARD® group with 16 (26%) patients vs. 2 (3%) patients in the BARD group ($p=0.001$).

Conclusion: We failed to demonstrate a statistically significant difference in CLABSI or CR-UEVDT in CHLORAG+ARD® versus Polyurethane Power Injectable (BARD) PICC in our oncology patients, but significantly more catheter occlusions in the CHLORAG+ARD® group.

P-180

Outcomes of using adult peripherally inserted central catheters (PICC) as tunneled central venous catheters (TCVC) in neonates

R. Nourzaie¹, H. Abbas², I. Ahmed³, L. Monzon⁴, N. Karunanithy², S. Moser⁵, P. Gkoutzios⁶, S. Boolkah¹, M. Upadhyaya¹, D. Kufeji¹, A. Diamantopoulos⁷

¹Interventional Radiology, St Thomas Hospital, Pinner, UK, ²Interventional Radiology, Guy's and St. Thomas Hospitals NHS Foundation Trust, London, UK, ³Interventional Radiology, Guy's and St. Thomas' Hospitals NHS Foundation Trust, London, UK, ⁴Imaging, Guy's and St. Thomas' NHS Foundation Trust, London, UK, ⁵Radiology, Hammersmith Hospital, London, UK, ⁶Department of Radiology, Guy's and St. Thomas' Hospital, London, UK, ⁷Interventional Radiology, Guy's and St. Thomas' NHS Foundation Trust, King's Health Partners, London, UK

Purpose: Intensive treatments of neonates with complex medical disorders often relies on continuous venous access. We present our experience using adult PICC lines as tunneled central catheters in this age group.

Material and methods: We retrospectively searched our electronic hospital database for a 10 years period collecting data from consecutive neonatal patients who underwent tunneled central venous catheter (TCVC) insertion. The patient's demographics, site of access, and procedure details were recorded where outcomes included technical success and post procedure complications.

Results: From April 2008-April 2018 a total of 46 TCVC were inserted in 44 patients ($n=16$ male, 36.4%). Mean age was 16.7 days (range: 0-28 days) with an average weight of 2.4kg (range 1.8-4.5). The most common indication was antibiotics use in 31.8% of cases ($n=14$) and parenteral feeding 31.8% ($n=14$). Technical success was 97.8%. The majority of the lines, 82.3% remained in situ for the intended duration of treatment.

Early post procedure complications (occurring between 0 and 7 days post insertion) occurred in 4 patients including two catheter occlusions, one catheter related infection, one Supraventricular tachycardia. Late post procedure complications (occurring in more than 7 days post insertion) were recorded in 5 patients including; catheter related infection 6.5% ($n=3$) and thrombotic occlusion 4.3% ($n=2$).

Conclusion: Tunneled Central Venous Catheters using adult PICC line devices in neonates is a safe technique with excellent success rate and minimal complications rates.

P-181

Adult peripherally inserted central catheters (PICC) as tunneled central venous catheters (TCVC) in infants

R. Nourzaie¹, H. Abbas², L. Monzon³, N. Karunanithy², S. Moser⁴, P. Gkoutzios⁵, I. Ahmed⁶, S. Boolkah¹, N. Bouhadiba², I. Yardley², A. Diamantopoulos⁸

¹Interventional Radiology, St Thomas Hospital, London, UK, ²Interventional Radiology, Guy's and St. Thomas Hospitals NHS Foundation Trust, London, UK, ³Imaging, Guy's and St. Thomas' NHS Foundation Trust, London, UK, ⁴Radiology, Hammersmith Hospital, London, UK, ⁵Department of Radiology, Guy's and St. Thomas' Hospital, London, UK, ⁶Interventional Radiology, Guy's and St. Thomas' Hospitals NHS Foundation Trust, London, UK, ⁷Interventional Radiology Department, Guy's and St. Thomas Hospitals NHS Foundation Trust, Pinner, UK, ⁸Interventional Radiology, Guy's and St. Thomas' NHS Foundation Trust, King's Health Partners, London, UK

Purpose: Maintaining central venous access in infants can be challenging owing to patient size, vein anatomy and dimensions. We present our experience with using adult PICC lines as TCVC within in our unit over a 10-year period.

Material and methods: During a ten years period we looked into all consecutive paediatrics patients (less than 1 year old) who underwent tunneled central venous catheter insertion. The following data were recorded: Patients demographics, site of access, procedure details

including technical success, PICC device type, reason for removal and post procedure complications

Results: A total of 136 TCVC were inserted in 117 patients (n=64, 54.7% males). Mean age was 132 days (range 29-342) with average weight 4.64 Kg (range 1.80–9.40). The majority of the lines was used for antibiotics (n=52, 44.4%) followed by parenteral feeding in 42 patients (35.8%). Technical success was 99%. Early post procedure complications (0-7 days) included amongst others, inadvertent line removal in 6.6% and thrombotic occlusion in 0.85%. Late post procedure complications included inadvertent line removal in 7.7% and line sepsis in 3.7%. 102 of the 136 lines (75%) remained in situ for the intended duration of treatment.

Conclusion: The use of adult PICC lines as TCVC in infants is a safe technique with good success rate and acceptable complication profile.

P-182

Surfacer: new central venous approach "inside out system" in hemodialysis patients

S. Gitto¹, P. Rigamonti², M. Tramarin³, M. Scarabello¹, M. Femia¹, G. Damiani², U.G. Rossi⁴, M. Magazzini¹, M. Cariati⁵, S. Squarza⁶

¹Postgraduation School in Radiodiagnostics, Università degli Studi di Milano, Milan, IT, ²Radiology and Interventional Radiology, San Carlo Borromeo Hospital, Milan, IT, ³Diagnostic and Interventional Radiology, San Paolo Hospital - Milan, Milan, IT, ⁴Diagnostic Imaging Department - Interventional Radiology Unit, E.O. Galliera Hospital, Genoa, IT, ⁵Diagnostic Sciences, San Carlo Borromeo Hospital, Milan, IT, ⁶Radiologia, ASST Santi Paolo e Carlo, Milan, IT

Purpose: Failed venous access attempts are a serious concern in hemodialysis patients with chronically occluded central veins. We report on our preliminary experience with the Surfacer Inside-Out access catheter system to achieve a central venous access to the right jugular-brachiocephalic venous axis.

Material and methods: The Surfacer Inside-Out device is introduced through the femoral vein and advanced to an exit point in the right internal jugular vein under fluoroscopy guidance. The device penetrates the vein and exits via the neck, then it is pulled back and a catheter is inserted into the right internal jugular vein. A central venous catheter was positioned with Surfacer technique in four hemodialysis patients with internal jugular-brachiocephalic vein obstruction, at our hospital, from May 2017 to March 2018. The occlusion site was at the level of the right internal jugular vein in 2 cases and at the level of both the right internal jugular and the right brachiocephalic veins in 2 cases.

Results: Technical success was reached in 100% of patients. No complications occurred. The duration of the procedure ranged between 24 and 70 minutes.

Conclusion: The Surfacer Inside-Out system is a safe and promising device to achieve central venous access in patients with occlusive venous pathology. Larger studies are needed to validate the effectiveness of this tool.

P-183

Percutaneous endovascular treatment of dysfunctional native arteriovenous fistulas: transjugular versus conventional approach

D.K. Lee¹, S.B. Cho¹, Y.H. Kim¹, J.W. Kwak¹, H.H. Chung², S. Lee², M.G. Song³, D.J. Sung¹

¹Radiology, Korea University Anam Hospital, Seoul, KR, ²Radiology, Korea University Ansan Hospital, Ansan, KR, ³Radiology, Korea University Guro Hospital, Seoul, KR

Purpose: To compare the outcomes of transjugular approach with the results of conventional approach for endovascular treatment of hemodialysis fistulas.

Material and methods: Between May 2015 and June 2018, total 73 patients with dysfunctional native arteriovenous fistulas (AVFs) were included and divided into transjugular group (n = 26) and conventional

group (n = 47). With a retrospective review of electronic medical records and angiographies, time to first fistulography, procedure time, success rates, mean patency periods, and complications including internal jugular vein (IJV) stenosis were assessed.

Results: There were no statistically significant differences in time to first fistulography (12.8 vs. 9.7 minutes; p = 0.178), total procedure time (59.3 vs. 55.6 minutes; p = 0.578), technical success rate (88.5 vs. 97.9%; p = 0.126), and clinical success rate (80.8 vs. 91.5%; p = 0.266) between the two groups. Excluding 9 patients who did not achieve clinical success, multivariate Cox proportional hazard regression models showed significantly longer mean secondary patency period in transjugular group than in conventional group (473.1 days vs. 410.4 days; p = 0.037). There was no significant difference in the mean primary patency period (449.3 days vs. 327.0 days; p = 0.106). Complications related to the IJV were not found during the mean follow-up period of 480.1 days.

Conclusion: Transjugular approach for the endovascular treatment of dysfunctional native AVFs is useful and effective. Longer secondary patency period of treated AVFs might be expected with transjugular approach.

P-184

Thromboaspiration of dialysis fistulas

M. Femia¹, G. Damiani², M. Scarabello¹, S. Gitto³, M. Tramarin², P. Rigamonti², S. Squarza², G. Muscogiuri¹, U.G. Rossi⁴, M. Cariati²

¹Postgraduation School in Radiodiagnostics, Università degli Studi di Milano, Milan, IT, ²Diagnostic-Therapeutic Advanced Technology Department - Diagnostic and Interventional Radiology Unit, ASST Santi Paolo e Carlo - San Carlo Borromeo Hospital, Milan, IT, ³Radiology, Università degli Studi di Milano, Milan, IT, ⁴Diagnostic Imaging Department - Interventional Radiology Unit, E.O. Galliera Hospital, Genoa, IT

Purpose: The treatment of thrombosed dialysis access has been performed by vascular surgeons with Fogarty catheter, or by interventional radiologists through percutaneous rheolytic thrombectomy. The objective of our study is to evaluate the results of percutaneous thrombectomy procedures performed with the Penumbra Indigo System.

Material and methods: From September 2017 to December 2018, 16 consecutive percutaneous thrombectomies were performed on 13 hemodialysis patients. All procedures were performed by an interventional radiologist with the Penumbra Indigo System. Primary, assisted primary, and secondary patency of the fistulas were assessed along with factors potentially influencing patency.

Results: The technical success in recanalizing the efferent vein was 100% and a regular postprocedure dialysis session was possible in all the cases. In some patients we performed adjunctive procedures, such as balloon angioplasty (9 pts, 69%), and stent-graft (3 pts, 23%). No complications related to thrombectomy were found. The secondary patency rates at 30 days, 90 days, and 180 days were 92.3% (12pts), 84.6% (11pts) and 84.6% (11pts), respectively. There were no major complications, and all complications were treated successfully during the procedure.

Conclusion: Percutaneous thromboaspiration of autogenous dialysis fistulas with the Penumbra Indigo System is effective in restoring patency and allowing subsequent hemodialysis. The complication rate is acceptably low, and the majority of the fistulas are still used for hemodialysis at 6 months follow-up.

P-185

Assessment of the effect of peripherally inserted central catheter tip position and laterality on the risk of dysfunction and infection among patients of St. Luke's Medical Center Global City and Quezon City from March 2012-2017

R.C.N. Fabian, D. Villanueva

Institute of Radiology, St. Lukes Medical Center-Global City, Taguig City, PH

Purpose: Reliable peripherally inserted central catheter (PICC) is necessary for the management of patients who require sclerosing drugs, chemotherapeutic agents, infusion of hypertonic solutions, or prolonged antibiotic therapy. PICC's result in fewer procedural complications, lower infection rates, and decreased costs when compared with jugular or subclavian central venous catheters. However, the impact of PICC tip position and laterality of insertion on catheter dysfunction and infection has not been fully elucidated.

Material and methods: This is a retrospective cohort study wherein intraprocedural fluoroscopic images, catheter tip culture results and charts of patients who undergone PICC line insertions and removal at St. Lukes Medical Center-Quezon City & Global City in the Philippines from March 2012 to March 2017 were collected and reviewed.

Results: Of 426 PICC placement, 28 were exchanged because of dysfunction. The over-all dysfunction rate requiring exchange was 0.062 episodes per 100 catheter-days. During this study period, 63 were removed because of catheter infection, at a rate of 0.063 episodes per 100 catheter-days. Results suggests that the PICC line tip position is an important determinant of episodes of dysfunction. Mid- to deep right atrium tip position showed the least rate of dysfunction. With left-sided access of PICC lines, the incidence of infection is significantly higher when the catheter tip is positioned in the superior vena cava than the pericavoatrial junction and mid-to deep right atrium.

Conclusion: Therefore when positioning the PICC tip from either side of access, pericavoatrial junction to the mid-deep right atrium would be recommended to minimize the risk of catheter dysfunction or infection.

P-186

Eluvia drug-eluting vascular stent: a new alternative for treating venous stenosis in AV fistulas and grafts?

M. Arroyo Lopez¹, A. Pla Romero¹, R. Castro Valdes², R. Villar Esnal¹, A. Sanchez Guerrero¹

¹Vascular Interventional Radiology, Hospital Universitario 12 de Octubre, Madrid, ES, ²Radiology, Hospital Universitario 12 de Octubre, Madrid, ES

Purpose: To evaluate the outcomes of Eluvia® drug-eluting stent (Boston Scientific®) in the treatment of venous stenosis of AV fistulas and grafts.

Material and methods: This retrospective study involved a non consecutive case series of patients with stenosis in AV fistulas (9) and PTFE fistulas (7) treated with Eluvia® stent.

Treatment response was evaluated using hemodynamic criteria obtained by Doppler ultrasound over a follow-up period between 6 and 31 months. We assessed in each patient stenosis location (venous-graft union, efferent cephalic vein or cephalic arch), stent proven patency period since its placement, intrastent stenosis and clinical evolution (continuity in hemodialysis program, kidney transplant or fistula ligation).

Results: Stent patency was observed at 6 months of placement in 100% of the patients in the series. For a set of 10 patients with a 24 follow-up, stent patency was observed in 70% of the cases.

No intrastent stenoses were detected in permeable stents over 24 months since placement, except from one case, which presented with non-hemodynamically significant intimal hyperplasia.

Some patients with no proven long-term stent patency undergone fistula ligation or kidney transplantation losing clinical follow-up of the fistula.

Conclusion: Drug-eluting stent can be a safe and effective treatment in fistulas outflow venous stenosis with high mid- and long-term permeability rates.

P-187

Effectiveness of anticoagulation therapy for arteriovenous accesses with recurrent thrombosis

R.Y. Tan¹, C.W. Tan¹, S.P. Teh¹, S.C. Pang¹, A. Gogna², T.T. Chong³, C.S. Tan¹

¹Department of Renal Medicine, Singapore General Hospital, Singapore, SG, ²Radiology, Singapore General Hospital, Singapore, SG, ³Department of Vascular Surgery, Singapore General Hospital, Singapore, SG

Purpose: Patency rates following successful salvage of clotted arteriovenous (AV) accesses have been low. We aim to evaluate the effect of anticoagulation therapy in the patency of clotted AV accesses following the intervention.

Material and methods: The case records of hemodialysis patients who underwent thrombectomy for recurrent AV access thrombosis (more than 2 thromboses in 3 months) from 2015 to 2016 were retrospectively reviewed. Outcomes and patency rates following interventions were compared between patients who received anticoagulation therapy (intervention group) and those who did not (control group).

Results: During the study period, 71 patients underwent thrombectomy for recurrent AV access thrombosis. Of which, 29 (40.8%) received anticoagulation therapy. Four patients were on warfarin while the remaining 25 patients received enoxaparin. Anatomical success rates were 100% for both groups while clinical success rates and complication rates were similar for both the anticoagulation and control groups (100% vs. 97.6%, $p=0.568$ and 6.9% vs 7.3%, $p=0.662$). One patient developed minor bleeding complication following anticoagulation therapy. Kaplan-Meier analysis demonstrated significantly better postintervention primary and secondary patency in patients receiving anticoagulation therapy compared to control (log-rank $p=0.004$ and 0.035) although the primary assisted patency rates were similar (log-rank $p=0.099$). After adjusting for potential confounders, anticoagulation remained an independent predictor of postintervention primary patency (hazard ratio: 0.504; 95% confidence interval (CI): 0.282-0.893; $p=0.019$) and secondary patency (hazard ratio: 0.456, 95% CI: 0.220-0.986, $p=0.046$) for AV accesses with recurrent thrombosis.

Conclusion: Our results suggested that anticoagulation therapy is safe and effective in improving patency rates of AV accesses with recurrent thrombosis.

P-188

Initial clinical experience with a tunneled hemodialysis catheter designed to reduce tip clotting

M. Tal¹, A.S. Yevzlin²

¹Radiology, Assuta Hospital, Tel Aviv, IL, ²Nephrology, University of Michigan, Ann Arbor, MI, US

Purpose: Side-holes at the catheter tip are believed to be associated with thrombus formation due to adherent clot and heparin seepage from the proximal side-holes. Catheter thrombus is associated with catheter dysfunction, fibrin sheath formation, and catheter related blood stream infections (CRBSIs).

This abstract describes the initial clinical experience with the Pristine™ catheter: a symmetric, Y-tip™, non side-hole, tunneled hemodialysis catheter designed to reduce the formation of catheter tip thrombus.

Material and methods: Forty-six Pristine™ hemodialysis catheters (Pristine Access Technologies Ltd., Israel) were placed in forty-five end stage renal disease patients (27 males; 18 females) by six different operators (one surgeon, one radiologist, and four nephrologists). Forty-two catheters were placed in the RIJ and four catheters were placed in the LIJ. Patients had dialysis three times per week. Nominal catheter flows,

incidence of poor flows, and catheter related infections were recorded at each dialysis session and analyzed.

Results: Average follow-up time was 142 days for a total of 6,260 catheter days. Twenty five catheters are still being followed per clinical protocol. Seven patients died from reasons unrelated to the catheter and one patient switched to a fistula. Three patients had poor flows necessitating catheter replacement. Two patients had CRBSI which resolved with antibiotics. These two events equate to 0.32 CRBSIs per 1,000 catheter days. Catheter survival was 100%, 97.6%, 90.1% at 30, 90, 180 days, respectively.

Conclusion: Initial clinical experience with a new symmetric Y-tip™ catheter design without side-holes demonstrates good performance and survival with low complication rate. Larger clinical trials are needed to confirm these findings.

P-189

Tunnelled dialysis lines – what are the options? From the ordinary to the extra-ordinary

C. Aleman, W.R. Thomas, S. Walker, A. Willis, R.G. Jones
Interventional Radiology, University Hospital Birmingham, Birmingham, UK

Learning objectives:

1. Recognise the variety of tunnelled central venous access options for dialysis lines, including internal jugular vein, subclavian and femoral vein, trans-hepatic, trans-lumbar, direct inferior vena cava, and extra-ordinary access sites.
2. Be aware of the debate regarding the appropriateness of each access site.

Background: Tunnelled central venous access for dialysis can provide a lifeline for dialysis patients. There is no internationally agreed standardised approach to venous access sites for tunnelled dialysis access. As Interventional Radiologists it is important to understand the range of venous access options, from the ordinary to the extra-ordinary. Over time the ordinary access sites are at risk of being lost and having appropriate knowledge of the next access option will provide the patient with the best available care. Eventually you may find yourself achieving extra-ordinary access.

Clinical Findings/Procedure Details: All the aforementioned access sites have been used in our department. We present an educational pictorial review of each site, including the pros and cons, tricks and tips, and some extra-ordinary cases.

Conclusion: Having a broad understanding of vascular access options allows us to plan a logical and safe approach to the insertion of tunnelled lines in dialysis dependent patients. This approach should be in-line with the current evidence and international debate. This optimises patient care whilst they await definitive vascular access (ie: fistula / graft) which remains the gold-standard.

P-190

Thrombosed hemodialysis grafts: rheolytic thrombectomy from a central venous approach

S. el Assar de la Fuente, R. Reyes Perez, A. Cabrera Peña, C. Ormeño Anturiano
Department of Radiology, Interventional Radiology Unit, University Hospital Dr. Negrin, Las Palmas, ES

Learning objectives: To describe retrograde central venous access to declot thrombosed arteriovenous grafts with AngioJet rheolytic system.

Background: 15 procedures were performed over 1 year in 11 subjects (mean age, 64.2 ± 10.8 years; females, 81%) with thrombosed grafts. The procedure encloses usage of AngioJet rheolytic system from an ipsilateral internal jugular vein access, followed by adjunctive techniques such as balloon angioplasty and stenting.

Clinical Findings/Procedure Details: Ten standard procedures were performed using exclusively the ipsilateral internal jugular vein, while in

the remaining five ones a modification was made by a puncture of access graft to aid in the process. A standard procedure had a mean duration time of 63 min from access vein puncture till the end of intervention. There were three tiny non-expanding hematomas at the graft puncture site in the modified technique. Three patients exhibited vasovagal symptoms due to AngioJet effects, which were spontaneously resolved. Both anatomical and procedural success rates were 100%, while a clinical success rate of 86.6%, was achieved.

Conclusion: AngioJet rheolytic system from a retrograde central venous approach seems capable of safely and effectively declotting thrombosed grafts

P-191

Hemodialysis and the role of interventional radiology

S. Torbica¹, V. Popov², A. Petres³, S. Stojanovic³, V. Till³

¹Radiology, General Hospital Subotica, Subotica, RS, ²Radiology, Lahey Hospital & Medical Center, Burlington, MA, US, ³Center of Radiology, Clinical Center of Vojvodina, Novi Sad, RS

Learning objectives: In 2017, 3.2 million patients in the world were receiving hemodialysis. Dialysis access includes dialysis catheters (temporary or permanent), grafts (AVG) or arteriovenous fistulas (AVFs). Ideal hemodialysis access is an endogenous fistula created by surgical anastomosis of artery and vein.

Background: Major disorders of hemodialysis AVFs and AVG are stenosis (venous anastomosis, arterial anastomosis, venous outflow, in-graft), thrombosis, pseudoaneurysms, ischemia and venous hypertension.

Clinical Findings/Procedure Details: Stenosis at AVF is often caused by neonatal hyperplasia that usually develops at the sites of turbulent flow. Common sites for stenosis are: AV anastomosis, venous anastomosis and sites with non-linear flow such as cephalic arch or swing segment in basilica transposition fistulas.

Percutaneous transluminal angioplasty (PTA) is the most commonly performed procedure for treatment of stenosis in hemodialysis fistulas and grafts. In cases where PTA is not sufficient to restore adequate flow through stenotic segments of the vein or graft, bare metal or covered stents are deployed. In case of AVFs or AVG thrombosis, the standard procedure is mechanical or pharmacological thrombolysis.

Conclusion: Interventional radiology plays a vital role in the treatment of all the major disorders of hemodialysis access. Interventional radiologist should be a member of the dialysis team involved in the choice of optimal vascular access and management of possible complications.

P-192

Efficacy of the percutaneous manual aspiration thrombectomy technique in thrombotic occlusion of native arteriovenous fistula for hemodialysis

S.Y. Choi¹, M.U. Kim², S. Cho¹

¹Radiology and Research Institute, Ewha Womans University, Seoul, KR, ²Department of Radiology, Ewha Womans University, Seoul, KR

Learning objectives: To evaluate the safety and efficacy of the percutaneous manual aspiration thrombectomy technique for native AVF occlusion.

Background: In the endovascular treatment for native AVF occlusion, it is common to use a thrombolytic agent and a device for mechanical thrombectomy in these endovascular therapy. However, there are some complications such as hemorrhage, prolonged operation time, vascular damage. In this study, we evaluate the safety and efficacy of a new endovascular therapy which excludes the use of both thrombolytic agents and a mechanical thrombectomy device.

Clinical Findings/Procedure Details: Materials and Methods

A retrospective review of 20 patients who underwent percutaneous manual aspiration thrombectomy for native AVF occlusion between March 2012 to December 2017 was performed. We evaluated technical

and clinical success rate, and complication. The primary and secondary patency rates were calculated by using the Kaplan-Meier analysis.

Results

Percutaneous manual aspiration thrombectomy technique was performed in 20 cases (n = 20) with concomitant balloon angioplasty. Overall 20 cases, both technical and clinical success rates were 85% (n=17). The sites of AVF were left radiocephalic fistula (n=13), left brachiocephalic fistula (n=4), and right radiocephalic fistula (n=3). Underlying stenosis was detected in the juxta-anastomotic venous site (n=16), outflow draining vein (n=12), and central vein (n= 4). The primary and secondary patency rates at 1, 3, 6, and 12 months were 100%, 70.6%, 70.6%, 56.5% and 100%, 94.1%, 94.1%, 86.9%, respectively. There was no complication associated with procedure.

Conclusion: Percutaneous manual aspiration thrombectomy technique for treatment of the native AVF occlusion is a safe and effective treatment method.

P-193

Novel revascularisation of a brachio-cephalic venous occlusion using a diamond coated chronic total occlusion drill

J.A.B. Soares, R. Chidambaram, J. Waldron, J. Tibbles, J. Ferguson, S. Samuelson

Radiology, Sir Charles Gairdner Hospital, Perth, WA, AU

Clinical History/Pre-treatment Imaging: The patient is a dialysis access patient who has a right brachiocephalic fistula, with a clinically symptomatic type 2- total venous central occlusion.

Treatment Options/Results: Under general anaesthetic, groin access was obtained through a 5 Fr sheath. A 65cm.038 BER 2 was advanced into the superior vena cava. Subsequently, we performed a right internal jugular vein puncture and inserted a 12.5cm 6Fr brite-tip cordis sheath to the occlusion. The True-Path device is a powerful solution for intraluminal treatment of arterial chronic total occlusions. At 0.018" in diameter, the guidewire-like profile is designed for optimal steering and crossing. Once positioned, the self-rotating tip of the TruePath Device drills effortlessly. We used this 'off-label' to drill through the venous occlusion, directing the drill towards the superior vena cava. Audible feedback from the drill confirmed when we were intra-luminal within the superior vena cava. The occlusion was dilated with a 4 x 40mm 0.018 balloon and subsequently treated with a 13.5 x 40mm Fluency stent and post-dilated with a 10 x 40mm balloon. Surveillance is performed through clinical examination, three monthly fistulography. Primary patency is maintained at 6 months.

Discussion: Clinically successfully treatment of a chronic total central venous occlusion, using a novel diamond tip chronic total occlusion re-entry device. This has the potential to change the way we treat central venous occlusions using arterial chronic total occlusion technology.

Take-home points: We demonstrated novel use of a diamond coated drill to re-cannalise an occluded central vein, which could set a new scope for central venous occlusion.

P-194

A challenging permcath placement for a failed transthoracic intratrial dialysis catheter

M.P. Brassil, W. Torreggiani, P. Govender

Radiology, Tallaght University Hospital, Dublin, IE

Clinical History/Pre-treatment Imaging: A 68 year old patient with a history of chronic kidney disease had two previous failed renal transplants and multiple upper and lower limb dialysis permcaths over a 20 year period in our institution. All routine venous access sites were exhausted. Cardiothoracic surgeons had placed a transthoracic intraatrial dialysis catheter which functioned normally for 3 years. This line developed extensive tip thrombus and had become retracted, the patient was in critical need of haemodialysis.

Treatment Options/Results: We exchanged the intraatrial dialysis catheter wire over a guidewire and positioned a 10Fr Brite tip sheath. An Advantage guidewire was manipulated into the right subclavian vein with some difficulty, location was confirmed with ultrasound. The proximal to mid right subclavian was then accessed with a Neff Set under US guidance, the wire was passed retrogradely into the right axillary vein to allow placement of a 6Fr short vascular sheath, through this a 25mm en snare was advanced into the right axillary vein and the guidewire was advanced and snared. The guidewire was pulled back and snare advanced to restore access from subclavian vein to right atrium. The occluded subclavian vein was dilated up to 18Fr to allow placement of a right chest wall tunnelled dialysis catheter via subclavian vein to right atrium. Indwelling Britetip sheath was gradually retracted to allow tract healing.

Discussion: An improvised rendezvous type access of occluded venous system allowed recanalisation and line placement.

Take-home points: In difficult central venous access cases, antegrade and retrograde access may be necessary to reestablish central venous patency.

P-195

Percutaneous transrenal placement of a tunneled dialysis catheter

W.J. Yang¹, J.H. Shin², M.G. Song¹, T.-S. Seo¹, S.Y. Noh³, S. Park⁴, H.H. Chu²

¹Radiology, Korea University Guro Hospital, Seoul, KR, ²Radiology, Asan Medical Center, Seoul, KR, ³Radiology, Soon Chun Hyang University Hospital, Seoul, KR, ⁴Radiology, Gachon University Gil Medical Center, Incheon, KR

Clinical History/Pre-treatment Imaging: We report two patients who were diagnosed with end stage renal disease (ESRD) and had undergone a kidney transplantation. They presented chronic rejection of the renal graft requiring hemodialysis and were referred for hemodialysis catheter placement. On pre-procedural imaging studies, traditional sites for venous access were exhausted or not suitable.

Treatment Options/Results: After further evaluation for other potential sites for central venous access, a decision was made to attempt insertion of a transrenal hemodialysis catheter. The procedure was technically successful in all patients and we had no significant complications during insertion of the catheters.

Discussion: Hemodialysis catheters are commonly inserted via jugular veins, subclavian, or common femoral veins, which will often become occluded. Alternative percutaneous access sites described in previous literatures include hepatic, lumbar, neck collaterals, cephalic, hemiazygous, and azygous veins. However, in patients who were not suitable candidates for alternative percutaneous access, other approaches become necessary. In this case report, we present two successful cases of transrenal access for the insertion of a tunneled hemodialysis catheter. Our report shows that percutaneous transrenal placement of hemodialysis catheter is feasible in a patient with limited options.

Take-home points: Percutaneous transrenal placement of hemodialysis catheter is feasible in a patient with limited options.

P-196

SVC recanalization resulting in perforation into the pericardium managed by coil embolization of the false tract

A. Shrivastava¹, D.A. Valenti¹, K. Muchantef²

¹Radiology, McGill University, Montreal, QC, CA, ²Radiology, McGill University Health Centre, Montreal, QC, CA

Clinical History/Pre-treatment Imaging: A 61 years male patient with chronic renal failure managed remotely with hemodialysis catheters and more recently with renal transplantation. He was referred for placement of a new tunnelled hemodialysis line due to graft failure. There was no pre-procedure imaging.

Treatment Options/Results: Ultrasound showed chronic occlusion of both internal jugular veins. The right external jugular vein was accessed and it was discovered that the lower SVC was occluded. Right femoral access was obtained and after prolonged attempts some apparent progress was made from the jugular access. Contrast injection, however, demonstrated filling of pericardial space.

On-table cardiac echo showed rapid progression to cardiac tamponade. 100 mL of hemopericardium were drained via the intrapericardial angiographic catheter from the jugular approach. Two 0.014 microwires were placed in the pericardium (one working wire and one safety wire). Over the working wire a microcatheter was used to deploy a microcoil in the false tract. Follow up echocardiogram after 15 minutes showed no reaccumulation of fluid. The safety wire was removed. The patient was admitted overnight to the cardiac care unit. Serial echocardiograms showed no significant hemopericardium.

Discussion: Endovascular treatment is generally safe for recanalization of central venous occlusions, however, life-threatening complications can occur with aggressive manipulations.

Take-home points: Rapid development of cardiac tamponade from intrapericardial SVC perforation is life-threatening but can be managed by transjugular pericardiocentesis and coil embolization of the false tract.

P-197

Balloon assisted thrombin injection of large pseudoaneurysm in a dialysis fistula

C. Miller, B. Almazedi

Radiology, York Teaching Hospital NHS Foundation Trust, York, UK

Clinical History/Pre-treatment Imaging: A 68yr old male dialysing through a right arm basilic vein transposition (BVT) fistula created three months earlier presents with a stenosis and large pseudoaneurysm detected on ultrasound.

The patient was referred to interventional radiology, on-table ultrasound showed two pseudoaneurysms (30mmx25mm, 25mmx15mm) arising from the fistula needling sites.

Treatment Options/Results: A fistulogram via a right jugular approach and catheter positioned in the brachial artery proximal to the anastomosis confirmed filling of both pseudoaneurysms (Fig. 1). 6mmx8cm balloon was inflated across the short, wide neck of the larger pseudoaneurysm whilst human thrombin solution was injected under direct ultrasound guidance (Fig 2). Controlled balloon deflation under ultrasound assessed for complete thrombosis and the process was repeated three times to achieve this. Same procedure repeated for the smaller pseudoaneurysm. Completion fistulogram confirmed no flow into either pseudoaneurysm. The patient continues to dialyse successfully.

Discussion: Pseudoaneurysms can be treated with manual compression if small, larger pseudoaneurysms usually require intervention with percutaneous thrombin injection (if the neck is suitable) or surgical repair. In this case utilising assisted balloon occlusion under simultaneous ultrasound and fluoroscopic guidance we expanded the indication for thrombin injection to include wide neck pseudoaneurysms that otherwise would require surgical repair.

Take-home points: Large pseudoaneurysms with wide necks can be treated safely with percutaneous thrombin injection while occluding the neck with a balloon, avoiding the need for surgical repair and/or dialysis line. The inflated balloon prevents thrombin entering the fistula and systemic circulation during injection into the pseudoaneurysm and controlled balloon deflation under ultrasound allows assessment of thrombosis.

Embolotherapy (excluding oncology)

P-198

Clinical application of interventional embolization in hemorrhage after radiotherapy for head and neck tumors

H. Lu

Interventional Radiography, Union Hospital, Tongji Medical College, Huazhong University of Science, Wuhan, Hubei, P. R. China, CN

Purpose: To evaluate the feasibility and security of interventional embolization in hemorrhage after radiotherapy for head and neck cancer.

Material and methods: We collected and analyzed 20 cases who had been confirmed head and neck cancer by pathology in our hospital, and they had hemorrhage after radiotherapy. All of the 20 patients (16 cases of nasopharyngeal carcinoma (NPC), 2 cases of tongue cancer, 1 case of external auditory canal tumor, 1 case of esophageal cancer) still had hemorrhage after using other clinical hemostatic measures, then they had underwent DSA and interventional embolization. Intraoperative use of embolism materials was gelatin sponge particles, PVA particles and spring coil.

Results: After the neck and head artery DSA, we found bleeding liability vessels, 4 cases of liability vessels were internal carotid artery, 15 cases were maxillary artery branch, 1 case was thyroid artery; 20 patients were successfully completed interventional embolization 21 times, of which 1 patients still had active bleeding in 12h after embolization, and the hemorrhage stopped after an interventional embolization again. Hemostatic efficacy was 95.2% (20/21). All the patients had no serious complications such as cerebral infarction, facial paralysis and ectopic embolism during the follow-up period.

Conclusion: Interventional embolization treatment for hemorrhage after radiotherapy in head and neck cancer is effective and safe, finding out the responsibility blood vessels and choosing the appropriate embolism materials during the embolization treatment is the key to success. By adopting appropriate embolization techniques, intervention embolism in internal carotid artery hemorrhage after radiotherapy is safe and feasible.

P-199

Bronchial artery embolization in patients with non-massive hemoptysis

J.H. Hwang, J.H. Kim

Division of Cardiovascular Imaging and Interventional Radiology, Gacheon University Gil Medical Center, Incheon, KR

Purpose: Bronchial artery embolization has been well known to be effective life-saving procedure for the patients with massive hemoptysis. This study was to evaluate the safety, efficacy, and long-term outcome of bronchial artery embolization for the treatment of non-massive (< 300mL within 24 hours) hemoptysis.

Material and methods: This was a retrospective study of patients referred for bronchial artery embolization to manage non-massive hemoptysis. From March 2005 to September 2014, BAE was performed in 233 patients (143 male, 90 female; mean age, 57 years; age range, 17 ~ 92 years). We assessed technical success, clinical success, recurrence, additional treatment, and major complications in all the patients.

Results: Technical success was achieved in 224 patients (96.1%). Total of 219 patients (94.0%) was discharged with symptom improvement. During or after admission, hemoptysis recurred in 64 patients (27.5%) with mean recurrence time of 374 days (range, 0 ~ 2445 days) after embolization. The patients with recurrent hemoptysis underwent repeat embolization (42 patients), surgical treatment (3 patients), or both (5 patients). The remaining 24 patients was treated conservatively. Total of 169 patients were uneventful during follow-up period (mean, 595 days; range, 2 ~ 3381 days). All the patients did not show any major complications.

Conclusion: Bronchial artery embolization was safe and effective for the management of non-massive hemoptysis.

P-200

Impact of the hybrid emergency room system on IR practice time for trauma patients

R. Zako, H. Kondo, E. Hoshino, S. Inui, A. Suzuki, S. Toshimasa, T. Yokoyama, M. Yamamoto, J. Toda, H. Oba
Radiology, Teikyo University School of Medicine, Tokyo, JP

Purpose: The Hybrid Emergency Room System (HERS) is an emergency room that is equipped with CT scanner and fluoroscopy, where IR procedures and surgery can be performed simultaneously or alternately without transferring patients. We investigated the impact of the HERS on IR practice time for trauma patients.

Material and methods: A retrospective analysis was performed for 85 trauma patients who underwent transcatheter arterial embolization (TAE) from April 2015 to November 2018. 27 patients were excluded for having damage control surgery or conservative treatment before IR procedure. The remaining 58 patients were divided into two groups; conventional ER group (n=45) and HERS group (n=13) depending on the timing of treatment before and after the installation of the HERS. Time to CT (time from admission to CT scan), time to embolization (time from admission to bleeding control), IR procedure time, ICU days, length of hospital stay, Injury Severity Score (ISS) and Probability of Survival (Ps) were collected from the electronic medical record. Statistical analysis was performed using the Mann-Whitney U test.

Results: Time to CT and time to embolization were significantly shorter in the HERS group than the conventional ER group (25min vs 53min; $p < 0.001$ and 106min vs 192min; $p < 0.001$, respectively). There was no significant difference in IR procedure time, ICU days, length of hospital stay, ISS, Ps and survival rate in the two groups.

Conclusion: Time to CT evaluation and time to transcatheter hemostasis were shortened after the installation of the HERS. This system may be effective for saving trauma patients.

P-201

Transcatheter embolization for bleeding visceral artery pseudoaneurysm in patients with pancreatitis or pancreatic surgery

M. Tsurusaki, I. Numoto, T. Oda, Y. Yagyu, A. Suzuki, T. Kadoba, N. Kashiwagi, K. Ishii
Radiology, Kindai University, Faculty of Medicine, Osakasayama, JP

Purpose: Pseudoaneurysm develops as a result of inflammation, trauma, or surgical procedures. Pseudoaneurysm associated with pancreatitis or pancreatic surgery is a rare but life-threatening complication. We present a retrospective study evaluating the efficacy and safety of transcatheter arterial embolization (TAE) for a pseudoaneurysm that occurred secondary to pancreatitis or as a consequence of pancreatic juice leakage after pancreatectomy.

Material and methods: Between March 2004 and December 2018, a total of 42 patients (38 men and four women, mean age 60 years) underwent TAE for a bleeding visceral artery pseudoaneurysm. 23 patients had bleeding caused by a complication after surgery, and the other 19 patients had bleeding as a complication of pancreatitis. 19 patients underwent TAE with N-butyl cyanoacrylate (NBCA) or NBCA + microcoils, and 23 patients underwent TAE with microcoils and/or stents. The technical and clinical success rates, recurrent bleeding, and complications, including pancreatitis, were evaluated.

Results: All TAE procedures were technically successful and immediate hemostasis was achieved. The rate of recurrent bleeding or inability to control bleeding was 15.8% (3 of 19) in TAE with NBCA and 17.4% (4 of 23) in TAE with coils. No clinically significant ischemic events of the pancreas and duodenum were observed in the embolized areas. Serum amylase did not increase compared to the initial levels after any of the procedures. 32 patients were alive at 30 days after TAE.

Conclusion: TAE has high success rate of management hemorrhage and few complications. TAE for pseudoaneurysm in patients with pancreatitis or pancreatectomy might be effective.

P-202

Cervicofacial arteriovenous malformations (AVMs): new staging system and experience of a referral center

P. Biondetti¹, A.M. Ierardi², G. Colletti³, M. Dessy³, G. Carrafiello⁴
¹Diagnostic and Interventional Radiology, University of Milan, San Paolo Hospital, Milan, IT, ²Radiology, University of Milan, San Paolo Hospital, Milan, IT, ³Oral and Maxillofacial Surgery, University of Milan, San Paolo Hospital, Milan, IT, ⁴Diagnostic and Interventional Radiology, University of Milan, Milan, IT

Purpose: To report the experience of a referral center in classification and treatment of cervicofacial AVMs, and to propose a new classification system that has therapeutic implications.

Material and methods: 76 patients presented with cervicofacial AVMs at the San Paolo Hospital in Milan between 2009 and 2017. Age of patients and anatomical sites involved were registered. All patients were evaluated by a multidisciplinary team and classified according to the SECg system, which is based on Surgical-anatomical, Endovascular, Clinical and Growth evaluation of AVMs. Treatment modalities included surgery, percutaneous alcoholization and endovascular embolization, and were assessed for each case. A therapeutic algorithm based on the SECg classification was proposed.

Results: Age of population was 5-82 years. Multiple sites were involved in 43% of cases. According to SECg classification, AVMs involved: ≥ 2 tissues or functionally/cosmetically important structures in 70% of cases, a single tissue in 20%, vital structures in 10%. Patients had arteriolo-venular malformations in 96% of cases. Clinically the population showed: local symptoms or local complications in 94% of cases, no symptoms in 5%, systemic complications in 1%. In 90% of cases the anomaly had grown in the 6 months before evaluation.

Outcomes results were: cure in 64% of cases, stability in 23%, progression in 2% and recurrence in 11%.

Cure was achieved in 42% of patients with prior treatment and in 81% of non previously treated cases ($p < 0.01$)

Conclusion: The SECg system resulted a valid tool for classifying patients and its application can aid physicians in the selection of the most appropriate treatment.

P-203

Transcatheter coil embolization of splenic artery aneurysms: technique and midterm follow-up

T. Oda¹, M. Wakana², M. Tsurusaki², A. Suzuki², I. Numoto², T. Kadoba³, Y. Yagyu², N. Kashiwagi², K. Ishii²
¹Radiology, Kindai Hospital, Osakasayama, JP, ²Radiology, Kindai University, Faculty of Medicine, Osakasayama, JP, ³Radiology, Tenri Yorodu Soudansho Hospital, Tenri-city, JP

Purpose: We aimed to analyze early and midterm results of endovascular treatment of splenic artery aneurysms regarding technical considerations, technical success rate, and end-organ ischemia.

Material and methods: Between May 2009 and September 2017, 33 patients with 34 SAAs (male/female = 14:19, mean age = 57.4 years) were treated with coil embolization. Aneurysmal shape, size, and location were investigated. The technical success rate of treatment, avoidance rate of retreatment, and incidence of complications, including splenic infarction (SI), were calculated. Furthermore, differences in the results corresponding to the treatment method and aneurysmal location were evaluated.

Results: All aneurysmal shapes were saccular, except for four pseudoaneurysms, and the mean size of the aneurysms was 19.7 mm. The technical success rate of treatment was 100%, and the avoidance rate of retreatment was 94.1%. The incidence of complications was 64.7%; one patient

had slight pancreatitis. The remaining 21 complications were SIs. Six SIs were extensive ($\geq 50\%$), but serious complications that required invasive treatment were not observed. Overall, 16 SAAs (group A) were treated by packing and the remainder (group B) by isolation or a combination of both methods. Recurrent SAAs (2 cases) were included in group A. There was no significant difference between the two groups in the incidence of complications. Overall, 25 SAAs were located at the splenic hilum, and SI occurred significantly at the hilum.

Conclusion: The results of coil embolization for SAAs were satisfactory. Few cases treated by packing required retreatment. Serious complications were not seen, and SI occurred more often in the splenic hilum SAAs.

P-204

Human cadaveric specimen study of the prostatic microvasculature anatomy: implications in the choice of particle size for prostate artery embolization

R.D. García-Mónaco, L. Garategui, M. Onorati, N. Rosasco, O. Peralta
Interventional Radiology, Hospital Italiano de Buenos Aires, Buenos Aires, AR

Purpose: To describe the prostatic microvasculature anatomy and to measure the diameter of the intra-prostatic vessels from human cadaveric specimens, highlighting implications in the choice of particle size for prostate artery embolization.

Material and methods: The prostates of 18 white adults of 35-68 years old were fixed in 10% formaldehyde phosphate-buffered solution and processed histologically with hematoxylin and eosin, Masson trichrome, immune peroxidase and immunofluorescence. Fluorescence-conjugated antibodies (anti-CD34 and anti-actin smooth muscle) were used to mark the endothelium and the fibro muscular stroma, respectively. Each slide was digitally scanned and photographed under microscopy to measure the intra-prostatic arterial diameters with an image-analysis software.

Results: The microvasculature study identified three types of intra-prostatic arterial distribution: inter-nodal (IT), peri-nodal (PN) and intra-nodal (IN). The IT arteries are located at the trabeculae of the hyperplastic stroma between the nodules. The PN arteries are located at the periphery of each hyperplastic nodule before entering into it. The IN vessels are located inside the hyperplastic nodules as terminal arteries to the glands. Their mean diameters were as following: IT arteries: 311 μm (min-max: 155- 555), PN arteries: 145 μm (min-max: 59-266) and IN arteries: 56 μm (min-max: 24 - 104). The diameter of the intra-prostatic arteries did not correlate with the prostate volume, maintaining similar sizes for the PN and IN vessels even when the prostate volume was increased.

Conclusion: The description of the prostatic microvasculature anatomy, as described by this cadaveric study, may provide useful information in the choice of particle size for prostate artery embolization.

P-205

Emergency percutaneous endovascular repair for delayed hemorrhage after pancreaticobiliary surgery: indications and outcomes in a retrospective cohort

R. Muglia¹, E. Lanza², D. Poretti³, F. D'Antuono², N. Gennaro³, F. Gavazzi⁴, A. Zerbi⁴, V. Pedicini³

¹Radiology, Humanitas University, Rozzano, IT, ²Diagnostic and Interventional Radiology, Humanitas Research Hospital, Rozzano, IT, ³Radiology, Humanitas Research Hospital, Rozzano, IT, ⁴Pancreatic Surgery, Humanitas Research Hospital, Rozzano, IT

Purpose: To evaluate the outcomes of emergency percutaneous endovascular repair (PER) for delayed bleeding after pancreaticobiliary surgery.

Material and methods: We retrospectively evaluated PERs following pancreaticobiliary surgery performed from 2010 to 2017 in a single center. Data collected were: patient characteristics; surgery; pathology; incidence of postoperative pancreatic fistulas (POPF); bleeding signs on CT and

angiography; damaged artery and endovascular tools used; technical success; intervals between surgery, embolization and discharge; survival rates.

Results: We identified 21 patients (M:F=13:8, median age=64 years) undergoing 23 PERs. Sixteen patients had pancreatoduodenectomy, three hepaticojejunostomy, two distal pancreatectomy. Indications to surgery were mainly biliary (33%), pancreatic (19%) or duodenal (10%) malignancies. Seventeen patients had "grade C" POPF, three suffered a biliary leak, one had no POPF. Signs of active bleeding were present in 17/23 CTs and in 22/23 angiographies, mostly from hepatic (43%), gastroduodenal (22%) and splenic (13%) arteries. Embolic tools used were: coils (26%), glue (22%), stent grafts (22%) and their combinations (30%). PER was the sole treatment for 16 patients; among the others, one underwent a second PER, three had surgery, one had repeat PER followed by surgery. Median hospital stay was 37 days (range 12-75); median surgery-embolization and embolization-discharge interval days were 21 (2-36) and 12 (8-47), respectively. We observed 4/21 in-hospital deaths (median: 31 days from PER, 4-53); one-year survival rate of discharged patients was 71%.

Conclusion: PER can be successful in halting postoperative hemorrhage after pancreaticobiliary surgery, avoiding 17/21 repeat laparotomies. For our patients, this translated into a mean overall survival of 26 months after the event.

P-206

Outcome of hemorrhoidal arterial embolization for rectal bleeding: a single institution experience with 34 patients over 20 years

S. Park¹, Y. Kim², J.H. Shin¹, W.J. Yang¹, S.Y. Noh¹, H.H. Chu¹, C. Chen³, H.-K. Yoon¹

¹Radiology, Asan Medical Center, Seoul, KR, ²Radiology, Chungbuk National University Hospital, Cheongju, KR, ³Radiology, Cancer Hospital, Zhengzhou University, Zhengzhou, CN

Purpose: To evaluate the efficacy of HAE for the treatment of rectal bleeding and the prognostic factors related to rebleeding.

Material and methods: A total of 34 patients who underwent HAE for treatment of rectal bleeding were retrospectively reviewed. Procedure details, technical and clinical success, rebleeding, and treatment failure were evaluated.

Results: The technical success rate was 97.1% (33/34). Clinical success rates of the first HAE session and of both initial and repeat sessions, were achieved at 64.7% (22/34) and 73.5% (25/34), respectively. The most common bleeding focus was in the superior hemorrhoidal artery. Treatment was failed in 12 patients, due to rebleeding (11/12) or technical failure (1/12). The most common reasons for treatment failure were rebleeding due to incomplete initial angiography (83.3%). The use of N-butyl-2-cyanoacrylate (NBCA) was related to a significantly lower incidence of rebleeding ($p < 0.01$).

Conclusion: HAE was feasible and safe. However, the low clinical success rate resulted mainly from rebleeding related to incomplete initial angiography. The use of NBCA was a significant factor related to rebleeding.

P-207

Protective proximal coil embolisation during PAE: technique and outcomes

J. Briggs¹, M. Gibson¹, A. Speirs¹, F. Ahmad¹, S. Kumar², M.W. Little¹

¹Interventional Radiology, Royal Berkshire NHS Foundation Trust, Reading, UK, ²Department of Urology, Royal Berkshire Hospital NHS Foundation Trust, Reading, UK

Purpose: Prostate artery embolisation (PAE) is an established therapy for treating symptoms of benign prostatic enlargement (BPH). Proximal coil embolisation of non-prostatic arteries can be performed as a protective measure, to reduce the risk of non target embolisation and allow adequate treatment to be delivered. This study assesses the outcomes of this technique.

Material and methods: 61 consecutive cases of PAE were included in the study. Data were collected prospectively with comparison made between patients who underwent protective coiling (cPAE) and those who did not (nPAE). Pre-treatment prostate volume, symptoms severity, screening time and radiation dose were recorded. Outcomes including technical success, symptomatic improvement, complication rates were compared between the two groups.

Results: 18% of patients underwent protective coiling and 82% did not. We saw no significant difference in the prostate volume, preoperative symptoms score ($p=0.7$), intraoperative screening time ($p=0.1$), patient radiation dose ($p=0.3$), or length of stay ($p=0.8$) between the groups. No significant difference in complications rate was observed between the groups, and no adverse affects were attributed to protective embolisation. Technical success (defined as successful bilateral embolisation) was significantly higher in the cPAE than in the nPAE group (90% vs 62%, $p=0.005$).

Conclusion: Protective coil embolisation is a useful tool in PAE. In some circumstances, by occluding collateral vessels which pose a high risk of non-target embolisation, this technique can allow successful embolisation where it may not have otherwise been achievable. We did not find any associated increase in screening time, dose, or complication rate.

P-208

Patients free from hypertension, diabetes and coronary artery disease have improved outcomes after prostate artery embolization (PAE): a retrospective multivariate analysis of the UK-ROPE database

D. Maclean¹, A. Al-Rekabi², G. Vigneswaran³, S. Modi³, M.R. Harris⁴, T.J. Bryant⁵, N. Hacking⁶

¹Interventional Radiology, University Hospital Southampton, Southampton, UK, ²Interventional Radiology, Southampton General Hospital, London, UK, ³Radiology, University Hospital Southampton, Southampton, UK, ⁴Urology, University Hospital Southampton, Southampton, UK, ⁵Radiology, Southampton General Hospital, Southampton, UK, ⁶Clinical Radiology, University Hospital Southampton, Southampton, UK

Purpose: While many recent studies have examined which factors can predict a better outcome after PAE, cardiovascular risks factors have yet to be examined as independent predictors of outcome. We aimed to investigate the impact of these risk factors on several outcome variables.

Material and methods: Retrospective analysis of the UK Registry of Prostate Artery Embolization (UK-ROPE) database was performed. Analysis of covariance (ANCOVA) assessed the effect of several cardiovascular comorbidities (hypertension, diabetes, coronary artery disease CAD, peripheral vascular disease PVD, smoking history) on International Prostate Symptom Score (IPSS) reduction and Quality of Life (QoL) score at 12 months, Prostate Volume reduction at 3 months, and screening/ overall procedure time.

Results: Comorbidity data was recorded in 196 out of 216 registry patients (mean age 65.5, IPSS 21.5, Qmax 8.0). The absence of hypertension (130/196) was the most significant independent correlator with IPSS improvement ($B=23.9$, $p=0.012$). Patient's smoking status ($p=0.60$) and patients without either CAD ($p=0.90$), PVD ($p=0.51$), or diabetes ($p=0.10$) alone did not correlate with a greater IPSS improvement. The absence of hypertension, CAD and diabetes simultaneously ($n=50$) resulted in the greatest improvement in IPSS ($B=28.4$ $p=0.03$). No correlation was seen between proxy outcome variables (prostate volume $p=0.87$, Qmax $p=0.58$), screening time ($p=0.36$) and procedural time ($p=0.57$) with co-morbidity status.

Conclusion: Individually, the absence of hypertension was the only risk factor of significance in relation to improved IPSS outcome. However, the absence of hypertension, coronary artery disease and diabetes combined, is predictive of greater IPSS improvement after PAE.

P-209

To compare the safety and short-term efficacy of transcatheter geniculate artery embolization (GAE) using embosphere microspheres (ES) vs imipenem-cilastatin (IM-CS) for mild to moderate radiographic knee osteoarthritis (OA) resistant to conservative treatment

S.S. Bhatia¹, M. Shibuya², Y. Okuno³

¹Interventional Radiology, University of Miami, Davie, FL, US, ²MSK Intervention Center, Okuno Clinic, Tokyo, JP, ³Radiology, Edogawa Hospital, Tokyo, JP

Purpose: To compare the safety and short-term efficacy of transcatheter geniculate artery embolization (GAE) using Embosphere Microspheres (ES) or Imipenem-Cilastatin (IM-CS) for mild to moderate radiographic knee osteoarthritis (OA) resistant to conservative treatment.

Material and methods: This IRB approved retrospective study (March-April 2018) compared 2 cohorts: 10 patients (8M,2F) (5 bilateral) (mean age of 73 years (range 59-82)) treated with GAE using 100-300um ES and 11(7M,4F) embolized with IM-CS (7 bilateral) (mean age of 66 (46-81 range)), for total of 33 knees via antegrade ipsilateral femoral artery access. All patients had Kellgren-Lawrence grade 1-3 with pain resistant to conservative management. Outcomes were evaluated at 3 months using the WOMAC pain score and clinical examination.

Results: Technical success was 100%. There were no major adverse events related to the procedures in either group. In the ES cohort, Mean WOMAC pain score and total score decreased from 11.7 at baseline to 5 and 41.3 to 22.2 respectively at 3 months follow up ($P<0.05$). In the IM-CS group mean WOMAC pain score and total score decreased from 11.1 at baseline to 3.7 and 41.3 to 17.3 respectively at 3 months follow up ($P<0.05$). The differences in ES and IM-CS groups were not statistically significant.

Conclusion: GAE significantly improved pain symptoms and clinical function in patients with knee OA (KL1-3) in both the Embosphere Microspheres and IM-CS cohorts. In this limited study with short term follow up, ES appears to be safe and effective, with a short-term efficacy profile equivalent to IM-CS.

P-210

Transcatheter arterial embolization for relief of chronic shoulder and elbow pain refractory to conservative treatment

J. Min¹, S.W. Park²

¹Radiology, Konkuk University Medical Center, Neungdong-ro, Gwangjin-gu, KR, ²Radiology, Konkuk University Medical Center, Seoul, KR

Purpose: To evaluate the effectiveness and safety of transcatheter arterial embolization to relieve chronic shoulder and elbow pain refractory to conservative treatment.

Material and methods: This study included 24 patients (32 cases) who underwent embolization between November 2015 and September 2018 to treat chronic shoulder pain (14 with rotator-cuff tendinopathy, 4 with calcific tendinitis, and 1 with acromioclavicular joint arthrosis) or elbow pain (11 with lateral epicondylitis, 2 with medial epicondylitis) refractory to conservative treatment. Microspheres were used in the first 4 cases, and imipenem/cilastatin sodium was used in the remaining 28. Visual analog scale (VAS) score changes were recorded. Decrease in VAS score and degree of enhancement on digital subtraction angiography were compared.

Results: The technical and clinical success rates were 100% (32/32) and 78% (25/32), respectively. The mean VAS scores at baseline, 1 day, 1 week, 1 month, and 4 months after embolization were 5.9, 4.9, 4.2, 3.5 and 2.3, respectively ($P<0.05$ after 1 day). Pain improved in 17 of 19 cases (89.5%) with evident enhancement and 8 of 13 cases (61.5%) with no evident enhancement. The VAS scores in the evident enhancement group decreased more than those in patients with no evident enhancement (4.2 vs 2.7; $P<0.05$). Forearm cutaneous erythema was noted in 1 patient treated with microspheres.

Conclusion: Transcatheter arterial embolization may be an option for relieving chronic shoulder and elbow pain refractory to conservative treatment. The degree of angiographic enhancement might be a possible factor affecting degree of pain relief after embolization.

P-211

Diagnosis and treatment of hepatic venous malformations

W.F. Yakes

Interventional Radiology, The Yakes Vascular Malformation Center, Englewood, CO, US

Purpose: To determine the role of ethanol endovascular therapy in the management of liver "hemangioma" (venous malformation of the liver). Currently, only surgical lobectomy with its attendant severe morbidity is the only other treatment option.

Material and methods: 10 patients underwent 34 treatments by direct puncture into the VM involving single and multiple lobes of the liver. 3m and 7f with age range of 30 – 50, mean age, 40. Patients underwent arteriography and direct puncture repair; all patients had follow-up performed by CT and MR imaging. Early in the series one patient developed a fever and was placed on antibiotics. Currently all patients are placed on Flagyl and Levoquin for 7 days.

Results: Reduction in the VM within the liver was noted in all patients. All pain symptoms resolved. One intractable hiccups resolved. One developed a left foot drop due to pressure on the sciatic nerve. This completely resolved. One developed a fever and was successfully treated with antibiotic therapy. Patients were followed-up by CT and MR imaging documenting the shrinkage of single and multiple lesions (follow-up range: 13 – 52 months; mean: 37 months). Three of ten had minor abdominal and right shoulder pain post-procedure.

Conclusion: Direct puncture ethanol endovascular therapy is efficacious in the management of liver VMs. We recommend covering patients with antibiotics (Flagyl and Levoquin) due to the potential of bacterial seeding of the malformation from the portal system. This procedure is well-tolerated by patients compared to current treatment by liver resections/lobectomy/bile leaks/bile strictures/death that are noted to occur with surgery.

P-212

Ear arteriovenous malformation management

W.F. Yakes

Interventional Radiology, The Yakes Vascular Malformation Center, Englewood, CO, US

Purpose: To determine the efficacy of Ethanol Endovascular Repair of Ear Arteriovenous Malformation (AVMs).

Material and methods: 14 patients (9 female, 5 males; age range 6-39 years; mean age: 22 years) with ear AVMs presented for therapy. Two patients had failed prior embolizations (PVA/coils/nBCA/steroids) and 2 patients had other therapies (laser/excisions/grafting). All presented with a grossly enlarged painful ear, and 5 patients had intermittent bleeding. All patients underwent transcatheter and direct puncture ethanol treatments. (86 procedures).

Results: All 14 patients were cured of their AVM at long-term follow-up (mean follow-up: 52 months). One patient had transient partial VII nerve palsy. Two patients had minor blisters and ear injuries that healed on the outer tragus. The longest follow-up demonstrating cure was 12 years.

Conclusion: Ethanol endovascular repair of Ear AVMs can achieve cures in this vexing lesion that previously was treated with resection of the ear and with high recurrence rates. This series documents long-term cures of AVMs of the ear and scalp that were not treatable by endovascular approaches as previously documented in the world's literature. Permanent treatment of the auricular AVMs is documented and no recurrence occurred in any patient. Only one article is published (group from Shanghai, China) emulating this technique.

P-213

Ethanol embolotherapy management of pelvic arteriovenous malformations

W.F. Yakes

Interventional Radiology, The Yakes Vascular Malformation Center, Englewood, CO, US

Purpose: To determine the curative role of ethanol endovascular and/or ethanol coils in the treatment of large pelvic arteriovenous malformations (AVMs).

Material and methods: 48 patients (25f; 23m; age range: 4y - 86y; mean age: 37y) underwent 315 endovascular procedures to treat their pelvic AVMs. Two had bilateral pelvic AVMs (1m; 1f). Two had traumatic lesions (2m). Patients underwent transarterial, retro-grade transvenous, and direct puncture embolization procedures. Embolic agents included absolute ethanol and coils, at times in combination.

Results: 41 patients are cured of their pelvic AVM (mean follow-up: 43m) and 7 patients' treatments are on-going. Pelvic AVMs were cured by using ethanol, coils, combination. The addition of coils was particularly useful in those AVMs with aneurysmal venous outflows and in those AVMs with giant venous aneurysms. Three suffered transient sciatic nerve injuries. One suffered an ipsilateral perineal numbness, resolved. Four instances of perineal blistering and tissue injury, resolved. One had a rectal wall injury requiring bowel diversion, healed, underwent re-anastomosis. One elderly patient died within 30 days of a 4th procedure from pulmonary embolus (PE). One coils eroded thru bladder wall and endoscopically removed. One had a small bleed that was self-limited not requiring transfusion.

Conclusion: Endovascular approaches to manage pelvic AVM have proven to be curative at long-term follow-up. In our cases, surgery adjunctively to remove the AVM has not been required. Despite previous embolizations prior to being referred to our institution, endovascular and direct puncture approaches using ethanol, ethanol and coils, has proven to curatively manage pelvic AVMs involving soft tissue and bone with low complications and no recurrences.

P-214

Head and neck endovascular repair of vascular malformations

W.F. Yakes

Interventional Radiology, The Yakes Vascular Malformation Center, Englewood, CO, US

Purpose: To determine the efficacy of ethanol embolotherapy of extra-cranial head and neck vascular malformations of all types, particularly after failure of other endovascular and surgical treatments.

Material and methods: 164 patients (64m, 102f; mean age: 38 yrs) presented with extracranial AVMs of the head and neck area. Over half of the patients had undergone previous failed therapies. All patients underwent ethanol embolotherapy under general anesthesia. 45 patients had AVMs and 121 patients had VM.

Results: Of 45 AVM patients, 26 patients are cured (mean follow-up 2 ½ years); of 121 VM patients, 65 are at end-therapy (mean follow-up 4 ½ years). The remaining patients are not at end-therapy and are being treated for their residual malformations. In AVM follow-up, arteriography is the main imaging modality to determine cure or residual AVM as MR is less sensitive in the evaluation of residual AVM. In VM follow-up, MR is the main imaging tool, particularly with T-2 fat suppression and/or STIR imaging. All patients demonstrated improvement post-therapy. Complications were 4.5%, to include bleeding, partial 7th nerve palsy, skin injury, infection, and pain.

Conclusion: Ethanol has proven its consistent curative potential at long-term follow-up for high-flow AVMs and low-flow VM lesions at long-term follow-up as lesions in the periphery. Complication rates remain low. The procedures are tolerated well by the patients and done on an out-patient basis. Prior surgery and embolization procedures can

cause difficulty in lesion access, but does not obviate further ethanol endovascular treatment.

P-215

Management of tongue venous & lymphatic malformations

W.F. Yakes

Interventional Radiology, The Yakes Vascular Malformation Center, Englewood, CO, US

Purpose: To determine the efficacy of ethanol embolization in management of tongue venous and lymphatic malformations.

Material and methods: 40 patients (23 females, 17 males; mean age: 38 years) presented with tongue low-flow malformations. Forty-seven patients had undergone 61 failed previous procedures (embo, laser, surgery, steroid injection, alpha-interferon, radiation). All patients had baseline arteriograms and MRs. All patients underwent direct puncture ethanol endovascular therapy.

Results: Of 40 patients with venous and lymphatic malformations, 32 patients had dramatic reduction and 7 patients' therapy is on-going with concurrent reductions (mean f/up: 60 months). One patient with AVM required additional surgery and 1 patient with mixed veno-lymphatic malformation required surgical debulking of excess tissues. Minor complications such as tongue blisters (9 instances) healed spontaneously; 3 tongue focal areas of necrosis healed spontaneously; 3 infections responded to antibiotic treatment; 1 focal tongue hemi numbness resolved. 1 patient with dense VMs had a portion of the tongue slough and the tongue healed and remolded with no treatment required.

Conclusion: Ethanol embolotherapy is a primary and consistent form of therapy to eradicate low-flow vascular malformations of the tongue permanently at long-term follow-up. Rarely is concurrent surgery required. Ethanol sclerotherapy is a curative treatment in which recurrences do not occur and permanent ablations are the rule. Complications are minor and rare.

P-216

Splenic artery embolization for refractory thrombocytopenia

J. RiChard, B. Thornburg, R.J. Lewandowski, A. Gabr, A. Al Assad, R. Salem, A. Riaz

Department of Radiology, Division of Interventional Radiology, Northwestern University, Chicago, IL, US

Purpose: Splenectomy was the historic treatment for refractory thrombocytopenia. We present our institutional experience of splenic artery embolization (SAE).

Material and methods: With IRB approval, all patients who underwent SAE (2010-2017) at our institution for treatment of primary/secondary thrombocytopenia were included. Technique, embolic agent(s) (EA), length of hospital stay (LOS), and outcomes were analyzed, including sub-stratification of cirrhotic patients.

Results: 21 patients included 12(57%) males (mean age 57). Thrombocytopenia was due to cirrhosis [13(62%)] or other causes (e.g. myeloproliferative disorders) [8(38%)]. SAE was performed from the main splenic artery [19(90%)] or lower pole branch [2(10%)]. EA included gelfoam [13(62%)], 300-900µm particles [7(33%)], combined particles/coils [1(5%)]. Significant post-SAE platelet increase was observed: cirrhotics [mean 132K/UL (CI:33-230)]; non-cirrhotics [mean 25K/UL (CI:9-40)] ($p<0.001$). There was no association between EA and platelet increase. Splenic volume (SV) change was not significant (mean pre-SAE 1604 cm³ vs post-SAE 1560 cm³; $p=0.58$). Complications included: 5(24%) abdominal pain/vomiting; 1(5%) low-grade fever; 1(5%) CFA bleeding. 5(24%) patients (3 cirrhotics) underwent repeat SAE within 1 month. No splenic abscesses or encapsulated organism infections were seen. Mean LOS was 6.5 days (CI:0.4-12.6) in non-cirrhotics and 15.9 days (CI:8.2-40) in cirrhotics ($p=0.23$). Median OS was 19 months (CI:9.8-19.7) in non-cirrhotics and 12.1 months (CI:1.8-13.2) in cirrhotics ($p=0.43$).

Conclusion: SAE was a safe and effective treatment for thrombocytopenia. Platelet increase was more impressive in cirrhotics and not associated with SV decrease. Mean LOS was more than 6 days. Future analyses (which may decrease LOS) should focus on particle size, SV embolized, embolization end-points, and alternative EA such as yttrium-90.

P-217

Semi-automatic prostatic artery detection with cone-beam CT (CBCT) during prostatic arterial embolization (PAE)

M. Jonczyk¹, A. Maxeiner², G. Wieners¹, B. Hamm¹, B. Gebauer¹, D. Schnapauff¹

¹Department of Radiology, Charité Berlin, Berlin, DE, ²Department of Urology, Charité Berlin, Berlin, DE

Purpose: To evaluate the accuracy for prostatic artery (PA) detection of CBCT performed from the aortic bifurcation in combination with a semi-automatic detection software in comparison to oblique view digital subtraction angiography (DSA) with internal iliac artery (IIA) injection.

Material and methods: 22 consecutive patients referred for PAE were included in this single-center analysis between 7-12/2017. For PA detection CBCT from the aorta and 30° oblique-view DSA from both IIA were obtained. Results of suggested PAs from the semi-automatic vessel detection software and assumed PAs in DSA were compared. Moreover, dose area product (DAP) was recorded. Statistical analysis included Spearman's correlation, Mann-Whitney-U and the Wilcoxon-Test considering p-values <0.05 as significant.

Results: PA type was rated differently between DSA and CBCT ($p=0.007$), whereas semi-automatic detected arteries proved to be correct during the procedure. In DSA, PAs could not be identified in 18% on the left and in 17% on the right side. CBCT detected all PAs including one from the external iliac axis, although truncation occurred in 59% because of the limited field of view. Mean DAP of the whole procedure was 257,161.32±127,909.36mGy*cm². Mean DAPs were for a single DSA 14,502.51±9,437.67mGy*cm² and for one CBCT 15,589.23±2,722.49mGy*cm². In mean 14.82 DSAs and only one CBCT were performed. CBCT accounted for 6% and DSA for 84% of the entire DAP of the procedure.

Conclusion: In conclusion, CBCT with semi-automatic feeding vessel detection software facilitates prostatic artery depiction at an early stage of the procedure and may reduce radiation dose.

P-218

Endovascular treatment of wide-necked aneurysms of the visceral and renal arteries using the double microcatheter technique via a single access route

B.C. Lee¹, J.K. Kim², N.Y. Yim³, H.-O. Kim², Y.J. Kang⁴, H.D. Jung⁵

¹Radiology, Chonnam National University Hwasun Hospital, Jeollanam-do, KR, ²Radiology, Chonnam National University Hospital, Gwangju, KR, ³Diagnostic Radiology, Chonnam National University Hospital, Gwangju, KR, ⁴Diagnostic Radiology, Chonnam National University Hwasun Hospital, Jeollanam-do, KR, ⁵Radiology, Human Medical Imaging and Intervention Center, Seoul, KR

Purpose: To evaluate the utility of and complications associated with the double microcatheter technique for the treatment of wide-necked visceral and renal artery aneurysms (VRAs).

Material and methods: Nine patients (mean age: 58 years; age range: 42-69 years; male: female =4:5) with wide-necked VRAs who underwent treatment with the double microcatheter technique from January 2016 to July 2018 were included in the study. For all patients, anatomical features were confirmed using Cone beam CT with rotational angiography. The aneurysmal location, size, volume, neck-to-dome ratio and number of coils used were investigated. Technical success, complications (coil migration and organ ischemia), and recurrence were evaluated.

Results: Three renal artery aneurysms and six splenic artery aneurysms were treated by double microcatheter technique. The mean size of the aneurysms was 26.09 ± 4.76 mm, mean volume was 6.19 ± 3.69 cm³, and mean neck-to-dome ratio was 1.53 ± 0.24 . The number of coils used ranged from 7 to 16. All nine patients showed technical success. Renal ischemia occurred in two with renal artery aneurysm, of whom one patient showed almost full recovery in the follow-up CT examination. There was absence of coil migration or disease recurrence in all nine patients.

Conclusion: The double microcatheter technique for the treatment of patients with wide-necked VRAs appears to be a safe and useful technique.

P-219

Embolization for delayed arterial bleeding after percutaneous self-expandable metallic stent placement in patients with malignant biliary obstruction

J.W. Kim, D.I. Gwon

Radiology, Asan Medical Center, University of Ulsan College of Medicine, Seoul, KR

Purpose: To evaluate the safety and efficacy of embolization for delayed arterial bleeding secondary to percutaneous self-expandable metallic stent (SEMS) placement in patients with malignant biliary obstruction.

Material and methods: From January 1997 to September 2017, 1858 patients underwent percutaneous SEMS placement for malignant biliary obstruction at a single tertiary referral center. Among them, 19 patients (mean age, 70.2 years [range, 52–82]; 13 men) presented with delayed SEMS-associated arterial bleeding.

Results: The incidence of delayed SEMS-associated arterial bleeding was 1.0% (19/1858). The median time interval from SEMS placement to the onset of bleeding was 225 days (range, 22–2296). Digital subtraction angiographic findings were pseudoaneurysm alone close to the stent mesh (n=10), pseudoaneurysm close to the stent mesh with contrast extravasation to the duodenum (n=3), pseudoaneurysm close to the stent mesh with arteriovenous fistula (n=1), in-stent pseudoaneurysm alone (n=4), and in-stent pseudoaneurysm with arteriovenous fistula (n=1). In all 19 patients, immediate hemostasis was achieved after transcatheter arterial embolization. The overall clinical success rate was 94.7% (18/19). Recurrent bleeding 3 days after initial embolization occurred in one patient (5.3%), and was treated with a second embolization. The overall 30 day mortality rate was 26.3% (5/19). A major procedure-related complication was acute hepatic failure in one hilar bile duct cancer patient (5.3%), which was associated with an obliterated portal vein.

Conclusion: Embolization is safe and effective for the treatment of delayed arterial bleeding after percutaneous SEMS placement for malignant biliary obstruction

P-220

Out-of-hours endovascular haemorrhage control procedures: implementation and early experience of a pilot multicentre registry

R.D. White¹, N.J. Young², C. Rowlands¹, I. Robertson³, I. Zealley²

¹Department of Clinical Radiology, University Hospital of Wales, Cardiff, UK, ²Radiology, Ninewells Hospital, Dundee, UK, ³Interventional Radiology Unit, Gartnavel General Hospital, Glasgow, UK

Purpose: To develop, pilot and optimise a multicentre registry of out-of-hours endovascular haemorrhage control procedures (OOH EHCPs) to ascertain case load, case mix and procedural outcomes

Material and methods: Prospective collection of details of OOH EHCPs in three tertiary UK IR centres (two with dedicated on call, one with ad hoc on call) starting Feb 2018, with survey completion for all relevant cases. Data on factors including the need for anaesthetic support, other staff present during the procedure, site of haemorrhage, embolic agents

and technical success were collected. 30-day mortality was subsequently collected for all cases. The first 59 cases are presented here.

Results: Key findings:

51% of OOH EHCPs required anaesthetic support.

Upper GI (hollow viscus) haemorrhage was the most common (31%), followed by iatrogenic (20%), lower GI and trauma (each 15%).

Haemorrhage was successfully treated in 78% of cases. Only one case was a technical failure, with the remaining cases being non-therapeutic (no haemorrhage seen).

30-day mortality was 28% (at time of abstract submission).

Conclusion: Creation of this registry has provided important data regarding out-of-hours endovascular haemorrhage control procedures and their outcomes. Feedback from IRs at pilot centres has facilitated improvements in the registry format and we are rolling the modified registry format out to more centres to gain a more comprehensive picture of OOH EHCPs in the UK.

P-221

Comparative efficacy and safety of chemoembolization with lipiodol and 70-150µm drug-eluting beads in patients with hepatocellular carcinoma of BCLC A/B

M. Yu

Intervention Radiology, The Second Xiangya Hospital of Central South University, Changsha, Hunan Province, CN

Purpose: To compare the tumor response and toxicity of using lipiodol and drug-eluting beads (DEB) in transarterial chemoembolization (TACE) for treatment of hepatocellular carcinoma (HCC).

Material and methods: This is a prospective, randomized, single-blind study. A total of 100 patients with BCLC A (n=31) or B (n=69) were randomized (1:1) to receive DEB-TACE (75-150 µm DC BeadM1) or conventional TACE (cTACE). The primary endpoint was tumor response (mRECIST) at 6 months after the procedure following review of CT/MRI studies. Toxicity was graded by Common Terminology Criteria for Adverse Events v5.0 (CTCAE v5.0). The differences in tumor response and toxicity were compared between the cTACE group and DEB-TACE group.

Results: DEB-TACE group showed higher rates of complete response, objective response and disease control compared with cTACE group. Regarding the advanced disease such as tumor size greater than 5 cm (P<0.05), DEB-TACE also showed a better disease control than cTACE. There was no death within 30 days after the procedure. Mild abdominal pain and fever were more frequently in DEB-TACE group than cTACE group (P<0.05).

Conclusion: Compared to cTACE, DEB-TACE using DC BeadM1 offers greater efficacy for HCC patients in BCLC A/B. However, the tolerability of the procedure is better in patients treated with cTACE than DEB-TACE.

P-222

Rectus sheath hematomas: what clinical/radiologic factors necessitate escalation of care?

S. Warhadpande¹, W.S. Lindquister², M. Kilbridge², J. Park²

¹Interventional Radiology, UPMC, Pittsburgh, PA, US, ²Radiology, University of Pittsburgh Medical Center, Pittsburgh, PA, US

Purpose: To identify what factors predict the need for interventional radiology or surgical management in patients with rectus sheath hematomas (RSH).

Material and methods: Retrospective chart review of 91 patients with rectus sheath hematomas on imaging between the years 2010 and 2018 was performed. Imaging, procedural, clinical, and laboratory data was collected and analyzed.

Results: Of the 91 patients, 19 required either endovascular or surgical interventions (16 endovascular, 2 surgical, 1 drain placement). All 19 patients had either active extravasation on CT and/or hemodynamic instability (defined as systolic blood pressure <100). 35 total patients had hemodynamic instability but only 9 of these patients underwent an

intervention. The remainder were managed conservatively with volume resuscitation (+/- transfusions) and cessation/reversal of anticoagulation (AC). 22 total patients demonstrated active extravasation on CT; 14 patients required an intervention, 1 patient died from profound hemodynamic instability prior to any interventions, and 7 were managed conservatively. Patients managed conservatively demonstrated continued hemodynamic stability. In total, 3 patients died from their RSH and 3 patients suffered thromboembolic events after cessation of their AC (2 pulmonary emboli, 1 cerebral infarction).

There was no obvious relationship between need for intervention and the RSH size, need for transfusions, or the patient's AC.

Conclusion: In patients with RSH, a combination of active extravasation AND hemodynamic instability is most predictive for escalation of care to endovascular therapy. Many patients with hypotension alone can be successfully managed conservatively. RSHs can be hemodynamically significant but present a clinical challenge as cessation of anticoagulation can lead to thromboembolic events.

P-223

Peri-procedural prostate enhancement during prostate artery embolisation does not predict clinical outcomes at 12 months

T. Barge¹, A. Macdonald², P. Boardman³, C.R. Tapping⁴

¹Department of Radiology, Oxford University Hospitals NHS Foundation Trust, Oxford, UK, ²Radiology, John Radcliffe Hospital, Oxford, UK, ³Radiology, Churchill Hospital, Oxford, UK, ⁴Radiology Department, Churchill Hospital, Oxford University Hospitals NHS Foundation Trust, Oxford, UK

Purpose: To assess whether the degree of prostatic enhancement on peri-procedural cone-beam CT (CBCT) during prostate artery embolisation (PAE) predicts clinical outcomes at 12 months.

Material and methods: 38 patients undergoing PAE had their lower urinary tract symptoms (International Prostate Symptoms Score (IPSS)), health-related quality of life (EQ5D) and prostatic volume (MRI) prospectively assessed before, and at 12 months following, embolisation. Peri-procedural CBCTs were obtained in all patients prior to embolisation using the same contrast injection parameters. Hemi-prostatic parenchymal enhancement was scored on CBCT, where 0 was no enhancement, 1 was partial and 2 was complete. The scores for each hemi-prostate were added together to give a final 'enhancement score'. Differences between groups were analysed using ANOVA.

Results: Results are shown in Table 1. Enhancement did not correlate with change in clinical outcomes or prostatic volume. There remained no correlation when cases with multiple prostatic arteries were excluded. Similarly, there was no difference between adenomatous and non-adenomatous disease.

Table 1: Comparison between prostate enhancement and change in clinical outcome measures 12-months following PAE.

	Enhancement score (Values are change in mean [frequency])				ANOVA p-value
	1	2	3	4	
IPSS	-	-13.9 [7]	-13.1 [16]	-13.2 [9]	0.98
EQ5D	-	14.2 [6]	11.5 [16]	9.3 [9]	0.69
Prostatic Volume	-	1.7 [7]	-5.0 [12]	-5.8 [6]	0.62

Conclusion: Prostatic enhancement on peri-procedural CBCT does not correlate with clinical outcomes or change in prostatic volume at 12-months and should not be used to predict procedural success during PAE.

P-224

Pulmonary arteriovenous malformation embolization with the microvascular plug system (MVP)

C.R. Bailey¹, A. Arun¹, M. Towsley¹, W.K. Choi², J. Betz³, S. McKenzie¹, M. Abou Areda¹, M. Duvvuri², S. Mitchell¹, C.R. Weiss⁴

¹Radiology, Johns Hopkins Hospital, Baltimore, MD, US, ²School of Medicine, Johns Hopkins Hospital, Baltimore, MD, US, ³Biostatistics, Johns Hopkins Hospital, Baltimore, MD, US, ⁴The Russell H. Morgan Department of Radiology and Radiologic Science, Johns Hopkins University School of Medicine, Baltimore, MD, US

Purpose: Pulmonary arteriovenous malformations (PAVMs) are anomalous connections between a pulmonary artery and vein without intermediary capillaries, and are seen in Hereditary Hemorrhagic Telangiectasia. These can manifest with dyspnea, exercise intolerance, headache, stroke/transient ischemic attack, and pulmonary hemorrhage. Embolization therapy traditionally involves coils or Amplatzer plugs (St. Jude Medical). However, the newest embolic device is the microvascular plug (MVP) (Medtronic). In this abstract, we describe our institution's experience with MVPs in treating 119 PAVMs.

Material and methods: This IRB-approved retrospective study examined fifty-two patients with 119 PAVMs treated exclusively with MVPs (70 procedures) between July 2014 - July 2018. Patient consent requirement was waived. Patient demographics, procedural attributes, technical success rate, and device costs were collected and analyzed.

Results: All procedures were technically successful without major complications as defined by SIR criteria for outcomes complications. Average feeding artery diameters of treated PAVMs were 3.3 mm (SD: 1.2 mm, range 2-7.9 mm). Average fluoroscopy time per procedure was 35 min (SD: 16 min) with contrast volume 217 cc (SD: 101 cc). Mean follow up time was 328 days (SD: 258 days) without any instances of PAVM persistence.

Conclusion: MVPs are safe and effective options for PAVMs with relatively smaller feeding arteries due to high technical success rates and lack of observed persistence.

P-225

Preliminary evidence for selection of embolic devices to treat pulmonary arteriovenous malformations - an update

C.R. Bailey¹, A. Arun¹, M. Towsley¹, W.K. Choi², J. Betz³, S. McKenzie¹, M. Duvvuri², S. Mitchell¹, C.R. Weiss⁴

¹Radiology, Johns Hopkins Hospital, Baltimore, MD, US, ²School of Medicine, Johns Hopkins Hospital, Baltimore, MD, US, ³Biostatistics, Johns Hopkins Hospital, Baltimore, MD, US, ⁴The Russell H. Morgan Department of Radiology and Radiologic Science, Johns Hopkins University School of Medicine, Baltimore, MD, US

Purpose: To compare detachable coils, Amplatzer vascular plugs (AVPs), and microvascular plugs (MVPs) for the treatment of pulmonary arteriovenous malformations (PAVMs) by analyzing feeding artery size, contrast volume, fluoroscopy time, procedure time, device cost, technical success, and complications, including persistence.

Material and methods: This retrospective study had institutional review board approval; the requirement for patient consent was waived. Sixty-eight patients with 102 PAVMs were treated with coils, AVPs, or MVPs (72 procedures) between January 2012 and July 2016. Multiple regression was used to assess associations between treatments and outcomes.

Results: There were no clinically relevant differences in procedure attributes across groups and no major complications. AVPs were used in the largest feeding arteries, followed by coils and MVPs. AVPs were 69% less expensive than coils (95% CI 59%-76%) and 50% less expensive than MVPs (95% CI 38%-60%). MVPs were 37% less expensive than coils (95% CI 14%-54%). Persistence rates and median (interquartile range) follow-up times were as follows: for coils, 11% (recanalization) at 500 (222, 1351) days; for AVPs, 0% at 523 (206, 1165) days; and for MVPs, 0% at 192 (137, 749) days.

Conclusion: AVPs are best used for PAVMs with larger feeding arteries (median, 4.3 mm; IQR, 3.3, 5.8) given the larger device sizes, cost-effectiveness relative to MVPs and coils, and lower rate of persistence. For PAVMs with relatively smaller feeding arteries (median, 3.0 mm; IQR, 2.5, 3.8), MVPs are the best option given their cost-effectiveness relative to coils and their low rate of persistence.

P-226

Comparison of two different embolization techniques for varicocele endovascular treatment in a pediatric patient cohort

G. Granata¹, A. Sacchini², C. Floridi², G. Carrafiello², E.M. Fumarola¹, P. Grillo¹, G.M. Rodà¹, A.P. Savoldi¹

¹Radiologia diagnostica ed interventistica - Ospedale San Paolo, Università degli studi di Milano - Scuola di specializzazione in radiodiagnostica, Milan, IT, ²Diagnostic and Interventional Radiology, San Paolo Hospital, University of Milan, Milan, IT

Purpose: To evaluate pain, radiation and recurrence rates in pediatric patients undergoing varicocele embolization with two different embolization techniques.

Material and methods: Retrospective study of 165 consecutive patients (12-18 yo) who underwent transcatheter retrograde varicocele embolization from July 2014 to July 2018 with glue (Glubran®2) and sclerosing agent (Atossiscerol) (group 1, n=81) or sclerosing agent alone (group 2, n=84). Patients were asked by telephone interview to evaluate pain during embolization and at 1, 7 and 30 days using a quantitative pain scale ranging from 0 to 10. Duration of scopy, kinetic energy released per unit mass (kerma) and dose area product (DAP) were assessed as radiation parameters during embolization

Results: Patients in the two study were comparable for age, clinical indication and embolization side. No difference was noted for significant pain (pain score ≥ 3) during embolization and at 1, 7 and 30 days after treatment. Discomfort (pain score < 3) was more frequent in group 1 than in groups 2. No difference in discomfort was noted during embolization or at 1 and 30 days. Duration of scopy was shorter and kerma was lower in group 2 than in groups 1. DAP was lower in group 2 than in group 1 but no difference was noted between the two groups. The residual rate at a mean follow-up of 24.4 months (2-53 months) was comparable in the two groups.

Conclusion: The use of Atossiscerol alone for varicocele embolization is safe and leads to less radiation and same residual rates than is the case for combined materials embolization endovascular treatment.

P-227

Incidence and management of severe spontaneous non-cerebral hemorrhage

L. Reppas¹, G. Festas², A. Theodosis², S. Spiliopoulos², K. Palialexis², E. Brountzos¹

¹2nd Department of Radiology, ATTIKON University General Hospital, Athens, GR, ²2nd Department of Radiology, Interventional Radiology Unit, ATTIKON University General Hospital, Athens, GR

Purpose: To report the incidence and treatment outcomes of severe spontaneous non-cerebral hemorrhage (SSNCH) in a high-volume, tertiary University Hospital.

Material and methods: This is a retrospective study of all patients diagnosed with SSNCH between January 2016 and June 2017 (18-month period), in a single institution. For patients demonstrating active bleeding at CT-angiography (CTA), endovascular treatment (group EVT) was performed, while conservative treatment was decided after CTA negative for active bleeding (group CM). Outcome measures included the incidence of SSNCH, 6-month rebleeding and survival rates in the two groups. Technical success and complications of EVT were also recorded.

Results: Overall, 44 SSNCH cases (rectus sheath=13; limb=13; retroperitoneal=9; intra-abdominal=5; thoracic/mediastinum=3; massive

haemoptysis=1) were identified (annual incidence: 29.3 cases), mainly attributed to antithrombotic therapy (84.1%; 37/44 cases). In total, 19/44 patients (43.2%) underwent EVT (embolization or stent graft deployment or both), and 25/44 patients (56.8%) were managed conservatively. Rebleeding occurred in two patients in group CM (7.4%) and underwent EVT. Technical success of EVT was 100% and rebleeding noted in 1 case (5.2%) was successfully re-embolized. No EVT-related complications occurred. According to the Kaplan-Meier analysis, the 1, 3 and 6-month survival rates were 68.4%, 63.2% and 42.1% for group EVT and 87.5%, 75.0% and 58.3% for Group CM, respectively.

Conclusion: In this study, the annual incidence of SSNCH was noteworthy. EVT offered in patients with clinical signs of ongoing haemorrhage and active bleeding at CTA, resulted in effective and uncomplicated, minimal invasive hemostasis, in a population with severe comorbidities. Rebleeding, following either conservative or endovascular treatment was minimal.

P-228

Prostatic embolization as a treatment for urinary catheter dependent patients with great benign prostatic hypertrophy

F. Casero¹, J. Sampere Moragues², A. García Gamez², P. Puyalto De Pablo², V. Benito Santamaria², G.A. Tovar Felice²

¹Radiology, Germans trias i pujol, Barcelona, ES, ²Radiology, Germans trias i pujol, Badalona, ES

Purpose: To assess the efficacy and to describe the complications of prostatic embolization in patients with high comorbidity index and permanent urinary catheter due to great prostatic hypertrophy.

Material and methods: Medical records from 15 patients, with permanent bladder catheterization, who underwent prostatic embolization, from July 2015 to October 2018, were retrospectively reviewed. Age, Charlson comorbidity index, previous and post-embolization prostatic volume, measured by ultrasound, and subjective assessment of symptoms improvement were recorded. A CT angiography was performed in order to assess the anatomy of the prostatic arteries prior to embolization. Supraselective embolizations were performed using 400µ embospheres. Clinical effectiveness was determined if the patient no longer need urinary catheter 3 months after prostatic embolization. Complications were assessed with the Clavien-Dindo classification.

Results: The median age was 83 years (64-95) and Charlson comorbidity index, adjusted by age, ranged from 3 to 11. The median prostatic volume pre-embolization was 90 ml.

The median prostatic volume reduction was 14.24%. At three months, 76.9% of patients no longer needed urinary catheter. 84.6% of the patients reported improvement of their previous symptoms.

1 of 15 patients presented a technique related complication (urosepsis) and 2 more patients showed (suffered from) disorientation and exacerbation of their baseline chronic obstructive pulmonary disease.

Conclusion: Prostatic embolization represents a safe and effective option for the management of patients with permanent bladder catheterization, especially in those patients with large prostates and high comorbidity index.

P-229

Angio-jet rheolytic for massive and submassive PE

N. Anning¹, L. Villalba²

¹Dept of Vascular Surgery, The Wollongong Hospital, Bondi Junction, NSW, AU, ²Dept of Vascular Surgery, The Wollongong Hospital, Wollongong, NSW, AU

Purpose: Catheter directed thrombolysis (CDT) is a contemporary technique for the treatment of massive and sub-massive PEs throughout the world. We sort to evaluate the immediate and short term clinical outcomes of patients treated with Angio-jet pulse spray rheolytic treated for PEs at a single tertiary referral hospital over a 2-year period.

Material and methods: Medical records and diagnostic tests of all patients treated for massive or sub-massive PEs at The Wollongong Hospital during a 2 year period. Assessment of outcomes based on haemodynamic improvement at 24-48 hrs post op and follow-up imaging with TTE and CTPA at 4 weeks.

Results: 23 patients underwent CDT with Angiojet for massive (n=18) or sub-massive (n=5) PE. RV dysfunction was normal in 95% at 24-48hrs post-op. 16 patients underwent follow up TTE at 4 weeks post-procedure with 94% (n=15) demonstrating normal RV function. 18 patients underwent follow up CTPA with 88% (n=16) reported normal. 91% (n=21) patients were discharged with no evidence of respiratory compromise. 2 deaths were reported post procedure.

Conclusion: The morbidity and mortality associated with PEs is significant. In our centre we have had positive results to date with CDI in massive and sub-massive PE's. Initial results have resulted to the initiation of a PERT team to providing a multi-disciplinary approach to the rapid assessment and management of suitable patients.

P-230

Effectiveness of therapeutic lymphangiography alone or in conjunction with glue embolization in postoperative abdominal lymphatic leaks

N.K. Gunji¹, M. Maybody², E.G. Santos Martín³

¹Interventional Radiology, Memorial Sloan Kettering Cancer Center, New York, NY, US, ²Radiology, Memorial Sloan-Kettering Cancer Center, New York, NY, US, ³Radiology, University of Pittsburgh Medical Center, Pittsburgh, PA, US

Purpose: To evaluate the efficacy of therapeutic lymphangiography alone or in conjunction glue embolization techniques for the management of postoperative abdominal lymphatic leaks.

Material and methods: Retrospective study from two institutions (MSKCC, UPMC). It includes 19 patients who underwent intranodal lymphangiography (INL) with or without glue embolization between Oct 2011 and Sept 2018 for post-operative abdominal lymphatic leaks including chylous ascites (CA) (n=15) and lymphoceles (output > 200 cc/day) (n=4). Glue embolization was performed depending on the location of the leak and operator's experience.

Clinical success was defined:

- In patients with CA if surgery or Denver shunt placement weren't required.

- In patients with lymphoceles if surgery or sclerotherapy weren't required.

Results: Therapeutic INL was performed in 7 patients and was associated with glue embolization in 12 patients. The mean duration of conservative treatment before lymphatic intervention was 59 days. The median time from the lymphatic intervention to clinical success (drainage catheter removal) in lymphocele patients was 35 days. Overall clinical success rate achieved was 89.4% (17/19). Clinical success rate in patients with lymphoceles (n=4) was 100% (4/4) and in patients with CA was 86.6% (13/15). All 7 patients who underwent INL only showed a 100% clinical success. There were no procedure-related major or minor complications.

Conclusion: Therapeutic lymphangiography alone or in conjunction with glue embolization is an effective and safe technique for the treatment of abdominal post-operative lymphatic leaks.

P-231

Intraarterial treatment in patients with arterial steal syndrome after orthotopic liver transplantation: where to embolize?

F.N. Fleckenstein¹, W.M. Luedemann¹, A.S. Küçükaya¹, R.W. Günther², B. Gebauer³, G. Wieners¹

¹Diagnostic and Interventional Radiology, Charité University Medicine, Berlin, DE, ²Radiology, Charité Universitätsmedizin Berlin, Berlin, DE, ³Klinik für Strahlenheilkunde, Charité Universitätsmedizin Berlin, Berlin, DE

Purpose: This study compared proximal and distal embolization of the splenic artery (SA) in patients with arterial steal syndrome (ASS) after orthotopic liver transplantation (OLT) regarding changes of liver function after treatment in order to find an ideal location of embolization.

Material and methods: 80 patients with ASS after OLT treated with embolization of the SA were retrospectively analyzed. Perinterventional DSA was used to assess treatment success and to stratify patients according to the site of embolization. Liver function was assessed using following lab-data: Bilirubin (TBIL), Albumin, Gamma-glutamyltransferase (GGT), Alanine-transaminase (ALT), Aspartate-transaminase (AST), INR and thrombocytes. Descriptive statistics were used to summarize the data. Mean values of pre, one- and 3-days, as well as 1-week and 1-month post-embolization were compared. Further, Multivariate-Regressions will be used to identify differences between the groups.

Results: All procedures were successful and showed an improved blood flow in the hepatic artery post-embolization. 34 patients had to be excluded due to incomplete data. TBIL (6,5 vs. 9,8 mg/dl), ALT (103,40 vs. 321,06 U/l) and AST (62,65 vs. 259,28 U/l, all values post-3-days respectively) showed a clear trend towards separation within the first 3-days post-embolization, showing an increase of parameters in the distal treatment group. However, 1-month post-embolization the values matched again, showing no trend towards any separation.

Conclusion: Our data indicates, that a more proximal embolization of the splenic artery might preserve the liver function in patients suffering from ASS after OLT early after treatment. However, in midterm follow-up there seems to be no difference, indicating a self-adjusting steady-state of the liver.

P-232

Vascular plug to treat bronchopleural fistulas

A.J.M. Pinilla¹, E. Cruces Fuentes², F. Sanchez Blanco³, J. Irurzun⁴, S. Gil Sánchez³, D. Contreras Padilla¹

¹Interventional Radiology, Hospital General de Alicante, Alicante, ES, ²Radiología Vascular Intervencionista (2ª planta), Hospital General Universitario de Alicante, Alicante, ES, ³Radiología Vascular Intervencionista, Hospital General Universitario de Alicante, Alicante, ES, ⁴Radiology, Hospital General Universitario de Alicante, Alicante, ES

Purpose: Bronchopleural fistulas (BPF) is a communication between the pleural space and the bronchial tree, represent difficult management problem and are associated with very high mortality and morbidity due to a loss of pleural space sterility after the establishment of direct communication with the airway. The placement of vascular plugs under radiologic guidance is a viable alternative treatment for these patients. The purpose of this research is to evaluate the safety and results in our center, of the endobronchial closure of BPF by the implantation of an amplatzer vascular plug (AVP).

Material and methods: After locating the fistula using computed tomography (CT) and bronchography, under rigid bronchoscopic guidance and through a guide sheath into the fistula the self-expanding plug was deployed. After the procedure, the patients was followed clinically and with CT.

Results: 4 AVPs were placed in 3 patients, one female and 2 males, with a mean age of 70 years (range: 67 - 74 years). The etiologies for BPF development were lobectomy for lung cancer. In two patients, the

development of the procedure was successful and symptoms related to BPF disappeared following closure by the AVP. In one patient the treatment was not effective requiring surgical management, we believe it was due to concomitant local infection.

Conclusion: The use of the Amplatzer device to facilitate the closure of BPF is a feasibility and safety option in patients who fail conservative therapy.

P-233

Patient outcomes following endovascular treatment of spontaneous, non-traumatic, extraperitoneal haemorrhage - a systematic review of the literature

A. Cullen, C. Farrelly

Department of Radiology, Mater Misericordiae University Hospital, Dublin, IE

Purpose: To evaluate the safety and technical success of endovascular treatment in patients with spontaneous extraperitoneal haemorrhage and the incidence of mortality post embolisation.

Material and methods: A PubMed search was performed. Medical Subject Headings (MeSH) terms included embolization, extraperitoneal, retroperitoneal or spontaneous haemorrhage. Studies listed in similar articles were also reviewed. All studies published in English from 2000 to 2018 were included. Evidence was appraised for validity and strength. Results from papers with the highest level of evidence were grouped together and analysed. We selected articles with well described indications for embolisation which provided detailed descriptions of the procedures and outcomes, including technical success, incidence of re-bleeding and re-intervention, and morbidity and mortality rates post procedure. We excluded studies with fewer than 10 patients and anecdotal case-reports to avoid selection bias. Studies involving haemorrhage from trauma and known pathological sources such as tumours were excluded.

Results: 7 studies were selected with a total of 271 patients. Studies represented case series from individual institutions with the largest cohort of 89 patients. The majority of patients were on anticoagulant therapy. Cases frequently featured more than one bleeding vessel. Technically successful embolisation was achieved in a high number of cases with a low rate of re-intervention. All-cause mortality was inconsistently reported but measured up to 31% at 30 days and 43% at 12 months.

Conclusion: Spontaneous extraperitoneal haemorrhage occurs with substantial clinical frequency and may result in life-threatening bleeding. Trans-arterial embolisation is a safe and effective treatment, however the mortality rate within the 12 months post procedure is high.

P-234

Percutaneous foam sclerotherapy with higher concentration of 3% sodium tetradecyl sulphate for peripheral slow flow vascular malformations – single centre initial experience

S. Kalmath, A.R. Somu, M. Palaniswamy

Interventional Radiology, Gleneagles Global Health City Chennai, Chennai, IN

Purpose: Few of previously published literature has reported a lower efficacy of 3% STS foam alone in the resolution of peripheral low flow vascular malformations and a higher rate of recurrence as compared to lower concentrations of foam.

In this background the aim of this study was to evaluate the safety, efficacy and response to a higher concentration of STS in their image guided percutaneous therapy as there is dearth of literature on the same.

Material and methods: This is a prospective, non comparative, single centre case series. Six patients with peripheral slow flow vascular malformations diagnosed on bimodal cross sectional imaging of USG and MRI were treated with 3% STS (SETROL) alone in a 1:1 ratio with nonionic iodinated contrast injected intralesionally via a pair of 26 gauge needles under USG and fluoroscopic guidance. Dose was limited to 0.5ml/kg

body weight. Endpoint of procedure was the flow of contrast into the draining veins.

All patients were followed up at 4 weeks post therapy. Primary goals of assessment were reduction in size of lesion and decrease in visual analogue pain score. Secondary goals were the assessment for any adverse events in periprocedural period and on follow up.

Results: Mean patient age was 33.5 years. Female to male ratio – 4:2. Mean lesion size was 4.3 cm, Mean decrease in the volume of the lesion was 78%, mean decrease in the visual analogue pain score was from 5.6 preoperatively to 1.1 post operatively. Two of the patients had mild superficial changes of the skin overlying the lesion which resolved with conservative management. No major adverse events were seen. All the lesions showed complete involution on follow up. No residual or recurrence was seen.

Conclusion: Our initial experience with a 3% STS foam sclerotherapy alone for peripheral slow flow vascular malformations is promising, feasible and safe. Detailed and long term follow up with randomization of cases is needed for long term data.

P-235

ALBI and P-ALBI predicts overall survival in Child Pugh A patients responding to drug eluting embolics - a single center study

U. Carling¹, B. Røsok², P.-D. Line³, E.J. Dorenberg⁴

¹Dep. for Radiology and Nuclear Medicine, Oslo University Hospital Rikshospitalet, Oslo, NO, ²Dep. for HPB Surgery, Oslo University Hospital Rikshospitalet, Oslo, NO, ³Dep. for Transplantation, Oslo University Hospital Rikshospitalet, Oslo, NO, ⁴Dept. of Radiology and Nuclear Medicine, Oslo University Hospital, Rikshospitalet, Oslo, NO

Purpose: ALBI and P-ALBI grades are newly developed liver function grades that has been validated as prognostic markers for HCC patients across several treatment methods, including TACE. However how these grades are performing in patients responding to treatment is not clear. We analyzed whether ALBI and P-ALBI grades were prognostic in patients responding to TACE treatment with drug eluting embolics (DEE-TACE)

Material and methods: Forty-nine patients with Child-Pugh class A, diagnosed with HCC (BCLC A: 3, B: 26, C:20) treated with DEE-TACE, were retrospectively analyzed. Clinical and tumor characteristics, radiological response (mRECIST) one month post treatment and overall survival (OS: censored for patients with post TACE curative treatment) was analyzed with respect to ALBI and P-ALBI grade.

Results: ALBI distribution in the cohort was; ALBI 1: 21, ALBI 2: 27; ALBI 3: 1 and P-ALBI distribution was P-ALBI 1:29, P-ALBI 2: 17, P-ALBI 3: 3 patients. Objective response rate was 74% with no statistically significant difference for ALBI (1 vs. 2; P=0.08), or P-ALBI (1 vs. 2; P=0.49). OS was 14.8 months (range= 1.7–62.0; ALBI 1 vs. 2: P=0.08; P-ALBI 1 vs. 2: P=0.003). OS in responders with ALBI 1 and 2 was 28.9 vs.10.2 months (P=0.02), and P-ALBI 1 and 2 was 26.7 vs. 8.6 months (P<0.001).

Conclusion: Both grading systems can differentiate survival in patients responding to DEE-TACE treatment.

P-236

Interventional radiology point of view in pulmonary arteriovenous malformation (AVM): from diagnosis to embolization

U.G. Rossi¹, P. Rigamonti², L.C. Pescatori³, M. Femia², F. Pinna⁴, A. Valdata⁴, A.M. Ierardi⁵, G. Carrafiello⁶, M. Cariatì⁷

¹Diagnostic Imaging Department - Interventional Radiology Unit, E.O. Galliera Hospital, Genoa, IT, ²Radiology and Interventional Radiology, San Carlo Borromeo Hospital, Milan, IT, ³Postgraduation School in Radiodiagnostics, University of Milan, San Donato Milanese, IT, ⁴Interventional Radiology Unit, E.O. Galliera Hospital, Genova, IT, ⁵Radiology, University of Milan, San Paolo Hospital, Milan, IT, ⁶Diagnostic and Interventional Radiology, University of Milan, Milan, IT, ⁷Diagnostic Sciences, San Carlo Borromeo Hospital, Milan, IT

Learning objectives: To describe the role of the Interventional Radiology in the management of symptomatic pulmonary ArterioVenous Malformation (AVM), with emphasis from the clinical / diagnostic evaluation to the therapeutic phase.

Background: Pulmonary AVM is a rare anomaly that presents in several different ways: cyanosis, polycythemia, haemoptysis, cerebral and peripheral infarction / abscess. It can present as an isolated finding, or more often (80% of cases) in the context of hereditary haemorrhagic telangiectasia. Different types of pulmonary AVM carry different prognoses and require different types of treatment, specific to each category.

Clinical Findings/Procedure Details: The aim of this poster is to describe: a) the definition, b) the causes and pathophysiologic features, c) imaging diagnosis of pulmonary AVM, d) discuss the management with emphasis on transcatheter embolization, e) and possible complications associated with transcatheter embolization.

Conclusion: Pulmonary AVM represents a multifaceted disease, with many different causes, that it can be a clinical emergency when it manifests itself with massive haemoptysis. The interventional radiologist, in this pathology, has an essential role ranging from diagnosis to transcatheter embolization.

P-237

Internal coil packing technique for amplatzer vascular plugs

M. Koganemaru, S. Tanoue, A. Kuhara, T. Kugiyama, Y. Shinjyo, N. Tanaka, T. Abe

Radiology, Kurume University School of Medicine, Kurume, JP

Learning objectives: We hypothesized that a mesh structure will allow a microcatheter or coil to enter the Amplatzer Vascular Plug (AVP; type I and 4). Here, we report successful embolization of splenic artery aneurysm using this technique.

Background: Patency of AVPs cannot be established following their placement when the mesh structure fails to occlude the target vessel.

Clinical Findings/Procedure Details: In the experimental test, an AVP was implanted within a vessel using a vascular model. A 4-Fr catheter was advanced adjacent to AVP I, and a 1.7-Fr microcatheter was coaxially inserted through the Nitinol mesh of AVP I. The internal packing of AVP I was performed by inserting 0.010-inch detachable coils through six procedures; these procedures allowed for the insertion of only 0.010-inch microcoils through the Nitinol mesh of AVP 4. A similar embolization procedure was employed in a case of incomplete occlusion after AVP I placement in the afferent vessel for the treatment of splenic artery aneurysm. These experimental tests confirmed successful internal coil packing of both AVPs I and 4. For splenic artery aneurysm embolization with incomplete occlusion following AVP I placement, this technique successfully occluded the aneurysm.

Conclusion: We demonstrate technical feasibility of the reported technique to reinforce AVPs with detachable coils in cases of incomplete occlusion or recanalization following short-segment embolization.

P-238

Treatment strategies for pelvic arteriovenous malformation: the importance of concomitant transvenous and transarterial embolization

S. Takenaga¹, H. Ashida², K. Masuda³, Y. Nozawa⁴, Y. Matsui², K. Morikawa¹

¹Radiology, The Jikei University Katsushika Medical Center, Tokyo, JP, ²Radiology, The Jikei University School of Medicine, Tokyo, JP, ³Radiology, Tokyo Dental College Ichikawa General Hospital, Chiba, JP, ⁴Radiology, Japanese Red Cross Medical Center, Tokyo, JP

Learning objectives: To describe treatment strategies for pelvic arteriovenous malformation (AVM), emphasizing concomitant transvenous embolization (TVE) and transarterial embolization (TAE).

Background: Pelvic AVM is a rare and challenging vascular lesion, with symptoms that include pelvic discomfort, pain, hemorrhage (including hematuria), impotence, orchitis, and high-output heart failure. For symptomatic lesions, endovascular interventions are considered the first-line treatment. However, relatively high clinical and radiological recurrence rates have been reported after TAE alone.

Clinical Findings/Procedure Details: Symptomatic pelvic AVM usually has large venous sac (VS) shunted to multiple feeders through the niduses. To reduce the incidence of post-treatment reperfusion, concomitant TVE (coil embolization of VS) and TAE (injection of liquid embolic materials, such as glue) are effective treatment options. Although the order of treatments remains an area of controversy, in our experience, treating with TVE, then TAE produces superior outcomes. This may be because the injected material fills the gaps throughout the coils in the VS. Additionally, this treatment order may decrease the migration of glues into drainers. In cases where venous tortuosity or stenosis renders VS access difficult, TAE alone or direct puncture of the VS may be used as an alternative.

The advantages and disadvantages of each procedure will be discussed in this educational presentation. Additionally, we will discuss a variety of embolic materials used for TAE and a novel technique called 4D-DSA, which enhances visibility of AVM angioarchitecture.

Conclusion: Careful treatment selection is essential for successful embolization of pelvic AVMs.

P-239

Interventional radiologist role in war time

N.A. Alghareem¹, E.M. Alsaeed²

¹Radiology Department, King Khaled Hospital, Najran, SA, ²Rehabilitation Department, King Khalid Hospital, Najran, SA

Learning objectives:

1. Classify bomb blast injuries.
2. How to deal with war victims in IR.
3. Determine the type of injury and management plan according to patient condition and CT findings.
4. How to deliver a proper IR management for war victims.

Background: War and bomb blast injuries are of growing importance and increasing in frequency with unrest in many countries in the Middle East. Terrorism bears another burden for the blast injuries in the civil setting. For the last 8 years, we have lots and different types of blast victims who underwent radiological evaluation and many underwent interventional therapeutic and supportive procedures.

Clinical Findings/Procedure Details: Along the last 8 year since 2011, up to date a lot of war victims have undergone emergency CT scanning, many of them need further evaluation by interventional radiology for therapeutic and supportive care.

I am presenting a range of cases with different injuries, and different degrees and sites.

The review was for patient underwent angiography and cases with major vascular injuries required intervention with arterial embolization, stenting or revascularization was selected and presented here for sharing

knowledge and experience. CT scan was always done for hemodynamically stable patients, for identification and classification of injuries, with high sensitivity and specificity. CT has a high negative predictive value to allow immediate discharge from ER.

Conclusion: IR plays a unique lifesaving role in many cases as was discussed. Embolization and graft stenting plays life-saving core procedures. Most of the early deaths are due to blood loss, early blood loss has a significant effect on late deaths.

P-240

Computed tomography imaging features and technical tips on transarterial embolization for spontaneous hepatic bleeding

S. Kisaki

Department of Radiology, The Jikei University School of Medicine, Minato-ku, JP

Learning objectives: To describe computed tomography (CT) imaging features and technical tips on transarterial embolization (TAE) for controlling spontaneous hepatic bleeding (SHB).

Background: SHB is a life-threatening condition that is caused by a wide variety of diseases. Therefore, radiologists should be aware of the underlying etiology of the preprocedural CT images and accordingly perform an appropriate treatment strategy.

Clinical Findings/Procedure Details: Patients presenting with SHB from January 2016 to December 2018 were retrospectively evaluated at our hospital. Hepatocellular carcinoma (HCC) was identified as the most common cause (n = 5 cases), followed by hemangioma, hepatic metastasis from melanoma, necrotizing vasculitis, and amyloidosis. HCC, hemangioma, and hepatic metastasis cases were found to be widely in contact with the hepatic capsule or demonstrated protrusion of the hepatic contour. It was strongly suspected that a normal thin hepatic parenchyma surrounding the tumors and the development of extrahepatic collateral arteries makes a tumor prone to rupturing. In amyloidosis case, massive hepatic subcapsular hemorrhage and extravasation from the extra hepatic collateral artery was observed. It was thus assumed that hepatomegaly and vascular fragility associated with amyloid deposition may cause hepatic capsular rupture. In case of necrotizing vasculitis, although the clinical success of initial TAE for hemostasis was achieved, it was difficult to diagnose the underlying etiology of hemorrhage on preprocedural dynamic contrast-enhanced CT. Necrotizing vasculitis was pathologically revealed via hepatectomy.

Conclusion: It is difficult to detect the underlying etiology that leads to SHB before TAE in some cases. However, TAE is considered to be an effective treatment to obtain hemostasis in such cases.

P-241

Endovascular management of acute and chronic visceral aneurysms and pseudoaneurysms

W.R. Thomas¹, H. Mehrzad², S. Karkhanis³, S. Boo¹

¹Radiology, Queen Elizabeth Hospital Birmingham, Birmingham, UK, ²Interventional Radiology, QEHB Hospital, Birmingham, UK, ³Interventional Radiology, University Hospital of Birmingham NHS Foundation Trust, Birmingham, UK

Learning objectives: To understand the role and techniques of percutaneous endovascular treatment in the management of visceral aneurysms and pseudoaneurysms, with example cases from a quaternary Centre.

Background: Visceral artery aneurysms and pseudoaneurysms are increasing in incidence, partly due to increasing use of cross sectional and ultrasound imaging as well as increasing life expectancy. Visceral artery aneurysms and visceral artery pseudoaneurysms often pose difficult management dilemmas, with a number of possible treatment options. There is contention in the literature regarding treatment threshold size for true visceral aneurysms, examples of borderline cases are included.

Clinical Findings/Procedure Details: Coeliac, Hepatic, Splenic, renal and branch vessel aneurysms and pseudoaneurysms are included in this review. Case histories and technical details regarding methodology of percutaneous endovascular management (stenting, coiling and the use of liquid embolics) have been included. Follow up imaging is provided wherever possible.

Conclusion: Visceral aneurysms and pseudoaneurysms are a heterogeneous group of pathologies, with no 'one size fits all' approach. A multidisciplinary approach and careful planning before endovascular treatment is advisable. This review demonstrates the wide range of endovascular treatment options available.

P-242

Endovascular management of maxillofacial arteriovenous malformations

T. Garg, R. Saraf

Department of Interventional Neuroradiology, Seth GS Medical College & KEM Hospital, Mumbai, IN

Learning objectives:

1. To learn the definition of AVMs
2. To learn the basic pathology and classification of AVMs.
3. To learn the various clinical presentations and treatment modalities used for maxillofacial AVMs.

Background: Mulliken and Glowacki (1982) classified vascular lesions into vascular tumours and vascular malformations. They are classified on the basis of the velocity of blood flow into low-flow and high-flow malformations. AVMs are high-flow lesions due to the presence of high inflowing pressure and collateral recruitment of local vessels which is responsible for their rapid enlargement over time.

Clinical Findings/Procedure Details: The most common area affected by extracranial AVMs is the midface as described by Kohout et al. AVMs are classified by Schobinger Clinical Staging into quiescent, expanding, destructing and decompensating lesions. Diagnosis is made by MRI which defines the extent of the lesion and soft tissue involvement considered crucial for planning treatment. The timing of intervention is based on the staging and the onset of symptoms, the method of choice for treatment is embolization (direct puncture onyx or glue injection) followed by surgical resection within 1-14 days. Due to the availability of limited data, the best strategy is selection of liquid embolic agent (n-BCA versus Onyx) based on the clinical and angiographic characteristics of each patient.

Conclusion: Maxillofacial AVMs are rare errors of vascular morphogenesis which have unpredictable behaviour which needs to be identified and treated to provide better outcomes. A multidisciplinary team approach involving interventional radiologists, plastic surgeons, cardiovascular thoracic surgeons and maxillofacial surgeons is quintessential for complete resection with good cosmetic outcomes.

P-243

Pictorial review of bronchial arteries - CT and angiography

C. Hazar

Radiology Department, Manchester University NHS Foundation Trust, Manchester, UK

Learning objectives:

1. Describe bronchial anatomy including variants
2. Describe diseases which cause hypertrophy of bronchial arteries
3. Describe the technique of bronchial artery embolisation

Background: Bronchial arteries normally supply one percent of the blood supply to the lungs however in certain diseases can cause hypertrophy of the bronchial arteries. In these cases bronchial arterial supply is the main cause of massive haemoptysis. Bronchial artery embolisation is an effective and safe procedure to treat haemoptysis. However careful interpretation of the angiographic images is required to identify spinal vessel to avoid non-target embolisation which could result in paraplegia.

Clinical Findings/Procedure Details: Bronchial arteries are most commonly originates from descending thoracic aorta (orthotopic, 64%) with different ectopic origins i.e aortic arch, subclavian artery, bronchicephalic trunk, internal mammary artery and throcervical trunk.

A pictorial review of CT and angiographic images will be examined to deliniate anatomical origins of bronchial arteries.

Bronchial artery embolisation technique will be desribed with example cases.

Conclusion: Bronchial artery embolisation is a safe and effective treatment of massive haemoptysis. Anatomical variations needs to be considered before any embolisation procedure to maximise the safety and success of the procedure.

P-244

Percutaneous thoracic duct embolisation for chylous leak post gastrectomy: 5 year review of practice

M. Vasquez Rios¹, C. Finan¹, R. Miles², T. Pandher²

¹Interventional Radiology, Derriford, Plymouth, UK, ²Radiology, Derriford Hospital, Plymouth, UK

Learning objectives:

1. Understand the technical challenges when performing thoracic duct embolisation.
2. Understand the challenges when managing chlyous leak in a multidisciplinary setting.

Background: Chylous leak has been reported as high as 3.9% following oesophago/gastrectomy. Few case reports of thoracic duct embolisation have been published; it is an uncommon and relatively difficult technique due to extensive anatomical variability between patients.

TDE is however a good alternative to open surgical ligation, due to its low morbidity and high success rate. It should be considered a first line treatment in many cases of traumatic chylous leak.

Clinical Findings/Procedure Details: Six patients at Derriford, UK since 2014 had TDE for chylous leak following gastrectomy (surgical treatment for gastric carcinoma).

Three patients underwent embolisation successfully with complete resolution of chylous leak. Opacification of the thoracic duct was attempted with lipiodol and embolised with a variety of embolic materials. In two unsuccessful cases methylene blue was also injected, this proved beneficial when locating the leak during subsequent open ligation.

There was large anatomical variability between patients and therefore success rate of the procedure was lower than previously published results. There was no mortality or post-procedure morbidity in this case series.

Conclusion: TDE has been shown to be an effective treatment for traumatic chylous leak with low morbidity. The technique is however relatively difficult due to anatomical variety between patients.

More research should be undertaken in TDE for traumatic chylous leak, particularly optimal opacification of the thoracic duct and imaging the source of the leak.

P-245

Management of transcatheter arterial embolization for frozen shoulder: focus on anatomical findings

A. Kuhara, M. Koganemaru, T. Kugiyama, Y. Shinjyo, S. Tanoue, N. Tanaka, T. Abe

Radiology, Kurume University School of Medicine, Kurume, JP

Learning objectives: The purpose of this report was to clarify the anatomy of the vessels involved in transcatheter arterial embolization (TAE) for frozen shoulder. We have also discussed procedural recommendations in light of these variations.

Background: TAE is considered an effective treatment option for patients with intractable frozen shoulder with severe chronic pain. Arteries distributed throughout the shoulder joints exhibit high anatomical variability,

as do the branching radial artery and other arteries which can serve as potential originating sites for cerebral infarction.

Clinical Findings/Procedure Details: The ascending cervical and deep cervical arteries are most likely to cause cerebral infarction during TAE. These arteries may diverge from the thyrocervical artery, possibly anastomosing from the radiculomedullary artery to the spinal or vertebral arteries. Examination of arterial anatomical variation confirmed that the radial artery branches from the axillary artery. Arteries distributed throughout the shoulder joint also showed common points of origin: the suprascapular and thyrocervical arteries, suprascapular and acromiothoracic arteries, anterior and posterior circumflex humeral arteries, and circumflex scapular and posterior circumflex humeral arteries. Branching of the radial artery from the axillary artery makes it difficult to perform TAE with vasospasm and catheterization of the target vessel. Therefore, we must confirm the existence of variations of radial artery branching using ultrasound prior to puncturing the artery.

Conclusion: This report conveys important knowledge that is necessary for TAE in patients with frozen shoulder. These contents enable a more safe and accurate TAE.

P-246

Pulmonary arteriovenous malformations. Diagnosis and treatment. Pictorial review and our experience

M.J. Martinez Cutillas¹, M.C. Gutiérrez Ramírez², A. Capel Alemán², A. Ocete Ocete², E. Nuñez Peynado³, A. Castillo García²

¹Radiology Department, HCUVA, Murcia, ES, ²Interventional Radiology, "Virgen de la Arrixaca" University Hospital, Murcia, ES, ³Vascular and Interventional Radiology, Hospital Universitario Doctor Peset, Valencia, ES

Learning objectives:

1. Pictorial review of pulmonary arteriovenous malformations types proving CT angiography and post processed images as a perfect noninvasive tool for detecting and pretreatment mapping of the lesion.
2. To review the steps of percutaneous embolization and embolic agents used in our center, as well as advantages and disadvantages against surgical resection.
3. To show our patient's imagines pre and post treatment.

Background: Pulmonary arteriovenous malformations (PAVMs) are rare vascular anomalies of the lung that act as direct right-to-left shunt between the pulmonary artery and vein.

Despite most patients being asymptomatic, they can lead to dyspnea and cyanosis due to right-to-left shunting, and embolic events due to paradoxical emboli.

They can be classified as simple (commonest), complex or diffuse and it is frequent its association whit hereditary hemorrhagic telangiectasia (HTT).

Clinical Findings/Procedure Details: CT angiography with 3D reconstruction and post processed images (MIP, VR) are the perfect tool detecting PAVMs and for pretreatment mapping of the lesion.

Selective embolization of PAVMs leads to an immediate occlusion with low risk of complications, hence this is considered the first-line treatment procedure being coils the embolic agent most used.

Conclusion: Pulmonary arteriovenous malformations (PAVMs) are rare vascular anomalies, CT angiography is the chosen noninvasive technique for its detecting and planning its treatment and selective embolization is the first-line treatment procedure.

P-247

Liquid embolic agents: technical, practical and clinical aspects

S. Walker¹, W.R. Thomas², C. Aleman¹, I.J. McCafferty³

¹Interventional Radiology, University Hospital Birmingham, Birmingham, UK, ²Radiology, University of Wales Hospital Cardiff, Cardiff, UK, ³Radiology, The Queen Elizabeth Hospital Birmingham, University Hospital Birmingham NHS Trust, Birmingham, UK

Learning objectives:

1. List and categorise currently available liquid embolic agents
2. Describe the physical and chemical characteristics of the most widely used agents and appreciate the key differences
3. Be able to select an appropriate agent based upon the lesion to be treated
4. Understand the need for appropriate delivery catheter selection
5. Describe ways in which safety can be maximised when administering liquid embolic agents
6. Be aware of potential pitfalls associated with liquid embolic administration and how they can be avoided

Background: Liquid Embolic Agents are an essential tool in the interventional radiologist's armamentarium and have a wide variety of applications. Rapid development of new agents continues to broaden the indications and treatment possibilities. However, in order to use Liquid Embolic Agents safely and effectively, the interventional radiologist must have a sound theoretical and practical understanding of their nature and differences.

Clinical Findings/Procedure Details: This educational exhibit will introduce the interventional radiologist in training to commonly used Liquid Embolic Agents and describe their composition, behaviour and applications. Case examples, technical data and illustrations will be used to demonstrate their usage in both common and uncommon scenarios. Safety implications, best working practices and important pitfalls will be explained.

Conclusion: Liquid Embolic Agents allow the interventional radiologist to treat a wide variety of conditions and have an ever-expanding role in contemporary embolotherapy. A thorough understanding of the technical, practical and clinical aspects of these agents is essential if treatment is to be both safe and successful.

P-248

The essential role of iodized oil based CT-lymphangiography for dedicated treatment planning of specific lymphatic second-line interventions in patients with complex postoperative therapy-refractory lymphatic fistula (LF) in different locations

C.M. Sommer¹, F. Pan², M. Loos³, T. Hackert³, H.U. Kauczor⁴, A. Hatopp¹, G.M. Richter¹, C. Goerig⁵, H. Killguss⁶, T.D. Do²

¹Diagnostic and Interventional Radiology, Klinikum Stuttgart, Stuttgart, DE, ²Diagnostic and Interventional Radiology, University Hospital Heidelberg, Heidelberg, DE, ³Surgery, University Hospital Heidelberg, Heidelberg, DE, ⁴Department of Radiology, German Cancer Research Centre, Heidelberg, DE, ⁵Vascular Surgery, Klinikum Stuttgart, Stuttgart, DE, ⁶Surgery, Klinikum Stuttgart, Stuttgart, DE

Learning objectives: In this educational exhibit, the essential role of iodized oil based CT-lymphangiography for dedicated treatment planning of specific lymphatic second-line interventions in patients with complex postoperative therapy-refractory lymphatic fistula (LF) in different locations is outlined.

Background: In the management of patients with complex postoperative therapy-refractory LF in different locations, iodized oil based conventional lymphangiography is an established diagnostic and therapeutic approach. In the patients with clinical failure, however, specific lymphatic second-line interventions are indicated. For optimal prospective treatment planning with intention to maximize clinical success and to minimize procedure related complications, cross sectional imaging of the

lymphatic system with definition of type, degree and location of the LF is essential. In contrast to off-label gadolinium based interstitial or intranodal MR-lymphangiography, CT-lymphangiography can be performed easily after iodized oil based transpedal or intranodal lymphangiography as an approved technique.

Clinical Findings/Procedure Details: CT-lymphangiography performed after iodized oil based conventional lymphangiography identifies reliably (I) direct and indirect signs of LF and (II) potential targets for specific lymphatic second-line interventions. Thereby, adequate timing of CT-lymphangiography is mandatory: 1/3-6/6-9 hour(s) after conventional lymphangiography for LF in the lower extremity and groin/pelvis and abdomen/thorax and neck. Irrespective of the location of the LF, CT-lymphangiography defines small afferent lymph ducts for percutaneous sclerotherapy, large lymph ducts for percutaneous puncture and subsequent embolization, and afferent lymph nodes and the fistula point itself for interstitial embolization.

Conclusion: Iodized oil based CT-lymphangiography is essential for dedicated treatment planning of specific lymphatic second-line interventions in patients with complex postoperative therapy-refractory LF in different locations.

P-249

Post caesarian - underdiagnosed inferior epigastric artery injuries

M. Imran

Deccan College of Medical Sciences, Hyderabad, Hyderabad, IN

Learning objectives: Postpartum Hemorrhage (PPH) can be a fatal obstetric emergency, that contributes to maternal mortality. PPH can lead to serious morbidity, such as disseminated intravascular coagulation, shock, hepatic failure, renal failure, respiratory distress syndrome and Sheehan syndrome. Inferior epigastric artery represents a potentially overlooked source of pelvic arterial hemorrhage. This article includes 4 such cases diagnosed as inferior epigastric artery bleed following caesarian section, which were managed by endovascular intervention.

Background: Postpartum Hemorrhage can be a fatal obstetric emergency that contributes to maternal mortality. Delay in diagnosis and appropriate treatment has been identified in most cases of maternal death associated with PPH

An estimated blood loss in excess of 500ml following a vaginal birth or a loss of greater than 1000ml following caesarean birth often has been used for the diagnosis, but the average volume of blood lost at delivery can approach these amounts

The diagnostic approach to PPH is generally based on estimated blood loss, volume of blood products transfused, hemoglobin concentration, platelet count and coagulation values.

Clinical Findings/Procedure Details:

S. No.	Artery Injured	Treatment done	Immediate Post Op	Follow up
1.	Inferior Epigastric Artery	Coiling	Patient Improved	Doing well
2.	Inferior Epigastric Artery	Glue	Patient Improved	HELLP Syndrome. Expired
3.	Inferior Epigastric Artery	Glue	Hepatic Encephalopathy	Expired
4.	Inferior Epigastric Artery	Surgical Management	Patient Improved	Doing well

Conclusion: Inferior epigastric artery bleed is a serious complication following caesarean section. An aortoiliac arteriographic overview of

the pelvic vasculature can help detect any unsuspected extrauterine vascular injury leading to extravasation of contrast material in post caesarean patients.

P-250

Efficacy of N-butyl cyanoacrylate/ Lipiodol emulsion in embolization of periprosthetic venous leakage for erectile dysfunction

D.V. Meccia¹, F. Daviddi¹, F. Acquafredda¹, F.P. Tarantino¹, R. Cioni², A. Lunardi²

¹Diagnostic and Interventional Radiology, University of Pisa, Pisa, IT, ²Diagnostic and Interventional Radiology, AOU PISA, Pisa, IT

Learning objectives: The purpose of this study is to evaluate the efficacy of combination of N-butyl cyanoacrylate and Lipiodol in embolization of periprosthetic venous plexus leakage in patients with erectile dysfunction (ED).

Background: Treatment of ED depends on overall health and underlying cause of the problem. Many conditions have been reported to cause ED. One of these, veno-occlusive dysfunction, has a variable incidence and can be detected by color doppler ultrasonography (CDUS) and cavernosography.

Clinical Findings/Procedure Details: From January to December 2018 six patients with ED not responsive to PDE-5 inhibitors underwent to this procedure. Prior CDUS evaluation after pharmacological stimulation (Alprostadil) and dynamic cavernosography confirmed venous leakage that prevented adequate penile rigidity. US-guided direct percutaneous puncture of the deep dorsal vein of the penis or external pudendal vein (EPV) under local anesthesia allowed controlled injection of the embolizing mixture until complete periprosthetic venous plexus embolization. One month later all the patients underwent to dynamic CDUS evaluation to confirm absence of residual venous outflow. International Index of Erectile Function (IIEF-6) questionnaire have been administered before and after procedure at 1, 3 and 6 months.

Short and midterm results based on the IIEF-6 questionnaire showed performance and self-esteem improvement in all treated patients. Two patients had midterm recurrence of venous leakage from EPV, confirmed by CDUS and pharmacological stimulation, that was successfully treated by direct US-guided cannulation and embolization of the EPV.

Conclusion: Embolization of periprosthetic venous leakage is an effective tailored treatment in patients with ED not responsive to pharmacotherapy. Eventually it can be repeated to improve results.

P-251

Treatment of high flow arteriovenous malformations; the pearls and pitfalls

W.R. Thomas¹, S. Walker², A. Willis³, I.J. McCafferty⁴, R.G. Jones⁵

¹Radiology, Queen Elizabeth Hospital Birmingham, Birmingham, UK, ²Interventional Radiology, University Hospital Birmingham, Birmingham, UK, ³Interventional Radiology, University Hospital of Birmingham MHS Foundation Trust, Birmingham, UK, ⁴Radiology, The Queen Elizabeth Hospital Birmingham, University Hospital Birmingham NHS Trust, Birmingham, UK, ⁵Interventional Radiology, Queen Elizabeth Hospital Birmingham, Birmingham, UK

Learning objectives: To understand the approach, risk stratification and techniques used in the treatment of symptomatic high flow peripheral Arteriovenous malformations (AVMs).

Background: High flow arteriovenous malformations are a heterogeneous group of pathologies which can lead to significant clinical and cosmetic symptoms. A multidisciplinary approach is essential. Treatment strategy will depend on anatomical location, vascular architecture and flow dynamics. Treatment may be curative or palliative in its intent.

Clinical Findings/Procedure Details: We describe the treatment of a range of high flow peripheral AVMs, highlighting access approach, potential complications, choice of embolic material, and treatment

response as learning points. Follow up imaging and/or photography is included wherever possible.

Conclusion: Successful treatment relies on embolization of the malformation nidus with minimal non-target embolization, this often requires several treatment sessions over time.

P-252

Prostate artery embolization for treatment of symptoms related to benign prostate hyperplasia: state of the art

A.P. Savoldi¹, P. Grillo¹, G. Granata¹, M. Pecorilla¹, A.M. Ierardi², M. Petrillo², C. Floridi², G. Carrafiello²

¹Radiologia diagnostica ed interventistica - Ospedale San Paolo, Università degli studi di Milano - Scuola di specializzazione in radiodiagnostica, Milan, IT, ²Diagnostic and Interventional Radiology, San Paolo Hospital, University of Milan, Milan, IT

Learning objectives: To learn about technical details and potential advantages of Prostate Artery Embolization (PAE)

Background: The current gold standard treatment for moderate to severe lower urinary tract symptoms related to Benign Prostate Hyperplasia (BPH) is Transurethral Resection of the Prostate (TURP). However, TURP has a 20% rate of complications, and many BPH patients are at high surgical risk because of advanced age and comorbidities. Such patients may benefit from Prostate Artery Embolization (PAE), a mini-invasive procedure that has shown promising results in recent years.

Clinical Findings/Procedure Details: PAE is usually performed with a transfemoral approach. Bilateral embolization and larger particles are generally preferred, but there are no conclusive studies. PAE is a technically difficult procedure due to the highly variable anatomy of prostatic arteries and because of the potential risk of non-target embolization of nearby organs. However, studies have shown very high rates of technical and clinical success, with a very low rate of major complications and an acceptable rate of minor complications such as transient haematuria or haematospermia. As a minimally invasive procedure, it also has the advantage of a very short hospital stay. Moreover, in BPH patients with larger prostate glands (>80 ml) PAE has shown good results, whereas TURP has higher complication rates.

Conclusion: Although it hasn't been included into urological society guidelines yet, PAE is a promising alternative to TURP in patients who are unfit for surgery; ongoing trials comparing PAE with TURP and investigating long-term efficacy of the procedure will shed more light on its role.

P-253

Corona mortis as a source of persistent pelvic bleeding - a vascular variant to keep in mind

M. Leyva Vásquez Caicedo¹, C.J. Gonzalez Nieto², J.E. Armijo Astrain², J.V. Méndez Montero³

¹Radiology/Vascular and Interventional Radiology, Hospital Universitario Clínico San Carlos, Madrid, ES, ²Radiology, Hospital Clínico San Carlos, Madrid, ES, ³Vascular and Interventional Radiology, Hospital Universitario Clínico San Carlos, Madrid, ES

Clinical History/Pre-treatment Imaging: We report a case of a 64 year old male who was transferred to our hospital after a traffic accident. A CT scan showed a pelvic fracture with a right ischio-pubic fracture and hematoma of pectineus muscle with active arterial bleeding. During the examination the patient became hemodynamically unstable. He received a blood transfusion and was transferred to the angiosuite for embolization.

Treatment Options/Results: A selective arteriography into the internal iliac artery was performed and the obturator artery was identified as source of the bleeding, this was successfully embolized with N-butyl cyanoacrylate, but the bleeding continued. Examination of the external iliac artery was performed and an anatomical variant related to the anastomosis between the internal and external iliac system was found, this variant called "Corona Mortis" an atypical artery arising from the inferior

epigastric branch was found feeding the bleeding. Finally we catheterized this branch and embolized with N-butyl cyanoacrylate.

Discussion: The corona mortis, a vascular anastomosis between the obturator artery and the external iliac artery should keep in mind in pelvic trauma with active bleeding. The interventional radiologists should be aware of this anatomical variant as a possible source and persistence of the hemorrhage. We therefore recommend that during pelvic embolization procedures, angiographic control series should also include the external iliac artery.

Take-home points: In pelvic trauma patients with active bleeding we should be aware of this anatomical variant as a possible source and persistence of the hemorrhage.

A complete angiographic control series before and after embolization should also include the external iliac artery.

P-254

Endovascular management of adrenal artery pseudoaneurysm after total nephrectomy

M. Leyva Vásquez Caicedo¹, C.J. Gonzalez Nieto², J.E. Armijo Astrain², J.V. Méndez Montero³

¹Radiology/Vascular and Interventional Radiology, Hospital Universitario Clínico San Carlos, Madrid, ES, ²Radiology, Hospital Clínico San Carlos, Madrid, ES, ³Vascular and Interventional Radiology, Hospital Universitario Clínico San Carlos, Madrid, ES

Clinical History/Pre-treatment Imaging: We report a case of a 54-year-old male with polycystic kidney disease who underwent a total pre-transplant nephrectomy. After the surgery the patient presented severe abdominal pain, drop of haemoglobin levels and hemodynamic instability. A contrast-enhanced CT scan showed postoperative haematoma in right renal fossa and surgical bed with an 15 mm hyperdense rounded lesion contained within the right adrenal hematoma compatible with adrenal pseudoaneurysm.

Treatment Options/Results: We performed an urgent transarterial aortogram that shows a pseudoaneurysm formation of the right middle adrenal artery arising directly from aorta. After selective catheterization, the injured vessel was embolized with microcoils. Finally the control angiogram confirmed the complete occlusion of the right middle adrenal artery. After embolization, the hemodynamic status of the patient improved.

Discussion: Adrenal artery pseudoaneurysm formation, which is contained rupture of the vessel wall, is an uncommonly recognized complication following nephrectomy. It can result in massive hemorrhage and conventional treatment has been surgical ligation or resection.

We describe a successful endovascular coil embolization of a postoperative adrenal artery pseudoaneurysm in a 54-year-old patient. Because multiple arteries can supply the adrenal gland, it is important to investigate all of the potential sources of bleeding.

Take-home points: The patients with adrenal artery pseudoaneurysm can be identified and treated successfully with percutaneous angiography and embolization. This technique is a less invasive and safe alternative to surgery with successful results.

Due to multiple vascularization of the adrenal gland, it is important to know the anatomy and investigate all the potential sources of the bleeding.

P-255

Prostatic artery embolization for bleeding from benign prostate hyperplasia: a case report

T. Tajima-Komatsu¹, Y. Ishisaka¹, A. Okumura¹, E. Sakata¹, Y. Moribata¹, T. Koyama¹, T. Magaribuchi²

¹Department of Diagnostic Radiology, Kurashiki Central Hospital, Kurashiki, JP, ²Department of Urology, Kurashiki Central Hospital, Kurashiki, JP

Clinical History/Pre-treatment Imaging: A 70s-year-old male, who had several episodes of hematuria and urinary retention due to benign prostate hyperplasia (BPH), presented to ER complaining urinary retention. CT revealed massive hemorrhages in the urinary bladder without any identifiable source of hemorrhage.

Treatment Options/Results: Urologists performed emergency cystostomy, bladder irrigation and hemostyptics injection. However, bleeding from the bladder continued, and his hemoglobin dropped to 4.8 g/dl. Surgery was considered difficult since the patient refused transfusions due to his religious belief. Therefore, prostatic artery embolization (PAE) was selected. CT prostatic arteriography was performed to confirm that prostatic arteries only supplied prostate. Then, the arteries were embolized with 300-500 µm tris-acryl gelatin microspheres (Embospheres) and gelatin sponges. The follow-up CT on post-procedural day six confirmed that the prostate significantly shrank, and hematuria and urinary retention improved.

Discussion: PAE can be the alternative treatment of choice for hematuria, especially when the surgery is considered difficult. PAE can be performed even without evidence of distinct source of bleeding, which is rarely identifiable on angiography. In addition, the combined use of CT arteriography is advantageous since it helps identify non-target vessels, thus avoid complications. Furthermore, PAE has a potential to shrink BPH itself and improve its major symptoms such as urinary retention and frequency.

Take-home points: PAE might be an effective treatment for intractable hematuria even if CT does not reveal active bleeding from BPH. Moreover, PAE may shrink BPH and improves its symptoms.

P-256

Embolization of arteriovenous malformation type Yakes IIIa

K. Pyra, **M.B. Bąk**, M. Sojka, M. Nowakowska, A. Drelich-Zbroja, T. Jargiełło

Department of Interventional Radiology and Neuroradiology, Medical University of Lublin, Lublin, PL

Clinical History/Pre-treatment Imaging: A 30-year-old woman without any notable medical history was evaluated due to non specific lower abdominal pain and felling "rumbling in stomach". USG Doppler and angio-CT was carried out. It demonstrated arteriovenous malformation (AVM). An angiographic study showed that AVM was supplied by: internal iliac artery, median sacral artery and branches of inferior mesenteric artery (fig. 1). There was high blood flow through the malformation to single outflow vein drainage toward ovarian vein. The malformation Yakes type IIIa was diagnosed with nidus in vein wall.

Treatment Options/Results: First embolization of supplying AVM arteries was performed using liquid embolic agents and coils. The treatment only slightly reduced the flow through AVM, in the following procedure under ultrasound and fluoroscopy guidance the nidus was percutaneously puncture and multiple coils were deposited. In the last stage of treatment, due to residual flow: 98% ethanol in total dose of 5ml was injected. Follow-up angiography performed after 6, 12 and 24 months confirmed complete closure of AVM (fig.2).

Discussion: The circulatory connections of pelvic vascular malformations are complex. This case demonstrates that Yakes type III AVM can be successfully cured with direct coil embolization and attempts from arterial side are usually ineffective.

Take-home points:

- “rumbling in stomach” may have an unusual cause
- Yakes classification precisely determines the method of treatment
- AVM Yakes type IIIa AVM can be successfully cured with direct coil embolization

P-257**Spinal infarction due to development of substantial extradural spinal arteriovenous malformation after venous embolization of pelvic arteriovenous malformation: a case report**

S. Wada, Y. Ogawa, K. Hosoi, K. Hashimoto, J. Moriya, S. Hamaguchi, H. Mimura

Radiology, St. Marianna University School of Medicine, Kawasaki, JP

Clinical History/Pre-treatment Imaging: An 80-year-old woman presented with abdominal pain and right lower limb pain. Radiological examination revealed pelvic arteriovenous malformations (pAVMs). Although transarterial embolization was repeated, dilation of the common iliac vein worsened.

Treatment Options/Results: PAVM had arteriovenous shunts between the branches of the right internal/external iliac arteries and internal iliac vein and many shunt points in the wall of the internal iliac vein. Transvenous embolization of the dilated right internal iliac vein was performed using detachable coils and a mixture of n-butyl-2-cyanoacrylate and lipiodol via the right femoral vein 4 times. The arteriovenous shunts had almost completely disappeared after the procedure. However, paraplegia of the lower limbs and bladder and bowel dysfunction gradually occurred a day after the final procedure. Spinal magnetic resonance imaging revealed spinal infarction with spinal arteriovenous fistula (sAVF) was suspected. An additional angiography revealed an extradural sAVF with intradural venous drainage from the pAVM; hence, surgical interruption of the draining vein was performed. The symptoms gradually improved.

Discussion: There is a report of focal bladder necrosis as an early complication after embolization of pAVM; however, there are no reports of sAVF as a complication. It must be kept in mind that venous outflow into the patient's residual outflow veins can increase and it may aggravate substantial extradural sAVF, causing spinal venous infarction.

Take-home points: Although pAVM seems to be a rare disease, diagnosis and treatment at an early stage may be able to block the outflow vein, leading to early recovery of symptoms.

P-258**Plug-assisted retrograde transvenous obliteration (PARTO) performed simultaneously through gastrosplenic shunt and gastrosplenic shunt in gastric varices patient**

J.M. Lee¹, J. Ohm², S.B. Yang³, C.H. Kang⁴, W.-H. Lee⁵, J.J. Shim¹

¹Radiology, SoonChunHyang University Bucheon Hospital, Bucheon, KR, ²Radiology, Chungnam National University Hospital, Daejeon, KR, ³Radiology, Soonchunhyang University Hospital, Gumi, KR, ⁴Radiology, Gangneung Asan Hospital, Gangneung, KR, ⁵Radiology, Soonchunhyang University Cheonan Hospital, Cheonan, KR

Clinical History/Pre-treatment Imaging: A 54-year-old man with liver cirrhosis due to hepatitis B was admitted to our hospital with hematemesis. Abdominal CT showed prominent gastric varices and drainage through the gastrosplenic and gastrosplenic shunt.

Treatment Options/Results: PARTO was performed simultaneously via gastrosplenic and gastrosplenic shunt.

Discussion: PARTO is effective for gastric varices treatment and can be performed through gastrosplenic shunt as well as gastrosplenic shunt.

Take-home points: PARTO is effective treatment for gastric varices.

P-259**Percutaneous thrombin injection - an alternative approach to treatment of intercostal artery pseudoaneurysm**

E. Kresic, M. Prutki, A.M. Alduk

Department of Diagnostic and Interventional Radiology, University Hospital Centre Zagreb, Zagreb, HR

Clinical History/Pre-treatment Imaging: An 88-year-old male patient with a stab wound was referred for contrast-enhanced computer tomography (CECT) that showed retroperitoneal hematoma with a pseudoaneurysm (PSAN) of the right-sided 11th intercostal artery (Figure 1A).

Treatment Options/Results: Digital subtraction angiography (DSA) confirmed PSAN of the distal part of intercostal artery (Figure 1B), but embolization was unsuccessful due to instability of the guiding catheter. The patient was placed on his left side and ultrasound guided percutaneous thrombin injection (UGTI) was performed until complete cessation of flow within the PSAN (Figure 1C and 1D). Immediate control DSA (Figure 1E) and follow-up CECT confirmed complete occlusion of PSAN.

Discussion: Intercostal artery pseudoaneurysms are extremely rare and potentially fatal. Transarterial embolization is the first line of treatment, but superselective catheterization is not always possible, due to difficult anatomy, spasm, or catheter instability. Embolization from proximal part of intercostal artery is associated with the risk of spinal ischemia. UGTI is a widely accepted treatment method for groin artery PSAN, with shorter procedure times, lower costs, no need for anesthesia, high technical success rates, and low complication rates. Complications are caused by overinjection of thrombin or involve PSAN with a wide, short neck. However, occlusion of the distal part of intercostal artery has no clinical consequences and is desirable in the PSAN setting.

Take-home points: UGTI is a safe, simple and effective treatment for intercostal artery PSAN.

UGTI should be considered as a first line treatment for all PSANs with narrow neck or arising from a sacrificable artery.

P-260**The role of interventional radiology in multidisciplinary management of intralobar bronchopulmonary sequestration in adults**

M.S. Patil, S. Berry-Tony, E. Berkowitz, N. Kokabi

Department of Diagnostic Imaging, Emory University School of Medicine, Atlanta, GA, US

Clinical History/Pre-treatment Imaging: 52-year-old Bangladeshi male with hypertension and diabetes presented with subjective fevers, myalgias, and headache. Vital signs significant for mild tachycardia. Exam and laboratory results unremarkable. Chest radiograph significant for ovoid mass-like opacity in the anterior aspect of the right middle lobe. CT scan revealed 4.5x4.0x4.7cm right middle lobe soft tissue pulmonary mass with feeding vessels from the right internal mammary artery (RIMA) and draining veins converging into the pulmonary hilum.

Treatment Options/Results: Using right radial access, 5 French RIM catheter was advanced over 0.035 Bentson wire to the right subclavian artery at the level of the takeoff of the RIMA. Angiography revealed hypertrophied RIMA, as the systemic arterial supply to a right middle lobe mass. Abrupt venous drainage into the left atrium via the right pulmonary vein was noted. 2.8 French Progreat microcatheter and 0.018 GT glide wire were negotiated into the hypertrophied RIMA. Coil embolization of distal RIMA was performed using several detachable and pushable coils. Post embolization arteriography demonstrated stasis of flow within the RIMA. The patient went on to have successful right thoracoscopy and right middle lobe segmentectomy of the sequestration with minimal intra-operative bleeding.

Discussion: Intralobar bronchopulmonary sequestrations (BPS) are congenital pulmonary abnormalities rarely seen in the adult population. While, definitive treatment is surgical resection, coil embolization can be a safe and effective procedure to reduce intraoperative bleeding.

Take-home points: Interventional radiologists should be familiar with clinical presentation, cross-sectional imaging findings, and vascular anatomy of BPS. A multidisciplinary approach in management of BPS patient should include IR in contemporary clinical practice.

P-261

External pudenda artery embolization in a giant scrotal hematoma

G. Peta, A. Cappelli, C. Mosconi, M. Renzulli, A. Bruno, F. Modestino, M.C. Galaverni, R. Golfieri
Radiology Unit, Department of Experimental, Diagnostic and Speciality Medicine, Sant'Orsola Hospital, University of Bologna, Bologna, IT

Clinical History/Pre-treatment Imaging: A case of a 58-year-old man with a giant scrotal hematoma due to exporting a wart with laser therapy. The patient was hemodynamically stable so performed a CT study. The response of the CT reported an active bleeding in the scrotum, the values of serum hemoglobin had decreased by 2gr/dl within a few hours. Then the patient was moved to the angiographic suite.

Treatment Options/Results: After retrograde access, cobra catheter was used to catheterize the contralateral right common femoral artery. The vessel supplying the bleeding was a small branch of the superficial external pudenda artery and it was catheterized by using a bern shape tip microcatheter. Embolization was achieved using gelatin sponge material. The final check showed preserved flow in the superficial external pudenda artery and no more presence of active bleeding from the injured branch.

Discussion: We decided not to embolize upstream and downstream the afferent branch of the blood source to keep the patency of the superficial external pudenda artery, because in almost 7% of men the external pudenda artery contributes to erectile function. In the decision whether a definitive or reabsorbable embolizing agent, considering the good coagulation condition of the patient and the risk of escape of embolizing material in unsuitable target, we preferred a reabsorbable material.

Take-home points: Selective embolization of the arterial vessel is an effective and safe option for controlling iatrogenic/traumatic bleeding. Reabsorbable material is preferable in vessels that vascularize vital territories.

P-262

Endovascular management of superior mesenteric venous thrombosis and peristomal variceal hemorrhage: mechanical thrombectomy and balloon-assisted ethylene-vinyl alcohol copolymer embolization

A.L. Cho, J. Suh, D. Jin
Radiology, Loma Linda University Medical Center, Loma Linda, CA, US

Clinical History/Pre-treatment Imaging: A 59-year-old female with NASH cirrhosis and history of colon cancer status post total colectomy with end ileostomy creation presented with abdominal pain and recurrent severe hemorrhage into her ileostomy bag. Various methods of ileoscopies/endoscopies revealed no significant findings. Pre-procedural CT abdomen/pelvis demonstrated near-complete occlusion of the superior mesenteric vein (SMV) with thrombus and enlarged ileostomy peristomal varices.

Treatment Options/Results: A percutaneous transhepatic right portal vein approach 7-French sheath was placed into the portal vein confluence. After crossing the SMV thrombus, a 2.1 French balloon microcatheter (Scepter-XC™) was utilized to access the peristomal varices via the SMV (arrows). After insufflating the balloon, 3 mL of Onyx-18 was injected to completely fill the varices (asterisks).

Through a 6-French AngioJet™ catheter, tissue plasminogen activator was power-pulsed into the thrombus with subsequent thrombectomy (arrowhead). Persistent thrombus was treated with angioplasty using an 8 mm balloon. Follow-up venogram revealed a patent SMV of >60%

and successful embolization of peristomal varices. Patient has not had a hemorrhagic episode from her ileostomy over 9 months.

Discussion: The current case demonstrates successful balloon-assisted retrograde embolization of peristomal varices using Onyx™ liquid embolic agent and rheolytic mechanical thrombectomy of SMV thrombosis. Peripheral vascular use of Onyx™ has been well-documented in the literature; however, few cases demonstrate safe and effective use in peristomal variceal bleeding. This case further substantiates the use of AngioJet™ to effectively remove chronic SMV thrombus via direct transhepatic approach.

Take-home points: Transhepatic approach mechanical thrombectomy of SMV thrombosis and balloon-assisted EVOH copolymer embolization of peristomal varices are safe and effective.

P-263

Endovascular embolization of a rare arteriovenous malformation: an emergency intervention

N. Mukundu Nagesh¹, R.S. Chivate², R. Gali³, P. Thakrar⁴
¹Interventional Radiology, Exeter Medical School, Magdalen Road, Exeter, UK, ²Interventional Radiology, Tata Memorial Hospital, Mumbai, IN, ³Radiology, Horizon Hospital, Mumbai, IN, ⁴Radiology, Nirman Diagnostic Centre, Mumbai, IN

Clinical History/Pre-treatment Imaging: A 43-year-old female patient with a previously undiagnosed pulmonary arteriovenous malformation (PAVM) presented with two episodes of convulsions with shortness of breath. The initial chest X ray (Figure 1) revealed left sided atelectasis and the patient quickly deteriorated and suffered a cardiac arrest and oxygen saturations dropped to 70%.

Treatment Options/Results: Bilateral femoral vein access was obtained using a catheter and wire combination. A 12mm Amplatzer vascular plug was deployed from the 7Fr. guiding sheath to close to this fistula site. The moment this fistula was closed oxygen saturation immediately recovered to 95-97%. Repeat catheter and angiography was performed which revealed no leaks at the site of embolization. There was immediate expansion of left lung (Figure 2).

Discussion: The presentation of PAVM are non-specific and can be underestimated by the patient and clinician. However, complications of a large PAVM can be serious and potentially life threatening. We have presented for the first time a life threatening PAVM which was urgently managed by interventional radiologists. The patient had complete resolution of the PAVM and had regained exercise tolerance and improved quality of life at 6 months follow up.

Take-home points: The urgent embolization of the PAVM performed in this case was lifesaving and the patient was immediately stabilized and returned to normal activities of daily living. This case is a reminder of the expanding role of interventional radiologists in emergency medicine and the future scope of minimally invasive therapies.

P-264

Transcatheter embolization for recurrent ankle hemarthrosis in rheumatoid arthritis

C. Cross¹, K. Quencer², C. Kaufman²
¹School of Medicine, University of Utah, Salt Lake City, UT, US, ²Radiology, University of Utah, Salt Lake City, UT, US

Clinical History/Pre-treatment Imaging: A 55-year-old male with a past medical history of rheumatoid arthritis (RA) presented with recurrent right ankle pain and hemarthrosis. The symptoms started 3 years ago, at which time his right ankle was aspirated. He continued to have recurrent flares causing excruciating pain and preventing weightbearing. Pre-treatment T1-weighted MRI showed tibiotalar/subtalar joint effusions with enhancing synovitis.

Treatment Options/Results: The patient has been treated with methotrexate, prednisone, and leflunomide for his RA with continued worsening

of symptoms. The patient underwent angiography and embolization. Initial angiography demonstrated markedly abnormal hyperemia surrounding the joint with early draining to the posterior tibial vein (Figure 1). Two branches of the posterior tibial artery were subselected and embolized using 100-300 embospheres. Completion angiogram demonstrated decreased hyperemia (Figure 2). At follow-up at 1 and 9 months the patient was ambulatory with significant improvement in pain.

Discussion: Recurrent hemarthrosis can be debilitating. Embolization has been shown to decrease knee pain in osteoarthritis where it was hypothesized that hyperemia and accompanying nerves contribute to pain, as well as in the setting of recurrent hemarthrosis after total knee arthroplasty or hemophilia. However, this procedure has not previously been described in the literature for hemarthrosis due to RA. Our case suggests that embolization may prove an effective method in treatment and control of pain in hemarthrosis in the setting of RA.

Take-home points: Recurrent hemarthrosis can be painful and debilitating. Hyperemia and accompanying nerves may contribute to pain. Transcatheter embolization can be used to treat recurrent hemarthrosis from multiple etiologies.

P-265

Transarterial embolization for unruptured splenic aneurysm during pregnancy

S. Ikenaga

Radiology, Tokyo Medical University Hospital, Tokyo Nishishinjyuku, JP

Clinical History/Pre-treatment Imaging: 38 year-old woman, G1P1, with no splenic past history was pointed out of 3cm spindle-shaped aneurysm on the main trunk of splenic artery by abdominal ultrasound sonography performed as a routine annual medical check up. Simultaneously, she was found pregnant.

Treatment Options/Results: In consideration of fetal exposure, arterial embolization was performed at the 26th week of pregnancy, which is a stable period. Arterial embolization for splenic artery aneurysm (SAA) was performed, and distal and proximal arteries of the aneurysm were embolized with metallic coil under assist of a micro balloon catheter. The patient delivered 37 weeks without complications. The abdominal ultrasound sonography performed 6 months after the operation revealed a slight blood flow in the aneurysm. Angiography was performed, and the flow from transpancreatic artery to the aneurysm was identified responsible. Additional embolization was performed successfully.

Discussion: Pregnancy is a risk factor of SAA rupture. When ruptured, high maternal and fetal mortality rates are reported. For pregnant women with an SAA, minimally invasive surgical intervention including TAE is the recommended method of treatment. There are limited reports of SAA treated unruptured during pregnancy.

Take-home points: Pregnancy is a risk factor of splenic artery aneurysm rupture. For pregnant women with an SAA, minimally invasive surgical intervention including TAE is the recommended method of treatment.

P-266

Transarterial embolization for a patient with maxillomandibular direct arteriovenous shunts: a case report

M. Kamiya¹, H. Hiramatsu², S. Matsui², M. Kadowaki², Y. Kato³, S. Goshima⁴

¹Diagnostic and Interventional Radiology, Yaizu City Hospital, Yaizu, JP, ²Neurosurgery, Hamamatsu University School of Medicine, Hamamatsu, JP, ³Dentistry and Oral and Maxillofacial Surgery, Hamamatsu University School of Medicine, Hamamatsu, JP, ⁴Diagnostic Radiology and Nuclear Medicine, Hamamatsu University School of Medicine, Hamamatsu, JP

Clinical History/Pre-treatment Imaging: A 22 year-old woman was referred to our hospital for a month-long left-sided mandibular pain. Bruit and pulsation at the left mandible were noted. Her dentition and

neurological examination were normal. A panoramic X-ray showed a well-circumscribed radiolucency in the left mandible. A CT scan revealed dilated blood vessels at and around the left mandibular foramen. The left external carotid angiogram showed direct arteriovenous shunts with two feeding arteries, which were a branch of the first segment of the left inferior alveolar artery and a branch of the left submental artery, directly entering a venous segment draining to the left external jugular vein. No nidus-like component was noted.

Treatment Options/Results: Interventional radiology (IR) was the treatment modality. The shunted segment just to which the two feeding arteries entered was embolized tightly with coils. Angiographical total obliteration was achieved. After embolization, her left mandibular pain got slightly aggravated for 2 weeks. In two months, her symptom was resolved completely.

Discussion: Our patient had direct arteriovenous shunts with two discrete feeding arteries entering a single venous segment. So feeding artery occlusion would be the first treatment of choice. Occlusion of the venous segment was an alternative for our patient. For more complex shunts, embolization with liquid such as glue and ONYX, and combination of IR and direct surgery is necessary.

Take-home points: Maxillomandibular arteriovenous shunts vary in vascular complexity. Cure is achievable for simple ones with IR if analyzed and treated correctly. Right IR based on right understanding of vascular anatomy is crucial.

P-267

Postpartum life-threatening cerebral embolism due to pulmonary arteriovenous malformation

N. Hayashi¹, Y. Takeuchi², K. Ohwada³, B. Tokuda², O. Sato⁴

¹Radiology, Kyoto Prefectural University of Medicine, Kyoto, JP, ²Radiology, Fukuchiyama City Hospital, Kyoto, JP, ³Neurosurgery, Fukuchiyama City Hospital, Kyoto, JP, ⁴Radiology, North Medical Center, Kyoto Prefectural University of Medicine, Kyoto, JP

Clinical History/Pre-treatment Imaging: A 32-year-old woman with sudden E1V2M4 (GCS) neurological disorder was transferred to the ER two days postpartum. Brain imaging one hour after onset demonstrated an extra-axial aerogram in the left frontal lobe and a basilar artery thrombus. The basilar artery was recanalized by emergency catheter thrombectomy (Fig.1). Superficial sensory impairment on her left arm remained. Whole-body CT revealed multiple pulmonary arteriovenous malformations (PAVMs). She had no past history of hereditary hemorrhagic telangiectasia. Embolotherapy was scheduled to occlude the PAVMs suspected of causing the paradoxical cerebral artery embolism.

Treatment Options/Results: The transfemoral pulmonary angiogram demonstrated 4 PAVMs. Each had mono-feeding and mono-draining vessels. Detachable coils were deployed to occlude all of the lesions (Fig.2). No complications occurred and her cardiopulmonary function improved quickly. She left the hospital 82 days after admission.

Discussion: Postpartum complications can occur due to paradoxical cerebral embolism secondary to cardiac shunts caused by PAVM, in addition to posterior reversible encephalopathy syndrome, eclamptic attack, or brain hemorrhage. In this case, future events were prevented and the described embolic event was successfully treated with a series of interventional radiology.

Take-home points: Paradoxical cerebral embolism caused by PAVM leads to serious postpartum complications.

P-268

Pancreatic pseudoaneurysm treated by computed tomography guided percutaneous injection of glueE. Galli¹, Y. Baez Alvarado²¹Interventional Radiology, Sanatorio Prof. Itoiz, Avellaneda, AR,²Radiology, Sanatorio Prof. Itoiz, Avellaneda, AR

Clinical History/Pre-treatment Imaging: Pseudoaneurysm is a rare but potentially life-threatening vascular complication of acute or chronic pancreatitis, with untreated mortality approaching 90%. The treatment usually involves trans-arterial embolization or surgical resection.

We present a case of an inferior pancreaticoduodenal artery (PDA) pseudoaneurysm treated by direct percutaneous injection of glue in the pseudoaneurysmal sac guided by computed tomography (CT). A 47-year-old man with a history of acute pancreatitis and VIH infection, developed a severe gastrointestinal bleeding. Arteriography showed a 13 mm. pancreatic pseudoaneurysm and unsatisfactory endovascular embolization due to a dissection of the feeding artery, that nevertheless successfully stopped bleeding.

The hemorrhage recurred in a life threatening conditions two days later and another angiography showed complex difficulty in accessing PDA using both femoral and brachial approaches.

Treatment Options/Results: After failed transcatheter embolization, we performed a successful percutaneous CT guided injection of glue in the pseudoaneurysm of the pancreatic head, and immediately bleeding control. No complications or re-bleeding episodes were seen in a 10 months follow up.

Discussion: Computed tomography (CT)-guided percutaneous injection of glue is a relatively easy and safe procedure, and it can be considered as an alternative to trans-arterial embolization when the pseudoaneurysm cannot be visualized or catheterized on selective arteriography.

Take-home points: Pseudoaneurysm can be treated with direct puncture and injection of glue using CT.

P-269

Local isolation of PHA pseudoaneurysm after distal pancreatectomy with en bloc celiac axis resection with successful preservation of blood flow in upper abdominal organsH. Yukimokto¹, M. Nakamura¹, T. Sakisuka¹, S. Okubo¹, H. Sumikawa¹, A. Kuriu¹, K. Osuga², N. Tomiyama², H. Yakushiji³, K. Oyama⁴, H. Ogawa⁴, S. Nakahira⁴

¹Diagnostic Radiology, Sakai City Medical Center, Sakai, Osaka, JP, ²Diagnostic and Interventional Radiology, Osaka University Graduate School of Medicine, Suita, Osaka, JP, ³Emergency Surgery, Sakai City Medical Center, Sakai, Osaka, JP, ⁴Surgery, Sakai City Medical Center, Sakai, Osaka, JP

Clinical History/Pre-treatment Imaging: A 70-year-old male presented with active hemorrhage from the drainage tube after distal pancreatectomy with en-bloc celiac axis resection (DP-CAR) for locally advanced pancreatic body cancer. Prior to surgery, the common hepatic artery (CHA) and the left gastric artery were embolized with microcoils to redistribute the hepatic and gastric blood flow via the pancreatic arcade vessels. Contrast-enhanced CT images demonstrated a pseudoaneurysm along the proper hepatic artery (PHA).

Treatment Options/Results: Angiography confirmed the PHA pseudoaneurysm around the stump of distal CHA. Isolation of the pseudoaneurysm was attempted to preserve both the hepatic and gastric blood flow via the gastric anastomosis between the right gastroepiploic artery (RGEA) and the right gastric artery (RGA). Microcoils were deployed between the origins of RGA and RGEA under microballoon protection of RGEA. Post-embolization angiography confirmed exclusion of the pseudoaneurysm and established hepatopetal collateral flow via the gastric anastomosis. Bleeding was successfully controlled without sign of organ ischemia. CT

angiography after 3 months revealed the preserved blood flow in the upper abdominal organs.

Discussion: CHA stump pseudoaneurysm formation is a critical complication after DP-CAR. In the isolation technique, preservation of hepatic and gastric blood flow is essential. In our case, microcoil embolization under microballoon protection was helpful for accurate target vessel occlusion with critical anatomy.

Take-home points: Local isolation technique can be considered as a treatment option for PHA pseudoaneurysm after DP-CAR in a case with favorable vascular anatomy of the residual gastric arteries to avoid the upper abdominal organ ischemia.

P-270

Role of angiographic embolization in severe pancreas injury

S. Seo, S. Moon

Radiology, Wonkang University Hospital, Iksan, KR

Clinical History/Pre-treatment Imaging: A 43-year-old woman visited the emergency room after car accident. Initial BP was 75/58 mmHg. Computed tomography (CT) showed AAST grade 4 pancreatic injury with multiple active bleeding. In addition, AAST grade 3 liver injury was accompanied. As the operation room was not ready to immediate emergent operation, and we decided to perform endovascular treatment to prevent further bleeding.

Treatment Options/Results: Celiac angiography showed extravasation in the left hepatic artery, embolization was performed. Followed gastroduodenal artery angiography showed a cut-off sign with extravasation. The gastroduodenal artery embolization with coil was done. As there was a request of a surgeon, additional pre-operative splenic embolization was performed. After the endovascular intervention procedure, the BP was recovered to 96/67 and the total treatment time was about 45 minutes. After 30 minutes, the operation room was ready, subtotal pancreatectomy with splenectomy was performed. The surgeon reported that bleeding was scarcely visible and that good vision was obtained, and the operation was much easier to accomplish the successful outcome.

Discussion: Pancreatic injuries are relatively rare in trauma patients, but it is an important factor to predict prognosis of the trauma patients. In hemodynamically unstable patients, surgical treatment is the treatment of choice. It is known that angiographic embolization has a limited role in pancreatic injuries. This case shows the possibility of angiographic embolization as pre-operative hemostasis in severe traumatic pancreas injury patients.

Take-home points: If the interventional radiologist is always available for emergent cases, we expect that angiographic embolization can be an important measure for the preoperative procedure.

P-271

Congenital intrahepatic portosystemic shunt successfully treated with an Amplatzer duct occluderM. Echenagusia Boyra¹, F. Ballesteros², A. Alvarez Luque³, M. González Leyte⁴, E. Calleja Cartón⁵, C. Ballano Franco¹

¹Radiology, Hospital General Universitario Gregorio Marañón, Madrid, ES, ²Pediatrics, Hospital General Universitario Gregorio Marañón, Madrid, ES, ³Vascular Interventional Radiology, University Hospital, Madrid, ES, ⁴Interventional Radiology, Hospital General Universitario Gregorio Marañón, Madrid, ES, ⁵Vascular and Interventional Radiology, Hospital General Universitario Gregorio Marañón, Madrid, ES

Clinical History/Pre-treatment Imaging: Patient with Down's syndrome and a congenital intrahepatic portosystemic shunt discovered as an incidental finding on a postnatal US examination.

Two years later a new US examination and liver MRI revealed a mild enlargement of the portosystemic shunt, without laboratory abnormalities. Imaging showed that there was a small direct connection between

the portal vein and inferior vena cava (Park I type). Shunt length was of few millimetres.

Treatment Options/Results: Using a femoral vein approach the shunt was catheterized and an Amplatzer duct occluder II (ADO type II) was deployed. This device is usually used to close patent ductus arteriosus. In this case the distal disc of the plug was released into the portal vein and the proximal disc into the inferior vena cava. Follow-up with Doppler-US revealed complete occlusion of the portosystemic shunt.

Discussion: Intrahepatic congenital shunts are abnormal communications between portal branches and suprahepatic or cava veins. According to Park's classification there are four types of shunts.

Type 1 portosystemic spontaneous shunts are more commonly associated to liver cirrhosis and portal hypertension. The management of these shunts may be surgical or endovascular. In the present case shunt length is very short, so the use of regular embolization devices is not advisable due to the high risk of distal migration. We decided to deploy an Amplatzer Duct Occluder (type II) that allows an effective closure with low risk of distal migration.

Take-home points: To consider Amplatzer Duct Occluder as an effective embolic device in congenital intrahepatic portosystemic shunts, specially in those with short length.

P-272

Abdomen CT is not always enough for buttock pain: a case of persistent sciatic artery aneurysm managed with endovascular exclusion

M. Rosati¹, M. Macchini¹, F. Salvatori², D. Dabbene², E. Paci¹, M. Fichetti¹, P. Boscarato¹, R. Candelari¹

¹SOD Radiologia Interventistica, Az Osp-Univ OORR Torrette, Ancona, IT, ²Scuola di specializzazione in Radiodiagnostica - Università Politecnica delle Marche, Az Osp-Univ OORR Torrette, Ancona, IT

Clinical History/Pre-treatment Imaging: A 79 years old woman was admitted to our hospital for right flank/buttock pain. Abdominal CT scan revealed a right persistent sciatic artery (PSA) with aneurysm in the right buttock. Before starting any kind of treatment, a CT angiography of the lower extremities was performed to define anatomical features: it showed a complete PSA with a normal femoral artery (type 1 according to classification).

Treatment Options/Results: Exclusion of the aneurysm was necessary for the high risk of rupture. Thanks to the presence of a normal femoropopliteal axis, the exclusion of the PSA was possible without a femoropopliteal bypass being performed. Endovascular exclusion of right PSA aneurysm seemed the best choice for the patient relative to minimally invasive features of procedure. We performed an embolization of the aneurysm with a "sandwich technique" to avoid retrograde recanalization. Two vascular plugs (Amplatzer Vascular plug 12 and 14 mm) were released in the PFA, one proximal and one distal to the aneurysm.

Discussion: The main problem of surgical approach is the risk of iatrogenic injury to sciatic nerve. Endovascular approach has been demonstrated a good strategy without risk of nerve injury or other complications.

To plan the correct treatment, a CT is essential: thanks to CT information, it's possible to see the course of the PSA, the presence and the diameter of the aneurysm and the status of the superficial femoral artery.

Take-home points: Endovascular exclusion of PSA aneurysm is an effective and safe technique.

A complete angiography CT is essential to plan the appropriate treatment.

P-273

Transhepatic arterial embolization for inaccessible iatrogenic hepatic arterial pseudoaneurysm

R. Sato¹, T. Aramaki¹, K. Iwai¹, H. Hongyo², M. Moriguchi³, M. Endo⁴, K. Asakura⁴

¹Division of Interventional Radiology, Shizuoka Cancer Center, Shizuoka, JP, ²Diagnostic and Interventional Radiology, Osaka University Graduate School of Medicine, Suita, Osaka, JP, ³Diagnostic Radiology, Shizuoka Cancer Center Hospital, Shizuoka, JP, ⁴Division of Diagnostic Radiology, Shizuoka Cancer Center, Shizuoka, JP

Clinical History/Pre-treatment Imaging: Eighty-year-old male had biliary bleeding after percutaneous transbiliary drainage (PTCD). CT scan showed hepatic arterial pseudoaneurysm in the anterior segment along PTCD tube. The patient had pancreatoduodenectomy (PD) for cholangiocarcinoma 7 years ago and coil embolization of common hepatic artery for the postoperative bleeding. Right hepatic artery was supplied by tortuous collateral artery from superior mesenteric artery. The transarterial route was inaccessible.

Treatment Options/Results: We had three options. One was direct thrombin injection for pseudoaneurysm. The second one was transbiliary arterial embolization via PTCD route. Although we tried to do both of them, it was not successful. We tried the last option, transhepatic arterial approach. Transhepatic arterial puncture was attempted with 21G-Chiba needle under ultrasound guidance. Microcatheter was inserted over 0.016inch guidewire in anterior branch of hepatic artery. N-butyl-2-cyanoacrylate was injected in the anterior branch and tract of puncture after placement of some microcoils for protection of liver. One week later CT scan revealed that pseudoaneurysm disappeared with no complication.

Discussion: There were a few reports about transhepatic arterial approach for inaccessible hepatic artery. Some were done under ultrasound and some were done under fluoroscopy. Both methods need some technique and experience but are not impossible. In this case fine artery was slightly visible under ultrasound and the puncture was successful.

Take-home points: Because transhepatic arterial puncture is a little challenging but possible, it should be considered as one of the options for inaccessible hepatic artery approach.

P-274

Selective transarterial embolization of lumbar spine aneurysmal bone cyst with ethylene-vinyl alcohol copolymer (Onyx)

A.Y. Qattan¹, M.T. Alshammari², M.H. Aljuwayed¹

¹College of Medicine, Princess Nourah bint Abdulrahman University, Riyadh, SA, ²Radiology, Security Forces Hospital Program, Riyadh, SA

Clinical History/Pre-treatment Imaging: A 26 years old male complaining of lower back pain associated with left leg pain and numbness. Lumbosacral spine magnetic resonance imaging (MRI) demonstrated an expansile lobulated multi-septated lytic lesion in the left transverse process and posterior element of the L5 extending to the spinal canal.

Treatment Options/Results: Selective angiogram of the left iliolumbar artery was done using microcatheter co-axial system that showed tumor hypervascularity. The feeder branches were embolized with 250 µm Triacryl gelatin microspheres followed by ethylene-vinyl alcohol copolymer (Onyx). A 3-month selective angiogram shows no residual or recurrence of the tumor hypervascularity. He is currently symptom-free and presented satisfying result and not crossed to surgical option.

Discussion: Aneurysmal Bone Cyst (ABC) of lumbar spine can be a very challenging surgical due to the expected profuse intraoperative bleeding from the cyst. Although selective transarterial embolization is considered one of the best treatment options for ABC in mobile spine, Onyx is rarely have been used as an embolic agent. Selective trans arterial embolization of lumbar ABC with Onyx is a safe and effective method of treatment.

Take-home points: Selective trans arterial embolization of lumbar ABC with Onyx is a safe and effective method of treatment.

P-275

Spontaneous retroperitoneal hemorrhage caused by rupture of an ovarian artery aneurysm

M. Magnus¹, B. Regent², T. Gorycki²

¹Radiology, University Clinical Centre in Gdańsk, Gdańsk, PL, ²Radiology, Medical University of Gdansk, Gdansk, PL

Clinical History/Pre-treatment Imaging: Our patient was 47 years old woman with past medical history of arterial hypertension and chronic kidney disease treated with kidney transplant. She presented to our emergency department complaining of intermittent right lower quadrant abdominal pain, no history of abdominal trauma. On admission patient was conscious and hemodynamically stable. Contrast-enhanced computed tomography revealed a large retroperitoneal hematoma and active extravasation from right ovarian artery.

Treatment Options/Results: Treatment of a ruptured ovarian artery consists of surgery that includes ligation of the artery proximal and distal to the site of rupture. Alternative therapy for patients who are hemodynamically stable is transcatheter arterial embolization (TAE).

Our patient was transferred to interventional radiology lab for TAE. A selective right ovarian artery angiogram revealed a tortuous vessel with ruptured aneurysm. TAE using NBCA was performed with success.

Discussion: Rupture of an ovarian artery aneurysm is extremely rare cause of retroperitoneal hemorrhage. There are only several cases described in the literature, and their pathogenesis is poorly understood. Most cases occurred in the peripartum period.

The most common cause of retroperitoneal hemorrhage is abdominal trauma, including iatrogenic injuries from surgical interventions, ruptured aortic or renal artery aneurysm, retroperitoneal tumors and clotting disorders.

Diagnostic angiography combined with subsequent TAE during the same imaging session is thought to be a highly effective therapeutic procedure for this condition.

Take-home points: • Ovarian arteries are potential sources of retroperitoneal hemorrhage and should be routinely studied when imaging demonstrates the presence of retroperitoneal hematoma.

• Transcatheter arterial embolization is highly effective therapeutic method in retroperitoneal hemorrhage

P-276

Kissing coil embolization technique using double microcatheter for densely packing of the fistulous portion of the pulmonary arteriovenous malformation

M. Maruno, H. Kiyosue, S. Matsumoto

Department of Radiology, Oita University, Faculty of Medicine, Yufu, JP

Clinical History/Pre-treatment Imaging: Three females (mean age 54 years) with pulmonary arteriovenous malformations (PAVMs) were referred to our department for embolization. CT showed all PAVMs were simple type. The maximum diameter of the sac was 20mm or more and the fistulous portion was dilated as funnel shaped.

Treatment Options/Results: To prevent coil migration and to embolize fistulous portion densely, we devised a kissing embolization technique. A microcatheter was inserted at the fistulous portion antegradely. Then, another microcatheter was advanced beyond the fistulous portion and it was turned over in the sac to the fistulous portion. The tips of two microcatheters were faced at the fistulous portion. Under flow control by temporally balloon occlusion of the feeding artery, the first detachable coil was deployed at fistulous portion via the turn-backed microcatheter, and the second detachable coil was deployed with tangling the first one from another microcatheter to form anchoring coils at the fistulous portion. Then, microcoils were sequentially filled from the fistulous portion to the feeding artery via the two microcatheters. All PAVMs were completely occluded without any complications. During 15-51 months follow-up period, no recanalization was observed.

Discussion: Dense embolization of the fistulous portion is essential for preventing recanalization. However, dense packing of coils at the fistulous portion was often difficult in some cases with the funnel shaped fistula. Kissing embolization technique enables to prevent coil migration and embolize fistulous portion densely.

Take-home points: Kissing embolization technique for PAVMs with large sac is one of the effective techniques for dense packing of coils at the fistulous portion.

P-277

Secondary arteriovenous malformation from internal mammary artery after embolization of pulmonary arteriovenous malformation adjacent to mediastinum

M. Inoue, S. Nakatsuka, N. Ito, H. Torikai, M. Hase, M. Jinzaki

Diagnostic Radiology, Keio University School of Medicine, Tokyo, JP

Clinical History/Pre-treatment Imaging: We report the case of a 75-year-old female who presented with an abnormal shadow on chest X-ray without symptom. Enhanced CT images showed tortuous and tangled pulmonary vessels with atelectasis located adjacent to mediastinum. She was diagnosed as pulmonary arteriovenous malformation (pAVM).

Treatment Options/Results: The pAVM was complex type and embolization was performed and venous sac as well as feeding arteries were embolized using detachable coils. Time-resolved contrast enhanced CT scan 2 years after embolization suspected recanalization and revealed multiple dilated branches of internal mammary artery (IMA) were connected to venous sac. Therefore, development of systemic artery-pulmonary vessels fistula due to angiogenesis was suspected. Pulmonary arteriography and selective IMA angiography were performed. The latter showed multiple fine and tortuous arteries from IMA were shunted to venous sac, which is compatible with type II artery venous malformation.

Discussion: The feeding artery of most pAVMs arises from the pulmonary arteries; however, rarely systemic arteries, such as the intercostal, phrenic, bronchial and internal mammary arteries, can provide feeders. In the present case, the branches of IMA became thickened after embolization of pAVM. According to previous papers, potential communication between systemic arteries and pulmonary arteries may exist. Therefore, in the present case, angiogenesis induced by embolization may develop arteriovenous malformation between IMA and pAVM. CT before treatment showed atelectasis around pAVM, which may mean chronic inflammation. Such chronic inflammation might cause hypertrophy of systemic arteries shunting to pAVM.

Take-home points: Systemic arteries rarely become feeding arteries of pAVM due to angiogenesis and cause recurrence of pAVM after embolization.

P-278

Staged endovascular treatment for giant splenic artery aneurysm and massive splenomegaly: a case report

Y. Koyashiki¹, H. Nakamura¹, A. Ugajin¹, N. Kunitomo¹, Y. Kawahara², T. Sasaki¹, S. Kijima¹, H. Sugimoto¹

¹Department of Radiology, Jichi Medical University Hospital, Shimotuke-shi, Tochigi, JP, ²Department of Radiology, Yokohama Rosai Hospital, Yokohama City, Kanagawa, JP

Clinical History/Pre-treatment Imaging: A 63-year-old woman presented with giant splenic aneurysms. She had primary portal hypertension and massive splenomegaly. Her splenic aneurysms that band of two aneurysm had been enlarge over time. The diameter of these aneurysms was 64mm and 57mm, respectively.

Treatment Options/Results: We decided to perform staged endovascular treatment, including partial splenic embolization (PSE).

Firstly, we performed PSE. About a month later, we performed second PSE additionally, and we treated this aneurysms with coils by isolation technique, packing aneurysms with n-butyl-2 cyanoacrylate (NBCA)

under flow control. Subsequent angiography showed that blood flow of this aneurysms was stopped completely and lower pole of splenic blood flow was preserved. No significant complications were observed

Discussion: The treatment of giant splenic artery has been difficult problem especially for complicated massive splenomegaly. Although there are different methods of treatment, including conventional surgical treatment, a staged endovascular treatment was a safe and efficacious for giant splenic artery aneurysms and massive splenomegaly.

Take-home points: Staged endovascular treatment of giant artery aneurysm and massive splenomegaly may be a treatment option.

P-279

Treatment of a rare gastroepiploic artery pseudoaneurysm

F. Arfeen, A. Hussain, M.R. Akhtar, J. Kyaw Tun, A. Antonietti
Interventional Radiology, Barts Health NHS Trust, London, UK

Clinical History/Pre-treatment Imaging: We present a case of a 76 year old gentleman who arrested on the intensive care unit post laparoscopic cholecystectomy and during a difficult recovery period, became haemodynamically unstable with abdominal pain 14 days later. The follow up contrast enhanced computed tomography (CT) study demonstrated an arterially avid 12mm pseudoaneurysm arising from a small branch of the left gastroepiploic artery, demonstrating features of recent bleeding.

Treatment Options/Results: Given the remote location of the pseudoaneurysm, endovascular approach would prove difficult and a decision was made to attempt thrombin injection percutaneously. The ultrasound study demonstrated Doppler flow within the pseudoaneurysm and just 0.2 millilitres of Floseal injection (100IU human thrombin) through a 21G Chiba needle achieved haemostasis. The patient recovered and was subsequently discharged. Follow up CT study carried out one month later demonstrated adequate resolution of the pseudoaneurysm with no evidence of recurrence.

Discussion: Clinically significant pseudoaneurysm formation post laparoscopic cholecystectomy is a rare complication and even more so involving a branch of the left gastroepiploic artery. Direct percutaneous embolisation under ultrasound guidance is a feasible treatment option in difficult endovascular access cases. It is minimally invasive, can be carried out at the bedside with local anaesthesia, eliminates radiation usage and potentially allows resource allocation for other cases in the department.

Take-home points: In our case, we have successfully percutaneously embolised a rare post operative pseudoaneurysm of the left gastroepiploic artery with no post procedure complications. It gives the reader an opportunity to add to their respective practices and techniques in difficult scenarios.

P-280

Transcatheter embolization to an iatrogenic arteriovenous fistula in a patient with type IV Ehlers-Danlos syndrome

K. Shibuya¹, M. Miyazaki¹, N. Koitabashi², Y. Tsushima¹

¹Diagnostic and Interventional Radiology, Gunma University Hospital, Maebashi, JP, ²Cardiovascular Medicine, Gunma University Hospital, Maebashi, JP

Clinical History/Pre-treatment Imaging: A 39-year-old female was admitted with sudden right back pain. Abdominal CT revealed a ruptured right renal aneurysm and multiple vascular lesions. Her mother died of aortic rupture shortly after childbirth. Vessel vulnerability was suspected, and we carefully performed coil embolization to the renal artery aneurysm. The embolization was successfully performed, however, arterial puncture was suspected when attempting to insert the central venous catheter from the right internal jugular vein during general anesthesia. CT demonstrated pseudoaneurysm with mediastinal hematoma. The size of aneurysm was increasing during follow-up, and an arteriovenous shunt from subclavian artery to right vertebral vein was confirmed by ultrasound and 4-dimension CT.

Treatment Options/Results: Type IV Ehlers-Danlos syndrome (vEDS) was confirmed by gene analysis using next-generation sequencing. Angiography was performed via the right brachial artery punctured by using 21G needle. Intravascular ultrasound showed an arteriovenous fistula with aneurysmal dilatation. Embolization using detachable microcoils underwent from the median cubital vein under flow control by using a balloon in subclavian artery. Thereafter, additional coil embolization was performed from the arterial side. The shunt flow markedly decreased after the procedure.

Discussion: Patients with vEDS have vascular fragility due to impairments of type III collagen. Arterial puncture is known to be highly risky in this patient group. In this case, careful planning and preparation enabled completion of embolization without severe complications. The rapid genetic diagnosis of vEDS was useful for the treatment planning.

Take-home points: Vascular complications related vEDS require a multi-disciplinary diagnostic and therapeutic approach to select the appropriate treatment strategy.

P-281

Embolization as a therapeutic option for the treatment of a giant infantile hepatic haemangioma

C.S.S. Menezes, H.S. Martin, B. Campos, T. Carvalho, D. Barbosa, H. Gouveia

Radiologia Intervencionista, Instituto Nacional do Cancer, Rio De Janeiro, BR

Clinical History/Pre-treatment Imaging: Female newborn with 9 days old, with giant hemangioma in the right hepatic lobe, diagnosed in prenatal ultrasonography.

Treatment Options/Results: In the catheterization of the celiac trunk, common hepatic and phrenic arteries were hypertrophied and nourishing the hypervascular lesion in right hepatic lobe, associated to arteriovenous fistulas with drainage for the suprahepatic veins and lungs. Embolization of the lesion was performed with lipiodol (ratio 1: 3) and coils. Angiographic control demonstrated embolization of most of the lesion with reduction of intrahepatic fistulas, remaining a small area of residual lesion confirmed on ultrasonography. There were also small pulmonary emboli. In conjunction with the procedure, the puncture limb was hypocromic and the USG, which showed vasospasm, was performed. After 3 days, the lower limb Doppler was performed, which showed partial thrombosis of the superficial femoral artery, conducted with anticoagulation. In clinical follow-up, improvement of hemodynamic parameters was shown, without pharmacologic treatment.

Discussion: Infantile hepatic hemangioma (IHH) is the most common benign tumor of childhood, affecting up to 10% of the pediatric population, especially females (3: 1), preterm and caucasian newborns. IHH can be diagnosed in prenatal tests or become apparent after birth, with involution until the age of 10 years. In patients with heart failure due to the high cardiac output caused by the lesion shunt, the first clinical treatment is propranolol. In case of failure or contraindication to clinical treatment, the control of hemodynamic symptoms is performed with embolization of the lesion.

Take-home points: Consider embolization as a therapeutic option for symptomatic Giant Infantile Hepatic Hemangioma.

P-282

Necrosis and detachment of the bladder urothelium after prostatic artery embolization (PAE): a report of two cases

A.F. Kanas¹, A.M. de Assis¹, A.M. Moreira¹, P.C.C. Viana², J.R. Kauffmann², A.J. Nesrallah², M.G. de Castro², F.C. Carnevale¹

¹Institute of Radiology - Interventional Radiology, University of São Paulo, São Paulo, BR, ²Interventional Radiology, Hospital Sírio Libanês, São Paulo, BR

Clinical History/Pre-treatment Imaging: Two patients presented Lower Urinary Tract Symptoms related to Benign Prostatic Hyperplasia refractory to optimized medical treatment for more than 12 months. They had prostate estimated sizes of 128 cm³ and 110 cm³, with no other relevant alterations on magnetic resonance imaging (MRI) or ultrasound.

Treatment Options/Results: Patients were submitted to bilateral Prostate Artery Embolisation (PAE), which were performed according to the PERFeCTED (Proximal Embolization First, Then, Embolize Distal) technique. One patient presented partial improvement of symptoms after the procedure. 3-month follow-up MRI showed a focal parietal thickening of the bladder. Because of the impossibility to exclude malignant causes, the patient underwent cystoscopy with transurethral resection of the lesion. Intraoperative aspect and anatomopathological analysis corresponded to an ischemic necrosis of bladder wall.

The other patient became asymptomatic and, during his first month follow up MRI, it was seen an area of discontinuity of the vesical wall with a saccular alteration. A cystoscopy was performed and showed two necrotic lesions on the vesical floor, probably secondary to ischemic insult.

Discussion: Absolute number of PAE complications is augmenting, as this technique is becoming more common. Therefore, rare and even some unknown complications are emerging and it is necessary that interventional radiologists understand and are capable to diagnose and manage them properly. Patients with focal periprostatic urothelium detachment after PAE may be safely managed by watchful waiting or symptomatic treatment.

Take-home points: Focal necrosis of the bladder urothelium after PAE is a possible complication of this procedure. Interventional radiologists should be capable to diagnose and manage it properly.

P-283

Post traumatic mediastinal bleed from pseudoaneurysm of a colic artery in patient post-colon interposition managed by percutaneous direct puncture coil embolization

A. Shrivastava¹, L.-M.N.J. Boucher²

¹Radiology, McGill University, Montreal, QC, CA, ²Radiology, McGill University Health Centre, Montreal, QC, CA

Clinical History/Pre-treatment Imaging: 61-year patient post poly-trauma admitted in our hospital with anterior mediastinal haematoma and pseudoaneurysm seen on CT. Patient known for previous esophagectomy and colonic interposition.

Treatment Options/Results: Angiogram from the left gastric artery and gastroduodenal artery showed no evidence of pseudoaneurysm. Splenic artery angiogram demonstrated collaterals to a large left colic artery which had been pulled up into the thorax secondary to the colonic interposition. A pseudoaneurysm was confirmed arising from a tiny branch of the transposed left colic artery. Due to the small size, we were unable to access the feeder with enough support to deploy embolization material safely into the pseudoaneurysm via intraarterial route without risking blocking the parent left colic artery supplying the interposed colon. Instead we opted for a direct stick approach under fluoroscopic guidance. The microcatheter was used to opacify the pseudoaneurysm with contrast. A 21g needle was advanced into the pseudoaneurysm percutaneously under fluoroscopic guidance and once position was confirmed by injection of contrast, embolization was performed with coils through the needle.

Follow up angiogram shows no flow in pseudoaneurysm and mild spasm in parent artery which resolved with nitroglycerine.

Discussion: The use of this direct stick approach was necessary to prevent damage to the parent colic artery, critical to avoid ischemia of the interposed colonic loop. Keeping in mind such atypical techniques increases the armamentarium of interventional radiologists.

Take-home points: Direct puncture and percutaneous embolization of pseudoaneurysm by coils can be safely performed in situations where the accessibility and anatomy of vessel is not favourable for transcatheter embolization.

P-284

Successful embolization with percutaneous transsplenic access for bleeding from ectopic varices after pancreaticoduodenectomy: report of a case

A. Dallongeville, S. Silvera, A. Petit, L. Novelli

Radiology, Hospital Saint-Joseph, Paris, FR

Clinical History/Pre-treatment Imaging: We report a case of successful embolization of pancreato-jejunal anastomosis varices after pancreaticoduodenectomy, resulting from peroperative ligation of the splenic vein. A 60-year-old man who had undergone one year ago a pancreaticoduodenectomy for cephalic adenocarcinoma was admitted for acute gastrointestinal hemorrhage. At that time, gastrointestinal endoscopic examination showed signs of fresh blood in the afferent limb and the pancreatojejunal anastomosis which was treated with clip and adrenal solution.

After one week, he was readmitted for bleeding recurrence. CT could not identify the source of bleeding but showed tremendous varices next to the pancreatojejunal anastomosis, those identified by endoscopy; angiography did not reveal active arterial bleeding.

Treatment Options/Results: Percutaneous transsplenic angiography was performed due to a ligation of the splenic vein, which prevented a trans-hepatic approach. Varices were embolized with coils and with the use of N-Butyl Cyanoacrylate-Lipiodol-Ethanol Mixture. Final angiography was satisfactory. There was no bleeding recurrence and CT one month later confirmed successful embolization and did not reveal new varices.

Discussion: The transsplenic approach can be useful for the management of ectopic variceal bleeding with unsuccessful endoscopic treatment in patients without transhepatic window.

Take-home points: Percutaneous transsplenic access can be used for venous procedures in patients without transhepatic window.

P-285

Technical challenge in prostatic artery embolization: a case report of rare anatomic variation of prostatic artery

N. Perez¹, N. Kisilevsky¹, P. Lylyk²

¹Interventional Radiology, ENERI - Clinica La Sagrada Familia, Caba, AR, ²Interventional Radiology, ENERI, Buenos Aires, AR

Clinical History/Pre-treatment Imaging: A 71 years old patient with history of benign prostatic hyperplasia (BPH), refractory to drug therapy. Contrast-enhanced MRI examination of the prostate gland showed BPH of 90 cc. We decided to perform a prostate arterial embolization (PAE).

Treatment Options/Results: During procedure, the left internal iliac arteriogram showed no branches to prostate area, confirmed with Cone Beam CT angiography. Left external iliac arteriogram showed the epigastric artery (EA) giving rise to the accessory obturator artery (AOA) and the prostatic artery (PA). The right PA arises along with vesical arteries from the right internal iliac artery. Both PA were selectively catheterized and embolized with 300-500 microns microspheres obtaining complete stasis.

Discussion: AE has been increasing exponentially in the past years. It has shown to be a safe and effective treatment in patients that are refractory/intolerant to drug therapy or have contraindications of surgical treatment. One of the major challenges, is the identification of and navigation through

pelvic and prostatic vascular anatomy. Several authors have described the anatomical patterns of the prostatic arterial vasculature, from the origin of the PA down to the peri/intraglandular segments. Our objective is to present a rare anatomic variation of the prostatic artery arising from the EA along with AOA, found in less than 0.35 % of the patients.

Take-home points: We believe that understanding the normal prostate vascularization and its anatomic variations is critical in order to achieve best clinical outcomes, minimize complications, reduce procedure time and radiation exposure.

P-286

Transradial embolisation of an adrenal myelolipoma with spontaneous hemorrhage

V.A. San Martín Luque, F. Carretero Lopez, M. Morales García, J. Cuesta Perez, J.M. Vicente Martín

Radiology, Hospital Universitario de Getafe, Getafe, ES

Clinical History/Pre-treatment Imaging: We presented a case of a 50 year-old man with anticoagulation therapy, who presented with intense epigastric pain irradiated to the chest and back. Acute aortic syndrome (AAS) was suspected therefore an aortic Angio-CT was performed, discarding it. Instead, it showed a retroperitoneal hemorrhage secondary to active bleeding of a 9cm left adrenal heterogeneous mass with fat-density areas, compatible with adrenal myelolipoma.

Treatment Options/Results: Right transradial angiography revealed an active bleeding from the inferior left adrenal artery. A 4Fr Cobra catheter and a 2.7Fr Progreat microcatheter with coaxial technique were used for superselective catheterization of the bleeding artery. Embolization was performed from distal to proximal using Glubran®-Lipiodol® (2:1), showing absence of hemorrhage in the post-embolization series.

Discussion: Adrenal myelolipoma is a benign tumor with fat and bone marrow tissue, usually asymptomatic. Spontaneous retroperitoneal hemorrhage is a rare life threatening complication presented in larger tumors (>7cm).

Preoperative embolization of ruptured myelolipoma can be useful in stabilizing patients prior to definitive operation, reducing the surgical risk of rebleeding.

Despite not being the most used, transradial access is a good alternative for urgent embolization, has shown lower morbidity and decreased bleeding complications compared to transfemoral access.

Take-home points: Despite being rare, large adrenal myelolipoma are in risk of spontaneous hemorrhage. Patients with adrenal myelolipoma with active spontaneous hemorrhage, benefit from embolisation prior to surgery. When possible, transradial access is a good alternative for urgent arterial embolization.

P-287

Arteriportal fistula with pseudoaneurysm in a liver transplant

M.L. Collado Torres¹, M. Alfageme Zubillaga², S. Méndez Alonso², A. García Suarez², R. González Costero²

¹Radiodiagnóstico, Hospital Universitario Puerta de Hierro, Majadahonda, Madrid, ES, ²Radiology, Hospital Universitario Puerta de Hierro, Majadahonda, ES

Clinical History/Pre-treatment Imaging: A 58-year-old male presents an increase in immunosuppression and bilirubin levels (10 mg/dL, previous: 4 mg/dL). As antecedes:

- Liver transplant in 2014 for cirrhosis due to HCV (1b) and hepatocellular carcinoma (3cm).

- Stenosis of the extrahepatic bile duct that has required biliary prosthesis (last september 2018).

Before the analytical worsening enters and a liver biopsy is performed (without new findings).

It evolves inadequately and interconsultation with vascular-interventional radiology. Abdominal ultrasound was performed, showing: dilation of

intrahepatic bile duct and incidentally right arterio-portal fistula with pseudoaneurysm. Subsequently, the biliary prosthesis (mud content) is unclogged and ultrasound is repeated to the days evidencing mild new-onset ascites.

Treatment Options/Results: It is completed with angio-CT that confirms the fistula (as responsible for ascites exercising portal hypertension). Therefore, diagnostic-therapeutic arteriography is performed with embolization (two coils and filling with Purefill®) of arterio-portal fistula dependent on a right-subsegmental branch with pseudoaneurysm, without incidences. In the control ultrasound a month there is complete resolution.

Discussion: The arteriportal fistula is a rare entity with an increasing incidence due to the increase in interventional liver procedures. They are mostly asymptomatic and incidentally diagnosed, with angio-CT being the non-invasive technique of choice. The two most frequent etiologies are hepatic trauma and iatrogenesis (like this case, probably after liver-biopsy). The therapeutic option will depend on the type and clinic, being the radiological arterial embolization the main treatment to be effective and low morbidity.

Take-home points: Transcatheter arterial embolization is a safe therapeutic option in arteriportal shunts and could be a definitive therapy.

P-288

Emergency embolization of complex arteriovenous malformation unstoppable hemorrhage

E.F. Bravo Rius¹, C.P. Moya Ochoa¹, G.J. Ortiz Calvo²,

B. Leon Rocha¹, N. Martinez Roje¹, T. Cermenati Bahrs¹, P. Palavecino¹

¹Interventional Radiology, Hospital Clínico Universidad de Chile, Santiago, CL, ²Radiología, Hospital Clínico Universidad de Chile, Santiago, CL

Clinical History/Pre-treatment Imaging: A 36 years-old woman, with history of complex gluteal arteriovenous malformation (AVM) with lower back and spinal channel extension, who received an embolization in 2014, and evolved with chronic skin ulcer at the site. In 2018, the patient returns due to uncontrollable bleeding of ulcerated area and hypovolemic shock. An emergency selective embolization was performed to stop bleeding.

Treatment Options/Results: Aortography showed numerous feeding arteries branches of bilateral lumbar arteries, left hypogastric, left deep iliac circumflex and epigastric arteries. Embolization was made using histoacryl/lipiodol 1:5 for distal and Squid 18 for proximal embolization. Hemodynamic instability management required volume, blood products and direct compression of the bleeding site. Embolization finished once the bleeding stopped.

The patient evolved with moderate-severe pain and increase skin necrosis, without neurological symptoms. One month later, due to new moderate bleeding episodes, second embolization was made. During the procedure, selective angiography showed communication of the nidus with anterior medullary artery, so it was decided to stop the embolization. She evolves with reversible acute urine retention, with persistent left lower limb paresthesias and M3 paresia.

Discussion: Life-threatening complex AVM hemorrhage are hard to treat, and the best management depends of the clinical setting of the patient and local resources. Embolization is effective to treat AVM even in emergencies scenarios.

Take-home points: The dynamic representation in arteriography of the collateral arteries must be taken into consideration. The interventional radiologist must balance risks, benefits and potential sequels of this treatment.

EVAR and TEVAR

P-289

Stent graft-induced new entry (SINE) after TEVAR for aortic dissection: correlation between the interval from the onset of aortic dissection to TEVAR and that from TEVAR to the development of SINE

T. Ouchi, N. Kato, K. Nakajima, T. Higashigawa, T. Hashimoto, S. Chino
Radiology, Mie University Hospital, Tsu, JP

Purpose: To investigate stent graft-induced new entry (SINE) in terms of its cause and the timing of the onset.

Material and methods: This study enrolled 61 patients who underwent TEVAR for the treatment of aortic dissection (AD) since January 2006 through December 2016 and completed surveillance for at least 6 months in our facilities. Of these 61 patients, 45 (73.8 %) were male and the median age was 66 years (interquartile range [IQR]: 60–76). The median follow-up period was 73 months (IQR: 37–97).

Results: Sixteen (26.2 %) of 61 patients developed SINE. There were four proximal SINEs and thirteen distal SINEs. Univariate analysis demonstrated that the oversizing ratio of stent grafts to the true lumen at the distal end and the timing of treatment were the predictive factors of development of SINE ($p=0.006$ and $p=0.048$, respectively). The median interval between the onset of AD and TEVAR was 3.0 months (IQR: 0.3–29.4), whereas that between TEVAR and the development of SINE was 33.0 months (IQR: 14.7–59.5). The interval between the onset of AD and TEVAR (X) had a strong positive correlation with that between TEVAR and the development of SINE (Y) ($Y = 19.225 + 0.695 X$, $P = 0.009$, $R^2 = 0.549$).

Conclusion: SINE is not a rare complication following TEVAR for the treatment of AD. To avoid it, sophisticated preoperative planning should be required. Close follow-up as long as possible would be preferable for patients who underwent TEVAR in chronic phase.

P-290

Long-term outcomes and late events of endovascular abdominal aortic repair

Y. Ogawa¹, H. Nishimaki², K. Chiba², A. Kotoku¹, T. Irahara³, T. Maruhashi², Y. Sakurai², H. Mimura¹, T. Miyairi²

¹Radiology, St. Marianna University School of Medicine, Kawasaki, Kanagawa, JP, ²Cardiovascular Surgery, St. Marianna University School of Medicine, Kawasaki, Kanagawa, JP, ³Radiology, Okinawa Prefectural Chubu Hospital, Urumashi, JP

Purpose: To assess clinical outcomes of endovascular aortic repair (EVAR) for infrarenal aortic aneurysm (AAA) and/or common iliac artery aneurysms (CIAA) over a 6-year period.

Material and methods: This study is a retrospective analysis of 155 patients (Mean age: 76.6 years, male 80%) who underwent elective EVAR using the bifurcated endograft at our institution between April 2011 and December 2016. There were AAA (113), CIAA (11) and AAA with CIAA (31). Fifty-seven patients (36.8%) showed outside of the instructions for use. The primary endpoints were 30-day and all-cause mortality and secondary endpoints included complications and need for re-interventions.

Results: Mean follow up was 33.8 months. No 30-day or in-hospital death were seen. Endoleaks (ELs) after 30 days were seen in 54 patients (34.6%) including type 1a (6), type 1b (3), type 2 (40), type 3 (3). Re-intervention was needed in 24 patients (15.5%). One patient who had type 2 EL treatment failed needed emergency open surgery due to rupture of the AAA. Of 6 late type 1a EL, 4 had the Endurant device for severely angulated proximal neck (mean 95 degree). Estimated survival at 1, 3, and 6 years were 95.9%, 88.1%, and 82.7%, respectively. Twenty-four patients died during follow up, most commonly due to malignant tumor (54.2 %). No aneurysm-related death was seen.

Conclusion: The long-term outcomes of EVAR demonstrates safe and durable treatment despite more complex lesions. The Endurant device may cause late type 1a EL. Using each bifurcated endograft for different anatomical morphology is an important in order to achieve favorable results.

P-291

Extended petticoat strategy in difussed (DeBakey III) aortic dissection type B. New strategy to stop aneurysmatic degeneration

A. Kazimierzczak¹, P. Rynio¹, T. Jedrzejczak², R. Samad¹, P. Gutowski¹

¹Vascular Surgery, Pomeranian Medical University, Szczecin, PL, ²Cardiac Surgery, Pomeranian Medical University, Szczecin, PL

Purpose: Diffused type B Aortic Dissection (AD) (DeBakey III) will faced aneurysmatic degeneration (30-60%) in long follow-up no matter their been initially treated with TEVAR. However, primary FEVAR/BEVAR technics might be recognized as an over-treatment. Therefore, alternative strategy is needed in most cases with presence of risk factors.

Material and methods: 50 patients with type B Aortic Dissection and with distal re-entry in iliac arteries were qualified for NEW strategy called expanded Petticoat (E-PETTICOAT). It is a classic Stent-graft in thoracic aorta plus additional distal bare stent into the abdominal and infra-renal aorta followed by forced ballooning and parallel stent-grafts into common iliac arteries.

Results: Primary technical success was 100%. The 30 days mortality rate was 0% in acute and 5% in chronic group. Visceral branches were restored in 88%. At 12 months favourable aortic remodelling and complete false lumen thrombosis were observed in 100% in the thoracic and infra-renal aorta. Volume of contrasted false lumen decrease from 186ml all along the dissection preoperatively (70-360ml±SD 75.4ml) to 6.32ml post op (range 0-19.6ml±SD 5.4ml) and was observed only in visceral aorta ($p=0.000089$). Maximal aortic size was stable in follow up. Neither paraplegia, nor visceral branches occlusion were noted in follow-up.

Conclusion: Treatment of aortic dissections with an expanded Petticoat strategy seems to be safe and provides good early results. It could be the alternative to FEVAR/BEVAR procedures in some cases. It significantly reduced volume of perfused false lumen. Further investigation of subsequent results will be necessary.

P-292

Dynamics of TEVAR stent volume changes in different thoracic aortic pathologies

M.A. Abdelmaksoud

Vascular and Endovascular Surgery, Mansoura University, Mansoura, EG

Purpose: To investigate the changes in thoracic aortic stent volumes following their implantation to treat different aortic pathologies.

Material and methods: 53 patients treated with TEVAR between 2002 and 2010 for different thoracic aortic pathologies were included in this retrospective study, mean age of patients was (58.8y +/- 14); including 13 females and 40 males. A first CTA after 3 months post TEVAR implantation then at 12 months then yearly thereafter. 170 post TEVAR CTAs were analyzed, 3D-reconstruction and volume analysis was carried out for the implanted TEVAR stents in consecutive follow ups. Duration of follow up ranged from 3 to 24 months with a mean of 13 months post-intervention for most patients.

Results: Our sample was categorized in 3 groups; patients who underwent TEVAR for thoracic aortic aneurysms; (group A, n= 19), those who underwent TEVAR intervention for type B aortic dissections (group B, n=25) and those who underwent TEVAR for other aortic pathologies including (traumatic aortic rupture, aortic stenosis and floating aortic thrombus (group C, n=9). Stent volume analysis was able to show a significant change towards an increase in group A and B TEVAR patients (P value < 0.0001) and with lesser statistical significance (P value= 0.007) for group C patients.

Conclusion: Stent volume increase in the investigated sample represents a reflection of adaptive in-vivo changes to accommodate the stent to the systemic circulation in a population of patients that suffer a diseased thoracic aortic tissue and hypertensive aortic pathology.

P-293

Ultrasound with superb microvascular imaging (mSMI) and contrast-enhanced ultrasound (CEUS) in the study of endoleaks in patients undergoing EVAR: comparison with computed tomography angiography

A. Meli¹, N. Casamassima¹, F. Piacentino², F. Fontana³, E. Macchi³, C. Fugazzola³

¹Institute of Radiology, ASST Sette Laghi - Ospedale di Circolo, Varese, IT, ²Radiology, University of Insubria, Varese, IT, ³Radiologia, Ospedale di Circolo e Fondazione Macchi, Varese, IT

Purpose: The aim of the study was to evaluate the diagnostic effectiveness of superb microvascular imaging (mSMI) compared to contrast enhanced ultrasound (CEUS) and computed tomography multislice angiography in the identification and classification of endoleaks after endovascular aneurysm repair (EVAR).

Material and methods: From September 2017 to June 2018, 38 Patients treated with EVAR performed a FU using mSMI and CEUS. All patients had previously performed a control with CT-angiography. The population included 36 males (mean age = 77.1 years) and 2 females (mean age = 78.5 years). Evaluation included sac diameter, stent-graft integrity, identification and classification of endoleaks. Sensitivity, specificity and accuracy values were evaluated for each modality of endoleak identification.

Results: CT-angiography detected 31 endoleaks; mSMI and CEUS have detected the presence of 29 endoleaks.

All identified endoleaks were type II: 22 originating from a lumbar artery and 9 from the mesenteric artery lower typed with angio-CT; 21 originating from a lumbar artery and 8 from the inferior mesenteric artery typed with mSMI and CEUS. No differences were in the typing of endoleaks between mSMI, CEUS and angio-CT.

Sensitivity, specificity and accuracy of mSMI and CEUS against CT-angiography was 91%, 100% and 94% respectively. There were no differences between mSMI and CEUS.

Conclusion: mSMI is available for the research of endoleaks after EVAR significantly reducing the number of CT-angiography and CEUS. Our next objective is to use only mSMI post-EVAR evaluation of the endoleaks reserving the CT-angiography only for patients who have a significant dimensional increase of the aneurysm sac (> 5mm), detected by mSMI.

P-294

Relationship of intra-aneurysm pressure changes and presence of type II endoleak after endovascular aortic repair (EVAR) between two vendor devices

S. Higuchi¹, Y. Hori¹, Y. Watanabe¹, T. Nisii¹, E. Tateishi¹, Y. Ohta¹, A. Kono¹, K. Kiso¹, Y. Inoue², A. Omura², Y. Seike², K. Uehara², H. Matsuda², T. Fukuda¹

¹Radiology, National Cerebral and Cardiovascular Center, Suita Osaka, JP, ²Vascular Surgery, National Cerebral and Cardiovascular Center, Suita Osaka, JP

Purpose: To compare intra-aneurysm pressure (IAP) changes and presence of type II endoleak after endovascular aortic repair (EVAR) between two vendor devices.

Material and methods: Fifty-nine patients (mean age, 80±8ys, female, 12) who underwent EVAR using Endurant or Excluder were enrolled. Eighteen patients were excluded due to n-butyl-2-cyanoacrylate injection into sac to prevent endoleak. IAP and systemic blood pressure (SBP) were measured using catheters left in sac and arterial line into the radial artery, respectively. IAP changes were calculated from SBP subtracted IAP. The presence of type II endoleak was evaluated using digital subtraction

angiography. For statistical analysis, paired t-test was used to evaluate the difference between SBP and IAP. T-test or Mann-Whitney U test was used to compare IAP changes between the two groups. Fisher's test was used to compare the frequency of type II endoleak between the groups. p<0.05 indicated statistical significance.

Results: Device A group demonstrated significant lower systolic and higher diastolic IAP than SBP (SBP vs. IAP=104±11vs. 86±20mmHg, p<0.01[systolic], 48[45-52] vs. 50[46-59]mmHg, p=0.02[diastolic]). Device B group demonstrated significant lower systolic, higher diastolic and lower mean IAP (100±16 vs. 72±11mmHg, p<0.01[systolic], 53[45-58]vs.56[49-62] mmHg, p=0.02[diastolic], 69±9 vs. 63±9mmHg, p<0.01[mean]). Systolic and mean IAP changes demonstrated significant larger in device B group than A group (A vs. B=14[4-28] vs.23[18-39]mmHg, p=0.03[systolic], 2±6 vs. 7±7mmHg, p=0.02[mean]). Type II endoleak was seen more frequently in device B group (A vs. B=17%[4/23] vs. 56%[10/18], p=0.02).

Conclusion: The degree of IAP changes was different depending on the device, and the frequency of type II endoleak was high in devices with a large decrease of IAP.

P-295

Developing sarcopenia predicts long-term mortality after elective EVAR

I.A. Lindström¹, S.M. Protto², N. Khan³, N. Sillanpää², J. Hernesniemi⁴, N. Oksala³

¹Faculty of Medicine and Health Technology, Tampere University, Tampere, FI, ²Medical Imaging Center, Tampere University Hospital, Tampere, FI, ³Division of Vascular Surgery, Department of Surgery, Tampere University Hospital, Tampere, FI, ⁴Finnish Cardiovascular Research Center, Tampere University Hospital, Tampere, FI

Purpose: Preoperatively detected sarcopenia as reflected by psoas muscle area (PMA) is associated with postoperative mortality after abdominal aortic aneurysm (AAA) repair. We studied, whether changes in PMA and lean psoas muscle area (LPMA) after endovascular AAA repair (EVAR) are associated with postoperative survival.

Material and methods: In 122 AAA patients treated between 2008 and 2016 (90% male, median age 77.8 years with IQR 11.5, rupture 2.5%) PMA and LPMA at L3 level were measured retrospectively from preoperative and 1-3 year follow-up computed tomography (CT) studies. Median duration of follow-up was 6.0 years (IQR 3.5) and all-cause mortality was 46.7%. Association of radiologic muscle parameters with all-cause mortality was evaluated with Cox regression. Clinical data was collected from an institutional database and patient record databases.

Results: There was a significant decrease in PMA and LPMA at L3 level (mean -4.4 cm², -26.8% for PMA and -130.4 cm² x HU, -21.6%, for LPMA, respectively) (p<.001) and the greatest decline occurred during the first postoperative year after EVAR. Relative PMA change during follow-up (ΔPMA/BL, BL= Baseline CT muscle parameter) was independently associated with reduced mortality in multivariable analysis (HR 0.977 for one percent unit increase, CI 0.960-0.995, p=.011).

Conclusion: The most significant loss of skeletal muscle occurs during the first year after EVAR. The relative change in PMA from baseline is an independent predictor of mortality. For every 10% unit increase in ΔPMA/BL bilaterally, there was a 21% decrease in the probability of death during the follow-up. Early detection (from CT studies) and prevention of sarcopenia may potentially improve survival in EVAR treated patients.

P-296

The efficacy of "steerable triple coaxial system" using high-flow steerable microcatheter on type II endoleak embolization

T. Sugiura, T. Ogi, K. Okumura, A. Yokka, J. Matsumoto, A. Izumozaki, W. Koda, S. Kobayashi, T. Gabata
Radiology, Graduate School of Medical Sciences, Kanazawa University, Kanazawa, JP

Purpose: Middle colic artery (MCA) and iliolumbar artery (ILA) are the most frequently targeted access routes on type II endoleak embolization (T2ELE), but catheterization is often difficult due to their acute angle branching. We considered that this problem can be solved with steerable microcatheter (SMC). The purpose of this study is to evaluate the efficacy and safety of triple coaxial system using high-flow SMC on T2ELE compared with conventional system.

Material and methods: From September 2017 to December 2018, 17 procedures of T2ELE were performed with triple coaxial system using high-flow type SMC (Leonis Mova, also known as SwiftNINJA, Sumitomo Bakelite, Tokyo, Japan) and 1.5Fr microcatheter (Carry Leon, UTM, Toyohashi, Japan) or 1.6Fr microcatheter (Carnelian MARVEL, Tokai Medical Products, Kasugai, Japan) were used. Technical success of embolization and complications related to SMC, such as vessel perforation, dissection or vasospasm were evaluated. During catheterization to MCA and ILA, fluoroscopy time, procedure time and radiation dose were measured, and compared with cases using conventional system. Results were statistically analyzed with Mann-Whitney U test.

Results: All embolization procedures were performed successfully with no complications. Seven MCAs and 13 ILAs were targeted. Compared with conventional system, steerable triple coaxial system enabled catheterization to MCA in significantly ($p < 0.05$) shorter fluoroscopy time (mean 83.1s vs. 696.5s, $p = 0.012$), procedure time (86.8s vs. 1020s, $p = 0.010$) and less radiation dose (17.4mGy vs. 190.8mGy, $p = 0.006$). There was no statistical significance with ILA, but these objects were also shorter and lower (88.9s vs. 125.2s, $p = 0.503$, 93.4s vs. 287.6s, $p = 0.052$, 19.03mGy vs. 31.02mGy, $p = 0.143$, respectively).

Conclusion: Steerable triple coaxial system is a safe and effective option for T2ELE.

P-297

Endovascular repair of ruptured or acute symptomatic pararenal aortic aneurysm: chimney & technique

M. Femia¹, U.G. Rossi², P. Rigamonti³, M. Tramarin⁴, G. Damiani⁴, M. Cariati⁵

¹Postgraduation School in Radiodiagnostics, Università degli Studi di Milano, Milan, IT, ²Diagnostic Imaging Department - Interventional Radiology Unit, E.O. Galliera Hospital, Genoa, IT, ³Radiology and Interventional Radiology, San Carlo Borromeo Hospital, Milan, IT, ⁴Diagnostic-Therapeutic Advanced Technology Department - Diagnostic and Interventional Radiology Unit, ASST Santi Paolo e Carlo - San Carlo Borromeo Hospital, Milan, IT, ⁵Diagnostic Sciences, San Carlo Borromeo Hospital, Milan, IT

Purpose: To describe our experience and the possible advantages of the Chimney&Periscope technique in patients with ruptured or acute symptomatic pararenal abdominal aortic aneurysm.

Material and methods: From January 2009 to January 2016, 22 patients (15 male and 7 female; mean age 69 years) with ruptured or acute symptomatic pararenal abdominal aortic aneurysm were treated with the Chimney&Periscope technique: 12 patients required chimney technique for just one renal artery, 7 patients underwent chimney technique for both renal arteries, 2 patients underwent chimney technique for visceral arteries, and 1 patient underwent chimney technique for visceral arteries and periscope technique for renal arteries. All patients had clinical, ultrasound and MD-CT follow-up.

Results: Technical success was achieved in all 22 patients. The MD-CT follow-up didn't show any sign of type I endoleak; 19 patients showed complete exclusion of the aneurismal sack; in 3 patients a persistent type-II endoleak was demonstrated on MD-CT or CEUS with growth of the aneurismal sack; thus they were successfully treated through endovascular embolization. All of the 22 patients have been asymptomatic over the follow-up period and the renal and visceral arteries treated were patent at colour-Doppler follow-up (mean 24 months).

Conclusion: Chimney&Periscope techniques are efficient and promising endovascular procedures for the treatment of ruptured or acute symptomatic pararenal abdominal aortic aneurysms. They allow the endovascular management of abdominal aortic aneurysms in the urgent setting, leading to the complete exclusion of the aneurismal sack and the regular patency of the treated aortic branches.

P-298

Thoracic endovascular aortic repair for ruptured acute type B aortic dissection

T. Hashimoto, N. Kato, T. Ouchi, K. Nakajima, T. Higashigawa, S. Chino
Radiology, Mie University Hospital, Tsu, JP

Purpose: The purpose of this study is to evaluate the efficacy of thoracic endovascular aortic repair (TEVAR) for ruptured acute type B aortic dissection (r-ATBAD).

Material and methods: The study included 18 patients (15 men and 3 women) who underwent TEVAR for r-ATBAD in two institutions between 1997 and 2017. The mean patient age was 74 ± 10 years. The false lumen was patent in 13 patients (72%) and was mostly thrombosed in 5 patients (28%). Three patients had malperfusion of aortic branches. Eight patients (44%) were in circulatory shock.

Results: Eleven patients (61%) died during or following TEVAR during admission. The causes of death were aortic rupture ($n = 6$), sepsis ($n = 2$), cerebral hypoxia ($n = 1$), pneumonia ($n = 1$), and renal failure ($n = 1$). Statistical analysis showed that dissection extending to the infrarenal level was significantly related with death from aortic rupture ($P = 0.013$). Early adverse events were observed in 12 patients (67%). One patient died from a non-aorta-related cause (sepsis) after discharge. The overall survival rate at 1 year was 39%. After discharge, an aorta-related adverse event (intimal injury) was observed in one patient. The adverse event-free survival rate at 1 year was 17%.

Conclusion: Our results indicate that TEVAR for r-ATBAD is associated with high mortality and morbidity. More advanced strategies may be required to improve the outcome.

P-299

Midterm results of the Altura™ abdominal aortic endoprosthesis prospective single-center registry for endovascular aortic repair

A. Massmann¹, F. Frenzel¹, P. Fries¹, R. Kubale¹, R. Shayesteh-Kheslat², A. Buecker¹

¹Diagnostic and Interventional Radiology, Saarland University Medical Center, Homburg, DE, ²Vascular Surgery, Saarland University Medical Center, Homburg/Saar, DE

Purpose: Midterm results of a prospective single-center real-world registry investigating the 14-F Altura™ (Lombard Medical) abdominal aortic stentgraft for endovascular aortic repair (EVAR).

Material and methods: During 2016-2019, 38 consecutive patients (3 females) (mean age 73 ± 9 ; range 53-88 years) underwent elective or urgent ($n=2$) EVAR of abdominal aortic aneurysms (AAA) mean diameter 55 ± 4 (50-65) mm; angulation 31 ± 23 (0-80°); infrarenal neck length 25 ± 10 (14-55) mm; aorto-iliac aneurysms ($n=2$; common iliac artery 35/45 mm) and one renal chimney (AAA 53 mm) using Altura™ endografts. Prospective follow-up recording morbidity and mortality outcomes, endoleak and re-intervention included contrast-enhanced duplex-ultrasound and computed tomography.

Results: Technical success for device deployment was 100%. Mean procedure time (needle-to-hemostasis) was 62 ± 14 (40-91) minutes; fluoroscopy 9.8 ± 4.3 (4.3-17.9) minutes; dosis-area-product $4,184 \pm 1,970$ (1,377-8,188) μGym^2 ; contrast-medium 75 ± 27 (40-150) ml. Compared to a per-aneurysm-characteristics matched cohort treated with Medtronic Endurant II™, fluoroscopy (median 15.4 vs. 10.6 minutes $p=0.0431$) and dosis-area-product ($p=0.0289$) were significantly lower for Altura™. Overall hospitalisation was 6.5 ± 2 (4-11) days (Intensive care 1.4 ± 0.8 (1-4) days). There was no relevant blood loss. Early (≤ 30 days) complications included endoleak type-2 in 30%; two patients experienced mild temporary post-implantation syndrome; one patient required surgery for symptomatic femoral artery dissection. During mean follow-up of 12 ± 6 (3-24) months freedom from device-related complications, aneurysm-related re-intervention or death was 100%. Aneurysm shrinkage (< 5 mm) was obvious in 20% of patients.

Conclusion: Mid-term results in a limited number of patients showed promising procedural and clinical results with the low-profile and easy-to-use Altura™ device. Long-term studies are mandatory to assess durability and occurrence of device-related complications.

P-300

Acute thoracic aortic diameter changes after TEVAR for blunt traumatic thoracic aortic injury

M.M. Nakano¹, E. Sohga¹, A. Yamamoto¹, A. Jogo¹, S. Hamamoto¹, K. Kageyama¹, S. Ogawa¹, K. Murai¹, T. Nota¹, Y. Sakai², T. Murakami³, Y. Takahashi³, A. Morisaki³, T. Shibata³, Y. Miki¹
¹Diagnostic and Interventional Radiology, Osaka City University Graduate School of Medicine, Osaka, JP, ²Radiology, National Hospital Organization Osaka Minami Medical Center, Osaka, JP, ³Department of Cardiovascular Surgery, Osaka City University Graduate School of Medicine, Osaka-shi, JP

Purpose: The purpose of this study is to evaluate acute changes in aortic diameter before and after thoracic endovascular aortic repair (TEVAR) for blunt traumatic thoracic aortic injury (BTAI).

Material and methods: From 2015 to 2018, 9 patients underwent TEVAR for BTAI in our hospital. The median age was 44 years, and 3 patients were women. One patient died after TEVAR because of lung contusion. Pre- and post-treatment computed tomography (CT) was available for 8 patients. Post-treatment CT was performed within 30 days after TEVAR. Procedural data, aortic and external iliac arterial diameter on pre- and post-treatment CT were reviewed retrospectively.

Results: The mean proximal neck, distal neck and external iliac arterial diameter on pre-treatment CT were 24.1 mm (range 20 to 28 mm), 19.5 mm (range 16 to 23 mm) and 5.94 mm (range 3.8 to 7.8 mm). And those diameter on post-treatment CT were 26.5 mm (range 22 to 31 mm), 21.4 mm (range 17 to 25 mm) and 7.17 mm (range 5.5 to 8.3 mm). Seven patients were repaired using the Conformable GORE® TAG® Thoracic Endoprosthesis, 1 patient was repaired using the RELAY® PLUS Thoracic stent-graft system. The mean proximal diameter of the endografts was 29.3 mm (range 26 to 34 mm). The mean oversizing was 24% (range 8 to 44%) in proximal neck.

Conclusion: Preprocedure aortic and EIA measurements were smaller as a result of hypovolemic and shock. Larger device selection than usual contribute to the avoidance of complications related to type 1 endoleaks.

P-301

Endoleak embolization with thrombin direct injection

M. Scaravello¹, S. Squarza², M. Femia¹, S. Gitto¹, M. Tramarin³, G. Damiani⁴, P. Rigamonti⁴, U.G. Rossi⁵, M. Cariatì⁶
¹Postgraduation School in Radiodiagnostics, Università degli Studi di Milano, Milan, IT, ²Radiologia, ASST Santi Paolo e Carlo, Milan, IT, ³Diagnostic-Therapeutic Advanced Technology Department – Diagnostic and Interventional Radiology Unit, ASST Santi Paolo e Carlo – San Carlo Borromeo Hospital, Milan, IT, ⁴Radiology and Interventional Radiology, San Carlo Borromeo Hospital, Milan, IT, ⁵Diagnostic Imaging Department – Interventional Radiology Unit, E.O. Galliera Hospital, Genoa, IT, ⁶Diagnostic Sciences, San Carlo Borromeo Hospital, Milan, IT

Purpose: The most common complication after endovascular aneurysm repair is type 2 endoleak (T2E). We performed a direct thrombin injection into the aneurismal sac to treat T2E in cases where endovascular approach was unsuccessful or not performed because of vascular anatomy.

Material and methods: Thrombin injection was performed under CT guidance in 19 patients. A 21-G needle was placed within the sac using a lumbar paravertebral approach. A 0.018" guidewire was introduced and, after needle removal, a coaxial 6-Fr sheath was advanced to the sac. Embolization was performed with Floseal hemostatic matrix. In 13 cases thrombin was injected directly through the sheath, in 3 cases a 4-Fr Berenstein catheter was used for injection. Injection was continued until slight resistance was felt and no blood flow was detected through the sheath. A median of 8 ml of thrombin was administered.

Results: T2E disappeared immediately after treatment in all cases. No complications occurred during the procedure. There were no cases of recurrence at a median follow-up of 16.9 months.

Conclusion: Direct thrombin injection into the aneurismal sac is an easy, safe and reliable alternative to endovascular treatment of T2E. The sac can be successfully punctured under CT guidance using a lumbar approach.

P-302

Management of life-threatening aorto-esophageal fistula: experiences learned from eight patients

J.W. Kim¹, J.H. Shin¹, Y. Kwon², J. Kim², I.J. Lee³
¹Radiology, Asan Medical Center, University of Ulsan College of Medicine, Seoul, KR, ²Radiology, Ajou University Hospital, Suwon, KR, ³Radiology, National Cancer Center, Goyang-si, KR

Purpose: To report the experiences in management of life-threatening aorto-esophageal fistula (AEF).

Material and methods: A total of eight patients (seven men and one woman; mean age, 59.4 years; range, 43–76 years) presenting with AEF were recruited between 2005 and 2018 from three different hospitals in Korea. The medical records of these patients were reviewed for patient demographics, clinical features, diagnostic and therapeutic modalities, and outcomes.

Results: Two patients died as a result of massive hemorrhage before endovascular or surgical treatment could be undertaken. Of the treated six patients, five patients underwent endovascular interventions: embolization of the fistula using n-butyl cyanoacrylate (NBCA) and subsequent thoracic endovascular aortic repair (TEVAR) in two patients, TEVAR alone in two patients, NBCA embolization alone in one patient. Among them, three patients who received TEVAR with or without NBCA embolization in a timely fashion recovered and discharged. Two patients who had received delayed TEVAR or NBCA embolization alone died of disseminated intravascular coagulation or hemorrhagic shock within three days, respectively. The remaining one patient who underwent surgical aortic repair is alive after 13 years.

Conclusion: TEVAR in a timely fashion facilitates hemodynamic stabilization by rapid hemorrhage control and may be an alternative to surgical repair. NBCA embolization of the fistula should be considered

as a bridge to TEVAR in hemodynamically unstable patients, because it has a temporizing effect.

P-303

Efficacy of ECG-gating cine-magnetic resonance images as an indicator for the prognosis of aneurysms treated by endovascular aortic repair

H. Kawada¹, S. Goshima¹, Y. Tanahashi¹, K. Kajita¹, Y. Noda¹, N. Kawai¹, T. Ando¹, S. Nagata¹, H. Imada¹, T. Kaga¹, N. Ishida², K. Shimabukuro², K. Doi², M. Matsuo¹

¹Radiology, Gifu University Hospital, Gifu, JP, ²General and Cardiothoracic Surgery, Gifu University Hospital, Gifu, JP

Purpose: To determine if electrocardiogram (ECG)-gated cine-magnetic resonance images (C-MRI) can generate predictive factors for the prognosis of abdominal aortic aneurysms treated by endovascular aortic repair (EVAR).

Material and methods: The institutional review board approved this prospective study, and all patients provided a written informed consent prior to their participation in the study. Overall, 46 patients (mean age 76.0 years; age range, 61–88 years) were enrolled in this study and underwent an ECG-gated C-MRI following EVAR treatment from January 2013 to August 2018 (68 months). Patients were categorized based on the changes in the maximum-minor axis diameter of the aneurysms assessed by computed tomography (CT) obtained after EVAR into enlarged (>5 mm diameter enlargement) or effective (stable and shrinkage) groups. We calculated the approximate volume change (AVC) of the aneurysmal sac in the systolic and diastolic phase using C-MRI, and created a new index (AVC value) obtained by multiplying AVC by the thrombus rate (TR), calculated by the preoperative CT image (AVC value = AVC × TR). Then, we evaluated the difference in AVC-value between the two groups using Mann-Whitney analysis.

Results: The median follow-up period after EVAR was 47.1 months (3–68 months). The AVC value of the enlarged group was significantly lower than effective group ($P = 0.012$).

Conclusion: The AVC-index calculated from C-MRI may be useful as a predictive evaluation of aneurysm prognosis following EVAR treatment.

P-304

Should age be a discriminator when offering in elective endovascular aneurysm repair (EVAR)?

M. Hennessy

Interventional Radiology, Queen Elizabeth University Hospital, Glasgow, UK

Purpose: We wished to assess survival after elective EVAR for octogenarians and whether it was significantly lower than for EVAR performed in those of other decades of life.

Material and methods: Data were collected retrospectively. NHS Greater Glasgow & Clyde and Forth Valley Radiology Information systems were queried for all EVARs. Patient information was checked against CHI24, a Scottish online system which collects mortality data. Data were analysed in R using Kaplan Meier survival analysis and log rank tests.

Results: Since 1996, 784 elective EVARs were performed. 127 were on octogenarians (mean age 83 years; 20 women) compared to 434 on septuagenarians (mean 75 years; 47 women.) Median ten year survival was 1734 days (4 years, 9 months) and 2987 days (8 years, 2 months) respectively. Survival differences between the decades at which EVAR was performed were significantly different for both 5 and 10 year survival.

Conclusion: EVAR is an expensive procedure aimed to reduce mortality from a ruptured aneurysm. It is often performed when the patient's aneurysm is at a size meaning its rupture risk is in the order of 1% per year. We have shown that 50% of octogenarians will be dead less than 5 years after elective EVAR. While further analysis into aneurysm-related mortality in this and a control group will provide more useful results,

these findings may indicate that elective EVAR for aneurysms just over 5.5 cms may not be worthwhile.

P-305

Endovascular aortic repair for infra-renal abdominal aortic aneurysms: outcomes of the Bi- versus Trimodular Endurant® stent-graft

S. Anton

Department of Radiology and Nuclear Medicine, University Hospital Lübeck, Lübeck, DE

Purpose: To compare outcomes of endovascular aortic repair (EVAR) of infra-renal AAA using either a bi- or trimodular stent-graft design.

Material and methods: Retrospectively, we identified 100 consecutive patients (90% male, mean age 71±9y) treated with EndurantTMII (n=66) or EndurantTMIIIs (n=34) devices. Endpoints included technical success (no surgical conversion, type I/III endoleak (EL)), 30d mortality, complications, EL formation and re-interventions.

Results: Median aneurysm diameter was 53mm (IQR 48–65mm). Mean follow-up was 740d. (95% CI 593–887d.). Six patients (6%) were lost to follow-up. Technical success was 95% (EL type I: 4/100 (4%) patients (END II: 2/66; END IIIs: 2/34, $p=0.491$). One surgical conversion (1%) was observed (END II). In END II one active bleeding occurred (2%), in END IIIs no procedure-related complications were recorded (0%) ($p=0.471$). Early complications (<30d) were seen in 8/100 patients (8%) (ENDII: n=6; ENDIIIs: n=2, $p=0.637$). Postinterventional type II EL affected 24/94 patients (END II: n=14, END IIIs: n=10, $p=0.479$). 8/100 patients (8%) showed a persisting type II EL with sac enlargement (END II: n=6, END IIIs: n=2, $p=0.429$). 14/100 patients (14%) needed re-interventions (END II: n=8, END IIIs: n=6 $p=0.451$). 30d mortality was 0%.

Conclusion: We found no significant differences comparing the outcome of EVAR using bi- (EndurantTMII) or tri-modular (EndurantTMIIIs) devices.

P-306

Safety and efficacy of subclavian artery embolization following thoracic endovascular aortic repair (TEVAR): a comparison of a brachial vs radial artery approach

T.C. Huber¹, D. Sheeran², S. Sabri³, M. Tracci¹, J.F. Angle⁴

¹Interventional Radiology, University of Virginia, Charlottesville, VA, US, ²Radiology & Medical Imaging, University of Virginia Health System, Charlottesville, VA, US, ³Radiology, Medstar Washington Hospital Center, Washington, DC, US, ⁴Radiology, University of Virginia, Charlottesville, VA, US

Purpose: To compare safety and efficacy of subclavian artery embolization after TEVAR using brachial or radial access.

Material and methods: Retrospective review of TEVARs over an eight-year period (1/1/2011–12/31/2018) involving subclavian artery embolization from brachial or radial access during TEVAR or as endoleak repair was performed. The choice of access was at the discretion of the operator. The study population consisted of 54 patients (55% male, average age 64 years); 34 from brachial approach and 17 from radial approach. Comorbidities included diabetes (13%), hypertension (83%), and tobacco use (30%).

Results: Immediate technical success, occlusion of the subclavian artery origin, was achieved in 100% of patients (N=54). Two patients (one from each access approach) were found to have a subclavian Type II endoleak on follow-up imaging, requiring repeat endovascular embolization. No access complications were observed when using a radial approach. Two (2/37) brachial approach patients had major access-related complications (per SIR Guidelines), both cases of arterial thrombosis at the access site. One patient required operative repair and the other percutaneous reintervention. Fisher's Exact test demonstrated no statistical difference in the complication rate between these groups ($p = 0.29$). Long-term follow-up imaging (median 301 days) demonstrated persistent occlusion

of the subclavian artery origin and no evidence of endoleak from either approach, excepting the two aforementioned failures.

Conclusion: Radial and brachial access are effective for subclavian artery embolization for prevention or treatment of Type II subclavian artery endoleaks after TEVAR. No access complications were observed when using radial access, versus a 5% major complication rate (2/37) using brachial access.

P-307

Evaluation of lower limb blood flow during endovascular aneurysm repair with left and right ratio of perfusion index

K. Suzuki, M. Shimohira, T. Hashizume, K. Ohta, Y. Sawada, S. Tsukahara, Y. Shibamoto
Radiology, Nagoya City University Graduate School of Medical Sciences, Nagoya, JP

Purpose: To evaluate the usefulness of Perfusion Index (PI) for evaluation of blood flow of the approached arteries during endovascular aneurysm repair (EVAR).

Material and methods: Eighty-four patients, 72 men and 12 women, with a median age of 80 years (range, 60–91) underwent EVAR for abdominal aortic aneurysm (n=73), common iliac artery aneurysm (n=9), or internal iliac artery aneurysm (n=2). In all cases, EVAR was approached from both femoral arteries. PI was monitored before and immediately after the EVAR on both feet. When the PI decreased immediately after EVAR, imaging examination (ultrasound, angiography and/or contrast-enhanced CT) was performed to evaluate the blood flow. When PI was normal, pulsation of dorsalis pedis artery was confirmed. The left and right ratio of PI values immediately after EVAR was compared and statistically examined between the normal group and the ischemic group.

Results: In total, 168 arteries were evaluated, and 3 of them showed decrease of PI. In these 3 arteries, the decrease of blood flow was confirmed by image examination, and surgical repair was performed immediately. In the normal group, the left and right ratio of PI value was less than 2 in 92%. In the all ischemic group, the ratio was greater than 2, and the average ratio was 10.6. Therefore, the agreement rate between PI evaluation and clinical evaluation was 100%.

Conclusion: The left and right ratio of PI monitored immediately after EVAR appears to be useful to evaluate blood flow of the approached arteries.

P-308

In-vitro performance assessment of the Gore VBX Stent-Graft for fenestrated endovascular aortic repair

G.F. Torsello¹, M. Herten², A. Frank³, M. Müller³, G. Torsello⁴, M. Austermann⁴
¹Klinik für Radiologie, Charité - Universitätsmedizin Berlin, Campus Virchow-Klinikum, Berlin, DE, ²Klinik für Orthopädie und Unfallchirurgie, University Hospital Essen, Essen, DE, ³Klinik für Unfall- und Wiederherstellungschirurgie, University Hospital Münster, Münster, DE, ⁴Vascular and Endovascular Surgery, St. Franziskus-Hospital, Münster, DE

Purpose: Fenestrated aortic aneurysm repair is limited by bridging-related complications. Recently, a new stent-graft has been introduced which has potential bridging stent features. Aim of this study was to evaluate device performance in an in-vitro model.

Material and methods: Polyester test sheets with either 6 or 8 mm diameter fenestrations were used simulating a fenestrated aortic endoprosthesis. Fifty Viabahn Balloon Expandable (VBX) stent-grafts were tested. After implantation, the stent-grafts were flared. Primary endpoint was the absence of fractures detected on x-ray or computed tomography and material failure detected by microscopy and water permeability testing. Secondary endpoints were forces needed for perpendicular dislocation (pull-out force) and axial dislocation (shear-stress force).

Results: Digital radiography and CT scans of 40 VBX stent-grafts did not show any stent fracture. No damage of the fabric or separation of the graft was detected by microscopy after flaring. After flaring of 10 stents, no water leakages were detected. Pull-out testing on 25 stent-grafts revealed pull-out forces between 11.3 and 31 N. Shear-stress force tests showed average dislocation forces by 50% diameter ranged between 5.75 and 6.91 N (mean 6.1±0.5 N) for the 6 mm stents and between 3.31 and 5.4 N (mean 4.4±0.8 N) for the 8 mm stents.

Conclusion: In this preliminary study, applicability of VBX as a bridging stent-graft in fenestrated endovascular aortic model was demonstrated.

P-309

Initial clinical experience with the Gore Viabahn balloon-expandable (VBX) stent-graft in branched and fenestrated endovascular aortic repair

E. Beropoulos¹, R. Munaó², M. Austermann², G. Torsello², K.P. Donas¹, G.F. Torsello³
¹Vascular Surgery, St. Franziskus Hospital, Münster, DE, ²Vascular and Endovascular Surgery, St. Franziskus-Hospital, Münster, DE, ³Klinik für Radiologie, Charité - Universitätsmedizin Berlin, Campus Virchow-Klinikum, Berlin, DE

Purpose: Until today, there is no dedicated bridging stent-graft available for use in fenestrated and branched endovascular aortic repair (f/bEVAR). The purpose of this study was to evaluate the initial clinical performance of the new Gore Viabahn Balloon Expandable (VBX) stent-graft in f/bEVAR.

Material and methods: Retrospective analysis of prospectively collected data was performed. Inclusion criteria were treatment with fenestrated or branched endografting for complex aortic pathologies, implantation of at least one VBX stent-graft as a bridging stent in one of the target vessels and a postoperative CT-scan. Procedural and postoperative data were analyzed. The primary endpoint of the study was technical success, defined as placement of the bridging stent-graft in the desired position with absence of endoleak in the final angiography. Secondary endpoints were freedom from perioperative major adverse events (MAE) as well as freedom from reinterventions and mortality at 30 days.

Results: Between December 2017 and October 2018, fifty patients (41 male, mean age 72 years) fulfilled the inclusion criteria. The primary endpoint was reached in all of the 166 VBX implanted. 122 branches (renal arteries: 74, superior mesenteric artery: 25 and celiac trunk: 21) sealed exclusively with VBX. There was a single stent-related reintervention due to stent occlusion of a left renal postoperatively, which was treated successfully with aspiration thrombectomy and relining with a bare-metal stent (0.6%). There were no MAEs. The perioperative- and 30-day all-cause mortality was 0%.

Conclusion: The new VBX showed promising preliminary results as a bridging stent for f/bEVAR. Further evaluation is mandatory to determine durability.

P-310

Age old question? What is too old for EVAR today?

P.E. Jenkins¹, H. Abbas¹, C. Finan¹, I.J. Walton², N.F. Gafoor¹
¹Radiology, Peninsula Radiology Academy, Plymouth, UK, ²Interventional Radiology, Plymouth Derriford Hospital, Plymouth, UK

Purpose: Advances in endovascular techniques and spinal anaesthesia mean that more patients who are Octo- and Nano-genarians can be treated with Endovascular Aortic Repair (EVAR). The high cost and risk profile leave a challenging decision for this cohort. Do patients over 80 have increased morbidity and mortality after EVAR?

Material and methods: We present a retrospective review of patients undergoing EVAR between January 2008 - December 2016. Departmental database was used with subsequent data collection from Radiological IT system, electronic patient records and letters. Data was analysed with SPSS (V24). Patient outcomes were compared between two groups.

Results: 174 patients received elective infrarenal EVAR (19 female) with a median age of 76 (range 52-91). 55 were symptomatic presentations, 73 screening, 33 incidental and 13 were unclear. 45 patients were aged greater than 80 (80-91) at EVAR with 129 patients aged between 52 and 79. Three months survival was 97.8% and 98.5% for the over and under 80's groups respectively (Pvalue 0.96). One year survival was 91.2% and 94.8% respectively (Pvalue 0.38). There were 13 endoleaks in the >80s compared with 41 in the <80's (Pvalue 0.71) with five re-interventions vs 19 (Pvalue 0.54). At median of 73 months follow up, 25 (0.55%) >80's remained alive compared to 85 (0.65%) in the <80's group.

Conclusion: Age at EVAR is not associated with increased endoleak or mortality. Age alone should not be used as contraindication to EVAR. In our series those under 80 and Octo- and Nano-genarians have comparable technical and clinical success with good survival post-EVAR.

P-311

Safety and efficacy of endoanchors in patients with thoraco-abdominal endovascular aortic aneurysm repair

Z. Qamhawi¹, T. Barge¹, G.C. Makris¹, R. Patel¹, A.J. Wigham², S. Anthony¹, R. Uberoi¹

¹Department of Radiology, Oxford University Hospitals NHS Foundation Trust, Oxford, UK, ²Radiology, John Radcliffe Hospital, Oxford, UK

Purpose: To assess the safety and efficacy of endoanchors in the treatment of Type Ia endoleak and graft migration in patients with thoracic and abdominal endovascular aortic aneurysm repair (TEVAR and EVAR).

Material and methods: A systematic review was performed per PRISMA guidelines. Databases were searched for clinical studies that investigated clinical outcomes of endoanchor use.

Results: Eleven, single-arm and open-label, studies were identified. Ten studies utilised the Heli-FX™ Endoanchor™ system (Medtronic) whilst one study used the Anson Refix endostapling system (Lombard Medical). In EVAR patients (n=660) treated with Heli-FX, technical success in endoanchor deployment was 91-100%. Type Ia endoleak was noted in 5.7% and graft migration in 1.1% of 459 patients after mean follow-up of 14.6 ± 13.1 months. Adverse events included 3 endoanchor fractures (0.5%), 3 dislocations (0.5%), and 1 entrapped endoanchor (0.2%). In EVAR patients (n=8) treated with Anson Refix, technical success was 69% with no type Ia endoleak or graft migration at 18 ± 2.2 months follow-up. In TEVAR patients treated with Heli-FX (n=78), technical success ranged from 82-100%, with a type I endoleak rate of 2.6% but no graft migration after mean follow-up of 7.5 ± 3.6 months. Adverse events were limited to one misdeployed endoanchor (1.3%).

Conclusion: Endoanchors, particularly the Heli-FX system, have a low rate of endoleak, graft migration, and complications. However, the current evidence lacks long term follow-up and randomised controlled trials. Further research is required as well as determining the cost effectiveness of endoanchors before their use in routine practice.

P-312

The accounts of a new embolic agent promising an improved follow-up in endoleak type 2 treatment

R.A. Foà, G. Leati, L. Boccalon, D. Diaco, A. Spinazzola
Interventional Radiology, Ospedale Maggiore di Crema, Crema, IT

Purpose: Type II endoleak is the most common long-term complication that can occur after endovascular repair of abdominal aortic aneurysm (AAA). The purpose of this study is to describe our preliminary experiences with the use of a new nonviscous embolic agent, easyx, in the treatment of endoleak type II. Easyx is an EVOH liquid embolic agent with polyvinyl alcohol ether polymer dissolved in DMSO.

Material and methods: Our experiences span through 9 cases of persistent type II endoleak following endovascular repair (EVAR). Translumbar puncture of the aneurysmatic sac was performed on 7 of the cases (4 treated only with easyx; 3 with easyx and coils). Transarterial embolisation

was performed on the remaining 2 cases (one treated only with easyx; one with easyx and coils). A follow up was conducted with a 64 slice TC scan exam after 1 month in all 9 cases.

Results: We observed a 100% technical success and hereunder a 86% success rate at the time of follow up. A treatment was considered successful with the observation of a decreased sac diameter and/or complete dissipation of the endoleak. One patient required re-intervention due to evidence of persistent endoleak in the CT scan.

Conclusion: Our experiences demonstrate safe usage and a lower radio-opacity as compared to other more widely used agents. Easyx therefore induce less streak artefact which allows for a more thorough and improved follow up. This gives us a better understanding of the success of the treatment

P-313

Accuracy of greater curvature measurement in estimating the length of endograft in TEVAR: comparison with manufacturer defined total endograft length

V. Ojha¹, K.P. Ganga¹, S. Sharma², S. Kumar¹

¹Cardiovascular Radiology and Endovascular Interventions, All India Institute of Medical Sciences, New Delhi, IN, ²Cardiac Radiology, All India Institute of Medical Sciences, Delhi, IN

Purpose: Centreline measurement has long been the norm for planning for endograft length estimation during TEVAR. This study was carried out to compare the accuracy of greater curvature length (GL), automated centerline (CL) and straightened centerline (SCL) aortic lengths TEVAR planning in a group of patients with thoracic aortic dissections (TAD) or aneurysms (TAA).

Material and methods: CT Angiographies (CTA) of 30 patients (22 males, mean age-49.2years) who underwent TEVAR for TAD (n=17) or TAA (n=13) were retrospectively analyzed. Patients in whom more than one device was used were excluded. The CL, SCL, manual tracing of GL, and manual straightline (axial)(SL). Results were compared with the actual manufacturer defined endograft length. Tortuosity index (CL/SL length) (TI) was calculated. Student t test and Pearson correlation coefficients were used for statistical analysis.

Results: There was significant difference between CL(16.67±4.07cm) and TL(17.75±4.29cm)(p<0.0001) and this was significantly greater in dissection group(1.75±1.14 cm) than in aneurysm group(0.20±0.94cm) (p <0.0001). The difference between SCL(16.86±4.16cm) and TL(TL-SCL) was also significant(p=0.001). However, mean GL(17.92±4.78cm) was similar to TL (p=0.414) and this difference was similar in dissection and aneurysm groups(p=0.9). The difference between TL and GL had a negative linear correlation with the endograft length in the dissection group(r=-0.50, p=0.03).

Conclusion: Greater curvature length is more accurate for sizing of thoracic aortic endograft compared to centerline or straightened centerline in both dissections or aneurysms and should be used in planning for TEVAR. The centerline lengths are more inaccurate in prediction of actual length of stent graft in dissections compared to aneurysms.

P-314

Do you know the glomerular filtration rate (GFR)? - Do the volumes of contrast given at endovascular aortic repair (EVAR) affect GFR?

C. Finan, P.E. Jenkins, H. Abbas, I.J. Walton, N.F. Gafoor
Radiology, Peninsula Radiology Academy, Plymouth, UK

Purpose: Contrast induced nephropathy is poorly understood but concerning complication of large contrast loads potentially used in EVAR. Various methods including CO₂ angiography, use of low osmolar contrast and fluid resuscitation are utilised. We present a 5 year review of EVAR in respect to renal function, contrast requirements and post-operative outcomes.

Material and methods: We present a retrospective review of patients who underwent elective EVAR from December 2011 - December 2016. Retrospectively data was collected from Radiological IT system and electronic patient records. Data was analysed with SPSS (V24) with respect to GFR, contrast type, contrast load, mortality and complications

Results: 121 patients received an elective infrarenal EVAR with anaesthetic support (112male). Median age was 76.7 (range 56-91). Median contrast load given was 220mls (Range 25 – 560mls)

Mean reduction of GFR was 1.9 ml/min per 1.73m² on day one post-op across the full cohort with CKD stage 1, 2 and 4 (5.3, 3.0 and 3.5 ml/min per 1.73m² respectively) seeing larger reductions. CKD stage 3a and 3b demonstrated an increase of GFR by 3.7 and 1.2 ml/min per 1.73m² respectively.

In nine patients GFR reduced by >25% with three classified as AKI. No correlation was demonstrated between contrast load, contrast osmolarity and post-procedure GFR. No patients required renal replacement therapy. Mortality at 3 months and 1 year was 3.3% and 28% respectively.

Conclusion: GFR is not significantly affected by the contrast load or osmolarity regardless of CKD stage 1-4. Contrast volumes currently used in EVAR can safely be administered in those with CKD stage 1-4.

P-315

Management of the celiac artery for thoracic endovascular repair of thoracoabdominal aortic aneurysm

O. Ikeda¹, Y. Tamura², S. Inoue³, Y. Yamashita¹

¹Diagnostic Radiology, Kumamoto University Graduate School of Life Sciences, Kumamoto, JP, ²Radiology, Kumamoto University Hospital, Kumamoto-shi, JP, ³Diagnostic Radiology, Kumamoto University Hospital, Kumamoto, JP

Learning objectives: Report experience with patients who underwent celiac artery coverage as an adjunct to thoracic endovascular repair (TEVAR) of thoracoabdominal aortic aneurysms (TAAA).

Background: Celiac trunk occlusion by coil may be necessary to prevent type Ib or type II endoleaks in endovascular treatment of TAAAs involving the celiac trunk or short distal landing zone.

Clinical Findings/Procedure Details: During the past 6 years, we performed 134 TEVAR procedures. In 7 patients (4 men, 3 women, mean age 73), the origin of the celiac artery was covered with a thoracic stent graft to obtain an adequate distal landing zone. Amplatzer vascular plugs (AVP) were used in 3 patients, and metallic coils in 4. Two of 4 patients in whom metallic coils were used and who had undergone celiac axis ligation, showed type II endoleaks from a branch proximal to the ligated celiac axis on follow-up CTA. No patient having TAE revealed type II endoleaks on follow-up. Mean fluoroscopy time was 49.9 min, and there was no difference between the coil embolization group and AVP group. Mean follow-up was 24 months by CT angiography. No ischemic complications were seen, and no patient having TAE showed type II endoleaks.

Conclusion: In patients with TAAA s and short distal necks, TEVAR with celiac trunk embolization can be an effective alternative to surgical ligation for preventing type II endoleaks. The AVP seemed useful for celiac trunk embolization, although the anatomical variation of the branches was a relevant factor.

P-316

Radiological assessment, planning and top technical pearls for the use of cerebral embolic protection devices during TEVAR procedures

B. Pitrola¹, N.R. Patel¹, S. Rostampour², M.S. Hamady³

¹Radiology, Imperial College Healthcare NHS Trust, London, UK, ²Interventional Radiology, Imperial College NHS Trust, London, UK, ³Interventional Radiology, Imperial College-London -St Mary's Campus, London, UK

Learning objectives:

1. Describe Patient selection and pre-procedure planning for cerebral protection using current cerebral embolic protection devices (CEPDs).
2. Describe technique of deployment and elaborate on tips and tricks employed to reduce the risk of embolic complications
3. Advantages and limitations of CEPDs.

Background: Embolic phenomena, specifically stroke and silent infarcts are a major predictor of mortality and morbidity following endovascular aortic procedures.

Thoracic endovascular aneurysmal repair (TEVAR) is a less invasive alternative to conventional open repair for aneurysms; however cerebral infarction is a major concern during the perioperative period with estimated risk of clinical stroke of 2-8% and silent infarcts of more than 70%. Risk modification strategy is multifaceted. (CEPD) is one of the adopted approaches to protect the brain.

Clinical Findings/Procedure Details: Patient selection is dictated by aortic arch morphology, landing zone, burden of atheromatous disease, great vessel luminal diameter and take off angle. A number of tips and tricks can be employed to ensure safe and accurate deployment and retrieval.

Conclusion: CEPDs are already an integral part of many trans-catheter aortic valve insertion procedures with favourable outcomes. Routine use in suitable patients undergoing TEVAR is safe and feasible with positive early results. There are key considerations that should be performed by interventional radiologists to ensure safe and successful procedure.

P-317

Imaging assessment and endovascular planning for complex aortic arch aneurysms: challenges and suggested solutions

S. Rostampour¹, W. Hakim², B. Pitrola¹, N.R. Patel³, M.P. Jenkins⁴, C.D. Bicknell⁵, C.V. Riga⁶, R.G.J. Gibbs⁷, M.S. Hamady⁸

¹Interventional Radiology, Imperial College Healthcare NHS Trust, London, UK, ²Clinical Radiology, St Mary's Hospital, London, UK, ³Radiology, Imperial College Healthcare NHS Trust, London, UK, ⁴Vascular Surgery, Imperial College Healthcare NHS Trust, St Mary's Hospital, London, UK, ⁵Vascular Surgery, Imperial College London, London, UK, ⁶Vascular Surgery and Interventional Radiology, Imperial College Healthcare, St Mary's Hospital, London, UK, ⁷Division of Vascular Medicine and Vascular Surgery, St Mary's Hospital, Imperial College NHS Trust, London, UK, ⁸Interventional Radiology, Imperial College-London -St Mary's Campus, London, UK

Learning objectives:

1. Describe CT findings and planning points of complex thoracic aortic aneurysms involving the aortic arch
2. Discuss the role of various intervention options
3. Demonstrate through case-based examples, the techniques, pitfalls and complications of endovascular complex interventions.

Background: Aortic aneurysms affecting the arch or ascending aorta represent an ongoing challenge for the endovascular community. Thoracic endovascular aortic aneurysm repair (TEVAR) for descending aneurysms, being less invasive with a lower early morbidity and mortality than open surgical repair, has become a well-established technique. Recent advances in technology including custom made stent grafts have allowed more complex cases to be both safely and successfully treated. We share

lessons learned in our tertiary centre's experience with treating the most complex aortic arch pathologies.

Clinical Findings/Procedure Details: In a pictorial format we present multiple examples of complex aortic arch reconstructions performed in our department including pre-procedure CT findings, intraoperative images and tips for appropriate graft selection and procedure techniques. We share examples of elephant trunk antegrade stenting, branched stents, chimney, scalloped and fenestrated stents including both the advantages and limitations of each.

Conclusion: With an increasing number of advanced TEVAR techniques available to treat complex thoracic aortic arch aneurysmal disease, it is vitally important that all Interventional Radiologists and trainees understand the advantages and limitations of the available treatment options.

P-318

Acute traumatic aortic injury: computed tomography classification and endovascular management

B. Oliver¹, M. Cline², K.J. Cooper³, M. Khaja¹, D.M. Williams²

¹Department of Interventional Radiology, University of Michigan, Ann Arbor, MI, US, ²Radiology, University of Michigan Health System, Ann Arbor, MI, US, ³Radiology, Loma Linda University, Loma Linda, CA, US

Learning objectives:

1. Understand the CTA findings and classification of acute traumatic aortic injury (ATAI)
2. Understand the management implications of different injury grades
3. Recognize possible pitfalls in diagnosis and management of ATAI
4. Understand the data on clinical outcomes following endovascular repair of ATAI

Background: Trauma is the leading cause of death from ages 1-44. In blunt trauma, acute traumatic aortic injury (ATAI) is the second highest cause of death with morbidity reaching up to 80%, therefore emergent identification is essential. Previously, open surgical repair was the favored treatment with mortality rates up to 35%. Advances in endovascular techniques and endograft technology have led to an increased role in ATAI and endovascular treatment has become the new standard, reducing mortality rates to 4.8-14.6%.

Clinical Findings/Procedure Details: Patients with ATAI may have nonspecific symptoms including chest/back pain, cough, discrepancies in blood pressure and/or a heart murmur. Initial chest radiograph may demonstrate a widened mediastinum, hemothorax or be completely normal. The gold standard for diagnosis of ATAI is CTA, which can demonstrate four grades of injury, most commonly involving the isthmus. Once identified, management is based on grade of injury and patient stability. Endovascular treatment is associated with significantly reduced mortality and complications compared to surgical treatment.

Conclusion: ATAI carries an extremely high mortality after blunt trauma. Prompt identification and treatment is essential to reduce mortality and improve outcomes. Knowledge of common clinical and CTA findings is essential to diagnosing and treating patients with suspected ATAI. Endovascular treatment of ATAI has now surpassed surgical intervention as the standard of care.

P-319

A tale of two stent grafts: parallel stenting of the esophagus and thoracic aorta for treatment of acute aorto-esophageal fistula

J.J. Mahn¹, B. DuBois¹, C.S. Branach², J.W. Albright¹, R.A. Pampati³, M. Khaja¹

¹Department of Interventional Radiology, University of Michigan, Ann Arbor, MI, US, ²Department of Vascular and Interventional Radiology, University of Michigan, Ann Arbor, MI, US, ³Radiology, University of Michigan Hospitals, Ann Arbor, MI, US

Clinical History/Pre-treatment Imaging: 61-year-old male with a past medical history bronchoesophageal fistula status post esophageal stenting, recurrent upper gastrointestinal bleeding and esophagitis presents with massive hematemesis, respiratory failure and hemorrhagic shock. **Treatment Options/Results:** Initial aortogram demonstrated irregularity of the thoracic aorta along the rostral aspect of the existing esophageal stent. A thoracic endograft was then deployed to exclude the area of aorto-esophageal fistula.

Patient continued to decompensate with spot imaging demonstrating mediastinal shift to the left.

Enteric access via patient's naris was performed with injection of contrast showing abrupt cutoff of the esophagus proximal to the existing esophageal stent and contrast within the trachea. Continued distension of the stomach and distal esophagus with ventilation additionally suggested area of prior bronchoesophageal fistula was no longer excluded by the migrated stent.

Retrograde access from gastrostomy tube was then obtained facilitating antegrade orogastric access. A Wallflex stent was then advanced from antegrade access proximal to the migrated stent with 5 cm of overlap and deployed.

Final aortogram and esophagogram demonstrated new parallel thoracic aortic and esophageal stents with no extraluminal contrast. Patient was admitted to the ICU and improved clinically.

Discussion: Thoracic endovascular repair for acute aortic injury is a fast an effective modality for treatment. It is important to assess the patient clinically post treatment as in our case, to determine need for further intervention.

Take-home points: 1. Thoracic endovascular repair for acute aortic injury is a fast an effective modality for treatment.

2. It is important to assess the patient clinically post treatment to determine need for further intervention.

P-320

Total endovascular repair of postdissection thoracoabdominal aneurysms

M. Zhou, Z. Shi, W. Fu

Department of Vascular Surgery, Zhongshan Hospital, Fudan University, Shanghai, CN

Clinical History/Pre-treatment Imaging: A 65-year-old male presenting with acute abdominal pain for 9 hours was referred to our emergency department. The patient received TEVAR for Stanford type B aortic dissection 9 years ago. The pre-operative CTA examination showed that false lumen (FL) of thoracic aorta was thrombosed, while abdominal aortic FL was filled with contrast. The maximum diameter of abdominal dissecting aneurysm was 77 mm. The right renal artery originated from FL.

Treatment Options/Results: A 28 mm×28 mm×150 mm C-TAG stent-graft was deployed in FL to cover the tears of abdominal aorta from the side of FL and promote thrombosis formation. One Interlock and 30 Nester coils were implanted in FL above renal arteries. A 8 mm×50 mm Viabahn was deployed in the right renal artery to bridge between the true and the false lumen. A 12 mm×100 mm Excluder was implanted in the right common iliac artery to repair the distal re-entries. At 15 months following TEVAR, CTA examination showed complete thrombosis formation in

the FL without endoleaks. The maximum diameter of abdominal aorta decreased to 65 mm.

Discussion: The stent graft was deployed in the FL to preserve the blood flow into lumbar arteries and reduce the risk of spinal cord injury, but compliant stent grafts with appropriate size were needed. The FL above renal arteries was occluded with coils to avoid back bleeding from the intercostal arteries.

Take-home points: Total endovascular repair is safe and effective in the treatment of postdissection thoracoabdominal aneurysms, but it needs diligent preoperative planning, precise operative execution and long-term follow-up.

P-321

Intraprocedural contrast enhanced ultrasound for endoleak localization during excluded sac direct puncture

A. Baheti¹, J.F. Angle²

¹Interventional Radiology, University of Virginia, Charlottesville, VA, US,

²Radiology, University of Virginia, Charlottesville, VA, US

Clinical History/Pre-treatment Imaging: An 88yo female status post EVAR in 2013 presented with increasing aneurysm sac size and pain 5 years postoperatively. She underwent an arteriogram at an outside facility, with coil embolization of suspected feeders.

She presented to our institution 4 months after this procedure with CTA showing persistent endoleak, favored to be a type II. A repeat arteriogram showed severely tortuous internal iliac system which was not amenable to catheterization, thus transcaval embolization of the endoleak with Onyx was performed. A repeat CT angiogram shows continued perfusion of the excluded aneurysm sac. The patient returned to IR from direct puncture of endoleak.

Treatment Options/Results: Contrast enhanced ultrasound using non-doppler imaging software was used during the procedure to demonstrate the exact location of the endoleak target. CEUS allowed direct visualization of the leak site, and improved localization of the chiba needle for direct puncture. The excluded sac was then embolized using Onyx. The patient was discharged on PPD1 in stable condition. Follow up imaging is pending.

Discussion: Pre-procedure CEUS for evaluation of endoleak has been described. It can be useful in patients with renal insufficiency or contrast allergy. CEUS may be more sensitive than CTA for detection of type II endoleaks supplied by the inferior mesenteric or lumbar arteries. To our knowledge, there is no description in the literature of intra-procedural CEUS for endoleak targeting. Especially in cases of recalcitrant endoleaks, CEUS can allow for real-time intraprocedural evaluation.

Take-home points: Contrast enhanced ultrasound improves intraprocedural localization of type II endoleaks, especially in the setting of recurrence.

P-322

Near-fatal distraction: endovascular treatment of a type IIIC endoleak and ruptured thoracoabdominal aortic aneurysm

B. DuBois¹, W. Sherk¹, D.M. Williams¹, S. Fukuhara², J.J. Mahn¹, M. Khaja¹

¹Division of Interventional Radiology, University of Michigan Health

System, Ann Arbor, MI, US, ²Department of Cardiac Surgery, University of Michigan, Ann Arbor, MI, US

Clinical History/Pre-treatment Imaging: 77-year-old man with Crawford type II thoracoabdominal aortic aneurysm status post fenestrated TEVAR and EVAR presented 7 months later with chest pain, 3 g/dL hemoglobin drop, and CT Angiogram showing a type IIIC endoleak from a distracted celiac branch stent with a ruptured abdominal aortic aneurysm and large right hemothorax.

Treatment Options/Results: Endovascular repair was performed with 2 overlapping Viabahn stent-grafts deployed across the celiac artery into the abdominal aorta with resolution of the type IIIC endoleak. Right chest

tube was placed to drain the hemothorax. The patient continues to do well at his 3-month follow-up visit.

Discussion: Type IIIC endoleaks occur when fenestrated-branch stents become discontinuous from the aortic portion of the graft. They represent a new class of endoleak following the rise of fenestrated EVARs. While considered a 'late' complication, there is little published data regarding their frequency and characteristics.

Take-home points: Distraction of a fenestrated-branch stent from the aortic base of the graft represents a new class of endoleak, categorized as type IIIC. Fenestrated-branch stent distraction can result in rapid aneurysm expansion and rupture. Treatment options include branch stent relining.

P-323

Fenestration, septotomy, and TEVAR for aortic dissection and mycotic aneurysm

C.S. Branach¹, M. Khaja², W. Sherk², J.J. Mahn³, B. DuBois⁴

¹Department of Vascular and Interventional Radiology, University of Michigan, Ann Arbor, MI, US, ²Department of Interventional Radiology,

University of Michigan, Ann Arbor, MI, US, ³Radiology, University of Michigan, Ann Arbor, MI, US, ⁴Division of Interventional Radiology,

University of Michigan Health System, Ann Arbor, MI, US

Clinical History/Pre-treatment Imaging: 61-year-old female referred to IR for evaluation and treatment of a contained rupture of a descending thoracic dissection and mycotic aneurysm with aortic dissection and false lumen. The patient was not a surgical candidate due to her history including three redo sternotomies and aortic arch replacements. Surveillance CTA revealed para-aortic inflammation with dissection flap extending into the aortiliac bifurcation. Graft infection was confirmed with PET/CT.

Treatment Options/Results: The decision was made to place an endograft to exclude the mycotic aneurysm but the distal landing zone was not adequate; however endovascular management was the patient's only option.

To create an adequate landing zone, the decision was made to perform a fenestration and subsequent septotomy. Two 8Fr sheaths were positioned within the true and false lumen and fenestration was performed with a BRK-1 needle. A guidewire was advanced and snared and was pulled inferiorly to slice through the dissection. With an adequate distal landing zone, two 45x45x100 Gore TAG thoracic endoprostheses were placed; a type III endoleak was identified and excluded via an additional 34x34x150 Gore TAG graft. Completion aortogram revealed patent flow through the stent and exclusion of the aneurysm. The patient tolerated the procedure well, with discharge on POD 7.

Discussion: In a nonsurgical candidate, endovascular repair via fenestration and septotomy allowed creation of a distal landing zone adequate for graft placement.

Take-home points: Unique interventions such as fenestration with subsequent septotomy expands the indications of endovascular interventions in thoracic aortic aneurysm repair and provides an option for treatment in nonsurgical patients.

P-324

"Modified" candy-plug device entrapment during TEVAR for false-lumen embolization in chronic type B aortic dissection rupture

T. Nota¹, E. Sohgewa¹, A. Yamamoto¹, S. Hamamoto¹, A. Jogo¹, K. Kageyama¹, M.M. Nakano¹, S. Ogawa¹, K. Murai¹, H. Yonezawa¹, A. Morisaki², K. Yamane², N. Kishimoto², T. Shibata², Y. Miki¹

¹Diagnostic and Interventional Radiology, Osaka City University Graduate School of Medicine, Osaka, JP, ²Department of Cardiovascular Surgery, Osaka City University Graduate School of Medicine, Osaka, JP

Clinical History/Pre-treatment Imaging: A 60-year-old male with a history of chronic type B aortic dissection who presented chest pain to

the emergency department. Computed tomography revealed a thoracic dissecting aneurysm with false-lumen rupture.

Treatment Options/Results: Emergent thoracic endovascular aortic repair (TEVAR) was performed. TEVAR resulted in suitable sealing over the primary entry tear. To prevent further deterioration of false lumen rupture, we attempted to implant a modified candy-plug device in the false lumen and adjacent to true lumen stent-graft ending above celiac artery. After the candy-shaped device using an Excluder aortic extender was deployed, it was difficult to remove the delivering shaft because the sutured device migrated. We inserted a CODA balloon to expand that entrapped device and pushed up the shaft to tear off the thread. However, the delivering shaft with the nose cone was fractured. A 16-mm Amplatzer Vascular Plug II was placed into the center of the candy-plug device while leaving the broken shaft and successfully occluded the retrograde flow. He was discharged after 14 days and no recurrence was observed.

Discussion: Although candy-plug technique have been reported using some devices, an Excluder aortic extender is easy to modify for lower false lumen diameter. There are some troubles with device modification. Operators should be aware of this complication and be familiar with the measures to manage it.

Take-home points: This is a first report of the modified candy-plug device entrapment of delivering shaft during a false lumen embolization.

P-325

Primary lymphoma of thoracoabdominal aorta

N. Inmutto, T. Srisuwan, T. Kattipatanapong, N. Nimitrungtaewee
Radiology, Chiang Mai University, Chiang Mai, TH

Clinical History/Pre-treatment Imaging: A 78-year-old woman had history of mild abdominal discomfort for 1 month. The abdominal ultrasound revealed eccentric blood clot surrounding the abdominal aorta. Subsequently, computed tomographic (CT) scanning demonstrated a hyperdense lesion around aorta and suspected contained rupture. She underwent emergency TEVAR.

Treatment Options/Results: TEVAR was performed by using Zenith TX2 and Zenith alpha. The 4 weeks follow up CT scan was done and demonstrated patency of stent graft with unchange of soft tissue surrounding the aorta. The second follow up CT scan was obtained and revealed significant increased in size and enhancement of periaortic soft tissue. Malignancy of aorta was suspected. The patient underwent US-guided biopsys. Pathology showed diffuse large B cell lymphoma.

Discussion: Dilatation of aorta with surrounding soft tissue could be intraluminal thrombus, hematoma or malignancy of aorta. Carefully evaluate location and characteristic of soft tissue is important. Intraluminal thrombus is seen inside the lumen and may calcified. Hematoma locates outside the lumen, high attenuation on noncontrast scan and doesn't show enhancement on postcontrast study. Primary malignancies of the aorta are extremely rare. It may appear like an aneurysm or obstruction on arteriogram, as a periaortic mass, or as an aneurysm.

The first CT scan of our patient look like ruptured aorta aneurysm with contained rupture. The follow up CT showed increased size of periaortic soft tissue which suggestive for malignancy in nature.

Take-home points: Primary malignancy of aorta may present like aneurysm. The appearance of periaortic soft tissue is crucial for differential diagnosis ruptured aortic aneurysmal and malignancy of aorta.

P-326

Aortic dissection flap fenestration under IVUS control with subsequent stent-grafting of the aorta after frozen elephant trunk procedure

D.E. Isaev¹, L.S. Kokov², M.V. Parhomenko¹, N.R. Chernaya¹, V.V. Sokolov¹, L. Khamidova³, N.V. Rybalko¹

¹Department of Endovascular Diagnosis and Treatment, The Moscow Department of Health N.V. Sklifosovsky Federal Research Institute of Emergency Medicine, Moscow, RU, ²Radiology, Sechenov First Moscow State Medical University, Moscow, RU, ³Department of Ultrasound Diagnostic, The Moscow Department of Health N.V. Sklifosovsky Federal Research Institute of Emergency Medicine, Moscow, RU

Clinical History/Pre-treatment Imaging: 39 years old male with clinical history of aortic dissection De Bakey I and hypertension had previously been performed supra-aortic repair and frozen elephant trunk technique using the Thoraflex device. After this procedure patient was suggested to perform stent-grafting of the remaining aortic segments. CT-angio reveal dissection from the aortic arch to the aortic bifurcation. Aorta angiogram demonstrated that the distal part of Thoraflex was implanted in false lumen (FL). Dissection flap fenestration using Brockenbrough needle under IVUS control and endografting of the aorta was decided.

Treatment Options/Results: Brockenbrough needle was guided in FL to the site of the IVUS transducer guided in true lumen (TL). Transmembrane puncture under IVUS control was performed. Aortic fenestration in the origin of diaphragma using balloon catheter (6,0 mm x 60 mm x 130 cm) was made. Stent-graft was implanted from the distal part of the Thoraflex to the celiac trunk origin. Stent-graft was extended using aortic stent to the origin of L3 vertebra. Balloon angioplasty after stent-graft and aortic stent implantation was performed. Post-operative CT scan demonstrated obliteration of the FL on all extent.

Discussion: Most studies described dissection flap fenestration as an option for visceral malperfusion prevent or arrest the process of retrograde false lumen thrombosis. In our case fenestration was performed to restore flow in the TL from the Thoraflex prothesis which was falsely locate in the FL.

Take-home points: Endovascular dissection flap fenestration under IVUS control is feasible and low-risk option for restoring perfusion between falsely located prothesis in the FL and TL.

P-327

Inside & outside fenestration of TEVAR in case of dissection type A

M.R. Sharafutdinov¹, U.U. Akhmedov²

¹Interventional Radiology, Regional Emergency Center, Naberezhnye Chelny, RU, ²Cardiac Surgery, Regional Emergency Center, Naberezhnye Chelny, RU

Clinical History/Pre-treatment Imaging: Marfan syndrome (mutation FBN1). Supracoronary repairing aneurysm of ascending part of aorta with aortic valve in 2001

In present: Aortic dissection type A with malperfusion syndrome and TIA risk factors:

atherosclerosis, cholesterol > 4,8 mmol/l

Hypertension > 160/110 mm.Hg

dilatation of ascending aorta 49.5mm

Treatment Options/Results: Aortic banding from mini-J sternotomy access, diameter aorta after banding 42 mm. Making outside fenestration of stent-graft. After TEVAR poor blood circulation in left CCA and subclavian artery. Blood flow in brachiocephalic trunk is saved. Take decision to inside fenestration of stent-graft with "Outback" catheter in to the left CCA and subclavian artery. The patient was discharged after surgery in good condition without neurological deficit.

Discussion: Surgical treatment with circulation arrest and hypothermia remains the gold standard for the treatment of the aortic arch pathology

but associated with high rates mortality. Using of fenestrated or branched TEVAR and Chimney technology can be attractive treatments for diseases of the aortic arch but they have the high cost, and custom made stent-grafts inability to wait for a few weeks production delay. That's why, we making inside & outside fenestration was used for patients with type A aortic dissection. Our emergency center conducted this treatment in three cases, with follow up 7 months.

Take-home points: The use of inside & outside fenestration has demonstrated efficacy, minimal invasiveness and could be a treatment option and alternative to open surgery for ascending aorta and aortic arch aneurysm and its branches. The patient safely transfers the postoperative period and reduces hospitalization time.

P-328

Endovascular fenestration of aortic dissection membrane after failed frozen elephant trunk procedure: the elegant solution of a catastrophic complication

J. Raupach¹, J. Vojacek², V. Chovanec¹, V. Kozakova¹

¹Department of Radiology, University Hospital, Hradec Králové, CZ,

²Department of Cardiosurgery, University Hospital, Hradec Králové, CZ

Clinical History/Pre-treatment Imaging: A 51 years old male was admitted for severe chest and abdominal pain. On CT, there was an acute aortic dissection type A involving the entire aorta with progression into both iliac arteries and a collapse of the true lumen. Under hypothermic circulatory arrest and selective antegrade cerebral perfusion a Thoraflex™ Hybrid Prosthesis was deployed. Subsequently, the aortic arch and supra-coronary part of ascending aorta were replaced. However, multi-organ failure immediately developed. CT angiography revealed an incorrect placement of the distal end of FET prosthesis into the false lumen.

Treatment Options/Results: Endovascular fenestration of the dissection flap with use of a peripheral re-entry catheter Outback 6F (Cordis, Miami, FL, US) was performed. Fenestration was supported by two thoracic stent graft extension. Despite several complications in healing, the patient recovered well and 8 months control CT angiography, a complete thrombosis and regression of the false lumen in the level of descending aorta was confirmed together with good perfusion of the visceral arteries.

Discussion: Re-entry catheter Outback was firstly described for aortic fenestration of complicated dissection B by Wuest in 2011. Largest series of 13 patients where Outback was used for aortic dissection fenestration was published by Wolfschmidt in 2015. Our case represents a first application of this technique for fenestration of incorrect FET prosthesis placement in to the false lumen, which resulted in acute multiorgan failure.

Take-home points: We consider this technique very efficient and safe and should be available in all centres where dissection treatment and FET procedures are performed.

P-329

TEVAR-BMS-EVAR in high-risk Marfan patient: a clinical case

M. Chernyavskiy, N. Zherdev, D. Chernova, A. Chernov, Y. Kudaev
Scientific Department of Vascular and Interventional Surgery, Almazov National Medical Research Centre, Saint Petersburg, RU

Clinical History/Pre-treatment Imaging: We describe the Petticoat technique using 2 thoracic grafts, bare metal stent and bifurcation graft in Marfan patient with complex past medical history. In 2009 mitral valve replacement, in 2015 Bentall procedure and partial debranching performed. In 1 year we did innominate artery bypass stenting because of proximal anastomosis narrowing. In sequel - dissection and aneurysm forming. Patient with severe concomitant pathology, kyphoscoliosis, giant thoracoabdominal dissection with aneurysm forming till femoral arteries.

Treatment Options/Results: We started with TEVAR till celiac trunk. In control CT - no significant changes in false lumen and aneurysm size. The next steps - full Petticoat on October/2018. Bare metal stent was implanted into the abdominal aorta. EVAR was performed the next step. We

isolated proximal and distal false lumen fenestrations and expect false lumen thrombosis and stop aneurism progression instead of permanent vitamin K antagonist intake.

Discussion: Positive remodeling of the entire aorta occurred in same cases according some papers data: false lumen thrombosis at the thoracic level with true lumen expansion at the visceral aorta at the 18-month CT angiogram.

Take-home points: Endovascular approach is not common in Marfan patients. But in this case it was conditioned by difficult past history and significant concomitant pathology. We suppose endovascular approach is safe and applicable in high-risk Marfan patients.

P-330

A case of total thrombotic occlusion of abdominal stentgraft after EVAR

S. Nagatomi, S. Ichihashi, S. Iwakoshi, H. Taguchi, Y. Yoshiyama, T. Nakai, H. Kishida, K. Kichikawa

Radiology and IVR center, Nara Medical University, Kashihara, JP

Clinical History/Pre-treatment Imaging: An 80's male, who had undergone endovascular aortic repair (EVAR) using Zenith for abdominal aortic aneurysm 3 weeks before, was admitted to our hospital with sudden hypoesthesia and coldness in bilateral lower extremities during bicycle ride. CT showed total thrombotic occlusion of the stent-graft from infra-renal aorta to bilateral external iliac arteries (EIA).

Treatment Options/Results: With bilateral femoral approach, thrombectomy using Fogarty catheter was performed. Then thrombosed stentgraft was relined with Excluder legs and Viabahn endoprostheses to exclude the massive thrombus. As there was residual calcified stenosis in left common femoral artery, endarterectomy was subsequently done to obtain sufficient outflow. During the procedure, distal embolism occurred in femoropopliteal and below the knee arteries, which was dealt with additional thrombectomy, balloon angioplasty and stent implantation in superficial femoral artery (SFA). The patient was discharged 1.5 month after procedure with no ischemic symptom. CT scanned 6 month later showed patent stent-graft.

Discussion: This is an extremely rare complication of acute thrombotic occlusion of entire stent-graft. The complication occurred probably due to stentgraft implantation with bilateral EIA landing and the poor vessel runoff with severe occlusive lesions in bilateral SFA. Literature search has identified only one case of thrombotic occlusion 5 months after EVAR using Anaconda device due to infolding of large iliac limb implanted in tortuous common iliac artery.

Take-home points: Thrombectomy and relining with additional stent-grafts were effective in a case of total thrombosis of the abdominal stentgraft. Particularly in cases with severe occlusive lesions in outflow vessels, angioplasty should be considered for securing vessel runoff.

P-331

A case of a high-risk patient treated by a modified candy-plug technique in emergency setting

D. Spinelli¹, D. Barillà², F. La Corte¹, N. Pipitò¹, F. Benedetto¹

¹Vascular Surgery, Policlinico Universitario G. Martino, Messina, IT, ²Cardiothoracic Surgery, Policlinico Universitario G. Martino of Messina, Messina, IT

Clinical History/Pre-treatment Imaging: A 79 year-old lady, treated in 2011 for acute type B aortic dissection at another institution by thoracic aortic endovascular repair (TEVAR), was admitted to the emergency room of our hospital for hemoptysis. As risk factors, she had arterial hypertension, chronic kidney disease, diabetes mellitus and chronic obstructive pulmonary disease.

The preoperative computed-tomography-angiography (CTA) showed false lumen (FL) distal extension and increased FL diameter (46mm). The right renal artery (RRA) branched from the FL (Fig.1).

Treatment Options/Results: The patient was treated by a modified Candy-Plug technique in order to occlude the FL, using a back-table-modified 28x100x28mm thoracic stentgraft (TAG, WL Gore, Phoenix, AZ, USA) and a 18x14mm Amplatzer Vascular Plug II (AVP II), implantation of a 14x10mm AVP II and 2 pushable coils in order to occlude the left subclavian artery and RRA fenestration/stenting with a 6x39mm covered stent (Fig.2).

Discussion: Candy-Plug is a challenging technique reserved to high-risk patients. This technique makes it possible the exclusion of a patent FL with a treatment limited to the thoracic aorta. The reported technique is feasible with materials commonly available also in emergency setting.

Take-home points: Candy-Plug Technique is a valuable tool for the treatment of secondarily complicated chronic aortic dissections, being feasible in a variety of settings and patients.

Further experience is necessary to confirm its effectiveness in the long term.

P-332

Saving inferior mesenteric artery with parallel grafts

V.Z. Cvetic¹, B. Lukić², M. Čolić¹

¹Center for Radiology and MR, Clinical Center of Serbia, Belgrade, RS, ²Centre for Radiology and MR, Clinical Centre of Serbia, Belgrade, RS

Clinical History/Pre-treatment Imaging: A 76-year-old patient underwent emergency surgery due to ruptured aneurysm of the abdominal aorta in our institution, seven years ago. After supraceliac clamping and adequate control of bleeding, aorta was reconstructed by a synthetic graft, with aorto- right iliacal - left femoral with reimplantation of the inferior mesenteric artery (IMA). Because the patient at the last control complained of severe back pain, control MDCT examination was performed and showing the existence of large pseudoaneurysm in region between the synthetic graft and reimplanted IMA.

Treatment Options/Results: Cardiac comorbidity and hostile abdomen precluded any open repair while short neck and colateral network made coil embolisation or exclusion with covered stent risky. Narrow distal aortic diameter made bifurcated stent graft implantation difficult.

We implanted Endurant (Medtronic) tube graft in distal part of dacron graft until its bifurcation with parallel implantation of Ventus (Jotec) covered stent in inferior mesenteric artery. Finally due to type Ib endoleak we added kissing iliac extensions inside tube graft.

The patient was discharged in good general medical condition 7 days following endovascular treatment. After one month of follow-up, the patient's condition was satisfying and MDCT finding was correct, with no CT signs of endoleak.

Discussion: For these patients ChEVAR can be completed with a high degree of success. However, perioperative complications including loss of chimney patency and endoleak, may occur at a higher rate than standard EVAR.

Take-home points: Elective use of ChEVAR should be performed with caution, and needed to determine long-term efficacy of this technique.

P-333

Combined use of Excluder IBE and VIABAHN endoprosthesis enables endovascular exclusion of hypogastric artery aneurysm while preserving hypogastric branches

T. Nakai¹, S. Ichihashi¹, Y. Tamura², S. Maeda³, M. Takewa³, K. Kichikawa¹

¹Diagnostic and Interventional Radiology, Nara Medical University, Kashihara, Nara, JP, ²Cardiovascular Surgery, Nara Prefecture Seiwa Medical Center, Ikoma, Nara, JP, ³Radiology, Nara Prefecture Seiwa Medical Center, Ikoma, Nara, JP

Clinical History/Pre-treatment Imaging: A 74-year-old man was referred to our department for an asymptomatic hypogastric artery aneurysm (HAA) and coexisting common iliac artery aneurysm (CIAA) and abdominal

aortic aneurysm (AAA). The contrast-enhanced CT scan showed HAA was 65mm in a minor axis.

Treatment Options/Results: First, major hypogastric branches including inferior gluteal artery and iliolumbar artery were embolized with coils and a plug before the Iliac branch component (IBC) was deployed. Then, VIABAHN was introduced into superior gluteal artery (SGA) and deployed. Sac embolization was subsequently done using NBCA/Lipiodol mixture via the second microcatheter advanced into HA sac in a parallel fashion. Finally, internal iliac component was deployed bridging between VIABAHN and IBC, followed by deployment of the Main body of Excluder C3 device. Final angiogram showed complete exclusion of the aneurysms with preserving flow into SGA.

Discussion: Gore Excluder Iliac Branch Endoprosthesis is the only branched device that has been available for CIAA in Japan. In a case of CIAA with coexisting HAA, a use of VIABAHN endoprosthesis enables distal landing in the hypogastric branches and preservation of the flow. To prevent type 2 endoleak, sac embolization using NBCA/Lipiodol mixture was performed via the second microcatheter which was advanced into HAA sac, outside of VIABAHN. The VIABAHN deployed in SGA can prevent unselective embolization by glue and secure the branch flow.

Take-home points: HAA was successfully excluded by combined use of VIABAHN and Excluder IBE. Primary stent-grafting into a gluteal branch enables safe sac embolization and preservation of the branch flow.

P-334

Staged comprehensive-endovascular-aortic-repair

S.S. Amin¹, O. Eldergash², J. Schnabel², R.P. Thomas³, T. Kowald¹, A. Weymann⁴, J. Easo⁴, M. Book⁵, A. Chavan⁶

¹Institut für diagnostische und interventionelle Radiologie, Klinikum Oldenburg, Oldenburg, DE, ²Radiology, Klinikum Oldenburg, Oldenburg, DE, ³Diagnostic and Interventional Radiology, University Hospital, Philipps University Marburg, Marburg, DE, ⁴Department of Cardiothoracic surgery, Klinikum Oldenburg AöR, Oldenburg, DE, ⁵Department of Anaesthesia and Intensive Medicine, Klinikum Oldenburg AöR, Oldenburg, DE, ⁶Institut für Diagnostische und Interventionelle Radiologie, Klinikum Region Hannover GmbH, Neustadt, DE

Clinical History/Pre-treatment Imaging: Our 63 year old patient presented initially with an acute type B aortic dissection accompanied by large aneurysm of the left iliac artery. The iliac aneurysm was repaired surgically and the dissection was managed conservatively. Over a period of 3 years the patient developed post-dissection aneurysm of the thoracic aorta in the follow-up CT's. Consequently TEVAR was performed which was eventually followed by surgical-graft repair due to endoleak. The follow up scans over 6 years revealed progressive post-dissection thoracoabdominal and right iliac aneurysm and patient complained of right sided claudication.

Treatment Options/Results: A multidisciplinary decision was made to perform a comprehensive endovascular repair of the aorta and the iliacs in 2 stages. Firstly the surgically implanted thoracic endograft was extended into thoracoabdominal aorta with fenestrated thoracic endograft. The second stage after 2.5 months involved the endograft extension along the abdominal aorta into iliacs with branching in the right iliac artery. A pre-interventional liquor drain was placed to manage likely ischemic spinal complications. However no ischemic complications were noted. The follow-up scans presented astounding results of complete aortic remodelling, the patient was completely asymptomatic.

Discussion: Complicated aortic dissections involving the arch and thoracoabdominal aorta have always been a challenging topic in endovascular surgery. Our case here demonstrates the technical feasibility and success of a planned and staged approach in the comprehensive repair of the aorta with new generation endografts without any complications.

Take-home points: This appeals for a less conservative approach in the new era of endovascular aortic repair in dissections.

Experimental work in IR

P-335

CBCT-based image guidance for percutaneous access - electro-magnetic navigation versus 3D image fusion with fluoroscopy versus combination of both technologies - a phantom study

M. Blain¹, E. Hérin¹, H. Derbel¹, M. Chiaradia², H. Kobeiter³, V. Tacher⁴
¹Radiology, Henri Mondor University Hospital, Créteil, FR, ²Service d'Imagerie Médicale, CHU Henri Mondor, Créteil, FR, ³Department of Radiology, Henri Mondor Hospital, Créteil, FR, ⁴Interventional Radiology, CHU Henri Mondor, Créteil, FR

Purpose: Evaluation of effectiveness, intervention time, x-ray exposure and precision of CBCT images based guidance for puncture of targets on an abdominal phantom with acute angle accesses (<45°) using 3D-image fusion with fluoroscopy (group-F), electromagnetic navigation (group-EM) or both technologies (group-EM+F) and with large angle accesses (>45°) for groups-EM and EM+F.

Material and methods: On an abdominal phantom (CIRS, Meditest, Tabuteau, France), four targets of 11mm[10-11] with acute angles accesses and four targets of 10mm[8-15] with large angles accesses were defined and punctured by 4 operators with various experiences. Effectiveness (target reached), intervention time, x-ray exposure, and precision (distance between the needle tip and target center), were reported and compared. **Results:** All targets were reached (100% effectiveness) with similar study parameters among operators. For targets with acute angles accesses among groups-EM, F and EM+F, intervention times (265s[236-360], 292s[260-345] and 320s[240-333], respectively) and precision (3mm[2-5], 2mm[1-3] and 3mm[2-4]) were similar whereas x-ray exposure was significantly reduced in group-EM (0, 708mGy.cm2[599-1128] and 51mGy.cm2[15-150]; p<0.001). For targets with large angles accesses among groups-EM and EM+F, intervention times (345s[259-457] and 425s[340-473], respectively; p=0.01), and x-ray exposure (0 and 159mGy.cm2[39-316]; p<0.001) were significantly reduced in group-EM with higher precision (4mm[4-6] and 4mm[3-4]; p=0.01).

Conclusion: Effectiveness and precision of puncture for acute target angle accesses in groups-EM, F and EM+F were similar. Group-EM was not limited to acute angle and did not necessitate x-ray exposure to reach the target. For large angle accesses the combination of EM+F increased precision at the cost of intervention time and x-ray exposure. These results need to be confirmed in a clinical trial.

P-336

Local application of Fe₂O₃-PDA-Dox and the vascular disrupting agent CA4P via the hepatic artery: chemoembolization-photo-thermal ablation treatment of liver cancer in rats

H. Yuan, F. Liu, X. Li
 Department of Interventional Radiology, People's Liberation Army General Hospital, Beijing, CN

Purpose: This study investigates the effectiveness of local application of Fe₂O₃-PDA-Dox nanoparticles and CA4P in treating liver cancer in rats.

Material and methods: The magnetic characteristics and photothermal effects of the nanoparticles were determined in vitro. Tumor-bearing Sprague-Dawley rats were divided into 3 groups of 8 according to treatment: controls, transarterial chemoembolization (pTACE)(Lipidol+Fe₂O₃-PDA-Dox+NIR), and CA4P + pTACE (CA4P+ Lipidol+Fe₂O₃-PDA-Dox+NIR). Drugs were administered through the hepatic artery, and the tumors exposed to 808-nm near-infrared radiation. The Fe content of tumors was assessed using neutron activation analysis. Treatment effectiveness was assessed using heating curves, imaging, pathology results, and immunohistochemical analysis.

Results: The mean tumor Fe content was greater in rats treated with CA4P + pTACE (1 h, 23.72 ± 12.45 µg/g; 24 h, 14.61 ± 8.23 µg/g) than in

those treated with pTACE alone (1 h, 5.66 ± 4.29 µg/g; 24 h, 2.76 ± 1.33 µg/g). The tumor T2 MRI signal was lower in rats treated with CA4P + pTACE. Following laser irradiation, the tumor temperature increased, with higher temperatures reached in the CA4P + pTACE group (62°C vs 55°C). Tumor cells exhibited necrosis, apoptosis, and proliferation inhibition, with greater effects in the CA4P + pTACE group. Transient liver and kidney toxicity were observed on day 3, with more severe effects after CA4P + pTACE.

Conclusion: Fe₂O₃-PDA-Dox nanoparticles are effective for TACE-PTA. Pretreatment with CA4P increases nanoparticle uptake by rat liver tumors, increasing the treatment effectiveness without increasing hepatorenal toxicity. This technique presents new options for liver cancer treatment.

P-337

Iradubicin-loaded superabsorbent polymer microsphere: in vivo analysis using rabbit VX2 liver tumor model

Y. Kimura¹, K. Osuga¹, K. Nagai², H. Hongyo¹, K. Tanaka¹, Y. Ono¹, H. Higashihara¹, N. Tomiyama¹
¹Department of Radiology, Osaka University Graduate School of Medicine, Suita, JP, ²Diagnostic and Interventional Radiology, Osaka University Graduate School of Medicine, Suita, Osaka, JP

Purpose: This study aimed to investigate the safety and efficacy of idarubicin (IDR) loaded superabsorbent polymer microspheres (HepaSphere™: HS) using rabbit VX2 liver tumor model.

Material and methods: Twelve rabbits with solitary VX2 liver tumor were randomly divided into two groups: transarterial chemoembolization using IDR-loaded HS group (Group 1, n=6) and transarterial IDR infusion with unloaded HS embolization group (Group 2, n=6). In Group 1, HS containing 0.5mg of IDR was injected into the left hepatic artery. In Group 2, 0.5mg of IDR was injected via the left hepatic artery followed by embolization using unloaded HS. The size of dry HS was 30–60 µm in each group. The VX2 tumor diameter ratio and volume ratio of day 7 to before treatment was calculated in each group with reference to computed tomographic images. Serum chemistry before and after the procedure (day1 and day 7) was evaluated. Histopathologic analysis using H-E staining and Ki-67 staining was performed.

Results: Median tumor diameter ratio and volume ratio of Group 1 and Group 2 were 1.1 times and 1.5 times (p=0.07), and 1.8 times and 3.4 times (p=0.02), respectively. Serum chemistry showed no significant difference between 2 groups at each time point. Regarding the histopathological analysis, no significant difference in tumor necrosis rate (79% vs 70%, p=0.82), but Ki-67 index was significantly lower in Group 1 (0.5% vs 3.3%, p=0.02).

Conclusion: In this in-vivo study, chemoembolization using IDR-loaded HS suppress tumor growth when compared with IDR injection with embolization using unloaded HS. A clinical feasibility study is warranted.

P-338

Flow cessation time and morphological evaluation of NBCA-lipiodol mixture in an in vitro flow model

N. Hayashi¹, H. Miura¹, Y. Takeuchi², Y. Arima³, M. Toda³, T. Okamoto¹, S. Asai¹, K. Sakai¹, T. Hirota¹, K. Yamada¹
¹Radiology, Kyoto Prefectural University of Medicine, Kyoto, JP, ²Radiology, Fukuchiyama City Hospital, Kyoto, JP, ³Institute for Frontier Life and Medical Sciences, Kyoto University, Kyoto, JP

Purpose: To measure the flow cessation time of NBCA-lipiodol mixture (NL) and evaluate the morphological change of NL in an in vitro flow model.

Material and methods: The flow model was a 2-mm inner diameter polyvinyl alcohol tube connected to a pulsation pump. Bovine serum was circulated at 30 ml/min and 60 bpm. A 0.64-mm inner diameter microcatheter was inserted and 0.5 mL of NL was injected. NL concentrations were as follows: 66, 50, 40, 33, and 20 vol% NBCA, and 100 vol% (i.e. absolute

NBCA). The flow cessation time was defined as the time until the flow stopped draining from the tube end. We measured the flow cessation time of each NL concentration and compared it with the polymerization time from the drop test. The dynamic behavior of NL at each concentration from the microcatheter was observed using a high-speed camera. The appearance of NL was evaluated on X-ray images of the tubes.

Results: The mean flow cessation time for 100, 66, 50, 40, 33, and 20 vol% NL was 0.32 ± 0.11 , 0.91 ± 0.59 , 1.61 ± 1.15 , 3.97 ± 1.89 , 4.91 ± 1.42 , and 9.51 ± 1.43 seconds, respectively. The flow cessation time was significantly shorter than the polymerization time, except for absolute NBCA ($p < 0.05$). Regarding dynamic behavior, the cast formed immediately with high concentration NL, whereas sludge or small fragments preceded the cast with low concentration NL. On X-ray images, small fragments were observed in 40, 33, and 20 vol% NL.

Conclusion: NL stopped vascular flow before complete polymerization. Low concentration NL was frequently fragmented after injection.

P-339

The first pass effect on contrast induced nephropathy (CIN) with transcatheter intraarterial injection of contrast media via renal artery and the prevention even after contrast administration: an experimental study in rats

K. Okumura, J. Matsumoto, T. Sugiura, T. Ogi, W. Koda, S. Kobayashi, T. Gabata
Radiology, Graduate School of Medical Sciences, Kanazawa University, Kanazawa City, JP

Purpose: To evaluate the CIN incidence and its mortality following direct intraarterial contrast medium (IA-CM) administration with first-pass renal exposure, which is a topic of European Society of Urogenital Radiology guideline (version 10.0), and the usefulness of direct hydration to renal arteries after administration

Material and methods: Adult male Sprague-Dawley rats (450–500g), after internal carotid artery cutdown and microcatheter inserted, received IA indomethacin (10mg/kg), N-nitro-L-arginine methyl ester (10mg/kg), and iopamidol (10mL/kg) to induce acute contrast-induced renal injury; Rats received IA-CM with (n=3) and without fist-pass renal exposure (n=4). CIN was evaluated by assaying blood tests collected after 24–48h and before the contrast injection, and examining the kidneys histopathologically. Direct renal artery hydration was performed with the same amount of physiological saline as the administered contrast agent (n=5). Mortality rate were compared between with (n=7) and without first-pass renal artery group (n=6).

Results: The median survival of IA-CM with fist-pass were approximately 24hours and the others is all alive. In evaluation for the surviving rats, the median elevated values of serum BUN and Cr were 429% and 400% after IA-CM with first-pass renal exposure, respectively. These were higher than groups without first-pass renal exposure (100% and 67%, respectively, $P < .05$) and in groups with hydration (100% and 71%, respectively, $P < .05$).

Conclusion: IA-CM administration with first-pass renal exposure could relate to pose a greater risk of CIN and induce high mortality. And even after administration of the contrast medium, hydration directly to the renal artery would be effective in preventing CIN.

P-340

Systematic evaluation of drainage fluids viscosity

D. Pinto dos Santos¹, R. Kloeckner², S.-H. Chon³, H.-U. Laasch⁴

¹Radiology, University of Cologne, Köln, DE, ²Department of Diagnostic and Interventional Radiology, University Medical Center of the Johannes Gutenberg University Mainz, Mainz, DE, ³Surgery, University of Cologne, Köln, DE, ⁴Dept. of Radiology, The Christie, Manchester, UK

Purpose: Currently, there is almost no evidence which size of drainage to use for percutaneous removal of fluid collections (e.g. abscesses, bilomas,

etc.). While some use 12 French as standard for percutaneous drainage, others argue that smaller drainages might suffice.

The aim of this ongoing study was therefore to analyze various drainage fluids with regards to their viscosity and to establish a fluid model for testing of various drainages.

Material and methods: In this IRB-approved study, until now, we collected 42 samples of fluids from various interventional and surgical procedures. Kinematic viscosity was measured using an Ubbelohde viscosimeter (ISO I). All measurements were performed at 37° C in a water bath to ensure reproducible conditions.

Results: Mean kinematic viscosity of serous fluids was 106.1 ± 25.2 mm²/s. While bile had a significantly higher kinematic viscosity of 379.5 ± 26.1 mm²/s. All measurements of pus-like fluids from abscesses failed due to clogging of the viscosimeter.

Conclusion: Most serous fluids have viscosities very similar to water, while bile is almost four times as viscous as water. Due to the inhomogeneous nature of pus further measurements using more sophisticated devices are needed (and already planned) to determine its viscosity. In the future this work will help to establish a fluid model to evaluate various drainage models so that evidence can be provided to maximize patient comfort while ensuring sufficient drainage capacity.

P-341

Initial experience of a novel drug delivery system for anticancer agent: monodisperse solid-in-oil-in-water emulsion using VX-2 tumor bearing rabbits

D. Yasui¹, S. Murata², T. Ueda¹, F. Sugihara¹, H. Saito¹, I. Tanaka¹, S. Shirai¹, H. Itoh³, M. Kobayashi³, A. Yamane⁴, S.-I. Kumita¹

¹Radiology, Nippon Medical School, Tokyo, JP, ²Radiology/Interventional Radiology Center, Teikyo University Chiba Medical Center, Chiba, JP, ³Veterinary Oncology, Advanced Animal Medical Center, Shizuoka, JP, ⁴Radiology, Nippon Medical School Musashikosugi Hospital, Kanagawa, JP

Purpose: Transcatheter arterial chemoembolization (TACE) is a standard of care for unresectable hepatocellular carcinoma; however, bile duct ischemia is one of the most severe complications. Finely-calibrated small-sized emulsion will path through the peribiliary plexus, thus ischemia can be avoided. The purpose of this study is to evaluate the safety and efficacy of monodisperse solid-in-oil-in-water (s/o/w) emulsion: miriplatin-lipiodol emulsion.

Material and methods: TACE was performed for 3 VX-2 tumor bearing rabbits (14 weeks old, body weight: 2.7 ± 0.09 kg). The monodisperse miriplatin-lipiodol emulsion was prepared using 20µm Shirasu-porous-glass membrane (SPG techno, Miyazaki, Japan) and 0.1mL of the emulsion was injected from the proper hepatic artery. All rabbits were sacrificed two days after the procedure. Pathological evaluation, as well as CT scan, were performed. Incidence of bile duct ischemia and tumor necrosis rate were evaluated with H&E stain. Oil O red stain was performed to evaluate the area of lipiodol accumulation. The amount of ipiodol in tumor tissue was measured by inductively coupled plasma mass spectrometry. Quantitative image analysis was performed using ImageJ and OpenCV.

Results: No finding of bile duct ischemia, as well as cholecystitis, was observed. Area of necrosis was 40.0, 70.1, and 19.4%, respectively. Lipiodol accumulation was observed in 4.1, 11.7, and 0.9% of the whole tumor, respectively. The amount of lipiodol in tumor tissue was 1100, 1400, and 700 ppm, respectively. CT density of the tumor was 95.9 ± 28.1 , 233.3 ± 130.0 , 54.6 ± 31.1 HU, respectively.

Conclusion: Monodisperse miriplatin s/o/w emulsion may be a safe and effective alternative for conventional suspension.

P-342

Thermal effect of irreversible electroporation a high-frequency irreversible electroporation inside metallic stent ex vivo

T. Juza¹, T. Rohan², P. Matkulčík³, D. Cervinka⁴, V. Novotná⁴, V. Válek⁵, T. Andrašina⁶

¹Department of Radiology and Nuclear Medicine, Faculty Hospital Brno and Masaryk University, Brno, CZ, ²Radiology and Nuclear Medicine, FN Brno, Brno, CZ, ³Medical Faculty, Masaryk University Brno, Brno, CZ, ⁴Faculty of Electrical Engineering and Communication, Technical University Brno, Brno, CZ, ⁵Department of Radiology, University Hospital Brno, Masaryk University, Brno, CZ, ⁶Department of Radiology and Nuclear Medicine, Faculty Hospital Brno, Brno, CZ

Purpose: To compare electrical and thermal parameters of irreversible electroporation (IRE) and high-frequency irreversible electroporation (H-FIRE) using tubular electrode prototype in biliary metal stent.

Material and methods: 3-electrode tubular catheter prototype was placed inside metallic biliary stent in ex vivo porcine liver model. 3 scenarios of stent occlusion using 2±1 mm thick piece of liver parenchyma were simulated. Only 2 electrodes were active in each time.

IRE were performed by one hundred pulses at voltages 300V, 650V, 1000V and 1300V with 100 µs pulse length. H-FIRE is a newer modification of electroporation methods using, in our case, 100 µs burst of alternating polarity pulses of 2,5; 5; 10 and 25 µs length, pause between pulses 0,5, 1 and 1,5 seconds with the same voltages as IRE.

Values of electric current were measured. Thermal effects were monitored by infrared thermal imaging camera.

Results: IRE and H-FIRE procedures were feasible in all settings with simulated obstruction of the voltages of 300 and 650V and in most of the cases with 1000 V. In higher voltages the safety limit of generator (12A) were exceeded. No significant difference in heating between IRE and H-FIRE was observed (p=0,49, Mann-Whitney). Maximal temperature increase in both methods was 7°C at 1000 V in model with one electrode in direct in contact with the stent and the other one with simulated obstruction.

Conclusion: No significant differences in thermal effects between IRE and H-FIRE delivering comparable amount of energy in metal stent were observed.

P-343

Balloon-assisted packing of wide-neck aneurysms using n-butyl cyanoacrylate-lipiodol-ethanol mixture in swine: a comparison of four concentrations of n-butyl cyanoacrylate

M. Hama¹, M. Nakai¹, A. Ikoma¹, F. Tanaka¹, H. Sato¹, T. Koyama¹, A. Kamisako¹, R. Okuhira¹, S. Ueda¹, M. Koike¹, K. Warigaya², S. Murata², T. Sonomura¹

¹Radiology, Wakayama Medical University, Wakayama, JP, ²Human Pathology, Wakayama Medical University, Wakayama, JP

Purpose: To clarify the optimal ratio of N-butyl cyanoacrylate (NBCA)-Lipiodol-Ethanol mixture (NLE) in balloon-assisted packing of wide neck aneurysms in swine.

Material and methods: We used 8 normal swine (Duroc species, female) and created 32 wide neck aneurysms (a neck length ≥4 mm, a dome-to-neck ratio <2.0) on the bilateral common carotid arteries and external iliac arteries under general anesthesia. Thereafter, we performed packing of the aneurysms using NLE with four different concentrations NBCA (40%, 30%, 20% and 14.3%) under balloon occlusion. We evaluated the state of the aneurysms by angiography before and after packing and compared the adhesion between NLE and balloon as well as the migration of NLE. Three days later, the aneurysms were removed and were evaluated histopathologically.

Results: Packing was not performed in 5 of the 32 aneurysms due to the spasm of the arteries and incomplete creation of the aneurysms. No adhesion between NLE and balloon was observed in any group. Migration of NLE was seen in 0/7 in the 40% NBCA group, 0/6 in the 30%

NBCA group, 5/6 in the 20% NBCA group and 7/8 in the 14.3% NBCA group. Medial necrosis of the arterial wall close to the aneurysms was observed in all groups.

Conclusion: In balloon-assisted packing of wide neck aneurysms in swine, NLE with a NBCA concentration of 30% or more can be a safe and reliable embolic material.

P-344

Balloon-expandable biodegradable stents versus self-expandable metallic stents: a comparison study of stent-induced tissue hyperplasia in the rat urethra

J.-H. Park, K.Y. Kim, N.G. Bekheet, J.S. Kim

Radiology and Research Institute of Radiology, Asan Medical Center, Seoul, KR

Purpose: The aim of this study was to compare the degrees of stent-induced tissue hyperplasia of balloon-expandable biodegradable stents (BEBs) with self-expandable metallic stents (SEMSs) in a rat urethral model.

Material and methods: All experiments were approved by the committee of animal research. A total of 20 male Sprague-Dawley rats were randomized in two groups. BEBS group (n=10) received poly-L-lactic acid (PLLA) biodegradable stent. SEMS group (n=10) received nitinol bare stent. All rats were sacrificed 8 weeks after stent placement. The degree of stent-induced tissue hyperplasia was assessed by comparing the results of retrograde urethrography and histologic examination between two groups. The Mann-Whitney U test was used to evaluate differences.

Results: Stent placement was technically successful in all rats. Two rats in BEBS group were excluded because of procedure-related death. The mean luminal diameter of stented urethra on urethrograms was no significant difference at 4 and 8 weeks between the two groups. At histologic analysis, the percentage of granulation tissue area (p < 0.001), thickness of papillary projection (p < 0.001), and inflammatory cell infiltration (p = 0.050) were significantly higher in BEBS group compared with SEMS group. There were no statistical differences in the number of epithelial layers and thickness of submucosal fibrosis between two groups.

Conclusion: Formation of stent-induced tissue hyperplasia was significantly evident in the rat urethra with similar degrees between BEBS and SEMS. The BEBS was associated with a thicker papillary projection and larger granulation tissue area resulting from higher inflammation compared with SEMS.

P-345

NIR-absorbing gold nanoparticle-coated stent-mediated photothermal therapy suppresses stent-induced tissue hyperplasia

J.-H. Park, K.Y. Kim, N.G. Bekheet, H.-Y. Song, J.S. Kim

Radiology and Research Institute of Radiology, Asan Medical Center, Seoul, KR

Purpose: The aim was to investigate the effectiveness of photothermal (PT)-mediated local heating for suppressing stent-induced tissue hyperplasia and to evaluate in vivo temperature during local heating in the rat gastric outlet.

Material and methods: All experiments were approved by animal research committee. A branched gold nanoparticle (BGNP)-coated, self-expandable metallic stent (SEMS) was produced for PT-mediated local heating under near-infrared laser irradiation. Forty-five rats were randomly divided into three groups (15 rats each). Group A received non-coated SEMS. Group B received BGNP-coated SEMS with local heating at 55°C. Group C received BGNP-coated SEMS without local heating. Five rats in each group were sacrificed after heating; the remaining 10 rats were sacrificed 4 weeks after stent placement. The effectiveness of local heating was assessed by western blot and histopathological analysis results.

Results: BGNP-coated SEMSs were successfully fabricated. All procedures were successful in all rats. Stent-induced tissue hyperplasia-related

variables were significantly lower in group B than in groups A and C (all $p < 0.001$). The mean degree of CD31-positive deposition was significantly lower in group B than in groups A and C (all $p < 0.001$). The mean degree of TUNEL-positive deposition was significantly higher in group B than in groups A and C (all $p < 0.001$). Ki67-positive mesothelial monolayers were more prominent in groups A and C than in group B.

Conclusion: PT-mediated local heating suppressed tissue hyperplasia after stent placement in the rat gastric outlet. The in vivo temperatures were significantly decreased compared to the in vitro temperatures during local heating.

P-346

Carbon dioxide dissolved in physiological saline: application for contrast media

S. Ota¹, A. Inoue², Y. Imai¹, K. Takaki¹, S. Sato¹, T. Iwai¹, Y. Tomozawa¹, Y. Murakami¹, A. Sonoda¹, N. Nitta¹

¹Radiology, Shiga University of Medical Science, Otsu, JP, ²Radiology, Higashi-Ohmi General Medical Center, Higashi-Ohmi, JP

Purpose: To examine carbon dioxide dissolved in physiological saline (CO₂-saline) in comparison with carbon dioxide (CO₂) ex vivo and in vivo, and to study whether CO₂-saline can be applied as a contrast medium.

Material and methods: CO₂ was extracted from the CO₂ injector, and CO₂-saline was made by a soda maker. Ex vivo experiment was performed using vascular models. Each contrast media was injected from a 4 Fr catheter into 3 kinds of vascular models (diameter: 3, 5, 8mm) under digital subtraction fluoroscopy. In vivo experiment was performed on rabbits. Each contrast media was injected from a 4 Fr catheter or a sheath into the upper aorta (celiac artery level), middle aorta (renal artery level), or lower aorta (aortic bifurcation level). Then, image qualities were evaluated by 3 interventional radiologists using the Likert scale from 0 (poor) to 100 (excellent).

Results: Ex vivo imaging abilities of CO₂ and CO₂-saline were 20.7 ± 8.6 , 20.7 ± 2.1 (3mm model), 54.3 ± 12.7 , 74 ± 14.9 (5mm model), and 69.7 ± 12.5 , 67.7 ± 9.3 (8mm model), respectively. In vivo imaging abilities of CO₂ and CO₂-saline were 66.5 ± 16.7 , 52.1 ± 17.3 (upper aorta), 77.3 ± 15.4 , 56.3 ± 12.9 (middle aorta), and 87.3 ± 5.6 , 50.1 ± 24.0 (lower aorta), respectively.

Conclusion: The imaging ability of CO₂-saline was almost the same as that of CO₂ in vascular models, however, it was less than CO₂ in rabbits.

P-347

Safety and efficacy of pig tail catheter for pneumothorax caused during pulmonary interventions

R.S. Chivate¹, P. Thakrar², R. Gali¹

¹Interventional Radiology, Jupiter Hospital, Thane, IN, ²Radiology, Nirman Diagnostic Centre, Mumbai, IN

Purpose: Incidence of pneumothorax is not uncommon during pulmonary interventions like biopsy or thermal ablative procedures. Pneumothorax during the procedure can hamper management plan unless the air is aspirated out. Collapsed lung can displace the target making it difficult to target the lesion. In this situation a pig tail catheter can be placed to aspirate the air and cause expansion of lung. Similar post intervention pneumothorax, pig tail catheter can be placed in pleural cavity for 3 days without the need for intercostal drainage catheter.

Material and methods: Over two years 56 patients had pneumothorax post CT guided pulmonary interventions. Youngest patient was of 22 years while the oldest was of 77 years old. 44 patients had undergone biopsy while 12 were being treated with thermal ablation. Of the 44 biopsy patients, 20 patients had undergone lung parenchymal biopsy of which 17 patients had lung emphysema. Pneumothorax was seen in 11 patients during subcarinal node, 7 para tracheal node and 6 pleural based nodule biopsies. Non resolving pneumothorax was subjected to insertion of 8 Fr. 22cm. pig tail catheter connected to under water seal

and discharged to home. Closure trial was given on 3rd day followed by removal of catheter.

Results: Out of 56 patients only 2 (3.5%) patients having lung emphysema had to undergo intercostal drainage catheter as the closure trial failed. 96.5% of patients did not require any further management.

Conclusion: Pig tail catheter for pneumothorax is safe and effective post pulmonary interventions and patients can be discharged home and followed up on out patient basis.

P-348

Computational fluid dynamics analysis of a novel flow diverter geometry for intracranial aneurysms

E. Rytkin, I.A. Sinitsyn, M. Maslennikov

Interventional Radiology, Russian Medical Academy of Continuous Professional Education, Ministry of Health of the Russian Federation, Moscow, Russian Federation, Moscow, RU

Purpose: The aim of this research was to perform computational fluid dynamics analysis of a novel flow diverter which is based on the auxetic geometry.

Material and methods: An.stl file of a flow diverter device was built utilizing Siemens PLM Software. A real anonymized DICOM image of a patient was evaluated, intracranial aneurysm sliced with 3DSlicer 4.8 and transferred into an.stl file. The computational fluid dynamics analysis was performed utilizing ANSYS Fluent 18.2. The Carreau Model for fluid viscosity was used with Time Constant, lambda 3.313 (s), Power-Law Index 0.3568 (n), Zero-Shear Viscosity 0.056 (kg/m-s), Infinite Shear Viscosity 0.0035 (kg/m-s). Density was used that of blood 1060 kg/m³. Numerical results of velocity and wall shear stress were retrieved. From that the conclusion of auxetic flow diverter interference on the blood flow was drawn.

Results: Without a flow diverter, minimal wall shear stress was $6.14395e-03$ [Pa] and maximal 3.58595 [Pa]. Blood flow velocity was minimum $9.43298e-08$ [m/s] and maximum 0.224575 [m/s]. With a flow diverter device in place, minimal shear stress was $4.494e-013$ [Pa] and maximal $1.695e+001$ [Pa]. Blood flow velocity with flow diverter in place was minimum 0 [m/s] and maximum $6.634e-001$ [m/s].

Conclusion: We are pleased with the results of computational fluid dynamics analysis of the novel auxetic flow diverter and can claim that it has the potential to treat intracranial aneurysms.

P-349

Mismatch diameter between radial versus distal radial artery: evaluation in patients suitable for vascular peripheral procedures

D. Meo, D. Falsaperla, M.C. Calcagno, A. Modica, F. Libra, C. Desiderio, D. Baldanza, P.M. Coppolino, S. Seminatore, R.F. Grasso, E.F. Santonocito, S. Palmucci, P.V. Foti, A. Musumeci, A. Basile

Radiology Unit I - Department of Medical and Surgical Sciences and Advanced Technologies - University of Catania, Azienda Ospedaliero Universitaria Policlinico Vittorio Emanuele, Catania, IT

Purpose: To describe the variability of the diameter of the radial artery (RA) measured at both levels used for percutaneous approach: proximal (within 2 mm) to the styloid process (pRA) and distal at the snuff box (dRA) correlating them to cardiovascular risk factors (CRF), sex, and age.

Material and methods: We enrolled 621 patients (290 female, 331 males) from July 2018 to January 2019. The diameter of left and right RA were studied with Ultrasound (US) and Color-Doppler Ultrasound (CD-US). Diameters of pRA and dRA were compared between different sex, age, and CRF (tabagism, hypertension, dislipidemia, BMI>30, diabetes); the possibility of a snuff box approach was also evaluated considering a diameter ≥ 2 mm as a cut-off for the feasibility.

Results: The average proximal diameter founded for the pRA were 2.58mm (SD=0.60 mm) at the right arm and 2.57mm (SD=0.63 mm) at the

left arm. The calibre of the dRA was about 31% lower than the proximal one, with an average diameter of 2.00mm (SD=0.53 mm) and 1.96 mm (SD=0.52 mm) for the left and right side respectively. Female patients showed smaller diameters than male patients, in particular at the dRA. We did not found significantly differences related to CFS. Between the 621 patients studied, 382 (62%) were eligible for dRA approach.

Conclusion: dRA approach is a relatively new technique with many advantages than "traditional radial access"; the evaluation of the feasibility with US and CD-US is a fast and accurate way to decide if the "snuff box approach" can be performed.

P-350

Comparison of 4 microwave devices in an ex-vivo bovine liver

T.C.H. Hui¹, D. Choo², U. Pua¹

¹Diagnostic Radiology, Tan Tock Seng Hospital, Singapore, SG, ²Yong Loo Lin School of Medicine, National University of Singapore, Singapore, SG

Purpose: Percutaneous microwave ablation (MWA) is an accepted treatment of non-operative liver cancer. The goal of treatment is to induce necrosis within an ablative zone with adequate margins while sparing non-target parenchyma. Knowledge of the sphericity of the ablation zone allows for accurate device placement and orientation to achieve this. This study compares ablation zones of 4 commercially-available MWA devices in an ex-vivo bovine liver (Amica, Emprint, Neuwave, Solero).

Material and methods: Four bovine livers were used at room temperature (25°C). Manufacturer recommended protocols were used to first achieve a total-energy of 800W-min (Phase 1), and length of 4-cm (Phase 2). The ablation zones were sectioned and analysed for length and diameter. The sphericity (S) was defined as: diameter/length. ANOVA followed by Tukey HSD post-hoc tests were used (SPSS 23.0).

Results: When equating for total-energy delivered (800W-min), Emprint (S= 0.908) was 'rounder' than Amica (S=0.708, p=0.002) and Solero (S=0.689, p=0.001) devices. Neuwave (S=0.824) was also found to be significantly more spherical than Solero device (p=0.039). When equating for length (4-cm), Emprint (S= 0.961) was 'rounder' than Amica (S=0.605, p=0.000), Neuwave (S=0.706, p=0.000) and Solero (S=0.673, p=0.000) devices. Neuwave was also found to be significantly more spherical than Amica device (p=0.011).

Conclusion: Our study shows that Emprint achieves the most spherical ablation zone when equating for total-energy delivered and length. Neuwave was also found to be more spherical compared to Solero (in Phase 1) and Amica (in Phase 2).

P-351

First clinical experience with the bendit2.7 - a novel steerable microcatheter

A. Bendet, E. Elnekave, M. Saksonov, G. Chudakov, A. Cohen, E. Atar, A. Belenky

Interventional Radiology, Rabin Medical Center - Beilinson Campus, Petah-Tikva, IL

Purpose: As the number of intra-vascular procedures increases, the necessity for better navigation and accuracy deems the need for innovative devices with superior technology.

The Bendit2.7 is a novel microcatheter with a steerable distal tip controlled via a proximal Steering Handle. The unique technology facilitates tip control and distal torquability together with locked tip deflection. The tip deflects up to 180 degrees in one direction with a radius of 3 mm and can be rotated bi-directionally while deflected by turning the Torque Knob on the Steering Handle.

This is the first clinical report of procedures done with the bendit2.7 as part of a prospective, multicentre open label clinical trial which was approved by the institution IRB committee.

Material and methods: After obtaining a separate informed consent, 4 procedures in 4 patients were done using the device. The procedures

consisted of PTA of the right common iliac artery, hepatic radioembolization, hepatic Tc mapping and groin tumor embolization. The device was used instead of a standard microcatheter in all procedures. All procedure, device use and AE data were collected in specific forms immediately after the procedures.

Results: No adverse events or device deficiencies occurred during the procedures. The device allowed all standard functions of a microcatheter with enhanced maneuvering ability.

Conclusion: According to the first ever human experience with the bendit2.7, the device is safe and may offer an advanced alternative to the standard microcatheter.

P-352

In vitro quantification of stent-graft behaviour during ch-TEVAR

R. Ubersoi¹, M. Hadi², J. Kwiecinski³

¹Radiology, John Radcliffe Hospital, Oxford, UK, ²Interventional Radiology, John Radcliffe Hospital, Oxford, UK, ³Department of Engineering Science, Oxford University, Oxford, UK

Purpose: To quantify endograft deformations and associated phenomena during double chimney thoracic endovascular aortic repair (ch-TEVAR).

Material and methods: Double ch-TEVAR procedures employing balloon-expandable (BE, BeGraft) and self-expandable (SE, Viabahn) chimney grafts (CGs) have been performed in a physiological model with retrospectively gated computed tomography (CT) used to evaluate endograft behaviour. Device interactions were characterized according to gutter volume, endograft deformation, and gutter surface deviation.

Results: Use of BE CGs resulted in three times the total gutter volume compared to SE CGs (52.5mm², or 7.0% versus 3.2mm², or 0.6% of lumen area). Gutter volumes were observed to vary dynamically between the end-diastolic and peak-systolic phases of the cardiac cycle, with the most substantial change associated with the BE configuration.

CG deformations were dependent on device type, with SE devices exhibiting up to twice the deformation as BE devices. A distinctly unique finding of this study was observed in the interactions of adjacent SE chimney grafts, as manifested by their varying lumen deformations: when in contact, SE chimneys appear to support each other, and as such, tend towards a more consistently circular shape.

Conclusion: The findings reported here support the recommendation that ECG-gated CT, or similar, should be used during follow-up of patients treated with chimney grafts to better identify device related complications. Finally, this is the first report to include detailed volumetric reconstructions of ch-TEVAR gutter volumes at critical time points during the cardiac cycle, and furthermore, to describe gutter surface deviation as a metric to characterize dynamic gutter phenomena.

P-353

Feasibility of changing intra-arterial flow direction by temporary occlusion using retrievable coils: study with a normal pig model

H.H. Chung¹, S.H. Lee¹, I.Y. Choi¹, Y.H. Kim², S.B. Cho², T.S. Seo³, M.G. Song³

¹Radiology, Korea University Ansan Hospital, Ansan, KR, ²Radiology, Korea University Anam Hospital, Seoul, KR, ³Radiology, Korea University Guro Hospital, Seoul, KR

Purpose: To evaluate feasibility of changing intra-arterial flow direction by temporary occlusion using retrievable coils.

Material and methods: In two healthy pig livers, injection of a lipiodol mixture (lipiodol: saline = 2:1) was performed at the segmental arteries after occluding one of the subsegmental arteries. This was accomplished using a retrievable coil in five different segmental arteries, (three in pig A and two in pig B). Injection of the lipiodol mixture was performed through a 3-way system using a hemostatic valve, while the retrievable coil delivery system operated through the lumen of a microcatheter. Successful coil deployment, occlusion of the vessel, and coil retrieval were evaluated.

Redistribution of flow after placement of the coil and vessel patency after coil removal were angiographically evaluated. The distribution of lipiodol mixture was evaluated using cone beam computed tomography (CT).

Results: All five of the retrievable coils were successfully deployed and removed. Angiography revealed successful occlusion after coil placement followed by restoration of flow after coil retrieval in all cases. On cone beam CT, lipiodol tagging was abundant in hepatic parenchyma supplied by the hepatic artery without coils compared to that supplied by the branch with coils.

Conclusion: Temporary arterial flow redistribution using a retrievable coil was feasible in the healthy pig model and could be applicable for endovascular procedures in which superselection is difficult or unavailable.

P-354

Development of radiopaque drug-eluting beads based on lipiodol/biodegradable-polymer for transarterial chemoembolization

T. Hasebe¹, T. Matsumoto¹, Y. Okamoto², K. Yano², K. Bito², K. Tomita¹, S. Maegawa², S. Kamei¹, E. Matsuoka³, Y. Imai¹, A. Hotta²

¹Department of Radiology, Tokai University Hachioji Hospital, Tokai University School of Medicine, Hachioji, Tokyo, JP, ²Department of Mechanical Engineering, Keio University, Yokohama, JP, ³Division of Translational Research, Keio University Hospital Clinical and Translational Research Center, Tokyo, JP

Purpose: To develop a novel radiopaque/biodegradable drug-eluting beads (LPD-DEB) for transcatheter arterial chemoembolization (TACE) and to evaluate their performance in vitro and in vivo.

Material and methods: LPD-DEB were fabricated using a microfluidic device. To analyze the biodegradation and the drug-release profile of LPD-DEB in vitro, they were immersed in phosphate-buffered physiological saline (PBS) or 1 mg/mL of lipase/PBS solution at 37°C. Then, the weight loss ratios of the microbeads and the amount of dissolved drug in the medium were quantified. Furthermore, to evaluate the radiopacity of LPD-DEB, a CT scan was performed in vitro. To evaluate the radiopacity and the biodegradability in vivo, LPD-DEB (φ100–300 μm) were injected into a hepatic artery of a healthy rabbit through a catheter and examined via a fluoroscopy after an hour and one month.

Results: Regarding biodegradability and drug-release properties in vitro, LPD-DEB had lost 63.5% of their weight in 11 days after immersion, while LPD-DEB had released 34.5% of Mitomycin (a lipophilic platinum-based anticancer drug) in 11 days. For radiopacity in vitro, LPD-DEB were clearly visualized through CT imaging, and had a mean attenuation of over 5600 HU. Regarding radiopacity and biodegradability in vivo, while the embolization by LPD-DEB in the rabbit vessel could be clearly recognized under fluoroscopic guidance in one hour, the location of embolization was not identified in one month because of their biodegradability.

Conclusion: The radiopaque/biodegradable LPD-DEB fabricated in this study has shown the potential to enhance TACE procedures, providing embolic-particle and drug localization.

P-355

CRISPR-Cas9 and interventional gene therapy

M. Schwenke, J. Greene, S. Braverman, M.K. Singh
Radiology, Santa Barbara Cottage Hospital, Santa Barbara, CA, US

Learning objectives:

1. To learn about recent advancements in gene therapy centered around CRISPR-Cas9.
2. To learn how gene therapy can be delivered via interventional radiology procedures.
3. To learn about recent interventional radiology gene therapy studies via a literature review.

Background: Recent renewed interest in gene therapy has been driven in large part by the discovery and increased understanding of CRISPR-Cas9, a genome-editing platform that holds great promise for treating disease.

Clinical Findings/Procedure Details: The CRISPR-Cas9 platform allows deactivation of genes or the inclusion of new genes at a specific site within the genome of the target cell. This can be leveraged to knock-out problematic genes (e.g. in cancer cells) or add production capabilities to cells which lack them (e.g. in genetic disorders). Delivering this platform to the target cells can be achieved by several methods including electroporation, hydrodynamic injection, nanoparticles, and viral vectors. Recent studies have shown increased effectiveness of locoregional delivery of these vectors as compared to systemic treatments by increasing local uptake and decreasing number of vectors that need to be administered. Transarterial and transvenous delivery via the portal vein or a balloon-occluded hepatic vein have all shown promising results. These procedures are central to interventional radiology (IR) training, placing IR at the forefront of the developing field of interventional gene therapy.

Conclusion: CRISPR-Cas9 can be delivered with viral and non-viral vectors to treat genetic disorders as well as cancer. Catheter directed delivery offers advantages over systemic administration and interventional radiology is poised to play a central role in the clinical future of this emerging field.

P-356

Immuno-oncology and interventional oncology: enhancing the abscopal effect of locoregional therapy with periprocedural immunotherapy

M. Schwenke, J. Greene, S. Braverman, M.K. Singh
Radiology, Santa Barbara Cottage Hospital, Santa Barbara, CA, US

Learning objectives:

1. To learn how locoregional therapies affect the immune system (i.e. the abscopal effect).
2. To learn about the types of immune responses and how they are targeted by immunotherapy.
3. To learn about recent studies on combined locoregional and immunotherapy via a literature review.

Background: Researchers are beginning to unravel the underpinnings of a phenomenon called the abscopal effect, whereby locoregional therapy triggers a distal antitumor response. The magnitude of this effect with local therapy alone is weak but could be strengthened with the addition of immunotherapy.

Clinical Findings/Procedure Details: Ablation and embolization differ from surgical resection in terms of systemic immune response. Surgical resection removes the tumor cells from the body whereas the cells that die via necrosis during ablation and embolization release tumoral antigens triggering a response both from the innate (i.e. local inflammatory response) and adaptive immune systems (i.e. B and T-cell mediated response). Immunotherapies largely target one of these two responses. For example, granulocyte-macrophage colony stimulating factor, imiquimod, and CpG-oligodeoxynucleotides stimulate the innate immune response when antigen presenting cells (APCs) encounter antigens. Similarly, checkpoint inhibitors affect the adaptive immune response by targeting interactions between APCs and T-cells, encouraging immunostimulation rather than immunosuppression. Improved abscopal effect has been demonstrated when innate or adaptive immunomodulators are combined with locoregional therapy. When all three therapies are used together, the effects are even more profound.

Conclusion: Locoregional therapies can be combined with immunotherapy to prevent local recurrence, improve treatment response in remote metastatic lesions, and even improve progression free survival.

P-357**Bariatric embolization****M. Fusco***Ospedale San Paolo, università degli studi di Milano, Salerno, IT*

Learning objectives: Evaluate the possibility of bariatric embolization in obese patients.

Background: Patologic obesity results in significant morbidity, mortality and cost to the healthcare system. A multipronged approach is essential to treat obesity. When lifestyle modifications fail the current gold standard therapy for obesity is bariatric surgery with great results but severe complications. Pharmacotherapy may be a great option but there's a big problem of compliance. Some study groups have proposed bariatric embolization of the gastric fundus to treat obesity; the purpose of this procedure is to decrease the gastric fundal production of ghrelin and therefore decrease the stimulus of hunger.

Clinical Findings/Procedure Details: There's few studies that evaluate the topic with few patients.

The procedure is relatively easy, in a Clifford R Weiss et al. study (5patients) the technical success of the procedure was 100%; the weight loss in this study was 9.0 ± 4.1 at 3-months; in Zhi Bin Bai et al. study's was 12.9 ± 14.66 kg at 9 months in a cohort of patient with mean weight of 102 ± 16.19 kg.

Bariatric embolization have shown safety and efficacy in the short and intermediate terms, the most common adverse effects was the gastric ulceration, less common the subclinical pancreatitis but a serious adverse effect in Ellens et al study's was a severe pancreatitis and gastric perforation.

Conclusion: Perhaps the best option would be find a resolute pharmacological therapy against obesity but, in the absence of this, bariatric embolization can be a valid and well tolerated option but studies on more numerous samples are needed.

P-358**Quantitative color-coded digital subtraction neuroangiography for pediatric arteriovenous shunting lesions****G.M.Y. Ma¹**, A. Dmytriw¹, M. Shroff², N. Shkumat², T. Krings³, P. Muthusami¹

¹Image Guided Therapy, The Hospital for Sick Children, Toronto, ON, CA, ²Diagnostic Imaging, The Hospital for Sick Children, Toronto, ON, CA, ³Medical Imaging, Toronto Western Hospital, Toronto, ON, CA

Learning objectives: To describe the potential role of quantitative color-coded digital subtraction angiography (qDSA) in neuroendovascular procedures in children with high flow arteriovenous shunting lesions.

Background: Endovascular treatments of neurovascular conditions in children pose unique challenges arising from patient size, pathophysiology and hemodynamics. There is an ongoing need for tools that provide accurate information for treatment planning, while minimizing radiation and contrast, particularly for high flow arteriovenous shunts that are challenging to assess using conventional techniques.

Clinical Findings/Procedure Details: Color-coded qDSA images can be generated without additional acquisition protocols. This technique color-codes time-to-peak (TTP) within each pixel to generate a single quantitative image from a DSA run. This allows evaluation of arterial inflow, aberrant arteriovenous connection and venous outflow on the same 2-dimensional image. We describe, using representative cases, how time versus contrast intensity curves generated within any region of interest offer quantitative comparison of blood flow characteristics such pre- and post-embolization and on follow-up evaluations. This can also be used to quantify vascular steal related to the shunting lesion. Overall, this allows real time flow quantification during endovascular treatment and holds potential for more precise end-points for endovascular treatment.

Conclusion: Color-coded qDSA provides unique flow-related information in high-flow shunting neurovascular lesions without added radiation or contrast. This relatively underutilized tool can be used for decision-making

for optimizing endovascular treatment protocols and determining treatment end-points.

P-359**Liquid biopsy: opportunities and challenges for interventional radiology****G. Stranieri¹**, B.C. Odisio², M. Calandri³, D. Basile⁴, S. Yevich⁵, R. Avritscher⁶, S. Kopetz², C. Gazzera³, A. Veltri⁴

¹Department of Oncology, University of Turin, Orbassano, IT, ²Interventional Radiology, The University of Texas MD Anderson Cancer Center, Houston, TX, US, ³Radiology Institute, Department of Surgical Sciences, University of Torino, Turin, IT, ⁴Department of Oncology, Diagnostic and Interventional Radiology Unit, University of Turin, Orbassano, IT, ⁵Interventional Radiology, Institut Gustave Roussy, Villejuif, FR, ⁶Radiology, UT MD Anderson Cancer Center, Houston, TX, US

Learning objectives: To evaluate current and future role of liquid biopsy, understanding opportunities and challenges that this technology offers to interventional radiologists

Background: Nowadays, despite image-guided tissue biopsies are gold standard for tumor genotyping they don't allow longitudinal monitoring of patients and they are virtually never representative of tumor heterogeneity and multiclonality.

Liquid biopsy, that encompasses wide spectrum of markers analysis such as circulating tumor DNA (ctDNA), miRNA or circulating tumor cells (CTC), is emerging as valide alternative. Applications of liquid biopsy in clinical practice or in ongoing clinical trials are: screening, early detection of relapse/minimal residual disease and evaluation of tumor heterogeneity.

Clinical Findings/Procedure Details: Liquid biopsy can be considered competitor for IRs: indeed, liquid biopsy is already considered gold standard as a first approach to evaluation of T790M EGFR mutation, reducing number of lung re-biopsies required to IRs. In colorectal metastatic cancer, detection of KRAS and BRAF mutation are already used in clinical trials to assess cetuximab and panitumumab resistance and several ongoing clinical trials are evaluating role of liquid biopsy in detection of early relapse after surgery.

On the other side liquid biopsy can be opportunity for IRs: Interventional Radiologists can improve detection rate of liquid biopsy by sampling through venous catheterization the tumor flow vessels. Viceversa, liquid biopsy can help IRs in order to early detect relapse from their treatments (thermal-ablation or transarterial procedures).

Conclusion: Liquid biopsy is promising diagnostic technique in oncologic field. Interventional Radiologists should be aware of possibilities of liquid biopsy in order to face challenges and get its opportunities.

P-360**Materials science for the interventional radiologist****A.E. Stroiescu¹**, M.D. Ryan², J.B. Hennebry¹, C.A. Byrne³, M.P. Bolger¹, L. Greene³, A.G. Ryan⁴

¹Division of Interventional Radiology, University Hospital Waterford, Waterford, IE, ²School Mechanical and Manufacturing Engineering, Dublin City University, Dublin, IE, ³Radiology, University Hospital Waterford, Waterford, IE, ⁴Division of Interventional Radiology, Department of Radiology, University Hospital Waterford, Waterford City, IE

Learning objectives:

1. To familiarise Interventional Radiologists with the core concepts of Materials Science with respect to medical devices.
2. To recognise the key properties of materials and alloys, their production processes and how these affect their behaviour in implantable devices.

Background: Innovations in Interventional Radiology are made possible by discoveries and developments in Materials Science. Effective design and production of wires, catheters, stents, stent grafts and ablation probes

is dependent on a knowledge of the physical and phase properties of the materials, individually and in alloys.

Clinical Findings/Procedure Details: The global medical device market is worth an estimated 140-200 billion euros. It behoves us as clinicians to have an understanding of the materials in our devices and how their physical properties impact their behaviour at the time of implantation, and subsequently with regards to device failure and patient well-being. Interventional Radiology inventors and innovators must have an even greater understanding of these principles when it comes to discussions with industry at the design phase.

We use devices and components composed of a disparate array of materials and alloys and recognise the names of many e.g. stainless steel, Nickel-Titanium (Nitinol), Polymethyl methacrylate, Polytetrafluoroethylene (Teflon), Polyethylene Terephthalate (Dacron), Polyurethane, silicone, collagen and platinum. Those properties most pertinent to device failure and patient safety will be reviewed, including macro- and microstability and potential harm arising from physical and ionic degradation.

Conclusion: Knowledge of Materials Science can help Interventional Radiologists understand their devices and their short- and long-term behaviours, particularly with regards to efficacy and safety.

P-361

Emerging technologies in vascular and interventional radiology: augmented and virtual reality

S.E. Junaid¹, A. Saeed¹, K. Moore², G. Salafia¹, R.D. White²

¹Radiology, Cardiff and Vale UHB, Cardiff, UK, ²Department of Clinical Radiology, University Hospital of Wales, Cardiff, UK

Learning objectives:

1. Understand the differences between Augmented Reality (AR) and Virtual Reality (VR) and raise awareness of the different technological solutions currently available
2. Appreciate the roles of AR and VR in contemporary vascular and interventional radiology (IR)
3. Highlight key areas for future development

Background: VR technologies have been in existence for a number of years, whilst AR is a more recent development, but technological advances are such that they can now easily be incorporated into the working life of an interventional radiologist, to great benefit.

Clinical Findings/Procedure Details: Uses of VR and AR pertinent to vascular and non-vascular IR are discussed and exemplified here, including teaching and training, pre-procedural planning, intra-procedural utilisation and facilitating the consent process, with potential future uses explored.

Conclusion: VR and AR technologies have a multitude of uses in radiology and their benefits should be embraced by the IR community.

P-362

Computed tomographically guided injection of cyanoacrylate in association with preoperative radioguided occult lesion localization of ground-glass opacities (GGO) - two case reports

V.H.V. Nogueira, C.J. Tyng

Radiology, AC Camargo Cancer Center, Sao Paulo, BR

Clinical History/Pre-treatment Imaging: Case one: 77 year-old female, asymptomatic, underwent a screening CT, which showed a nodular GGO. After comparing with previous exams, a surgical resection was indicated due to a slight increase of its dimensions (Fig. 1A).

Preoperative localization was performed using a coaxial 19-gauge needle to inject a solution with Sn-^{99m}Tc and cyanoacrylate (Fig. 1B, 1C). SPECT-CT confirmed the location (Fig. 1D). A video-assisted thoracoscopic surgery (VATS) was performed using a gamma probe and a lung segmentectomy was done.

Histologic examination showed a moderate lepidic-predominant invasive adenocarcinoma.

Case two: 55-year-old female, asymptomatic, passive smoker with a GGO stable on screening exams (Fig. 2A). The technique was the same in case one, but we also injected dextran-^{99m}Tc to try to detect the sentinel lymph node (Fig. 2B). SPECT-CT confirmed the location of the lesion and an intrapulmonary lymph node (Fig. 2C). The segmentectomy was successfully performed (VATS) with a gamma probe guidance.

Histologic examination was nonmucinous adenocarcinoma and de lymph node was negative for malignancy.

Treatment Options/Results: Intraoperative localization of a GGOs is difficult because it is not easy to palpate and it may be invisible at radiology.

Discussion: The injection of liquid materials for marking GGOs has been studied over years but our technique uses a CT-guided injection of a radiotracer with cyanoacrylate that polymerizes immediately in contact with the lung parenchyma, decreasing the potential spreading of the radiotracer.

Take-home points: Compared with others methods, the described technique has some advantages for the localization of GGOs.

P-363

Transhepatic pacemaker placement in a patient with recurrent SVC occlusion

M.M. Shnayder, J.J. Mahn, J.W. Albright, N. Kafity, D.M. Williams, M. Khaja

Department of Interventional Radiology, University of Michigan, Ann Arbor, MI, US

Clinical History/Pre-treatment Imaging: This is a 42-year-old female with a history of HOCM status post myectomy in 2002 with pacer dependence, SVC syndrome status post recanalization and stenting of the SVC, innominate, and left subclavian veins with subsequent occlusion. Between 2012 to 2016 she had three pacemaker/ICD explants secondary to infection. Following most recent device explanation, a Micra transcatheter pacing system was placed. Due to worsening CHF, interventional radiology was consulted by electrophysiology for assistance in transhepatic cardiac resynchronization therapy pacemaker (CRT-P) placement.

Treatment Options/Results: Under fluoroscopic guidance, transhepatic vascular access was obtained to the level of the inferior cavoatrial junction through the right hepatic vein. The Micra system was removed and cardiac leads were placed by electrophysiology.

The IR team embolized the hepatic parenchymal tracts and the electrophysiology team created a pocket for the CRT-P device. Two years post-operatively the patient has had no additional explants.

Discussion: Unique access must be considered in patients with chronic venous occlusions. In our case, a transhepatic approach was utilized due to her chronic occlusion of the SVC and other central veins. She was not a candidate for heart transplant secondary to antibody reactivity and was not an LVAD candidate due to diastolic dysfunction; thus, acquiring access for device placement was vital to her treatment plan.

Take-home points: Collaboration amongst interdisciplinary teams is necessary to identify creative solutions for complex patients. CRT-P can successfully be placed using a transhepatic approach when other options are not available.

P-364

Mechanical thrombectomy device - rescue approach in a case of pediatric post combined liver and renal transplant early hepatic artery thrombosis

M.K. Yadav¹, M. Unni²

¹Interventional Radiology, Kerala Institute of Medical Sciences, Trivandrum, IN, ²Radiology, Kerala Institute of Medical Sciences, Trivandrum, IN

Clinical History/Pre-treatment Imaging: 5 yrs old child on postoperative Day3 of combined deceased donor Liver and renal transplant had absent Hepatic artery signals which was confirmed on CT angiogram.

patient underwent exploratory laparotomy, dismantling of the hepatic arterial anastomosis followed by redo anastomosis of hepatic artery and was initiated on Heparin infusion.

Patient had hepatic artery thrombosis on day 5. Patient underwent redo laparotomy. On dismantling anastomosis no back bleed was noted from hepatic artery stump. tPA was injected directly into the arterial stump. Post injection also no backbleed was seen.

Treatment Options/Results: Treatment options considered were intra arterial thrombolysis or Retransplant. Thrombolytic therapy was excluded as maximum done was already delivered. Due to nonavailability of second graft, retransplant as not an option.

Digital subtraction angiogram showed complete occlusion of hepatic artery stump. The coeliac artery was engaged with a 4F cobra catheter, occlusion was crossed with a combination of synchro 2, 0.014 guidewire and Prowler select Plus Microcatheter. A 4 x 22 mm Revive SE Stent retriever device was deployed across the occluded segment. After a dwell time of five minutes the device was retrieved. Two such passes were made following which check angiogram showed complete recanalisation of the hepatic artery with good filling of the peripheral branches.

Discussion: Mechanical thrombectomy is easy to use, effective and achieves rapid recanalisation.

However larger studies are required to establish the safety and long term patency of the treated vessels.

Take-home points: Use of Stent retrievers in Hepatic artery thrombosis, even in pediatric population is safe, effective and provides immediate recanalisation.

P-365

Argon laser therapy by endoscopic and percutaneous access: a new hybrid technique for the treatment of post-traumatic biliary leaks

M.A. Rios-Vives¹, M. Gonzalo Carballes¹, M. Pérez Lafuente², C. Gonzalez-Junyent², D. Barnés², J.C. Correa Zapata², J. Armengol³, I. Díez Miranda²

¹Radiology, Hospital Universitari de la Vall d'Hebrón, Barcelona, ES, ²Interventional Radiology, Hospital Universitari de la Vall d'Hebrón, Barcelona, ES, ³Digestive Endoscopy, Hospital Universitari de la Vall d'Hebrón, Barcelona, ES

Clinical History/Pre-treatment Imaging: We present 2 pediatric patients (Case 1: 7 years old, Case 2: 14 years old) who, after suffering a high energy liver trauma (grade IV / V), developed a bile peritonitis due to persistent bile leak. Both have been treated with this new technique.

The degree of bile peritonitis and active leak point was confirmed by liver MRI. Both patients required placement of percutaneous drainage for symptomatic relief and bile leak debit control.

Treatment Options/Results: We describe a new hybrid technique, percutaneous and endoscopic, using the Argon laser together with a "detachable" tip microcatheter, by biliary endoluminal route, as a new therapeutic weapon for the always challenging treatment of post-traumatic biliary leaks.

The two patients presented complete resolution of the leak after treatment with this technique, without complications related to the procedure. The cessation of in situ leakage was confirmed by direct cholangiography, as well as the decrease in percutaneous drainage debit after performing the intervention.

In both patients a complete resolution of the biliary leak occurred with no recurrence on the 24 month follow up.

Discussion: Despite the small number of cases treated, the positive results and the absence of complications show a promising future for this technique, with the possibility of expanding to other non-traumatic etiologies.

The multidisciplinary teamwork with Radiology, Interventional Radiology, Pediatric Surgery and Gastrointestinal Endoscopy is essential for the proper management and treatment of these patients.

Take-home points: More experience should be obtained for the treatment of post-traumatic biliary leaks with argon laser therapy.

GI tract intervention

P-366

Synchronous stenting of patients presenting with simultaneous duodenal and biliary obstruction

J.E. Fish, B. Kawa, P. Ignatus, A. Shaw

Interventional Radiology, Maidstone and Tunbridge Wells NHS Trust, Maidstone, UK

Purpose: Concurrent duodenal and biliary obstruction is not an uncommon presentation in advanced upper GI malignancies. Such patients can undergo multiple separate fluoroscopic, endoscopic or surgical procedures in order to relieve both forms of obstruction. We present a synchronous fluoroscopic approach to stenting duodenal and biliary obstruction.

Material and methods: Pre-procedural planning is performed with Computed Tomography. The duodenal stent is sited fluoroscopically first via a peroral route. If the procedure is well tolerated with adequate stent expansion and with no complications, percutaneous transhepatic cholangiography is then immediately performed with biliary stent placement. A biliary drain is left in-situ following biliary stent placement and removed within the week. To our knowledge, synchronous fluoroscopic duodenal and biliary stent placement in a series of patients has not been previously described.

Results: We describe our experience placing synchronous duodenal and biliary stents on 5 patients with all patients relieved of gastric outlet obstruction and jaundice. There were no complications associated with any case.

Conclusion: Synchronous duodenal and biliary stent placement is technically feasible and provides earlier symptomatic relief of gastric outlet obstruction and jaundice, palliating symptoms quicker and saving patients from potential multiple endoscopic or surgical procedures.

P-367

Fluoroscopic colorectal stent placement in 41 patients with endoscopic stent placement failure

C.J. Yoon, Y.J. Kim, Y.N. Woo, D.R. Kim

Radiology, Seoul National University Bundang Hospital, Seongnam, KR

Purpose: To evaluate the technical feasibility and clinical effectiveness of fluoroscopic stent placement in malignant colorectal obstructions after failed endoscopic stent placement.

Material and methods: Between January 2004 and December 2017, 41 patients with malignant colorectal obstructions were referred for fluoroscopic stent placement after failed endoscopic procedure. The procedures were performed for palliation (n=35) or as a bridge to surgery (n=6). The technical and clinical success, complications, stent patency, and patients' survival were retrospectively analyzed.

Results: Fluoroscopic stent placement was technically successful in 38 patients (92.7%). The causes of technical failures were complete obstruction (n=1), redundant sigmoid colon (n=1), and colon perforation (n=1). Clinical success was achieved in 37 patients with technical success (97.4%). The major complications occurred in 3 patients (7.3%) including colon perforation (n=2) and incontinence (n=1). The 6 patients with stenting as a bridge to surgery underwent elective colectomy uneventfully (100%). In 35 patients with palliative stenting, the median primary stent patency and patients' survival were 318 (95% CI, 238-397) and 662 days (95% CI, 391-934), respectively.

Conclusion: Fluoroscopic colorectal stent placement is technically feasible and clinically effective in most patients with failed endoscopic procedure.

P-368

Palliative stent placement for malignant colorectal obstructions: extracolonic malignancy versus primary colorectal cancer

C.J. Yoon, Y.J. Kim, Y.N. Woo, H. Ahn

Radiology, Seoul National University Bundang Hospital, Seongnam, KR

Purpose: To compare clinical outcomes of palliative colorectal stent placement between patients with extracolonic malignancies (ECMs) and primary colorectal cancers (CRCs).

Material and methods: Between January 2005 and June 2017, 81 patients underwent palliative stent placement for inoperable malignant colorectal obstructions caused either by ECMs (n = 55) or CRCs (n = 26). Technical and clinical success, re-intervention rates, and stent patency were compared between the two groups. Predictive factors associated with stent failure were identified.

Results: Stent placement was technically successful in 53 patients with ECM (96.4%) and 24 patients with CRC (92.3%) (p = 0.58). ECM group required more re-interventional procedures including balloon dilation and/or additional stent placement (77.4% vs. 41.7%; p < 0.01) to achieve marginally lower clinical success rate, compared with CRC group (88.7% vs. 100%; p = 0.09). The 6- and 12-month stent patency rates were 64.6% and 51.7% in ECM and 73.9% and 64.7% in CRC group (p = 0.24). Long segmental (HR 1.26) and multiple obstructions (HR 3.67) were independent factors for stent failure.

Conclusion: Palliative colorectal stent placement is less effective and requires more re-interventions in patients with ECMs than CRCs. Long segmental and multiple obstructions were associated with stent failure.

P-369

Oesophageal dilations in a paediatric population: 5 year single centre cross-speciality experience

K. Reddy¹, B. Thomson², A.K. Gupta², A. Prashar², S. Cluney³, N. Hadjichristou⁴, D. Kufeji³, I. Yardley³, M. Motalib⁴, R. Vora⁴, J. Kammermeier⁴, A. Diamantopoulos², N. Karunanithy², S. Moser², L. Monzon²

¹Interventional Radiology, Guy's and St. Thomas' Hospitals, London, UK, ²Interventional Radiology, Guy's and St Thomas' Hospitals, London, UK, ³Paediatric General Surgery, Guy's and St Thomas' Hospitals, London, UK, ⁴Paediatric Gastroenterology, Guy's and St Thomas' Hospitals, London, UK

Purpose: Oesophageal dilations (OD) are commonly performed in paediatric patients for strictures following oesophageal atresia repair or caustic injury, often with multiple dilations. We sought to compare OD across disciplines (Interventional Radiology, Paediatric Gastroenterology and Paediatric General Surgery) and determine if the specialty performing dilations has an impact upon outcome, frequency of dilatations and the size of each dilatation.

Material and methods: All paediatric patients undergoing OD between April 2014 and December 2018 for all 3 specialties. Patients were identified via prospectively maintained databases and clinical coding records. Data collected included the oesophageal calibre achieved, balloon size, the increase in calibre from the previous dilatation, the interval to subsequent dilatation and complications.

Results: 226 dilations were included in 35 individual patients. Dilations were performed by interventional radiology (IR) (n=133, 59%), surgeons (n=58, 26%) and gastroenterologists (n=35, 15%). 24 (69%) patients had a previous OA/TOF repair, 5 (14%) had caustic strictures, with 6 (17%) other cases. Time to the next dilation was longer following surgical dilation compared to IR dilation (3.7 months v 1.8 months ANOVA, p<0.05). Surgeons frequently increased the size of balloon used (57% vs 33% vs 39%), but this was not significant. There was no significant difference in balloon size between specialties or in the incremental increase in size between subsequent dilations. One patient had a perforation which was managed conservatively.

Conclusion: We present for the first time the results of paediatric OD across three specialties noting no significant difference in patient outcomes showing that a multi-disciplinary approach to paediatric OD is key.

P-370

Image guided management of pancreatic duct benign obstruction via mature percutaneous drainage track

M. Mizandari¹, T. Azrumelashvili¹, G. Asatiani², O. Kepuladze³, N. Habib⁴

¹Diagnostic and Interventional Radiology, New Hospitals LTD, Tbilisi, GE, ²Surgery, Tbilisi State Medical University, Tbilisi, GE, ³General & Minimally Invasive Surgery, Clinic "Caraps Medline", Tbilisi, GE, ⁴Surgery, Imperial College London, London, UK

Purpose: Paper shows the technique and results of percutaneous image-guided treatment, performed via PD percutaneous drainage track.

Material and methods: 15 patients underwent post- PD drainage second-line procedures attempt; 28 procedures were attempted totally; among them -PD stone evacuation by balloon assisted percutaneous descending litholapaxy (BAPDL) – 15, balloon dilatation - 8, stent placement - 5. All second-line procedures were performed under fluoroscopy guidance using PD drainage track. 5 to 8 mm diameter balloon-dilatators and metal stents were utilized. BAPDL was performed by stone pushing down by balloon after papilla dilatation.

Results: in 2 (13.3%) second-line procedure could not be fulfilled because of wire conduction failure across the stricture; in the rest 13 patients PD patency restoration has been achieved. 8 PD stone cases require 16 procedures total (1-failure, among the rest of procedures - 3 stent implantations) to clear PD from stones; among 7 PD stricture patients 12 procedures were performed (1 – failure, among the rest of procedures - 2 stent implantations). All patients tolerated the procedures well, no procedure related complications were detected.

Conclusion: Second-line post-drainage procedures appear to be effective; those procedures might be easily and safely performed once PD is drained. Those interventions should be routinely suggested as the possible treatment options in the management of pancreatic duct benign strictures management.

P-371

Management of post gastric sleeve leakage by interventional radiology - a single center experience

O.Z. Alshehri¹, R. Salman², J. Alghamdi³, M. Aljarie⁴

¹Intervention Radiology, Prince Sultan Military Medical City, Riyadh, SA, ²Medical Imaging, King Abdulaziz Medical City, Riyadh, SA, ³Radiology, King Fahd Medical City, Riyadh, SA, ⁴Radiology, King Abdulaziz Medical City, Riyadh, SA

Purpose: Retrospective Study to evaluate the efficacy of gastroesophageal stenting for treatment of post gastric sleeve leakage using removable self-expandable covered stents.

Material and methods: Between February 2015 and December 2018, 21 patients (10 males) underwent 28 procedures of gastroesophageal stenting to treat post gastric sleeve leakage. Mean patients age is 30.7 years (18-41.42 years) with mean BMI of 29.99 (20.89 - 42.58).

A total of 28 stents were deployed with mean length of 22.3 cm (18-24 cm) and mean diameter 26.18 mm (22-30 mm). Out of the 19 patients who were found to have peri-gastric collection, 9 patients (47.3%) required pre-stenting percutaneous drainage. Stent re-insertion was needed in 5 patients. Mean duration of stenting was 37.19 days (8-85 days). All stents were successfully removed after healing under fluoroscopic guidance using forceps by interventional radiologists.

Results: Stent placement was technically successful in all patients. Stent migration occurred in 5 patients (23.8%) where re-intervention was successfully performed. Other complications included esophageal stricture (n=1) and persistence leakage (n=2).

Conclusion: Gastroesophageal stenting as a primary treatment for leakage after gastric sleeve is safe and effective alternative option to avoid a surgical re-intervention.

P-372

Early initiation of enteral nutrition in mushroom-retained gastrostomy catheters: a retrospective non-inferiority study

W.J. Klejch¹, A. Lionberg², R. Judd¹, B.S. Funaki¹, O. Ahmed²

¹Radiology, University of Chicago, Chicago, IL, US, ²Radiology, Section of Vascular and Interventional Radiology, University of Chicago Medicine, Chicago, IL, US

Purpose: To assess safety and short-term complications of early initiation of enteral nutrition in mushroom-retained (pull-type) gastrostomy catheters in comparison to balloon-retained (push-type) catheters.

Material and methods: A retrospective study comparing pull-type and push-type gastrostomy catheters placed by interventional radiologists was conducted at an academic center between 1/1/2017 and 12/31/2018. Primary objectives included procedural and catheter-related complications per medical chart review with a follow-up interval of at least 30-days. Excluded patients included those with delayed enteral nutrition >48 hours and/or patients with a prior history of gastrostomy (n=43). 303 gastrostomy tubes (n=184 pull-type, n=119 push-type) were included. The most common indications for placement included head & neck carcinoma for push-type catheters (n=76, 63.9%) and cerebral vascular accident for pull-type catheters (n=78, 42.4%). The study was statistically designed to assess for non-inferiority between the two cohorts.

Results: Average time to initiation of enteral nutrition for the pull-type cohort was 11.80 hours (95% CI [10.45-13.16]) and 21.18 hours (95% CI [19.70-22.65]) in the push-type cohort (P<.001). No difference in fluoroscopy times were observed between groups (5.3 vs 4.5 min, P>.08). No significant differences in the rate of total, major, and minor complications with 17 (9.2%; 6 major, 11 minor) reported in the pull-type and 7 (5.9%; 1 major, 6 minor) reported in the push-type cohort (P>.29).

Conclusion: Early initiation of enteral nutrition with pull-type gastrostomy did not result in increased short-term complication when compared with push-type gastrostomy.

P-373

Endovascular treatment for late post-pancreatectomy haemorrhage: efficacy and complications

M. Garms

Digestive Diagnostical and Interventional Imaging, Lille University Hospital (CHU de Lille), Lille, FR

Purpose: To assess the efficacy, complications and outcomes after endovascular treatment (EVT) for late post pancreatectomy hemorrhage (PPH).

Material and methods: From June 2011 to February 2018 we retrospectively included all patients who presented on CT for late PPH an arterial anomaly or an hematoma. Extravasations, false aneurysms and arterial irregularities were analyzed. Possible treatments for late PPH were EVT, surgery, endoscopy or wait and watch (WW). Clinical success was defined as no rebleeding 90 days after treatment. Statistics analyzes were realized between treatment for rebleeding rates and survival; associated factors for rebleeding were searched. Ischemic complications of EVT were analyzed on CT after treatment.

Results: 60 patients were included. 32 (54%) were treated by EVT, 14 (23%) by surgery, 3 (5%) by endoscopy and 11 (18%) by WW, with rebleeding rates of 28%, 64%, 67% and 0% respectively. Global rebleeding rate of population was 33%. WW group had significantly less rebleeding. There was no significative difference between groups for survival at 7 days, 1 month, 3 months, 6 months and 1 year. Global mortality at 3 months was 19%. 11 patients (22%) suffered from ischemic complication of EVT, and 1 of them died.

Conclusion: EVT is efficient with low morbidity. Potentials ischemic complications must be known.

P-374

Percutaneous interventions in acute necrotising pancreatitis: a single-center observational study

K.B. Lummer¹, M.R. Davlyatov², N.P. Bogdanova¹, I.P. Machenko³

¹Interventional Radiology, City State Hospital 29 Bauman, Moscow, RU, ²Surgery, Lomonosov Moscow State University, Moscow, RU, ³Surgery, City State Hospital 29 Bauman, Moscow, RU

Purpose: The aim of this study was to determine whether compared with conventional percutaneous drainage (PCD) the addition of trans-fistular necrosectomy (TFN) was associated with improved outcomes in patients with pancreatic and peripancreatic symptomatic acute necrotic collections (ANC).

Material and methods: A single-center observational study was conducted. Eight consecutive patients with pancreatic and peripancreatic symptomatic ANC undergoing PCD and TFN were evaluated. Primary outcome measures were the necessity for additional surgical necrosectomy and mortality. Secondary outcome measures were the length of hospital stay, the length of ICU stay before and after the intervention, the number of trans-fistular necrosectomies, the frequency of fistulographies and drain manipulations under fluoroscopic guidance.

PCD of symptomatic ANC was performed by the Seldinger technique under ultrasound and fluoroscopic guidance in all cases. TFN was performed in patients with drains upsized to 24-30 Fr. TFN was performed under fluoroscopic guidance using Dormia-type extraction baskets.

Results: Additional surgery was successfully avoided in all patients included in this study. Only one patient died. The median length of hospital stay was 37 days. The median length of ICU stay before the intervention was 10 days, after the intervention - 13 days. In average 3.5 TFNs was performed. Necrotic debris up to 5 cm was extracted by TFN. Fistulographies and drain manipulations due to dislodging and clogging were performed on average 14 times.

Conclusion: According to literature a considerable number of patients with symptomatic ANC can be treated with PCD alone. The addition of the TFN may increase the number of patients feasible for the "percutaneous only" approach. To support our clinical impression developed in the context of our case series further high-quality studies based on larger sample size and long term follow-ups are required.

P-375

Single tertiary centre experience of using the oesophageal Beta stent

A.K. Gupta¹, K. Reddy², U. Raja³, I. Ahmed¹, A. Botha⁴, T. Sabharwal⁵

¹Interventional Radiology, Guy's and St. Thomas' Hospitals NHS Foundation Trust, London, UK, ²Interventional Radiology, Guy's and St. Thomas' Hospitals, London, UK, ³Radiology, Guy's and St. Thomas' NHS Foundation Trust, London, UK, ⁴Upper GI Surgery, Guy's and St. Thomas' Hospitals, London, UK, ⁵Radiology, Guy's and St. Thomas' Hospital, London, UK

Purpose: Post operative leak, oesophageal perforation and tracheo-oesophageal fistula (TOF) formation are conditions associated with high morbidity and mortality. The non-operative approach is preferred as a first line management. Traditionally these conditions have a high migration rate due to the absence of a stricture. We present our tertiary referral centre outcomes of using the Beta stent

Material and methods: All patients who had a Beta stent inserted were reviewed. Indication, time to removal and complications were recorded.

Results: 24 patients had the Beta stent inserted between February 2014 – September 18.

Indications included; Boerhaave syndrome 4, post surgical leak 8, benign fistula 2, malignant fistula 7, malignant overgrowth of a previously inserted non Beta stent 2, and benign stricture refractory to multiple dilatations 1. 1 patient was lost to follow up, 15 were removed with average duration till removal 2.6 months (0.75 – 7 months), 9 were not removed by time of death (1 Boerhaave, 7 malignant fistula, 1 malignant overgrowth of previous non beta stent).

Complications encountered included migration 5, iatrogenic tracheo-oesophageal fistula requiring oesophagectomy 1, stent extension due to hold up against the pylorus 2.

Conclusion: The majority were used in benign conditions. Overall, in this small population a significant complication rate is seen with 21% migration rate, 8% extension rate, and 4% iatrogenic TOF requiring oesophagectomy. It is important to have close follow up of these patients and extend the stent into the gastric body or duodenum to prevent hold up against the GOJ or pylorus.

P-376

Combined microwave thermal ablation and liver resection for single step treatment of otherwise unresectable colorectal liver metastases

U.G. Rossi¹, A. Barberis², A.M. Ierardi³, P. Rigamonti⁴, L.C. Pescatori⁵, M. Femia⁴, G. Carrafiello⁶, M. Cariati⁷, M. Filauro²
¹Diagnostic Imaging Department - Interventional Radiology Unit, E.O. Galliera Hospital, Genoa, IT, ²Abdominal and Liver-Biliopancreatic Surgery, E.O. Galliera Hospital, Genova, IT, ³Radiology, University of Milan, San Paolo Hospital, Milan, IT, ⁴Radiology and Interventional Radiology, San Carlo Borromeo Hospital, Milan, IT, ⁵Postgraduation School in Radiodiagnostics, University of Milan, San Donato Milanese, IT, ⁶Diagnostic and Interventional Radiology, University of Milan, Milan, IT, ⁷Diagnostic Sciences, San Carlo Borromeo Hospital, Milan, IT

Learning objectives: To describe tips and tricks of combined microwave thermal ablation and liver resection for single step treatment of otherwise unresectable colorectal liver metastases.

Background: Over half of colorectal cancer patients will develop liver metastases. Thermal ablation for colorectal hepatic metastasis has been suggested as an alternative method to surgery in candidate patients. As surgery, thermal ablation improve survival in these patients. But, for patients with multiple colorectal hepatic metastases, combined microwave thermal ablation and liver resection for single step treatment. This hybrid surgical and interventional radiology technique can achieved radical resection in patients otherwise unresectable for colorectal liver metastases.

Clinical Findings/Procedure Details: The purpose of this poster is to illustrate all passages for combined microwave thermal ablation and liver resection for single step treatment of otherwise unresectable colorectal liver metastases, with particular emphasis on: i) pre-treatment MRI and MD-CT planning with axial and MPR images, ii) multidisciplinary discussion (Oncologists, Surgeons, Anaesthesiologists and Interventional Radiologists), iii) technical aspects to perform the procedure, iv) post-treatment follow-up.

Conclusion: Hepatic resection combined with microwave thermal ablation expanded indications for operative treatment of multiple bilobar liver metastases. This procedure promise to have good long-term outcomes in these patients.

P-377

Duodenal varices: a review of porto-systemic collateral pathways and endovascular interventions

M. Tsurusaki, I. Numoto, T. Oda, A. Suzuki, T. Kadoba, Y. Yagyu, N. Kashiwagi
 Radiology, Kindai University, Faculty of Medicine, Osakasayama, JP

Learning objectives:

1. To describe the pathophysiology of duodenal varices caused by portal hypertension, anatomy of porto-systemic collateral pathways, and endovascular treatment options.
2. To discuss the role of various interventional procedures for the management of duodenal varices.

Background: Duodenal varices are a rare complication of portal hypertension. Rupture of these vessels and failure to identify them as a source of massive enteral bleeding, in addition to difficult hemostasis with endoscopic or surgical techniques, has led to catastrophic outcomes. A few isolated studies have reported successful results with transjugular intrahepatic portosystemic shunts (TIPS), percutaneous transhepatic obliteration (PTO), and balloon-occluded retrograde transvenous obliteration (BRTO). The enhanced knowledge of the anatomy of porto-systemic collateral pathways is one of the most important key to success these procedures.

Clinical Findings/Procedure Details: A. Pathophysiology and clinical manifestations of portal hypertension
 B. Anatomy of various porto-systemic collateral pathways on CT and angiography
 C. Potential indications for various interventional procedures
 D. Endovascular management
 E. Outcomes
 F. Cases

Conclusion: We will provide information about porto-systemic collateral venous anatomy and its importance in guiding the appropriate interventional therapy.

P-378

Mini invasive treatment of gastric leak after sleeve gastrectomy

R.F. Grasso¹, **M.C. Calcagno**¹, D. Meo¹, A. Modica¹, F. Libra¹, C. Desiderio¹, P.M. Coppolino¹, D. Baldanza¹, E.F. Santonocito¹, S. Seminatore¹, G. Caltabiano², A. Basile¹
¹Radiology Unit I - Department of Medical and Surgical Sciences and Advanced Technologies - University of Catania, Azienda Ospedaliero Universitaria Policlinico Vittorio Emanuele, Catania, IT, AOU Policlinico G. Rodolico, Catania, IT, ²Diagnostic and Interventional Radiology Department, Garibaldi Hospital, Piazza Santa Maria del Gesù, Catania, IT

Learning objectives: To describe role of Interventional Radiologist in gastric leak (GL) after Sleeve Gastrectomy (SG), one of the commonest restrictive procedures in bariatric surgery.

Background: GL is one of the most common and feared complications after SG; it implies a long hospital stay, morbidity and mortality. No international consensus exist about the treatment, that should be based mainly on clinical status, timing of diagnosis and location of GL.

Clinical Findings/Procedure Details: Minimally invasive management includes placement of a covered stent under fluoroscopy guidance and CT-Guided percutaneous drainage of collections. Stent placement success is showed by clinical improvement. Stent removal procedures are carried out under endoscopic visualization 8-9 weeks later. In some patients a CT-Guided percutaneous drainage for a persistent GL can be necessary, with a complete resolution of the abdominal collection. A stent re-insertion procedures can be necessary due to stent caudal migration (the commonest periprocedural complication).

Conclusion: Stenting as a primary measure of GL post SG is a safe and effective procedure that offers lower hospitalization and greater compliance; CT-Guided percutaneous drainage performed in persistent GL is

very useful and achieve successful healing. Non operative treatment of leaks is still based on experience and requires a multimodality approach. The interventional radiologist has an important role, because the minimally invasive treatment can be a valuable alternative to repeat surgical interventions or a pre-operative step.

P-379

Liver transplant complications, the role of the interventional radiologist

D. Butrón Hernández¹, A.C. Hernández Villegas², S. Bustamante¹, R. García Buen-Abad³, J.A. Gabutti Tomas¹, I.E. Casanova Sanchez⁴, M. Guerrero Hernandez⁴

¹Departamento de Radiología e Imagen Molecular, Instituto Nacional de Ciencias Médicas y Nutrición, Mexico City, MX, ²Radiology, Instituto Nacional de Ciencias Médicas y Nutrición Salvador Zubirán, Mexico City, MX, ³Radiology & Molecular Imaging, The American British Cowdray Medical Center, Mexico City, MX, ⁴Radiology, Instituto Nacional de Ciencias Médicas y Nutrición Salvador Zubirán, Mexico City, MX

Learning objectives:

1. Understand the surgical technique and types of anastomosis in liver transplantation
2. Review of common and not so common complications after liver transplant
3. Recognize useful imaging findings in the diagnosis of complications after liver transplantation
4. Describe the role of the interventional radiologist in the management of complications associated with liver transplantation

Background: Liver transplantation is the treatment of choice in patients with chronic liver disease or fulminant acute liver failure. Over time the increase in this type of surgery has improved the quality of life of patients; however, there is the possibility of developing complications; therefore the role of the interventional radiologist is essential to detect and offer minimally invasive management of such difficulties for an adequate evolution of the patient.

Clinical Findings/Procedure Details: Surgical technique in liver transplant

Complications:

- Vascular: Stenosis and thrombosis of the hepatic artery, portal vein, and inferior vena cava; pseudoaneurysm; non-occlusive hepatic artery hypoperfusion syndrome.
- Biliary: choledochal stenosis; excluded segmental bile duct leakage
- Liver parenchyma: rejection; infection/abscess
- Perihepatic: biloma; hematoma

Conclusion: Nowadays, the role of the interventional radiologist has grown favorably, each day developing and performing work in different areas.

Knowing, identifying and analyzing each possible complication after hepatic transplantation is part of this role, however much of its strength lies in offering a minimally invasive treatment which is increasingly accepted by other physicians and by the patients themselves, in order to give an alternative besides surgery and so, an early solution to the complication presented.

P-380

Percutaneous transhepatic stenting for afferent loop syndrome

B. Kawa, J.E. Fish, S. Kemp, C. Elwood, P. Ignotus, A. Shaw
Interventional Radiology, Maidstone and Tunbridge Wells NHS Trust, Maidstone, UK

Learning objectives:

1. To describe afferent loop syndrome.
2. To describe our technique and outcomes using a novel direct small bowel transhepatic approach to stent and relieve afferent loop syndrome.

Background: Afferent loop syndrome (ALS) is partial or complete obstruction of the afferent loop created following pancreaticoduodenectomy (Whipples) and, less commonly, gastric by-pass surgery. The insertion of metallic stents for the relief of ALS has been described well in the literature following radiologically-guided transhepatic biliary catheterisation and percutaneous drainage. Endoscopic transgastric approaches have also been described and surgical management is currently considered second-line.

We aim to describe two cases involving a novel percutaneous transhepatic direct afferent loop puncture and successful insertion of a self-expanding metallic stent.

Clinical Findings/Procedure Details: We present two patients with a history of a Whipple's procedure and pancreatic cancer who presented with obstructive jaundice and afferent loop syndrome due to focal serosal recurrent disease. Following written consent, an ultrasound guided liver puncture was performed using an 18G DTN needle into the jejunum close to the site of choledochojejunostomy. An 8Fr pigtail drain is then inserted to relieve jaundice. A second-step procedure is performed a week later, a guide-wire is manipulated across the stricture and an uncovered duodenal stent is deployed.

Conclusion: Prompt treatment of ALS is vital to prevent perforation and sepsis. Both of our cases demonstrated clinical improvement of ALS. Direct transhepatic afferent loop puncture is a safe and effective alternative to previously described biliary catheterisation.

P-381

A guide to IR and EUS gastro-jejunostomy

A. Ngo¹, D.A. Valenti¹, Y.-I. Chen², C.R. Cassim¹, R. Abu Hana¹, P. Lourenco¹, B. Moosavi¹, A. Bessissow¹

¹Radiology, McGill University Health Centre, Montreal, QC, CA, ²Gastroenterology, McGill University Health Center, Montreal, QC, CA

Learning objectives:

1. To learn the indications and technique for IR/EUS guided gastro-jejunostomy
2. To understand the anatomy pertinent to the procedure
3. To appreciate the importance of inter-disciplinary collaboration between IR and Gastroenterology for a successful outcome

Background: In patients unsuitable for surgical gastro-jejunostomy, the endoscopic placement of self-expanding metal stents has been the standard approach to treating malignant gastroduodenal obstruction. However, where the obstruction may not be crossed endoluminally by endoscopic means, alternative approaches may be necessary. IR assisted endoscopic ultrasound (EUS) guided gastrojejunostomy is a novel procedure which has emerged as an important treatment option in such patients with both benign and malignant etiologies.

Clinical Findings/Procedure Details: At McGill, a collaboration between the IR and gastroenterology teams, each with their own unique expertise and skill set, plays a vital role in the efficient, safe and successful outcome of the procedure.

Communication between the stomach and jejunum may be achieved by:
- transhepatic or peroral IR guided access to the jejunum and placement of a snare or targeting balloon.

- EUS guided direct trans-gastric puncture into the target jejunal lumen

- through and through guidewire access to allow the endoscopic placement of a lumen-apposing, self-expanding fully covered metal stent

Conclusion: IR/EUS guided gastro-jejunostomy is an important alternative to surgical/endoscopic strategies to achieve bypass in the context of malignant or benign gastric outlet obstruction. Readers will gain an understanding of the advantages and challenges unique to this emerging procedure, as well as the interdisciplinary approach required to successfully deliver this service.

P-382

Endovascular management for mesenteric ischemia; treatment and key CT findings of diagnosis

S. Kanasaki¹, A. Furukawa², K. Fumoto¹, Y. Hamanaka¹

¹Radiology, Koseikai Takeda Hospital, Kyoto, JP, ²Radiological Sciences, Tokyo Metropolitan University, Tokyo, JP

Learning objectives:

1. To learn general consideration of mesenteric ischemia in various etiologies; incidence, clinical background.
2. To learn key findings enhanced multi-detector CT for assessment of bowel and mesenteric viability for selection of treatment options.
3. To learn current technique of endovascular treatment (EVT) for each etiologies of mesenteric ischemia in the treatment strategy.

Background: Acute mesenteric ischemia (AMI) is a life-threatening condition. Enhanced multidetector CT can depict mesenteric ischemia, its underlying causes, and its severity. The causes of AMI include arterial occlusion, venous occlusion, and nonocclusive mesenteric ischemia. Different treatment strategies depend on the etiology of mesenteric ischemia.

Clinical Findings/Procedure Details: When AMI is suspected, the following findings should be noted for etiologies and the bowel viability:

1. Bowel wall thickening,
2. A high-attenuating bowel wall at nonenhanced and contrast-enhanced CT,
3. Filling defects in the mesenteric arteries and veins,
4. The absence of wall enhancement,
5. A paper-thin bowel wall appearance,
6. Mesenteric stranding and ascites,
7. Pneumatosis, portomesenteric venous gas and free peritoneal gas.

Endovascular treatments should be performed before intestinal infarction occurs and when the ischemia is potentially reversible.

Endovascular treatment arterial occlusion includes;

1. Trans-catheter mechanical thrombectomy, aspiration, thrombolysis
2. percutaneous transluminal angioplasty (PTA) with or without stenting
3. intra-arterial drug perfusion (such as heparin or papaverine).

The first line treatment for mesenteric venous thrombosis is anticoagulation. Patients who deteriorate during medical treatment can be considered for endovascular treatment.

The first line treatment for NOMI is medical therapy combination with transcatheter infusion of vasodilators into the SMA.

Conclusion: We discussed Key findings and EVT for mesenteric ischemia.

P-383

Expanding fields in interventional radiology: role of bariatric embolization

S. Silipigni¹, C. Floridi², M. Petrillo³, S.A. Angileri⁴, A. Stagno⁵, A. Bottari¹, A.M. Ierardi⁶, G. Carrafiello⁶

¹Department of Biomedical Sciences and Morphologic and Functional Imaging, Policlinico Universitario G. Martino, University of Messina, Messina, IT, ²Radiology, Fatebenefratelli Hospital, Milan, IT, ³Section of Radiology, Department "Magrassi-Lanzara," Second University of Naples, Naples, IT, ⁴Radiology, University of Milan, San Paolo Hospital, Milan, IT, ⁵U.O.C Radiodiagnostica, A.O.U. G. Martino, Messina, IT, ⁶Interventional Radiology, Asst Santi Paolo E Carlo, Milano, IT

Learning objectives: Selective embolization of the Left gastric artery (LGA) causes ischemia of the fundic ghrelin producing cells, determining a loss of appetite. LGA embolization represents a minimally invasive alternative to surgery in selected cases.

Background: Morbid obesity represents a public health problem affecting today 6.6% of USA population; WHO recognized obesity as an epidemic among adults. Today surgery represents the best option, however not all patients are candidable for intervention and a certain percentage of complications is registered. Since first studies on animal population, few human prospective studies assessing the potential of LGA embolization have been carried out. Review of 7 papers was performed (3 trials, 2 prospective and 2 retrospective studies).

Clinical Findings/Procedure Details: Literature data report a mean reduction of body weight at 6 months between 4 and 16% with a mean value of 9,6 %. Most of the authors employed 300-500 µm embolizing particles (5 out of 7). Only two authors employed 500-700 µm particles. Reported complications are classified into minor complications (abdominal discomfort, nausea, self limiting gastric mucosa micro-ulcerations), more common and responsive to PPI therapy and painkillers and major complications (a single case of pancreatitis with gastric perforation and splenic infarction, and a case of subclenic pancreatitis).

Conclusion: LGA embolization represents a new promising and safe technique. Its efficacy seems to be limited and further studies with larger cohorts are needed to assess its effective utility as an alternative to surgery.

P-384

Percutaneous pancreatic duct access for antegrade pancreatic duct stent placement

R.R. Galuppo Monticelli¹, S. de Melo², J.A. Kaufman³

¹Interventional Radiology, Oregon Health and Science University, Portland, OR, US, ²Gastroenterology, Oregon Health and Science University, Portland, OR, US, ³Dotter Interventional Institute/Interventional Radiology, Oregon Health & Science University Hospital, Portland, OR, US

Clinical History/Pre-treatment Imaging: 68 year-old female with recurrent pancreatitis status post Whipple procedure for Papillary Mucinous Neoplasm and stenosis of the pancreaticojejunostomy anastomosis. Post surgical anatomy and stenotic pancreaticojejunostomy rendered the duct inaccessible from an endoscopic approach. The patient underwent direct percutaneous pancreatic duct access in 2016 allowing antegrade stent placement during a rendezvous procedure with gastroenterology. Unfortunately, the stent dislodged and developed symptomatic recurrent stenosis. She was referred for repeat rendezvous procedure with direct percutaneous pancreatic duct access.

Treatment Options/Results: The jejunum was accessed with an Olympus clear cap fitted PCF-H190L Peds Colonoscope #2517774, introduced through the mouth, and advanced to the jejunum. The pancreatic duct was visualized with ultrasound and measured approximately 3.8 mm in diameter. The duct was percutaneously accessed under ultrasound guidance with a micropuncture system. The microguidewire advanced easily into the jejunum and snared endoscopically. This allowed canalization of

the pancreatic duct with balloon dilatation (4 mm) and stent placement (7F x 7 cm). Postoperatively, the patient did well and had no pancreatitis.

Discussion: Percutaneous access to the pancreatic duct for antegrade pancreatic duct stent placement represents an alternative approach to patients with altered anatomy or challenging retrograde endoscopic access.

Take-home points: Antegrade pancreatic stent placement represents a feasible and safe alternative.

P-385

Initial experience with PHIL liquid embolic agent for gastrointestinal bleeding embolization and occlusion of enteric fistula using n-BCA glue

A. Tarkhanov¹, G. Bartal², S. Druzhin¹, V. Elishev³, E. Grebenev⁴, M. Kartashov⁴, R. Shakhbazyan¹

¹Interventional Radiology, Sverdlovsk Regional Oncology Center, Yekaterinburg, RU, ²Radiology, Meir MC, Kfar-Saba, IL, ³Oncology, Sverdlovsk Regional Oncology Center, Yekaterinburg, RU, ⁴Radiology, Sverdlovsk Regional Oncology Center, Yekaterinburg, RU

Clinical History/Pre-treatment Imaging: 71 y.o. female underwent Whipple resection for duodenal papillary adenocarcinoma. 7 weeks after surgery was readmitted with upper GI bleeding and enteric fistula. On CT-angiography no evidence of active bleeding. Direct fistulography demonstrated parapancreatic fluid collection with fistula into the bowel loop. In order to control the bleeding and close the fistula two sequential interventions were performed: empirical embolization and occlusion of fistula at the same session.

Treatment Options/Results: Celiac trunk was catheterized using C2 4F catheter. Gastroduodenal artery (GDA) appeared notably suspicious as a source of bleeding source of the enteric anastomosis. On SMA angiography we observed branches to GDA without evidence of bleeding. GDA was embolized with IDC microcoil (BSCI) and PHIL 25% (Microvention) via 1.7 F Headway (Microvention) microcatheter until complete occlusion. Fistulography was performed using Mach C2 (BSCI) Guiding catheter was introduced via surgical incision to anastomosis. Enteric fistula in the area of anastomosis zone was observed. Microcatheter was advanced into the fistula and an anastomotic leak was observed. Jejunal fistula was occluded using n-BCA Trufill system. Fistulography on day 5 following intervention without evidence of pathology. Further follow up was uneventful.

Discussion: PHIL liquid embolic agent can be used for termination of peripheral bleeding, whereas n-BCA Trufill system can be used for enteric fistula closure.

Take-home points: Intelligent matching of different liquid embolic agents to specific indications is effective in vascular and non-vascular interventions.

P-386

Utilizing methylene blue prior to embolization in a patient with upper gastrointestinal bleeding

S. Han, J.F.B. Chick, R. Srinivasa, V. Krishnamurthy
Vascular and Interventional Radiology, University of Michigan Health Systems, Ann Arbor, MI, US

Clinical History/Pre-treatment Imaging: Patient is a 26 year-old female, status post aortic valve replacement, tricuspid valve repair, with her ICU course complicated by hematemesis. Endoscopy showed multiple gastric ulcers, which were not able to be treated. After several days, she became unresponsive, hypotensive, with coffee ground emesis and IR was consulted for immediate embolization.

Treatment Options/Results: A diagnostic celiac arteriogram showed no active extravasation of contrast and the left gastric artery was empirically embolized with gelfoam. Minimal mucosal staining was also seen at the right gastroepiploic artery along the greater curvature of the stomach and selective arteriogram of this artery showed no active extravasation

of contrast (Figure 1). Due to large territory vascular compromise, determination of vasospasm versus gastric mucosal ischemia/necrosis was needed. 10 ml of methylene blue was injected under endoscopic visualization which showed extravasation of methylene blue dye into the gastric lumen at the ulcers (Figure 2), excluding gastric necrosis. Gelfoam embolization was subsequently performed at the right gastroepiploic artery and the bleeding ceased.

Discussion: Review articles and case reports have described the use of methylene blue to identify sources of bleeding from AVMs in the small and large bowel. However, the use of methylene blue to identify a source of gastric bleeding concomitantly with angiography and endoscopy has not yet been described in the literature.

Take-home points: Empirical embolization of the left gastric artery may be performed with ulcers present at the gastric fundus.

Methylene blue was used to exclude gastric mucosal ischemia/necrosis in the setting of vasospasm.

P-387

Massive rectal bleeding treated with transcatheter artery embolization: an unusual presentation of the solitary rectal ulcer syndrome

A. Vizzuso, M. Graziano, F. Ermili, Z. Ferrante, S. Dall'Ara, E. Salviato, R. Galeotti
Morphology, Surgery and Experimental Medicine, University of Ferrara - Saint'Hanna Hospital, Cona (Fe), IT

Clinical History/Pre-treatment Imaging: A 35-year-old paraplegic man because of a thoracic spinal cord injury and, history of constipation and self-digitation maneuver to evacuate, complained rectal bleeding and maroon-colored stools from some days. Laboratory findings revealed hemoglobin of 8.3 g/dL and a hematocrit of 25% requiring the transfusion of 3 units of packed blood cells. Esophagogastroscope was negative and colonoscopy was inconclusive showing blood and clots. Abdominal contrast enhanced CT showed endorectal active contrast extravasation from left superior hemorrhoidal artery (SHA). Endovascular angiography and embolization was performed for controlling acute bleeding.

Treatment Options/Results: Selective catheter angiography at the inferior mesenteric artery demonstrated active extravasation from a peripheral posterior branch of the left SHA (Fig.1). It was subsequently super-selective embolized with coils. Post-embolization images demonstrated resolved bleeding (Fig.2). Two days later endoscopy revealed a single shallow longitudinal ulcerating lesion covered by white slough on a hyperemic surrounding mucosa. Combination of symptomatology, patient history and endoscopy prompted the diagnosis of Solitary Rectal Ulcer Syndrome (SRUS).

Discussion: SRUS is a rare benign disorder supposed to be secondary to straining, self-induced trauma, paradoxical contraction of puborectal muscle, rectal prolapse and intussusception. Although rectal bleeding is one of the most common clinical features, massive hemorrhage is extremely rare. Patients with a massively bleeding rectal ulcer that does not stabilize with endoscopic or supportive therapy must be considered for operative treatment, including endovascular embolization.

Take-home points: -SRUS is an extremely rare cause of massive lower gastrointestinal bleeding.

-Embolization is a safe and effective alternative to endoscopic treatment and surgery for the rapid clinical stabilization.

P-388**Gastrointestinal bleeding from Dieulafoy's lesion: endovascular management with gelfoam and coil**

A. Vizzuso, M. Graziano, F. Ermili, Z. Ferrante, S. Dall'Ara, E. Salviato, R. Galeotti

Morphology, Surgery and Experimental Medicine, University of Ferrara - Saint'Hanna Hospital, Cona (Fe), IT

Clinical History/Pre-treatment Imaging: A 56-year-old man was admitted to our hospital for some day of asthenia. He reported aspirin intake for a month. His past medical history included splenectomy for trauma. Laboratory tests showed hemoglobin of 9.1 g/dL and digital rectal examination revealed melena. Esophagogastroduodenoscopy showed, in proximal gastric body, active arterial spurting from two close minute mucosal defect. These lesions were successfully treated with combined mechanical hemostasis and injection therapy. However, a following laboratory test revealed hemoglobin drop.

Treatment Options/Results: Patient performed endovascular angiography but no active source of gastrointestinal (GI) bleeding were found. After celiac trunk catheterization, images revealed distal left gastric artery branches maintaining constant arterial caliber and tortuous appearance (Fig.1), finding suspected of Dieulafoy's lesion. To minimize risk of premature rebleeding, embolization with gelfoam and coil was performed demonstrating reduce flow towards the proximal stomach (Fig.2).

Discussion: Although often misdiagnosed, Dieulafoy's lesion represents an important etiology of acute, life-threatening and recurrent GI bleeding. Hemostasis with angiographic embolization has been reported in sporadic case reports. To minimize the risk of bowel infarction, the super-selective catheterization technique and a temporary agent such as gelfoam slurry is mandatory. In our patient, despite active bleeding was no seen, we have decided to release also a proximal single coil. To our knowledge, it allows to reduce recurrent bleeding risk decreasing perfusion pressure but to maintain sufficient tissue blood flow avoiding ischemia.

Take-home points: The embolization strategy is essential in the endovascular management of Dieulafoy's lesion to balance the risk of rebleeding and the risk of bowel ischemia.

P-389**126/5000 embolisation of a lesion of dieulafoy of the stomach blender already subject to hemoclippping endoscopic: a case report**

G. Sarti, F. Arienzo, G. Santini

Radiology Vascular and Interventistic, P.O. Ospedale del Mare, Napoli, IT

Clinical History/Pre-treatment Imaging: Man 38 years old, with hematemesis and melena, was diagnosed with one hemorrhage from the upper GI tract; an EGDS examination allowed to identify a lesion of Dieulafoy on the gastric bottom and to proceed with the hemostatic treatment through clipping. This procedure was found to be inefficient due to acute re-bleeding with values of HB7g/dl.

Treatment Options/Results: On the second access, the man was postponed to an angiographic examination after the selective catheterization of the celiac tripod which, while not allowing to identify the source of bleeding in a left gastric site it was decided however to proceed to the embolization with metal spirals, in the dysplastic peripheral superselective seat, of the metal clips previously implanted by EGDS. The patient after 7 days was discharged in good general condition in the absence of symptoms of haemorrhage and with an increase in hemoglobin value of 9.9 g / dl, without resorting to transfusion therapy.

Discussion: Haemorrhages of the upper gastrointestinal tract pose complex situations in which the endoscopic examination appears an irreplaceable diagnostic stage. The lesion of Dieulafoy represents a condition in which hemostasis through the same endoscopy can be ineffective, but in which embolization represents a therapeutic choice practicable and certainly resolute.

Take-home points: Emphasize the possibility of attenuating a embolizing treatment in lesions of Dieulafoy. The endoscopic examination is a diagnostic evaluation and an intervention therapeutic hemostatic; frequent problems that endoscopic therapy fails or does not result feasible, conditions under which angiographic examination is; data embolization the most diagnostic-therapeutic efficacy.

P-390**Endovascular treatment of acute hemobilia following laparoscopic cholecystectomy**

M. Varrassi¹, A. Izzo², G. Bianchi³, M. Ruschioni², F. Formiconi², F. Cobianni Bellisari², A. Di Sibio⁴, S. Carducci⁵, A.V. Giordano⁴, C. Masciocchi²

¹Neuroradiology and Interventional Radiology, S. Salvatore Hospital, L'Aquila, IT, ²Applied Clinical Sciences and Biotechnology, University of L'Aquila, L'Aquila, IT, ³Division of Radiology, Department of Biotechnological and Applied Clinical Science, University of L'Aquila, S. Salvatore Hospital, L'Aquila, IT, ⁴Radiology, Ospedale S. Salvatore L'Aquila, L'Aquila, IT, ⁵Biotechnological and Applied Clinical Sciences, San Salvatore Hospital, L'Aquila, IT

Clinical History/Pre-treatment Imaging: An 18-year-old girl underwent laparoscopic cholecystectomy for biliary sludge. During surgery, a coledocic duct injury occurred; decision was taken to convert to open surgery with subsequent positioning of an endoscopic endoprosthesis for biliary tree.

Three months after surgery, the biliary endoprosthesis was removed but after twenty minutes the patient showed signs of hypovolemic shock. Patient underwent computed tomography angiography (CTA) showing a possible arterial lesion, just adjacent to surgical clip, with coledocic luminal hyperdensity as for hemobilia (Fig.1-arrows). Patient underwent angiographic examination (DSA) with catheterization of proper hepatic artery. DSA confirmed a 7mm pseudoaneurysm arising from cystic artery, likely draining in the biliary tree (Fig.2-arrows).

Treatment Options/Results: Using "sandwich" technique, the pseudoaneurysm was excluded performing super-selective catheterization of parent vessel and subsequent coil embolization (Fig.2-arrows). Selective arteriography of common hepatic artery, superior mesenteric artery confirmed exclusion of the lesion. The girl was discharged after two months in good health.

Discussion: Hemobilia is a rare, life-threatening complication after cholecystectomy. CTA represents a fundamental technique, able to highlight the high-attenuation clots in the biliary duct on non-enhanced scans and the presence of an arterial lesion; in the latter case, DSA should immediately follow CTA.

Take-home points: Transarterial embolization has become the first choice in the management of hemobilia sustained by an arterial injury. In these cases, coil embolization of parent vessel with sandwich technique is recommended to avoid possible reperfusion of the pseudoaneurysm from collateral circulation; packing of the lesion with coils is not advisable due to relatively high risks of rupture and reperfusion.

P-391**Embolization of aneurysm of the hepatic artery and dissection of the celiac tripod with splenic artery originating from the false lumen**

G. Sarti, F. Arienzo, G. Santini

Radiology Vascular and Interventistic, P.O. Ospedale del Mare, Napoli, IT

Clinical History/Pre-treatment Imaging: Patient with common hepatic artery aneurysm diagnosed with US-CD. An aneurysm of the common hepatic artery and an associated dissection of the celiac tripod with a splenic artery that originated from the false lumen is shown in the Angio CT.

Treatment Options/Results: It proceeds to the positioning of the introducer along (Flexor Cook 7Fr), and catheterization of the celiac tripod. You gain the false lumen of the tripod and place stiff guide in splenic and microcatheter in hepatic. The aneurysmal sac is embolized with controlled release (Concert spirals). The covered stent (Covera, 7x80mm) is implanted from the origin of the tripod at the point in front of the left gastric artery up to the proximal splenic, thus completely excluding the aneurysm but preserving the patency of the left and splenic gastric artery.

Discussion: This case presented a concomitant double vascular pathology in a territory such as the tripod of difficult handling and catheterization. Embolization of the a.hepatic, even if it does not lead to complications in the liver due to the double vascularization of this parenchyma, has led to embolization of a. gastroduodenal, therefore it was fundamental to preserve the patency of a. left gastric. Furthermore, the embolization of the hepatic artery would have led to an increase in flow of the splenic artery that could have extended the dissection, so treating this dissection with a stenting was essential.

Take-home points: The ability to treat both aneurysmal pathology and dissection in the same location, preserving important vessels such as the a.splenic and the left a.gastric.

P-392

Pre-operative embolization of jejunal stromal tumor presenting with life threatening lower gastro-intestinal bleeding

J.D. Vasani¹, B. Prosperi²

¹Interventional Radiology, University of Miami, Miami, FL, US, ²Radiology, University of Miami, Miami, FL, US

Clinical History/Pre-treatment Imaging: 33 y/o female presented to the ED with increasing melena and hypotension requiring blood transfusion. After initial hemodynamic stabilization, she was admitted to inpatient service for GI workup. Upper endoscopy revealed a bleeding mucosal mass in proximal jejunum with inconclusive biopsy results. CT abdomen revealed a 5 x 4.7 x 4.1 cm hypervascular mass without active contrast extravasation.

Treatment Options/Results: Embolization was performed with 300 – 500 um particles and 2mm x 4cm ruby coil until complete vascular stasis. 24 hrs later, uneventful laproscopic resection of the mass was performed. Frozen section confirmed jejunal stromal tumor with areas of erosion and necrosis compatible with post embolization changes.

Discussion: Gastrointestinal stromal tumors (GISTs) account for less than 1% of GI tumors. Although small bowel GISTs account for only 20% to 45% of GISTs, in recent years they have reportedly become more common and more aggressive. For patients who present with GI bleeding, endoscopic intervention, including clipping, or epinephrine injection, is the primary management. If endoscopic intervention fails to control the bleeding, embolization can be attempted to stop the bleeding.

Take-home points: GIST who present with life threatening bleeding which cannot be controlled with endoscopic interventions, can be safely treated in a two step manner which includes initial endovascular control of gastrointestinal hemorrhage achieving hemodynamic stability and subsequent safe laparoscopic resection.

P-393

Endovascular embolization of iatrogenic mesenteric fistula: a case report

S. Corraïne, A. Ferrari, F. Fusaro, C. Ganau, P. Enne, F. Schirru, S. Comelli

Neuroradiology and Interventional Radiology, Azienda Ospedaliera Brotzu, Cagliari, IT

Clinical History/Pre-treatment Imaging: A 36-year-old woman with previous history of intestinal resection for endometriosis was admitted to the hospital for nausea and abdominal pain in the last 3 months. During the hospitalization she experienced several gastrointestinal bleeding with

hematemesis and severe acute anemia. A gastroscopy showed bleeding esophageal varices. The Angio-CT revealed severe Superior Mesenteric Artery dilatation with early opacification of Superior Mesenteric Vein, dilatation of portal-systemic shunts and signs of intestinal ischemia. The selective angiography of SMA confirm a distal iatrogenic AVF between ileo-colical artery and SMV.

Treatment Options/Results: Endovascular treatment has been chosen as first option. Through a selective microcatheter (2.7F) 9 detachable coils were placed to significantly reduce the flow. The cast was then complete with injection with a 1:1 mixture of Glubran and Lipiodol as embolic plug. The final angiography showed the occlusion of the fistula and restored mesenteric arcades flow. No peri-procedural complication occurred. On day 7, CTA showed restoration of regular SMA caliber and porto-systemic shunt reduction, with confirmed occlusion of the fistula. The patient was discharged after 14 days in good general condition.

Discussion: Whilst open surgery could represent a challenging indication approaching hostile abdomen in post-operative complications, endovascular therapy is an emergent valid option for the treatment of iatrogenic sequelae as SMAVF.

Take-home points: According to literature endovascular treatment can be a safe and effective treatment for SMAVF complicated by acute gastrointestinal bleeding.

P-394

An uncommon cause of proctalgia post liver transplantation

N. Rutledge¹, G.M. Healy², J. McCann², D. Houlihan¹

¹Department of Hepatology, St. Vincent's University Hospital, Dublin, IE, ²Department of Radiology, St. Vincent's University Hospital, Dublin, IE

Clinical History/Pre-treatment Imaging: A 54yo gentleman presented with six months of severe proctalgia, diarrhoea and intractable pruritus ani following liver transplantation for autoimmune hepatitis and subsequent primary sclerosing cholangitis in 1997 & 2003.

His symptoms impacted his quality of life requiring nerve-block; he was opiate dependent secondary to proctalgia. An ileostomy was performed to manage pain but with minimal effect.

Colonic biopsy demonstrated portal colopathy. Multiphasic CT abdomen demonstrated two distinct leashes of abnormal vessels within the mesentery at the splenic flexure of the colon and adjacent to the rectum. There was arterial hypertrophy and arteriovenous shunting, consistent with colonic arteriovenous malformations. These had slowly developed over prior studies. His symptoms coincided with progressive flow-related stenoses of the superior and inferior mesenteric veins, suggesting that his proctalgia was due to impaired venous drainage from the AVM and resultant venous engorgement.

Treatment Options/Results: Treatment options were considered. Under the guidance of Interventional Radiology he underwent elective embolisation/sclerotherapy of the rectal AVM in 2014 using a 50:50 mixture of absolute alcohol and contrast administered via microcatheter. There was excellent symptomatic response.

Repeat embolisation/sclerotherapy was required in 2017 for minor recurrence of proctalgia, again using 50:50 alcohol and contrast. Pre-treatment angiography demonstrated significantly improved appearances with decreased AV shunting and symptoms again dissipated after treatment.

Discussion: This rare cause of proctitis can be considered in cases of intractable pain. Similar cases report AVM's as a cause of portal hypertension in the absence of hepatic disease.

Take-home points: Interventional Radiological options have a dramatic effect on symptom control and quality of life.

P-395

Colonic arteriovenous malformation embolisation

T. Gordon, G. Weir

Radiology, Royal Infirmary of Edinburgh, Edinburgh, UK

Clinical History/Pre-treatment Imaging: 63-year-old male presented with intermittent PR bleeding and abdominal pain over three days. Triple phase (pre, arterial and venous) CT was performed demonstrating an arterial blush of contrast within the ascending colon and pooling of contrast on the venous phase. Endoscopic investigation and therapy was not amenable due to poor bowel preparation, colonic tortuosity and the patient's haemodynamic status.

Treatment Options/Results: Catheter angiogram via the SMA demonstrated an arterial blush of contrast within the proximal ascending colon. Unusually, prompt filling of the peri-colic veins was seen. This presented an unusual diagnostic conundrum; angiographic findings were inconsistent with the common differential of haemorrhagic colonic lesions, namely, angiodysplasia and haemorrhagic diverticula. Instead, the applied pathophysiological findings were suggestive of a colonic arteriovenous malformation (AVM), a relatively rare entity. The AVM was treated with gelfoam and coils with satisfactory stasis.

Discussion: Colonic AVMs are a rare cause of colonic bleeding, especially in the setting of the haemodynamically compromised patient. Embolisation is infrequently reported in the literature, as supported by local experience. Never-the-less, a satisfactory outcome was achieved in this instance with no recurrence at one-year of follow-up.

Take-home points: Colonic AVMs are an uncommon cause of acute lower gastrointestinal haemorrhage. Few cases of treatment via intra-arterial embolisation are reported in the literature. This case report demonstrates good a clinical outcome following embolisation, admittedly in a single case, with no recurrence of lower GI bleeding at one-year.

P-396

A rare complication of stapled hemorrhoidopexy: giant pelvic hematoma treated with percutaneous angioembolization

P. Spadafora¹, M. Cariati², G. Damiani³, M. Tamarin⁴, P. Rigamonti³, S. Criscuolo³

¹Postgraduation School in Radiodiagnosics, Università degli Studi di Milano, Milan, IT, ²Diagnostic Sciences, San Carlo Borromeo Hospital, Milan, IT, ³Radiology and Interventional Radiology, San Carlo Borromeo Hospital, Milan, IT, ⁴Diagnostic and Interventional Radiology, San Paolo Hospital - Milan, Milan, IT

Clinical History/Pre-treatment Imaging: A 76-year-old woman complaining about recurrent anorectal bleeding and pelvic discomfort was referred to our Unit for hemorrhoidal prolapse. She had past history of arterial hypertension and chronic constipation. At consultation, a IV degree muco-haemorrhoidal prolapse (according to Goligher's classification) was diagnosed.

Treatment Options/Results: Procedure for Prolapsed Haemorrhoids (PPH) was offered and accepted by the patient. Operation was carried out, as usual, with PPH-03 stapler kit, with no intraoperative complication. At the end of the procedure the rectal suture was 4 cm above the dentate line and it was complete. Additional stitches were placed on the suture line and finally no bleeding points were noted. Finally, a postoperative endoanal sponge was left in place.

Discussion: No rectal bleeding nor other abnormalities were noted. Since the pain didn't cease after strong analgesic therapy, an urgent abdominal and pelvic contrast-enhanced CT-scan was performed. The exam showed a giant peri-rectal and retroperitoneal pelvic hematoma, with signs of active bleeding. A subsequent selective arteriography showed huge bleeding from the superior haemorrhoidal artery, that was treated with super-selective embolization. Ano-rectal examination showed regular stapler line with no prolapse recurrence and a new control CT scan revealed regression of the pelvic hematoma.

Take-home points: Conclusions: Severe complications may occur after PPH and one of the most serious is local bleeding. In our experience, no signs of external active bleeding were noted. Prompt diagnosis with CT scan allowed to offer efficacious non-operative treatment with angio-embolization, avoiding the need of reoperation for a potential severe complication.

Gynaecological intervention (including UFE)

P-397

Preoperative prophylactic balloon-assisted occlusion of internal iliac arteries in management of placenta increta/percreta

S.E. Park¹, S. Cho², H.C. Choi³, S.M. Lee³, Y.U. Lee¹

¹Radiology, Gyeongsang National University Changwon Hospital, Changwon-si, Gyeongsangnam-do, KR, ²Radiology, Ewha Womans University Medical Center, Seoul, KR, ³Radiology, Gyeongsang National University Hospital, Jinju, KR

Purpose: To report maternal and fetal outcomes after using prophylactic internal iliac artery balloons in women with placenta increta or percreta. To report maternal and fetal outcomes after using prophylactic internal iliac artery balloons in women with placenta increta or percreta.

Material and methods: Records of 37 consecutive patients with a diagnosis of placenta increta/percreta were retrospectively reviewed. Twelve (32.4%) patients underwent cesarean delivery with placenta increta or percreta after prophylactic occlusion balloon catheter placement in bilateral internal iliac artery (balloon group) and 25 (67.6%) similar patients underwent cesarean delivery without occlusion balloon placement (surgical group). Blood loss, transfusion volume, postoperative hemoglobin change, hysterectomy rates, hospitalization, and infant Apgar score of the two groups were compared.

Results: The mean intraoperative blood loss in the balloon group ($2,446 \pm 1,191$ mL, range 1,000-4,500 mL) was significantly ($p = 0.039$) lower than that in the surgical group ($4,219 \pm 1,376$ mL, range 1,500-10,500 mL). The mean volume of blood unit transfused in the balloon group ($2,140 \pm 1,154$ mL, range 1,200-8,000 mL) was significantly ($p = 0.046$) lower than that in the surgical group ($3,960 \pm 1,464$ mL, range 1,800-15,200 mL). There was no significant difference in postoperative hemoglobin change, hysterectomy rate, length of hospitalization, or infant Apgar score between the two groups.

Conclusion: Preoperative prophylactic placement of internal iliac artery occlusion balloons prior to cesarean delivery in patients with placenta increta or percreta is a safe and minimally invasive technique that can reduce intraoperative blood loss and transfusion requirements.

P-398

Uterine fibroid embolization efficacy and safety: 15 years experience in an elevated turnout rate center

A. Paladini¹, A. Borzelli², A. Cina³, F. Rosella⁴, C. Di Stasi⁵, G.E. Vallati⁶

¹SCDU Radiologia Diagnostica ed Interventistica, AOU "Maggiore della Carità" - Novara, Novara, IT, ²U.O.C. Neuroradiologia, AORN, Naples, IT, ³Department of Radiological Sciences, Institute of Radiology, "A. Gemelli" Hospital - Catholic University, Rome, IT, ⁴Radiodiagnosics, Agostino Gemelli Hospital, Roma, IT, ⁵Radiology, Università Cattolica del Sacro Cuore, Policlinico Universitario A. Gemelli, Rome, IT, ⁶Interventional Radiology, IFO Istituto Regina Elena National Cancer Institute, Rome, IT

Purpose: To evaluate effectiveness and safety of uterine fibroid embolization (UFE) as alternative to surgery, in treatment of uterine fibromatosis.

Material and methods: 255 patients (aged 26–55) with symptomatic UF, indication for surgery, followed in our center (2000–2014), single or multiple fibroids, pain and/or functional/compressive disorders, underwent embolization: injection of PVA particles (150–900 µm) from distal portion of uterine arteries (ascending section). Primary end-point: flow-stop

distally to injection site, disappearance of lesion design, preservation of flow in main trunk of UA. Secondary end-point: control of pain and functional/compressive disorders during follow-up (2–7 years).

Results: Procedure was performed bilaterally in 250 patients (98%). Mean duration: 47 min (average fluoroscopy: 10:50 min). Post-embolization pelvic pain (according with VAS score) was on average 2.2 at discharge (24 h). Follow-up at 2 years: resolution of menstrual disorders in 78% of patients and improvement in 14%; pain disappeared in 66%; significant improvement of menstrual flow and HCT/HB levels, decrease in total uterine (57.7%)/dominant fibroid (76.1%) volume. Recurrence in 18 patients.

Conclusion: UFE represents an excellent alternative to surgical treatment: it is safe, tolerable and effective both in short and long term, with evident advantages in economic and social terms.

P-399

Evaluation of the effectiveness of transvaginal fallopian tubes recanalization in the treatment of infertility

K. Pyra¹, M.B. Bąk¹, M. Nowakowska¹, I. Zych², A. Drelich-Zbroja¹, T. Jargiełło¹

¹Department of Interventional Radiology and Neuroradiology, Medical University of Lublin, Lublin, PL, ²Department of Obstetrics and Perinatology, Medical University of Lublin, Lublin, PL

Purpose: Tubal disease is responsible for infertility in approximately 30% of women, with 10–25% of such cases due to proximal tube obstruction. PTO is most commonly caused by mucus plugs (up to 40%). Tubal catheterization is minimally invasive procedure which enables treatment of PTO. The aim of this study is to evaluate the effectiveness of transcervical fallopian tubes recanalization in the treatment of infertility.

Material and methods: In 2016 and 2017 - 148 patients with bilateral and 43 patients with single tubal occlusion confirmed by HSG or laparoscopy (done outside of our center) were qualified for fallopian tube recanalization (FTR). After an initial hsg test with 12fr balloon catheter placed in uterine cavity and contrast medium administration under increased pressure in 78 patients bilateral patency of fallopian tubes was confirmed. In the remaining patients, the FTR was performed. Both fallopian tubes were catheterized with coaxial catheter – guidewire system.

Results: Technical success as recanalization and the flow of contrast media into the peritoneal cavity was obtained in 86% of cases. Based on questionnaires conducted 6 months after the procedure pregnancy rate among treated patients were 28 %.

Conclusion: Properly performed HSG test, with a suitable uterine sealing, allows you to get the right pressure of the contrast which is the key to success in correct diagnostics. Tubal catheterization is a minimally invasive, safe, patient-friendly and cost efficient procedure which enables a high percentage of clinical success. It offers a good alternative for tubular microsurgery and in vitro fertilization in patients with tubal obstruction.

P-400

Utilization of pre and post procedural pelvic MRI in patients with symptomatic uterine fibroids undergoing invasive therapies and associated direct cost

N.A. Davisson¹, M. Horny², J.M. Newsome¹, R. Carlos³, D.R. Hughes⁴, R. Duszak, Jr.², M. Xing⁵, N. Kokabi¹

¹Division of Interventional Radiology and Image Guided Medicine, Department of Radiology, Emory University School of Medicine, Atlanta, GA, US, ²Department of Radiology and Imaging Sciences, Emory University School of Medicine, Atlanta, GA, US, ³Division of Interventional Radiology, Department of Radiology, University of Michigan School of Medicine, Ann Arbor, MI, US, ⁴School of Economics, Georgia Institute of Technology, Atlanta, GA, US, ⁵Bloomberg School of Public Health, Johns Hopkins University, Baltimore, MD, US

Purpose: To evaluate the utilization of pelvic MRI before and after invasive procedures for management of symptomatic uterine fibroids (UF) and evaluate associated direct cost.

Material and methods: Using Truven[®] MarketScan Commercial Claims and Encounters database and International Classification of Disease version 9 codes, women aged 18–55 with symptomatic clinically significant uterine fibroids from 2009–2015 were identified. Patients who underwent hysterectomy, myomectomy, endometrial ablation, and/or uterine fibroid embolization (UFE) and received pelvic MRI before and/or after the procedure were identified using Current Procedural Terminology codes. One-way analysis of variance (ANOVA) and Chi-squared analysis was performed to compare rate of usage in different treatment cohorts. Average cost of pelvic MRI and out-of-pocket cost was also calculated.

Results: Overall, 838,620 patients with symptomatic fibroids were identified. Invasive therapy was performed on 369,465 (44%) of the cohort; 79% of patients underwent hysterectomy, 13% endometrial ablation, 4% myomectomy and 4% UFE. Pre-procedural MRI was obtained in a significantly higher number of patients who underwent UFE (80%) followed by myomectomy (32%), hysterectomy (5%) and endometrial ablation (2%; $p < 0.001$). Post-procedural MRI was primarily obtained in patients undergoing UFE (19%), followed by myomectomy (0.7%), endometrial ablation (0.6%) and hysterectomy (0.3%; $p < 0.001$). Mean payment per MRI of pelvis was \$1,175 (SD: \$971). Mean out-of-pocket payment for the MRI was \$173 (SD: \$321).

Conclusion: Utilization of pelvic MRI was significantly higher in UFE patients both pre- and post- procedure when compared to hysterectomy and other uterine-sparing therapies. Further studies regarding cost-effectiveness and clinical benefit of post-UFE pelvic MRI are needed.

P-401

Comparing perioperative outcomes of uterine artery embolization and hysterectomy: a retrospective, multi-center database study

J.D. Lavian¹, M. Sighary¹, C.R. Moattari², S.M. Mooney³, N.L. Angel⁴, S.G. DeSilva¹, N.V. Shah², B.G. Diebo², J.P. Walsh¹

¹Department of Diagnostic and Interventional Radiology, State University of New York - Downstate Medical Center, Brooklyn, NY, US, ²Department of Orthopaedic Surgery and Rehabilitation Medicine, State University of New York - Downstate Medical Center, Brooklyn, NY, US, ³College of Medicine, State University of New York - Downstate Medical Center, Brooklyn, NY, US, ⁴Sarcoma Oncology Research Center, Cancer Center of Southern California, Los Angeles, CA, US

Purpose: This study sought to identify the 30day readmission, 15day complication, and minimum 1year surveillance time reintervention rates of patients undergoing uterine artery embolization (UAE) or hysterectomy (HYST) for uterine leiomyoma.

Material and methods: Patients from the New York State's Statewide Planning and Research Cooperative System database admitted from 2009–2013 that were over 18 years old, diagnosed with uterine leiomyoma, and

who underwent non-radical hysterectomy or UAE were retrospectively reviewed. 1:1 propensity match was carried out, followed by a univariate analysis comparing demographics, complications, readmissions, and reintervention rates. Multivariate binary stepwise logistic regression models identified independent predictors of outcomes.

Results: 682 patients were identified (HYST: n=341; UAE: n=341). No significant differences were identified between HYST and UAE demographics, complication (2.90% HYST vs 2.60% UAE, $p=0.816$) or readmission rates (4.40% HYST vs. 3.80% UAE, $p=0.700$). 0.3% of UAE patients had a reintervention UAE and 2.60% of UAE patients had reintervention hysterectomy. HYST patients had a significantly longer average length of stay (2.42 vs 1.63 days, $p<0.001$). For UAE, Deyo score (OR: 18.25 [95% CI: 1.496 – 222.576], $p=0.023$) and obesity (OR: 4.294 [95% CI: 1.228 – 15.013], $p=0.022$) positively predicted readmission within 30 days. Deyo score (OR: 94.571 [95% CI: 7.651 – 1168.911], $p<0.001$) also positively predicted complications for UAE.

Conclusion: Patients undergoing hysterectomy had significantly longer hospital stays. For UAE patients, Deyo score and obesity positively predicted readmission within 30 days, and Deyo score positively predicted complications. Our findings support the safety and efficacy of both hysterectomy and UAE for uterine leiomyoma.

P-402

Transradial or transbrachial approach compared to transfemoral approach for uterine fibroid embolization

E. Sugihara¹, S. Kawamoto²

¹Radiology, Kansai Rosai Hospital, Hyogo, JP, ²Diagnostic Imaging, Osaka General Medical Center, Osaka, JP

Purpose: To investigate the feasibility of uterine fibroid embolization (UFE) via transradial/brachial approach (TRA/TBA) compared to the transfemoral approach (TFA).

Material and methods: We enrolled 30 consecutive patients (mean age: 44.3 years; age range: 33–50 years) who underwent UFE (9 TFA; 15 TRA; 6 TBA) at our institution from June 2014 to March 2018. The success rate, total procedure/fluoroscopic time, radiation exposure dose, major and minor complications, uterine corpus volume change, and the questionnaire answers related to the puncture site were compared between the TRA/TBA and TFA groups. The questionnaire was based on the visual analog scale (VAS), and the items were: Q1/Q2, discomfort during/after the procedure other than the embolization pain; Q3, patient satisfaction related to the puncture site; Q4/Q5, patient's choice between TFA and TRA/TBA for the subsequent procedure or for recommendation to others.

Results: The success rates of the techniques were 100% in both groups. The average procedure/fluoroscopic time, radiation exposure dose, and the uterine corpus volume change showed no significant differences between the groups. Cerebral infarction or regional nerve palsy did not occur in any of the cases. One case with TBA showed brachial artery occlusion, which re-canalized after 6 months. One TRA case had regional hematoma and one had temporary regional pain. The VAS scores of all question items were significantly higher in the TRA/TBA than in the TFA group: Q1, 7.98 ± 2.01 vs 5.47 ± 2.61 ($p=0.04$); Q2, 7.76 ± 1.90 vs 4.68 ± 2.92 ($p=0.04$); Q3, 8.68 ± 1.54 vs 5.50 ± 2.23 ($p=0.005$); Q4, 4.50 ± 0.54 vs 1.25 ± 1.83 ($p=0.005$); and Q5, 4.43 ± 0.59 vs 1.45 ± 1.91 ($p=0.011$).

Conclusion: TRA/TBA is a better alternative than TFA for UFE.

P-403

Hospital admittance rate for post-procedure pain complication in patients for elective outpatient uterine fibroid embolization

J. Lam¹, M.J. Hallisey², C. Reeves¹

¹Radiology, Hartford Hospital, Hartford, CT, US, ²Interventional Radiology, Hartford Hospital, Hartford, CT, US

Purpose: This study assessed the hospital admission rate for pain in patients who underwent Ambulatory Uterine Fibroid Embolization (AUFE).

Material and methods: IRB approved retrospective analysis of patients undergoing UFE at an Ambulatory office from 1/2013 to 7/2017. The sedation/dosage used, length of sedation and discharge pain medication were recorded. Post-procedure hospital admission and indication were collected at the 1-month follow-up visit.

Results: 133 patients between the ages of 35-54 were identified. 15 patients were excluded due to lost to follow up. All patients were discharged with Oxycontin 10mg and Percocet 5/325mg. 4 patients were admitted; 1 for bleeding, which was thought to be the patient's menstrual cycle restarting. 3 were for immediate post-procedure pain (2%). Mean age for admitted patients was 47.3 (SD:5.7) and mean sedation time was 47.8 minutes (SD:16.0). Range of Versed/Fentanyl used for admitted patients was 1.5-2.5 mg; 75-125 mcg (mean:2/93.8; SD:0.4/23.9). The average length of time for admission is 1 day.

Conclusion: Although outpatient UFE can be successfully performed⁽¹⁾, there are a lack of studies on post procedure pain control, outpatient UFE and hospital admissions respectively. 100% of our patients were discharged the same day with 2.0 % admission rate. UFE is an underutilized, safe procedure to perform in an outpatient setting once optimal pre-/post procedure pain control is achieved and thus, can decrease unnecessary hospitalizations.

P-404

Prevalences of four uterine artery anatomical variants in Asian women with uterine fibroids

H. Kato

Radiology, Juntendo University, Tokyo, JP

Purpose: As uterine arteries have various anatomical forms, understanding their anatomy prior to UAE can improve the efficiency of catheter insertion. We retrospectively examined the prevalences of four uterine artery anatomical variants in Asian women with uterine fibroids.

Material and methods: Gomez-Jorge et al. reported the prevalences of four uterine artery anatomical variants in Western women: type I, uterine artery is the first branch of the inferior gluteal artery; type II, uterine artery is the second or third branch of the inferior gluteal artery; type III, uterine artery, inferior gluteal, and superior gluteal arteries are at the same level (trifurcation); and type IV, uterine artery is the first branch of the hypogastric artery (proximal to the inferior gluteal and superior gluteal arteries). We retrospectively assessed non-contrast magnetic resonance angiography images together with abdominal angiography of 56 Asian women who underwent UAE at our hospital between December 2016–December 2018. The bifurcation patterns of the 112 uterine arteries were classified into type I–IV and compared with that reported by Gomez-Jorge et al.

Results: In our study, type I had the highest prevalence (61%) which is higher than the data of Gomez-Jorge et al. (45%). The prevalence of type II was comparable in both studies (8% vs. 6%). However, the prevalence of type III was markedly lower (14% vs. 43%) and that of type IV was higher (17% vs. 6%).

Conclusion: The differences between the prevalences reported by Gomez-Jorge et al. and those found in our study may indicate differences between Asian and Western women.

P-405

The usefulness of temporary prophylactic intravascular balloon occlusion in patients with obstetrics and gynecology diseases

T. Norikane¹, T. Sanomura², Y. Takami¹, Y. Nishiyama¹

¹Radiology, Faculty of Medicine, Kagawa University, Kagawa, JP, ²Radiology, Faculty of Medicine, Kagawa, JP

Purpose: The purpose of this study was to evaluate the feasibility of prophylactic balloon occlusion (PBO) for control of obstetric hemorrhage in patients with obstetrics and gynecology diseases.

Material and methods: We retrospectively analyzed 12 patients clinically diagnosed with high bleeding risk (placenta previa: 7, uterine fibroid: 3,

chorionic disease: 1, breech delivery: 1) with PBO (PBO group) and 20 placenta previa patients without PBO (control group). The amount of estimated blood loss volume (EBLV) during surgery, additional treatment and complications were assessed. PBO of the common iliac arteries was performed in 11 patients and of internal iliac arteries in 1 patients due to iliac artery variant.

Results: The median value of EBLV in the PBO group and in the control group was 1322.5 ml and 1930 ml, respectively. Patients in the PBO group had significantly less in EBLV than the control group ($p=0.04$). The incidence of additional treatment in the PBO group was 8% (1 of 12 patients) and in the control group was 10% (2 of 20 patients), respectively. There was no significant difference between two groups. The total hysterectomy was needed only in the control group. There were no major complications encountered in the PBO group.

Conclusion: Despite the fact that PBO group was high bleeding risk, the median value of EBLV in the PBO group was lower than that in the control group. PBO is likely to reduce hemorrhage in patients with obstetrics and gynecology diseases.

P-406

Uterine fibroid embolisation: what is the patient experience and is superior hypogastric nerve block the answer to periprocedural pain control?

B. Almazedi, T. Kalami, A. Bowker

Radiology, York Teaching Hospital NHS Foundation Trust, York, UK

Purpose: To evaluate the patient experience, and the effect of superior hypogastric nerve block (SHNB) on perioperative pain management, following uterine fibroid embolisation (UFE). To assess short-term clinical and imaging outcomes.

Material and methods: Total of 42 women, aged 35 to 58, with symptomatic fibroids underwent UFE, with or without SHNB, between January 2017 and September 2018. Procedure experience, symptomatic improvement, and periprocedural pain relief with and without SHNB, were assessed by anonymous questionnaires sent at 3 months using 6 point Likert scales. Complications were recorded and response to UFE on 3 month MRI was evaluated.

Results: Questionnaires were returned from 29 of 42 patients. All 11 (100%) patients in the SHNB group, compared with 7 out of 18 (39%) patients in the control group, rated their perioperative pain management as "very sufficient" or "quite sufficient", with a clear trend strongly favouring SHNB. 27 of 29 patients reported they were satisfied with the procedure experience, 83% responding with "extremely" or "moderately satisfied". 27 of 29 patients reported improvement of symptoms with 72% rating it as "very" or "moderately effective". No major complications. Three patients were treated for simple infections and 3 documented challenges with pain management. Two patients did not have MRI, and 23 of 27 (85%) showed complete response.

Conclusion: Significant symptomatic improvement is observed in majority of patients affected by uterine fibroids that underwent UFE, and most patients are satisfied with the procedure experience. Effective pain management in the perioperative period is challenging, with emerging data suggesting that SHNB can provide some added benefit.

P-407

CT-guided intramuscular injection of botulinum toxin A for treatment of myofascial pelvic pain: intermediate-term safety and efficacy

A. Moreland¹, K. Hong²

¹Interventional Radiology, Johns Hopkins Hospital, Baltimore, MD, US, ²Department of Radiology and Radiological Science, Division of Interventional Radiology, Johns Hopkins University School of Medicine, Baltimore, MD, US

Purpose: Myofascial pelvic pain is a significant source of morbidity among affected patients, and may be treated with botulinum toxin A (Botox) injection into pelvic floor muscles. Conventional injections are performed by a gynecologist using physical exam landmarks. CT-guidance may decrease complication rates due to definitive localization of injections. The present study evaluates intermediate-term safety and efficacy of CT-guided intramuscular injection of Botox for treatment of myofascial pelvic pain.

Material and methods: $n = 74$ patients with myofascial pelvic pain were treated with CT-guided pelvic floor muscle Botox injections in 109 treatment sessions. Referrals were made by gynecologists specializing in chronic pelvic pain, who requested injection of specific muscles in each patient according to point tenderness on pelvic exam. A 22 gauge needle was placed into each target muscle under CT fluoroscopic guidance. Botox suspended in saline was injected into the piriformis, obturator internus, and/or levator ani ($n = 98, 51$, and 68 treatments, respectively). Visual analog scale pain scores were compared pre-procedure and at follow-up.

Results: Successful injection of the full dose of Botox to the target muscle was accomplished in all cases (technical success rate: 100%). There were no major or minor complications by SIR criteria, including no patient report of new urinary or fecal incontinence in any case. Lower pain scores were reported post procedure following 69% of treatments ($p = 0.04$).

Conclusion: CT-guided percutaneous injection of Botox into pelvic floor muscles for treatment of myofascial pelvic pain demonstrates similar efficacy and lower complication rates as compared to those published for conventional injections.

P-408

Deep learning based on magnetic resonance imaging for predicting outcomes of uterine fibroid embolization

Y.-H. Luo¹, I.L. Xi², Z.-S. Zhang¹, R. Shlansky-Goldberg²

¹Department of Radiology, The Second Xiangya Hospital of Central South University, Hunan, CN, ²Interventional Radiology, University of Pennsylvania, Philadelphia, PA, US

Purpose: To develop and validate a deep learning model based on routine pre-procedure routine magnetic resonance imaging (MRI) to predict outcomes of uterine fibroid embolization (UFE).

Material and methods: Clinical data were collected on patients treated with UFE at a large academic center from 2007 to 2018. The fibroids for each patient was manually segmented by an abdominal radiologist on T2-weighted (T2WI) and post-contrast T1-weighted (T1C) sequence of pre and post-procedure MRI. A residual convolutional neural network (ResNet) model to predict fibroid volume reduction and clinical outcome was trained using pre-procedure MR images.

Results: The inclusion criteria were met by 727 fibroids in 417 patients. The average clinical follow up time was 118 days. Of the 727 fibroids, 76.2% ($n=554$) had a volume reduction of 10% or more, and 23.8% ($n=173$) had a volume reduction under 10% or increased in size. At clinical follow-up, 91.2% ($n=372$) patients (590 of 727 fibroids, 81.1%) experienced symptom resolution or improvement, and 10.8% ($n=45$) patients (137 of 727 fibroids, 18.9%) no improvement or worsening symptom. The final ensemble model combining T2WI, T1C and clinical variables achieved a test accuracy of 78.1%, F1 score of 0.875, and area under the precision-recall curve of 0.865 in predicting volume reduction and a test accuracy

of 84.7%, F1 score of 0.912, and area under the precision-recall curve of 0.916 in predicting clinical outcome.

Conclusion: Deep learning based on routine pre-procedure MRI has potential in predicting outcomes post UFE. This will help clinicians identify patients who benefit the most from this therapy.

P-409

Feasibility and safety of negative-balance isolated pelvic perfusion chemotherapy in patients with pretreated recurrent or persistent uterine cervical cancer

S. Murata¹, S. Onozawa², D. Yasui³, T. Ueda³, H. Yamaguchi³, F. Sugihara³, H. Saito³, K. Suzuki⁴, H. Tajima⁵

¹Radiology/Interventional Radiology Center, Teikyo University Chiba Medical Center, Chiba, JP, ²Radiology, Teikyo University Mizonokuchi, Kanagawa, JP, ³Radiology, Nippon Medical School, Tokyo, JP, ⁴Medical Engineering, Nippon Medical School, Tokyo, JP, ⁵Center for Minimally Invasive Treatment, Nippon Medical School Musashi-Kosugi Hospital, Kawasaki, Kanagawa, JP

Purpose: Second-line therapy has limited activity in patients with recurrent or persistent uterine cervical cancer that has progressed after chemoradiation and palliative chemotherapy. The purpose of this study was to evaluate the efficacy of negative-balance isolated pelvic perfusion (NIPP) in patients with pretreated recurrent/persistent uterine cervical cancer.

Material and methods: Between April 2004 and December 2015, 39 patients with recurrent (n=28) or persistent (n=11) uterine cervical cancer previously treated with platinum-based systemic chemotherapy and/or chemoradiotherapy received NIPP therapy at Nippon Medical School Hospital. NIPP therapy consisted of a 30-min isolated pelvic perfusion with cisplatin and 5-fluorouracil, followed by isolated pelvic dialysis. Primary endpoints were response rate (RR) and overall survival (OS), and secondary endpoint was safety. Platinum pharmacokinetics was also evaluated. **Results:** The RR and OS after NIPP therapy were 43.6% (complete response, 6 patients; partial response, 11 patients) and 25.1 months, respectively. OS was significantly (p<0.05) better in patients with squamous cell carcinoma (31.3 months) than in patients with adenocarcinoma (9.4 months). OS was significantly (p<0.01) longer in patients without extrapelvic metastases (51.2 months) than in patients with metastases (7.5 months). Distant metastases was thought as predictive factors. The plasma pelvic-to-systemic exposure ratios were 15.6 and 16.1 based on the maximum concentration and the concentration-time curve, respectively. Most adverse events were mild (grade 1–2). Severe neutropenia (≥ grade 3) occurred in only 7.7% of patients.

Conclusion: NIPP appears to be an effective and feasible method for patients with pretreated recurrent or persistent cervical cancer.

P-410

Role of interventional radiology in the management of uncommon causes of post partum hemorrhage

S.B. Chaluvashtetty¹, U. Gorsl¹, S.B. Boddapati¹, N. Kalra¹, A. Lal¹, M. Kang¹, V. Suri², M.S. Sandhu¹

¹Radiodiagnosis, Post-graduate Institute of Medical Education and Research, Chandigarh, IN, ²Obstetrics & Gynecology, Post-graduate Institute of Medical Education and Research, Chandigarh, IN

Purpose: Postpartum hemorrhage is the major cause of severe maternal morbidity and mortality, accounting for more than 30% of maternal deaths in India. This presentation is aimed at analyzing the uncommon causes of post-partum haemorrhage and its management by Interventional Radiology.

Material and methods: 35 women with the history of post-partum haemorrhage (PPH) secondary to causes other than atonic PPH referred for embolisation between January 2013 and January 2019 were retrospectively analysed. Time of presentation, cause of PPH, severity of bleeding, interventions undertaken and their outcomes were analysed.

Results: Out of 35 women treated with embolization (mean age 28 years; range, 20–38y) 6 women with uterine artery pseudoaneurysm underwent direct percutaneous embolization using glue/thrombin. Off 29 women treated with endovascular embolization, 9 women presented with post LSCS vascular injury, 5 women had post vaginal delivery traumatic PPH due to cervical/vaginal tear and associated vascular injury, and 1 woman presented with PPH following uterine artery ligation secondary to hypertrophied ovarian artery supplying uterus. Seven patients had uterine AVM as underlying cause whereas 7 patients had retained products of conception. Gelfoam was the used in all endovascular embolization cases either as primary embolising agent or as a compliment to PVA/coils. Coils were used in 6 cases of AVM/Aneurysm. Technical and clinical success achieved in all cases with no major complications.

Conclusion: Interventional Radiology offers minimally invasive, safe and effective embolisation procedures for the management of uncommon causes PPH, with low complication rate and high clinical success.

P-411

Pain management protocols for uterine fibroid embolization: a systematic review of the evidence

A. Saibudeen¹, A. El Zein², G.C. Makris³, A.J. Wigham², S. Anthony², R. Uberoi²

¹Medical Sciences Division, University of Oxford, Oxford, UK, ²Radiology, Oxford University Hospital, Oxford, UK, ³Interventional Radiology, Oxford University Hospitals, Oxford, UK

Purpose: Uterine fibroid embolisation (UFE) is an effective treatment for uterine fibroids. There are varying analgesia protocols published to help control the pain associated with this procedure. Our aim was to assess what protocols are most effective in controlling post procedural pain.

Material and methods: A systematic review of the Embase and Medline databases was conducted according to the PRISMA guidelines. Studies regarding analgesia protocols post uterine fibroid embolization with Visual Analogue Scale (VAS) or Numerical Rating Scale (NRS) pain scores were included. ANOVA analysis was performed.

Results: We identified 27 studies (total 3380 patients) which assessed analgesia protocols and pain scores post UFE. The protocols were deemed effective in >87%. We stratified the protocols into 4 groups. The mean VAS/ NRS scores were: for opioids ± NSAIDs (4.54, SD = 1.48); opioids, NSAIDs and nerve block (4.20, SD = 0.982); opioids, NSAIDs and intra-uterine artery drug administration (3.69, SD = 0.940); and opioids ± NSAIDs, and other (6.6, SD = 1.13) without significant difference between these groups (p=0.133). Similarly there was no difference (p>0.05) between the groups for time to discharge.

Conclusion: There is no evidence to suggest that of there is any superiority of one protocol above another in the published literature. Appropriate use of an opioid ± NSAIDs protocol alone is sufficient to control pain post UFE. However, due to the large heterogeneity of the studies in the literature no solid conclusions can be reached and further targeted research is warranted.

P-412

Improving the effectiveness of cervical pregnancy treatment by uterine artery embolization

D. Akiniev, A. Kozachenko, V. Bychenko, A. Kozlova

Radiology, National Medical Scientific Centre n.a. V.I. Kulakov, Moscow, RU

Purpose: To evaluate the effectiveness of uterine artery embolization (UAE) in combined treatment of cervical pregnancy in comparison to conventional Methotrexate intravenous therapy

Material and methods: The study includes 60 women (ages 25–44 years) with cervical pregnancies, who underwent combined treatment. The gestational age on admission ranged from 5 to 9 weeks. Patient were divided in two groups. Group 1 included 44 patients in early pregnancy without chorionic invasion into the cervix, while 16 patients in group 2

with later gestational age had chorionic invasion. In group 1 the combination of preoperative systemic Methotrexate therapy with subsequent resectoscopy was used. Patients in group 2 underwent bilateral UAE with immediate resectoscopy.

In group 2 patients underwent bilateral UAE with transradial approach. In all cases gelfoam particles were used.

In both groups intraoperative blood loss and length of hospital stay were evaluated. In group 2 the patency of uterine arteries was followed up by CT-angiography 1 month after UAE.

Results: In group 1 mean intraoperative blood loss was 100 ml (ranging from 20 to 180 ml). In group 2 the same parameter was 35 ml (20-50 ml). Mean hospital stay in group 1 was 15 days, while in group 2 it was 6,5 days. CT-angiographic control revealed complete patency of uterine arteries in 10 patients, partial (one uterine artery) in 3 patients and collateral arterial supply of uterus in 3 patients.

Conclusion: Utilization of UAE is associated with less blood loss and hospital stay in combined treatment of cervical pregnancy in comparison with Methotrexate therapy.

P-413

Adenomyosis – an emerging role for uterine artery embolisation?

A. Elsharkawy¹, R. Das¹, L. Ratnam¹, L. Mailli², S. Ameli-Renani³, R.A. Morgan¹, A.K. Emira¹, B. Hawthorn¹, I.T. Manyonda⁴

¹Department of Radiology, St. George's Hospital, London, UK, ²Interventional Radiology, Guy's and St Thomas' NHS Foundation Trust, London, UK, ³Radiology, St. George's Hospital NHS Trust, London, UK, ⁴Gynaecological Department, St George's Hospital, London, UK

Purpose: Objective – to ascertain UAE outcomes in adenomyosis
Introduction: Despite compelling RCT evidence for UAE in heavy menstrual bleeding due to fibroids, there are relatively few major trials involving adenomyosis and UAE. We have noted increasing referrals for the IR treatment for adenomyosis and evaluation of data in this field is important in counselling our patients and analysing outcomes. The increased utilisation of MRI pre and post UAE has also led to better identification of adenomyosis.

Material and methods: Retrospective review of cases performed over past 4 years at UK tertiary level IR unit with 280 UAE cases performed in this period with 35 cases of adenomyosis treated with UAE.

Of these 14 patients were identified with pure adenomyosis and 21 cases of patients with mixed adenomyosis and fibroids. Patients were treated in a standardised fashion via bilateral femoral access with PVA 355-500 microns, upsized to 500-700 and thereafter after initial 4 vials.

Results: Bilateral uterine artery embolisation was achieved in all patients. After 6 months, an improvement in total quality of life was obtained in most of the cases: pure adenomyosis demonstrated an average QOL of 39.65 pre-embolisation and 72.13 at 6 month follow-up. Cases of mixed fibroid and adenomyosis showed a QOL of 29.98 pre-embolisation and 73.94 at 6 months. Further data analysis of MRI of the two groups is in progress and will be available shortly.

Conclusion: Cases of adenomyosis have shown a favourable response to UAE. This and further evidence will allow us to better counsel patients undergoing UAE for adenomyosis.

P-414

Imaging, classification, planning and endovascular treatment techniques for ovarian vein embolization in pelvic congestion syndrome

U.G. Rossi¹, L.C. Pescatori², M. Femia³, P. Rigamonti³, F. Pinna⁴, A. Valdata⁴, A.M. Ierardi⁵, G. Carrafiello⁶, M. Cariati⁷

¹Diagnostic Imaging Department - Interventional Radiology Unit, E.O. Galliera Hospital, Genoa, IT, ²Postgraduation School in Radiodiagnostics, University of Milan, San Donato Milanese, IT, ³Radiology and Interventional Radiology, San Carlo Borromeo Hospital, Milan, IT, ⁴Interventional Radiology Unit, E.O. Galliera Hospital, Genova, IT, ⁵Radiology, University of Milan, San Paolo Hospital, Milan, IT, ⁶Diagnostic and Interventional Radiology, University of Milan, Milan, IT, ⁷Diagnostic Sciences, San Carlo Borromeo Hospital, Milan, IT

Learning objectives: To evaluate imaging diagnosis, classification, planning and endovascular treatment techniques of ovarian vein inversion of flow in female patients with suspected pelvic congestion syndrome.

Background: Clinical symptoms and a correct imaging diagnosis and consequently treatment for pelvic congestion syndrome have evolved over the years. Clinical spectrum of pelvic congestion syndrome can varies from few symptoms to debilitating pelvic pain. Many female patients have been treated for pelvic congestion syndrome based on many different methods with various degrees of accuracy and reproducibility. Thus, it remains debatable, which is the imaging analysis and classification to define the candidates for possible endovascular intervention.

Clinical Findings/Procedure Details: The aim of this poster is to describe: a) the definition pelvic congestion syndrome, b) classification of ovarian vein inversion flow, c) imaging diagnosis of ovarian vein inversion flow, d) planning evaluation, e) and discuss the possible treatments with emphasis on transcatheter sclerotherapy and/or embolization.

Conclusion: Clinical and imaging diagnosis in the detection of ovarian vein inversion of flow must be very accurate in order to guarantee the correct and most effective treatment to the patients.

P-415

Management of uterine fibroids: focus on utero-ovarian anastomosis of interventional procedure

M. Koganemaru, S. Tanoue, A. Kuhara, T. Kugiyama, Y. Shinjyo, N. Tanaka, T. Abe

Radiology, Kurume University School of Medicine, Kurume, JP

Learning objectives: We report the management of utero-ovarian anastomosis for uterine artery embolization of uterine fibroids.

Background: A utero-ovarian anastomosis sometimes exhibits blood flow from the uterine artery to the ovary or from the ovary to the uterus.

Clinical Findings/Procedure Details: In cases where blood flow from the uterine artery to the ovary is observed, various procedures can be considered for management. One procedure is embolization of only the uterine artery due to super-selective uterine arterial catheterization. Another embolization procedure is flow control for without inflow from utero-ovarian anastomosis under appropriate balloon inflation at the internal iliac artery using 5-Fr balloon catheter. Furthermore, coil embolization of utero-ovarian anastomosis may be performed prior to uterine artery embolization using a triple coaxial microcatheter system. In cases where blood flow from the ovarian artery to the uterus is observed, the following procedures are necessary. The 5-Fr catheter is withdrawn from the orifice of the uterine artery to increase flow from the uterine artery or coil embolization at the utero-ovarian anastomosis. Another procedure that may be effective is transporting particle embolic agents (i.e., microspheres) through the bloodstream of the ovarian artery under super-selective ovarian arterial catheterization.

Conclusion: In cases where the presence of utero-ovarian anastomosis is confirmed, the embolization procedure to be used should be carefully considered. With all the currently used procedures, attention must be

paid to uterine arterial spasm. A clear understanding of utero-ovarian anastomosis affects the treatment outcome for uterine fibroids and helps avoid inadequate ovarian functions.

P-416

General and endovascular management of postpartum hemorrhage aiming for further improvement of patient outcome

K. Michimoto¹, T. Higuchi², R. Kano³, K. Enoki², Y. Matsui³, S. Takenaga⁴

¹Radiology, Fuji City General Hospital, Fuji, JP, ²Radiology, The Jikei University School of Medicine, Kashiwa Hospital, Chiba, JP, ³Radiology, The Jikei University, Tokyo, JP, ⁴Radiology, The Jikei University Katsushika Medical Center, Tokyo, JP

Learning objectives:

1. To review the diagnosis and management of postpartum hemorrhage (PPH).
2. To appreciate endovascular management highlighting vascular anatomy, adequate embolic materials, tips and pitfalls, and complications.

Background: PPH is a life-threatening condition with increasing incident in developed countries. Prompt diagnosis and intensive resuscitation, including transcatheter arterial embolization (TAE) are required. Therefore, radiologists must be familiar with the treatment strategy of PPH.

Clinical Findings/Procedure Details: Targeted examination and proactive discussion with obstetrician are required to identify the cause of PPH. Attention should be paid for patients with hematological pathology, which may lead to coagulopathy, despite relatively small hemorrhage, such as placenta accreta. Initially, intensive managements based on well-established algorithm for PPH, such as bimanual fundal massage, uterine packing, administration of uterotonic agent, and massive blood transfusions are performed.

If continuous bleeding is observed, TAE will be considered as the next step for hemostasis. Not only recognizing normal variations in internal iliac artery, but also searching for uncommon collateral bleeding vessels is important for appropriate embolization. In most cases, gelfoam slurry is a sufficient embolic material, but other materials such as n-butyl-2-cyanoacrylate or coil are sometimes required.

This poster will illustrate comprehensive treatment strategy of PPH and details of TAE procedure. Technical tips, pitfalls, complications, and known risk factors of failed TAE are also mentioned with reviewing literatures and our cases.

Conclusion: Radiologists play a key role in PPH management. It is important to appreciate treatment strategy of PPH and update our knowledge of TAE to increase patient outcome.

P-417

Uterine artery chemoembolization as a treatment for caesarean scar pregnancy

M. Szymgin¹, K. Pyra¹, M. Sojka¹, T. Jargiełto²

¹Department of Interventional Radiology and Neuroradiology, Medical University of Lublin, Lublin, PL, ²Department of Interventional Radiology, University School of Medicine, Lublin, PL

Learning objectives: The purpose of this study is the evaluation of the efficacy and safety of the treatment of ectopic pregnancy located in the Cesarean Scar with Uterine Artery Chemoembolization with the mixture of Methotrexate and Gelfoam.

Background: 12 patients with CSP confirmed in Transvaginal Ultrasound Examination were treated with Uterine Artery Chemoembolization with mixture of Methotrexate and gelfoam. Successful embolization was confirmed in control angiography.

Clinical Findings/Procedure Details: Chemoembolization was successfully performed in all patients. Due to additional vascularity from the Ovarian Artery in one case second embolization was required. Four

had spontaneous abortion and in 8 cases suction and curettage was performed. In 1 case the menstruation did not recur after the procedure. 1 patient is currently pregnant 32 hbd. No serious complications were noted. **Conclusion:** Uterine Artery Chemoembolization is safe and effective method in treatment of Cesarean Scar Pregnancy and should be considered for patients willing to preserve their fertility.

P-418

Fallopian tube recanalisation in the management of primary and secondary subfertility: techniques, pearls and pitfalls

N.R. Patel¹, A.P. Hemingway¹, S. Moser², S. Rostampour¹, E. Kashef¹

¹Radiology, Imperial College Healthcare NHS Trust, London, UK,

²Radiology, Guys and St Thomas' NHS Trust, London, UK

Learning objectives:

1. To discuss the indications and contraindications for fallopian tube recanalisation (FTR) and its place in the work-up and management of women with subfertility.
2. To describe the procedure in a stepwise-fashion, understanding the potential technical pitfalls and how to avoid them.
3. To illustrate the technique with specific case examples.

Background: Fallopian tube occlusion is one of many factors that can result in primary or secondary subfertility in women. Fallopian tube recanalisation (FTR) is a minimally invasive, NICE approved, procedure performed by interventional radiologists to treat proximal tubal occlusion. Fallopian tube recanalisation has an approximately 90% technical success rate with few complications. FTR is less costly than many other treatments for subfertility and may allow women to conceive naturally. Pregnancy is reported in up to 60% of women treated by FTR.

Clinical Findings/Procedure Details:

-Patient selection for FTR is crucial to the success of the procedure and follows careful investigation of the subfertility including hysterosalpingography (HSG). The accurate diagnosis of true cornual or proximal tubal occlusion by HSG is dependent upon meticulous technique.

-FTR by guidewire and catheter will be explained in a step-by-step approach with an emphasis on the pearls and pitfalls of the procedure illustrated by specific case examples.

Conclusion: This educational poster provides an overview of FTR for the management of subfertility, including a step-by-step approach to the procedure as well as case examples to highlight pearls and pitfalls.

P-419

New ablative technique in treatment of ovarian endometriotic cysts: radiofrequency under transvaginal ultrasound guidance and completed by ceus evaluation

G. Dedone¹, G. Turtulic²

¹DISSAL, University of Study of Genoa, Genoa, IT, ²Radiologia, Ospedale Evangelico Internazionale, Genoa, IT

Learning objectives: To describe an alternative and new procedure to treat endometriotic cysts accessible by transvaginal route with radiofrequency thermo-ablation and contextual injection of dextrose solution in order to guarantee heat conduction and convection necessary to perform an effective and safe intervention. During and immediately after the treatment ceus evaluation is performed.

Background: Endometriosis is found in 10% of women of childbearing age. It's a chronic and recurrent benign disease, characterized by the proliferation of endometrial tissue outside the uterine cavity. The ovary is the organ most affected by endometriosis. Conventionally, therapeutic options include waiting, medical or surgical therapy and, in cases of infertility, assisted procreation techniques. An alternative technique performed in our center thanks to the use of radiofrequencies to treat endometriotic cysts is showed and compared with traditional therapeutic strategies.

Clinical Findings/Procedure Details: The thermo-ablative procedure US-guided through transvaginal route is described step by step, focusing

on the technical aspects, advantages, disadvantages, possible complications and outcome. Immediately after treatment, a ceus evaluation is also performed to evaluate extension and uniformity of the ablated tissue. Particular attention is given to assessing the possible benefits of this procedure on fertility.

Conclusion: In our experience this procedure has proved to be a valid alternative in the treatment of ovarian endometriotic cysts, as it is effective, safe and well tolerated by patients. The intraoperative and immediately after treatment ceus, compared to the ultrasound study alone, allowed a better evaluation of the extension and homogeneity of the ablated tissue, thus obtaining a better safety, precision and overall effectiveness of the procedure.

P-420

Anatomy and angiographic classification of utero-ovarian anastomoses

A. Modica, M.C. Calcagno, D. Meo, G. Costanzo, C. Desiderio, F. Libra, D. Baldanza, P.M. Coppolino, A. Musumeci, S. Palmucci, A. Basile

Radiology Unit I - Department of Medical and Surgical Sciences and Advanced Technologies - University of Catania, Azienda Ospedaliero Universitaria Policlinico Vittorio Emanuele, Catania, IT, AOU Policlinico G. Rodolico, Catania, IT

Learning objectives: The aim of our study is to report and describe the most common anastomoses between the ovarian arteries and the uterine arteries.

Background: The observation of uterine-ovarian anastomoses is a quite common finding in patients who undergo gynaecologic interventional radiology procedures particularly during Uterine Artery Embolization (UAE) performed to treat uterine fibroids. We retrospectively evaluated all patients who underwent gynaecological interventional procedures in our department to report the main angiographic images of utero-ovarian anastomoses.

Clinical Findings/Procedure Details: In 2002, Razavi et al., identified three different types of anastomoses. The most frequent pattern is Type I in which the ovarian artery provides the major blood supply to the fibroids by the means of anastomosis with the intramural tract of the uterine artery. This type of vascularization is observed in 21.7% of patients and has been divided in two different subtypes; Type Ia shows a direct blood flow toward the uterus without retrograde reflux in the ovarian artery where in Type Ib the presence of reflux in ovarian artery can be observed in selective uterine angiogram. Type II involves a direct blood supply to the fibroids from the ovarian artery. In Type III blood flows from uterine arteries in the tubo-ovarian segment towards the ovary. Type III and Ib present a higher risk of non-target embolization.

Conclusion: The operator must be aware of these variants of normal uterine vascularization due to the fact that their presence may affect the course of the procedures, the outcome and they may also cause severe complications.

P-421

Removal of subdermal implantable contraceptive devices utilizing ultrasound and fluoroscopic guidance

A. Heilala, D. Hillman, Y. Albeer

Department of Radiology, Henry Ford Hospital, Detroit, MI, US

Learning objectives:

1. Indications for subdermal contraceptive device removal.
2. IR role in removal of subdermal contraceptive device.
3. Techniques for removal under US and fluoroscopic guidance.

Background: Implantable subdermal contraceptive devices, such as the Nexplanon (etonogestrel) implant have become popular. Synthetic progestin is released to prevent ovulation and pregnancy for up to 3 years. Indications for removal include; side effects, expiration, or the patient

wanting to become pregnant. The device is placed subcutaneously within the arm, between the biceps and triceps muscle. In the outpatient setting the device must be palpated to be safely removed. An advantage of the Nexplanon device over prior versions is the inclusion of a radiopaque localizer, aiding in localization when the device is erroneously placed within deep tissues. Interventional Radiology may be consulted for localization and removal using various techniques including the use of ultrasound and fluoroscopy.

Clinical Findings/Procedure Details: We present six cases of women with subdermal contraceptive devices, that were unable to be removed by gynecology. The implants in all the 6 of cases were successfully removed by interventional radiology using ultrasound and/or fluoroscopic guidance. 4 patients were done using ultrasound guidance only and two had both ultrasound and fluoroscopic guidance. All were performed under local anesthesia. 3 of the 6 patients received mild IV sedation in addition to the local anesthesia.

Conclusion: Implantable subdermal contraceptive devices are increasingly popular. Due to deep implantation, these devices are not always able to be removed by gynecologists. In these instances Interventional radiology can use ultrasound and fluoroscopic guidance to safely remove subdermal contraceptive devices.

P-422

Transvaginal percutaneous ethanol sclerotherapy for cervicovaginal venous malformations

S.H. Bae¹, Y.-S. Do²

¹Radiology, Inje University College of Medicine, Ilsan Paik Hospital, Goyang, KR, ²Department of Radiology, Samsung Medical Center, Sungkyunkwan University School of Medicine, Seoul, KR

Clinical History/Pre-treatment Imaging: A 52 year-old female, para 2-0-0-2, presented with history of intermittent vaginal bleeding for the last two years. She has no previous history of abortion, trauma and abdominal surgery. She has been on conservative treatment for the last two years, but the amount of vaginal bleeding began to increase in the last three months.

Transvaginal ultrasonography and contrast CT revealed several phleboliths and dilated vessels around cervicovaginal wall without early draining vein. Pelvic angiography demonstrated the absence of arterial abnormality. On these findings, the lesion was considered most likely to be to a venous malformation (VM).

Treatment Options/Results: We considered percutaneous ethanol sclerotherapy as transvaginal route rather than surgical treatment. A procedure was performed under general anesthesia with lithotomy position. A 21-gauge Chiba needle attached to transvaginal probe was introduced to dilated vessel under ultrasonography guidance. 80% ethanol was used as an embolic agent. The patient had significantly decreased vaginal bleeding without complication after 4 sessions of sclerotherapy.

Discussion: Cervicovaginal VM are extremely rare. In most cases, cervicovaginal VMs need no treatment. However, if the patient has symptoms such as abnormal vaginal bleeding or protruding mass, treatment is needed. The conservative forms of treatment such as embolization or local incision are the first choice rather than hysterectomy. Surgical excision or hysterectomy is a difficult due to intra-operative hemorrhage. We report the first case of successful treatment of the cervicovaginal VM as transvaginal percutaneous ethanol sclerotherapy.

Take-home points: We need more cases, transvaginal percutaneous ethanol sclerotherapy is a safe and effective alternative treatment option in the cervicovaginal VM.

P-423

Angiographic masking of iatrogenic iliac artery injury due to pneumoperitoneum for laparoscopic surgery

S.J. Lee¹, G.S. Jeon², I.J. Kim³, S.Y. Choi⁴

¹Radiology, CHA Bundang Medical Center, Seongnam-si, Gyeonggi-do, KR, ²Dept. of Radiology, CHA Bundang Medical Center, CHA University, Seongnam, KR, ³Department of Radiology, Bucheon St. Mary's Hospital, Bucheon, KR, ⁴Radiology and Research Institute, Ewha Womans University, Seoul, KR

Clinical History/Pre-treatment Imaging: A 22-year-old female underwent laparoscopic surgery for ovarian endometrioma. In operation room, patient showed sudden drop of blood pressure (80/50 mmHg) after insertion of 2nd trocar. Retroperitoneal large vessel injury was suspected but exact focus couldn't be identified because of massive bleeding. The decision for an immediate angiography was made by surgeon.

Treatment Options/Results: Patient was transferred to angiographic suite while maintaining pneumoperitoneum to minimize blood loss. Repeated pelvic aortogram showed negative finding (Fig1). After removing pneumoperitoneum through trocar, aortography showed extravasation from left common iliac artery which had not been detected (Fig2). Covered stent was placed in left common iliac artery. Final angiography revealed no hemorrhage from iliac artery. After procedure, patient was stable and discharged without complications.

Discussion: Major vascular injury is devastating complication of laparoscopic procedures. In our case, gynecology surgeon decided to immediate endovascular treatment instead of midline laparotomy because she had no experience on managing major vascular injury. To minimize ongoing blood loss, the patient was transferred to angiography suite while maintaining pneumoperitoneum.

Iatrogenic injury of iliac artery was angiographically negative before removing gas. This finding suggests that maintaining pneumoperitoneum was effective to control bleeding, even from major vessel injury. Maintaining pneumoperitoneum helped to save time for endovascular repair. It is mandatory to confirm absence of bleeding after removing pneumoperitoneum during angiography.

Take-home points: Angiography after removing pneumoperitoneum should be obtained to exclude angiographic masking of major vessel injury during laparoscopic surgery.

Endovascular treatment of iliac artery injury is quick, efficient, and safe method of repair.

P-424

Transcatheter arterial embolization for the treatment of bleeding due to uterine vascular malformations: presentation of three cases

R. De Robertis, G. Puppini, G. Puntel, S. Perandini, S. Montemezzi
Radiology, Azienda Ospedaliera Universitaria Integrata Verona, Verona, IT

Clinical History/Pre-treatment Imaging: Between January 2017 and May 2018, three women with history of uterine curettage (mean age, 29 years; range 18-40) were admitted to our Emergency Department due to severe genital bleeding (mean hemoglobin level, hematocrit and red blood cell count: 87 g/L, 27.1% and $2.85 \times 10^{12}/L$, respectively). All patients underwent transvaginal ultrasound with diagnosis of uterine vascular malformation (1 cirroid aneurysm, 2 artero-venous fistulae).

Treatment Options/Results: After transvaginal US, the women were transferred to our Angiographic suite. Selective angiography confirmed the presence of uterine arterio-venous malformations; the predominant feeding uterine artery was catheterized for embolization. Superselective TAE of the chosen artery using embolic microspheres (700-1100 micron) was then performed. After embolization of the predominant feeding artery, angiography of the contralateral uterine artery; in all patients, unilateral embolization was considered sufficient to reduce the blood flow to the malformation. Vaginal bleeding stopped after treatment in

all cases. One woman with a cirroid aneurysm returned 3 months after embolization with recurrent bleeding, which was resolved by retreatment of the contralateral uterine artery. There were no complications.

Discussion: Uterine vascular malformations can cause life-threatening vaginal bleeding. Transvaginal ultrasound can diagnose uterine vascular malformations in women with vaginal bleeding. Transcatheter embolization is the preferable alternative to hysterectomy, especially in patients of child-bearing age. Microsphere TAE is an effective treatment for vaginal bleeding caused by uterine vascular malformations.

Take-home points: Uterine vascular malformations can cause life-threatening vaginal bleeding. Transcatheter embolization is an effective treatment for uterine vascular malformations. Unilateral embolization of the predominant feeding uterine artery may be sufficient to stop the bleeding.

P-425

Multidisciplinary approach in a tubaric extrauterine pregnancy

G. Capurri, C. Marcato, E. Epifani, A. Andreone, I. Paladini, M. Fantoni, R. Zannoni, U. Russo
Radiologia Interventistica, Azienda Ospedaliero-Universitaria di Parma, Parma, IT

Clinical History/Pre-treatment Imaging: A 35 yo woman sought consult at the emergency room for abdominal pain. Biochemical parameters and a transvaginal ultrasound suggested the possibility of an abdominal extrauterine pregnancy. The fetus had cardiac activity and biometric parameters were consistent with a gestational age week 13. Abdominal magnetic resonance and computed tomography scans were also done and findings were consistent with an extrauterine pregnancy with a large complex mass in the Douglas' pouch supplied by the uterine vessels, separated from the uterine fundus.

Treatment Options/Results: A multidisciplinary consultation was done and the plan was for preoperative embolisation to minimize blood loss, prior to evacuation of the product of conception through laparotomy. An iliac angiography showed the uterine arteries involved in the placental circulation. Both the uterine arteries had been embolised using Gelfoam injection through a microcatheter.

Laparotomic approach eventually showed a left tubaric pregnancy with placenta prolix in the Douglas' pouch; the patient underwent left salpingectomy and abortion.

Discussion: Blood loss is the major cause of mortality in ectopic pregnancies. Gynecologists and interventional radiologists managed this case together to identify all the sources of blood supply to the placenta in order to embolise the vessels that could be difficult to ligate during surgery.

Take-home points: Since embolisation can play a great role before and after laparotomy to prevent major bleeding in extrauterine pregnancies, it must be necessary a strong collaboration and a good teamwork between interventional radiologists and gynecologists to preserve the pregnant from the risk of mortality.

P-426

Successful uterine artery embolization for control of life-threatening metrorrhagia, in case of sudden fetal death in the pregnant uterus at the seventh month of pregnancy

S. Scardicchio, G. Lucente, F. Calcagni
Interventional Radiology Unit, ASL Brindisi, Brindisi, IT

Clinical History/Pre-treatment Imaging: A 29 years-old woman at 21 weeks of gestation presented to our emergency department with cardiac arrest due to spontaneous dissection of the interventricular artery that was treated with coronary stenting and administration of anticoagulants and antiplatelet agents, which probably led to copious metrorrhagia. From the evaluation of gynecologists the fetus deceased and the pregnant became hemodynamically instable.

Treatment Options/Results: As hysterectomy had high operating risks, we choosed endovascular option to treat the life-treatening metrorrhagia. From a single femoral access, after selective catheterization of both uterine arteries, we performed embolization by injection of resorbable embolic agent, such as gelatine sponge particles (Spongostan). The procedure took 40 minutes and led to immediate control of hemorrhages and restored cardiovascular status. The second stage of the fetus occurred on the second day, the patient did not have hemorrhagic recurrences and was discharged with outcomes of myocardial infarction.

Discussion: Embolization of the uterine arteries is the standard of care for management of acute bleeding after childbirth or gynecologic surgeries. Spongostan is the most frequently used embolic agent in post-partum bleeding and the embolization in 89-100% of cases, achieves hemostasis with low rate of complications. In scientific literature we did not find any report of embolization of uterine arteries with fetus in utero at the third trimester of pregnancy.

Take-home points: Even in life-threatening metrorrhagia, with deceased fetus in utero at the third trimester of pregnancy, embolization of uterine arteries can achieve rapid hemostasis, without recurrences and complications.

P-427

Uterine fibroid embolisation used successfully in a case of myoma nascens

N. Bonanno, K. Chirco

Medical Imaging, Mater Dei Hospital, Tal Qroqq, MT

Clinical History/Pre-treatment Imaging: A 44-year-old female with a history of abnormal uterine bleeding had an MRI revealing a large pedunculated submucosal fibroid which had spontaneously prolapsed through the endocervical canal.

Treatment Options/Results: Treatment options were discussed with the patient at a joint radiological-gynaecological consultation clinic. The patient refused a hysterectomy. The presence of a highly vascular stalk hampered the performance of transvaginal myomectomy. Uterine fibroid embolisation (UFE) was planned.

Angiography-guided flow-directed bilateral UAE was performed using 500-700µm PVA-particles and gel-foam slurry to ensure complete fibroid infarction. The procedure was uneventful; patient went home the next day. After 10 days the patient passed the fibroid, whole, per vagina, thereby precluding the need for surgical evacuation.

The patient returned for follow-up 4 months after UFE and reported complete resolution of her symptoms; MRI showed no fibroid remnant and complete uterine architectural restoration.

Discussion: To date, this is the first reported case of embolisation of a prolapsed submucosal fibroid with complete restoration of uterine anatomy. The presence of a pedunculated submucosal fibroid is a relative contraindication to UFE - there is a potential for fibroid material to cause cervical obstruction and occasionally sepsis. Embolisation of these lesions should only be undertaken at the hands of an experienced interventionist and after careful consideration and with plans in place for hysteroscopic fibroid retrieval from the endometrial cavity were this to occur.

Take-home points: Fibroid expulsion is a troublesome, but manageable, sequela that may occur after UFE.

Pre-procedure MRI has a role in predicting the outcomes of UAE and pre-empting arrangements for fibroid retrieval.

Imaging

P-428

A 2D-DSA based technique for assessing regional changes in hepatic perfusion during transarterial embolization

C.A. Hoffman¹, E. Meram², O. Wieben², P.F. Laeseke²

¹Medical Physics, University of Wisconsin Madison, Madison, WI, US, ²Radiology, University of Wisconsin-Madison, Madison, WI, US

Purpose: To determine if 2D DSA can be used to characterize embolization related changes in regional perfusion in the liver.

Material and methods: Hepatic transarterial embolization (TAE) was performed in 4 female domestic swine (average weight ~50kg) using 100-300 µm microspheres. 2D DSA images were acquired pre and post embolization by injecting iodinated contrast medium at 2 mL/s for 12 mL during a 15 second exam (250 ms frame rate). Perfusion related parameter maps were generated with and without novel vessel correction algorithms for: area under the curve (AUC), time of arrival (TOA), and slope at half max. Sørensen-Dice similarity was used to quantify variations in automatic region generation. The average mean intensity and area per region were used to characterize perfusion changes post-TAE.

Results: The resulting maps showed clear quantitative and qualitative changes in regional perfusion post TAE. The greatest variations in region size were seen in the highest (66±183%, 179±140%) and lowest (32±40%, 92±70%) intensity regions for both AUC and TOA, respectively. AUC and slope maps were similar while TOA showed clear differentiation in regional segmentation. The average Sørensen-Dice similarity coefficient for all regions, using AUC images as ground truth, showed a higher agreement with slope (0.79±0.16) than with TOA (0.14±0.03).

Conclusion: 2D DSA can provide regional hepatic perfusion maps that depict embolization related changes in perfusion. Contrast arrival (TOA) and contrast deposition (Slope and AUC) generate different maps allowing for multiple metrics from a single imaging sequence. Image registration and longer scan times could further improve accuracy.

P-429

Motion-correction algorithms for 2D-DSA based regional hepatic perfusion mapping

C.A. Hoffman¹, E. Meram², O. Wieben¹, P.F. Laeseke²

¹Medical Physics, University of Wisconsin Madison, Madison, WI, US, ²Radiology, University of Wisconsin-Madison, Madison, WI, US

Purpose: To characterize the effects of motion on 2D DSA based regional hepatic perfusion mapping and to investigate the impact of two motion-correction algorithms on the accuracy of the maps.

Material and methods: Hepatic transarterial embolization (TAE) was performed in 2 female domestic swine (average weight ~50kg) using 100-300 µm microspheres. 2D DSA images were acquired pre and post embolization for both swine with and without breath holds. Motion was assessed using the mean square error (MSE) of consecutive raw projection images. Perfusion related area under the curve (AUC) maps were generated with two different approaches: 1) Motion corrected 2D DSA with low motion image selection and splenic temporal fit and 2) raw 2D DSA single arterial enhanced frame application. Sørensen-Dice similarity was used to measure variation in automatic region generation with registered breath hold images as ground truth.

Results: The MSE plots showed semi periodic and random motion for the two scans. Method 1 showed a 2-fold increase in agreement with motion correction (0.64±0.11) compared to without (0.31±0.19). The single frame application in method 2 showed similar agreement with motion correction (0.61±0.11) in addition to improving agreement in the non-motion corrected images (0.65±0.10). Qualitatively, all regions followed similar trends for AUC when an average dice coefficient was greater than 0.60.

Conclusion: Regional hepatic perfusion maps from either motion corrected 2D-DSA images or a single frame from an uncorrected 2D DSA were similar to those generated without respiratory motion. Applying advanced registration and background frame selection techniques may improve future agreement in perfusion maps.

P-430

Evaluation of 2D-perfusion angiography (2D-PA) for the detection of leakage of venous double-balloon catheter in patients undergoing chemosaturation percutaneous hepatic perfusion (CS-PHP) with melphalan

C.L.A. Dewald¹, S.K. Maschke¹, T.C. Meine², J. Renne¹, M. Kirstein², F. Wacker¹, B.C. Meyer¹, J.B. Hinrichs²

¹Institute for Diagnostic and Interventional Radiology, Medizinische Hochschule Hannover, Hannover, DE, ²Department of Diagnostic and Interventional Radiology, Medizinische Hochschule Hannover, Hannover, DE

Purpose: To evaluate feasibility of 2D-PA to detect leakage of the double-balloon catheter used to isolate the hepatic inferior vena cava (IVC) in patients undergoing CS-PHP.

Material and methods: Altogether, 112 CS-PHP (09/2015-09/2018; 52 patients) were retrospectively screened for leakage of the double-balloon catheter and consecutive correction of the catheter position. Finally, 18 procedures in 12 patients were included. For the detection of leakage of contrast agent alongside the double-balloon using 2D-PA, acquired digital subtraction angiography (DSA) series were post-processed. A reference region-of-interest (ROI) was drawn in the IVC between the upper and lower balloon. Target ROIs were placed on DSA pre- and post-balloon adjustment in the same position. Two different target ROIs were used to assess a possible impact of localization and shape of the target ROI. Time to peak (TTP), peak density (PD), area under curve (AUC) and ratios of reference ROI/target ROIs were calculated.

Results: Leakages were located as follows: 15/18 cranial and 3/18 caudal. At the cranial balloon both ROIs showed a significant decrease of PD_{tROI}/PD_{REF} and AUC_{tROI}/AUC_{REF} (all $p < 0.0001$) and a significant increase of TTP_{tROI}/TTP_{REF} (ROI1: $p = 0.0009$; ROI2: $p = 0.0003$). When comparing ROI1 and ROI2 before balloon correction, PD_{tROI}/PD_{REF} of ROI1 was slightly higher ($p = 0.05$), whereas TTP_{tROI}/TTP_{REF} and AUC_{tROI}/AUC_{REF} showed no significant difference. Interestingly, following balloon correction the 2D-PA ratios of the two tested ROIs were significantly different ($p < 0.05$).

Conclusion: Detection of leakages alongside the cranial balloon using 2D-PA is feasible. Position of the upper ROI may have an impact on the measurements.

P-431

Role of multidetector CE-CT before transcatheter endovascular embolization in arterial active bleedings

A. Borzelli¹, A. Paladini², F. Pane³, F. Amodio⁴, E. Cavaglià⁴, R. Niola⁴

¹U.O.C. Radiologia Vascolare ed Interventistica, AORN "A. Cardarelli", Naples, IT, ²SCDU Radiologia Diagnostica ed Interventistica, AOU "Maggiore della Carità" - Novara, Novara, IT, ³Advanced Biomedical Sciences, AOU Federico II Napoli, Naples, IT, ⁴Vascular and Interventional Radiology, Cardarelli Hospital, Naples, IT

Purpose: Identify the role of CE-CT in active bleedings' detection according to clinical evidence and biomolecular parameters of patients

Material and methods: 1480 CE-CT performed between June 2015 and June 2018 for suspected active bleeding (median patient age 45; 902 M 578 F) in emergency setting, due to clinical and laboratory evidence of serum haemoglobin value lowering

Results: In 793 cases CE-CT revealed active bleeding followed by angiography. In the remaining 687 cases CT was negative, but due to clinical and laboratory values worsening, in 89 of them angiography was performed, revealing active bleeding in 65 patients; the latter owing

to pseudoaneurysms, intracavitary bleedings or through percutaneous drainages. Among the 793 CT-positive patients, in 64, angiography didn't reveal active bleedings and 28 of these were patients affected by DIC or wide small and diffuse bleedings, while in 36, CT revealed small active bleedings not detectable by the following angiography. In the last year (June 2018-January 2019) we considered CT-false positive patients and in 31 of them angiography was not performed for wide small and diffuse bleedings or for small bleedings detected by CT, preferring clinical and laboratoristic follow-up. In 2 cases, owing to worsening of symptoms and laboratory parameters, angiography was performed, showing active bleeding followed by successful endovascular embolization.

Conclusion: Multidetector CE-CT showed elevated accuracy in revealing active bleedings, but a correct assessment of clinical and laboratoristic conditions of patients is essential in presence of mismatch between imaging findings and clinical conditions. In particular in cases of wide small and diffuse bleedings and very small focal bleedings, only strict clinical and laboratoristic follow-up is appropriate, in order to evaluate later the necessity of diagnostic angiography.

P-432

Missed visceral artery pseudoaneurysms: frequency and causes of misdiagnoses in CT

I. Vittoria De Martini, T. Pfammatter

Division of Diagnostic and Interventional Radiology, University Hospital Zürich, Zurich, CH

Purpose: Visceral artery pseudoaneurysms (VAPA) carry a high risk of rupture but are sometimes missed or diagnosed with delay on CT examinations. The aims of this study were to determine the frequency and causes of misdiagnoses of VAPA in CT.

Material and methods: We retrospectively identified 77 patients with VAPA who underwent CT and assessed the frequency of delayed diagnosis and the reasons for misdiagnosis. We further identified the presenting symptoms, etiology and follow-up treatment of VAPA.

Results: Forty-five of the 77 patients (58%) had an initial misdiagnosis, meaning that the VAPA was not reported in the first but only in follow-up CT. The majority of VAPA was caused by previous surgical or interventional procedures ($n = 48, 62\%$). The reasons for misdiagnosis were a missed arterial phase in CT ($n = 16, 36\%$), artifacts masking the aneurysm ($n = 9, 20\%$), misinterpretation of the findings by the attending radiologist ($n = 1, 2\%$), and overlooked pseudoaneurysm ($n = 19, 42\%$). 61 patients (79%) had symptoms upon admission and 16 (21%) were asymptomatic. 57 of the symptomatic patients (74%) presented with a ruptured VAPA and related hemodynamic shock (9%), abdominal pain (62%) or signs of bleeding (18%). In 62 cases (81%) interventional treatment was performed. One patient underwent open surgery. In 14 cases (18%), patients were treated conservatively or intervention was unsuccessful.

Conclusion: Misdiagnosis of VAPA occurred relatively often with four main reasons for misdiagnoses. Adding an arterial contrast media phase to the CT protocol, techniques for artifact reduction and increased awareness of the attending radiologist should be considered for reducing the rate of misdiagnosis and delayed treatment.

P-433

Visibility of Fe²⁺-bound DC BeadTM on low keV monochromatic images from dual energy computed tomography and T1-weighted magnetic resonance imaging

K. Tanitame¹, T. Fujii², T. Kurose¹, Y. Takahashi³, K. Chosa³, H. Mitani², M. Kobayashi¹, K. Awai³

¹Diagnostic Radiology, Hiroshima Prefectural Hospital, Hiroshima, JP, ²Diagnostic Radiology, Institute and Graduate School of Biomedical Sciences, Hiroshima University, Hiroshima, JP, ³Radiology, Hiroshima University Hospital, Hiroshima, JP

Purpose: DC beadTM (DCB) cannot be visualized on computed tomography (CT) and magnetic resonance imaging (MRI), which makes the evaluation of embolization effect difficult. We thought that Fe²⁺ ions could bind DCB, and Fe²⁺-bound DCB could be visible on CT and MRI. The purpose of this study is to evaluate the visibility of Fe²⁺-bound DCB on low keV monochromatic images from dual energy CT (DECT) and T1-weighted MRI (T1WI).

Material and methods: We added DCB of 100-300 µm in diameter to distilled water and 100 mmol/l FeSO₄ solution, and scanned these solutions and fresh venous blood at 10 and 30 minutes, 1, 3, 6, 9, 18 and 27 hours after mixture using a DECT scanner. The CT values of precipitated DCBs and blood on 40 keV monochromatic images were measured. Next, we added the DCB to distilled water, 100, 10, 5 and 1 mmol/l FeSO₄ solutions, and scanned these solutions and fresh venous blood at 15, 30, 60, 90 and 120 minutes after mixture using a 3T MR scanner. The signal-noise ratios (SNRs) of precipitated DCBs and blood on T1WI were measured.

Results: The CT values of DCB in 100 mmol/l FeSO₄ solution gradually increased in processing time, and at 27 hours after mixture, which were 113.3 (blood: 7.8) HU on 40 keV images. The SNRs of DCBs in 1 mmol/l FeSO₄ solution increased and achieved equilibrium at 120 minutes after mixture, which was 120.5 and highest (blood: 49.7).

Conclusion: Fe²⁺-bound DCB can be discriminated from blood on 40 keV monochromatic images from DECT and T1WI.

P-434

Usefulness of contrast-enhanced US for follow-up of EVAR

H.-O. Kim¹, B.C. Lee², Y.J. Kang³, N.Y. Yim⁴, J.K. Kim¹, S.G. Song⁵

¹Radiology, Chonnam National University Hospital, Gwangju, KR, ²Radiology, Chonnam National University Hwasun Hospital, Jeollanam-do, KR, ³Diagnostic Radiology, Chonnam National University Hwasun Hospital, Jeollanam-do, KR, ⁴Diagnostic Radiology, Chonnam National University Hospital, Gwangju, KR, ⁵Radiology, Gwangju Veterans Hospital, Gwangju, KR

Purpose: To evaluate the usefulness of contrast-enhanced US (CEUS) compared with CTA to identify the endoleak and aneurysm sac diameter of abdominal aortic aneurysm (AAA) in post-EVAR patients.

Material and methods: This institutional review board-approved retrospective study included 86 patients who underwent EVAR for AAA between April 2016 and August 2018. All patients provided written informed consent before EVAR was conducted. We included who had follow-up with both CTA and CEUS after EVAR. And only patients with less than one month of interval between CTA and CEUS were included. To compare AAA diameter measured by CEUS and CTA, simple linear correlation with Pearson correlation coefficient was used. And we analyzed sensitivity, specificity, positive and negative predictive value of identifying the endoleak of CEUS compared with CTA.

Results: A total of 68 patients (52 men, 16 women; mean age, 75.8 ± 6.8 years) meeting the inclusion criteria were identified. There was an excellent positive correlation of post-EVAR aneurysm sac diameter size measured by CEUS and CTA ($P < 0.001$, Pearson's $r = 0.968$). The endoleaks were detected in 29 patients on CTA. Assuming CTA to be a gold standard, the sensitivity of CEUS to detect endoleak was 83%, and specificity was 92%. The positive and negative predictive values were 89% and 88%.

Conclusion: CEUS can be useful to detect the endoleak and AAA diameter changes in post-EVAR patients without any radiation or iodinated contrast media.

P-435

Parenchymal blood volume (PBV) measurement using C-arm-Dyna-CT as an prognostic marker for the response of HCC after repetitive transarterial chemoembolisation (TACE) treatment

T.J. Vogl¹, K. Graef¹, N.N. Naguib², N.-E.A. Nour-Eldin³

¹Institut für Diagnostische und Interventionelle Radiologie, Klinikum der Johann Wolfgang Goethe-Universität, Frankfurt, DE, ²Institute for Interventional and Diagnostic Radiology Frankfurt, University Hospital Frankfurt, Frankfurt, DE, ³Interventional and Diagnostic Radiology Department, Johann Wolfgang Goethe University, Frankfurt, DE

Purpose: To evaluate the prognostic value of intraprocedural parenchymal blood volume (PBV) using C-arm-CT for the response evaluation in HCC under transarterial chemoembolization (TACE).

Material and methods: In this retrospective study 67 patients (49 males/17 females; mean age:65.7, range:39-80) with HCC were treated with at least two TACE sessions in 4-6-week-intervals. Intra-procedural C-arm-CT was performed during each session. Post-procedural processing of the obtained images and reconstruction to create a PBV map were performed. Images were overlapped with follow-up MRI for correlating tumor diameter and PBV values.

Results: Significant correlations were observed between the alterations in PBV value and downsizing of the lesion. Average initial blood volume was 111.39ml/1000ml (SD 66.88), average size was 53.14mm. After first TACE, blood volume decreased on average to 73.69ml/1000ml with a reduction in diameter to 51.58mm. After repeated TACE the average blood volume decreased to 69.49ml/1000ml with a significant reduction to an average diameter of 47.73mm documented in MRI. In the course of the study both a considerable reduction in volume (-37.61%) and diameter (-10.19%) was documented.

Patients with initial tumor blood volume >100 ml/1000 ml decreased 12.61% in size and 51.62% in blood volume. Patients with a PBV of 50-100 ml/1000 ml dropped 6.88% in size and increased 7.08% in blood volume and patients with <50 ml/1000 ml decreased 6.93% in size and increased 51.76% in blood volume.

Conclusion: PBV measurements could be used for determining TACE effectiveness. Patients with a high initial PBV respond better to TACE regarding diameter and volume reduction.

P-436

Vessel wall enhancement of intracranial aneurysms on high resolution MRI: a rupture sign? The ICARUS study

L. Dinia¹, C. Vert Soler², L.L. Gramegna¹, F. Arian Abello³, M. Luzi⁴, D. Hernandez Morales¹, P. Coscojuela Santaliesra¹, E. Martinez Saez⁵, A. Rovira Cañellas², A. Tomasello Weitz¹

¹Interventional Neuroradiology, Vall D'Hebron University Hospital, Barcelona, ES, ²Section of Neuroradiology, Vall D'Hebron University Hospital, Barcelona, ES, ³Neurosurgery, Vall D'Hebron University Hospital, Barcelona, ES, ⁴Neurosurgery, Università Politecnica delle Marche, Ancona, IT, ⁵Neuropathology, Vall D'Hebron University Hospital, Barcelona, ES

Purpose: Instability state in saccular intracranial aneurysm (SIA) is still difficult to estimate. Inflammation plays a major role and aneurysm wall enhancement (WE) on MRI may be a surrogate of vessel wall inflammation. Main aim of the study is to assess the capability of WE to identify instability of SIA in real danger for rupturing.

Material and methods: Consecutive patients with ruptured and un-ruptured aneurysms underwent contrast 3T-MRI and histology to confirm wall inflammation. Statistical analysis was performed to investigate the association of WE with risk factors and histological markers of inflammation.

Results: A preliminary group of 50 patients was included. WE was present in 100% of the ruptured aneurysms, in 50% of unruptured symptomatic and in 33% of asymptomatics ($p=0.003$). Cut-offline of 4 in PHASES score was found, above which most of the aneurysms begin to enhance ($p<0.001$). Independent predictors of rupture were: WE ($p=0.018$) and presence of multiple aneurysms ($p=0.016$). Independent predictors of WE: size ($p=0.001$), variables of circle of Willis ($p=0.005$) and irregular morphology ($p=0.016$). Analysis of WE as a predictor of rupture has shown ($p=0.002$): 100% sensitivity, 64% specificity, 28%VPP, 100%VPN. At a cut-off of 7, there is a direct correlation between the number of altered immunohistochemical inflammation markers and presence of WE ($p=0.043$). A score higher than 7 entails a 100% sensitivity, specificity, VPP and VPN in relation to presence of WE.

Conclusion: Wall enhancement identifies instability-state in SIA. WE is a new and powerful rupture sign that could be crucial in deciding whether and how to treat SIA, even in small aneurysms.

P-437

Angular dependence of 2D DSA velocity quantification in a carotid artery bifurcation phantom

C.A. Hoffman¹, S. Periyasamy², R. Medero³, P.F. Laeseke²

¹Medical Physics, University of Wisconsin Madison, Madison, WI, US,

²Radiology, University of Wisconsin-Madison, Madison, WI, US,

³Mechanical Engineering, University of Wisconsin Madison, Madison, WI, US

Purpose: To characterize the effects of projection angle on 2D DSA velocity quantification in a carotid artery bifurcation phantom.

Material and methods: Imaging was performed on a carotid artery bifurcation phantom. A positive displacement pulsatile pump was used to generate near-physiologic waveforms. Flow and pressure sensors were used to monitor the pump, which was set to supply a mean flow rate of 315 ml/min with a frequency of 60 bpm. An injection of 2.5 ml/s for 25ml of iodinated contrast medium (Omnipaque 300 diluted to 50% with saline) was used for all acquisitions. The phantom was placed at isocenter and triplicate 30 fps DSA scans were acquired for C-arm angles of 0, 5, 10, 20, and 30 degrees. A cross-correlation technique was used to calculate the velocity in the common carotid artery.

Results: The average flow produced by the pump was consistent at baseline (313 ± 3.19 ml/s) and during injections (426 ± 1.71 ml/s). A decrease in calculated velocity was observed as the angle of projection increased. The variation in calculated velocities ranged from 1.26% to 4.37%. The decrease in calculated velocity due to increased projection angles compared to the theoretical decrease in velocity (using the cosine of the projection angle) resulted in errors ranging from 1.19% to 3.30%.

Conclusion: The 2D DSA velocities calculated experimentally agreed with the theoretically calculated velocities up to projection angles of 30 degrees. The consistency of these velocity measurements suggests that 2D DSA flow quantitation may be used clinically, where images are acquired over a range of projection angles.

P-438

Non-gated motion compensated aortic valve reconstruction before interventional replacement for patients with atrial fibrillation

C. Spink¹, T. Elss², R. Bippus³, M. Morlock², G. Adam¹, G. Lund¹, M. Grass³

¹Diagnostic and Interventional Radiology and Nuclear Medicine, University Medical Center Hamburg-Eppendorf, Hamburg, DE,

²Department of Biomechanics, Hamburg University of Technology, Hamburg, DE, ³Philips Research, Philips, Hamburg, DE

Purpose: Precise CT imaging is prerequisite for reliable planning of transcatheter aortic valve implantation (TAVI). Especially concerning patients with atrial fibrillation and non-ECG-gated CT scans, cardiac motion leads to severe artifacts in the reconstructed CT images. Blurring of the valve

and the neighboring vascular anatomy potentially result in incorrect device sizing. A second pass motion correction method for non-ECG-gated helical CT scans with a pitch <1 is introduced here.

Material and methods: A new post-processing method was applied to non-ECG-gated clinical datasets of 20 patients with known atrial fibrillation, acquired with a 256-slice CT scanner (Brilliance iCT, Philips Healthcare). Redundancy in the helical projection data was used to generate three image volumes at identical spatial positions, but different time points. The 3D edge-filtering scheme included Gaussian smoothing for noise reduction, gradient calculation for edge enhancement, non-maximum-suppression and hysteresis thresholding for reduction of incoherent edges. Datasets were evaluated by two readers using a TAVI planning software (IntelliSpacePortal9, Philips Healthcare) and compared using a two-tailed t-test.

Results: The new technique achieved significant motion artifact reduction in non-gated CT aortic valve reconstructions. A removal of doubled structures at the aortic boundaries could be observed, as well as reduced blurring compared to the uncompensated reconstructions. However the aortic annulus diameters were decreased by 10 % in reconstructed dataset with motion compensation.

Conclusion: Motion compensated reconstruction is feasible for non-ECG-gated helical CT scans using edge filtering and image based registration for motion estimation. Reconstructed CT datasets may improve planning and device selection for TAVI procedures, especially for patients with atrial fibrillation.

P-439

A clinically driven new classification for aortic dissections

S. Malekzadeh¹, D. Bodenmann¹, J.-A. Collinot¹, A.-M. Jouannic¹, S.D. Qanadli²

¹Radiodiagnostic and interventional Radiology, CHUV, Lausanne, CH,

²Radiology and Interventional Radiology, University Hospital of Lausanne, Lausanne, CH

Purpose: To report a new classification for aortic dissections (AD), based on a modified Stanford classification, to consider the aortic arch as a separate entity and integrate patterns influencing treatment strategy notably malperfusion syndrome (MPS). The proposed classification was evaluated in a large population of ADs.

Material and methods: All patients with proven de novo acute AD who were admitted to our hospital from 2005 to 2017 were included in this study. All pre-therapy CT angiographies were reviewed and reclassified using the new classification based on three types and four subtypes: Type A, dissection involving at least the ascending aorta; Type B, dissection involving exclusively the descending aorta; and type C, dissection involving the aortic arch with/without descending aorta. Subtype: 0; absence of MPS; 1, dynamic MPS; 2, static MPS; 3, static and dynamic MPS.

Results: A total number of 226 consecutive patients were included in the study. According to the new classification, AD were distributed as 152 type A (92A0, 12A1, 37A2, 11A3), 50 type B (38B0, 5B1, 6B2, 1B3) and 24 type C (17C0, 6C2, 1C3). The new type represented 11% of all ADs. MPS was present in 29% of type C. Treatment strategies in type C included endovascular interventions and surgery in 33% and 25%, respectively.

Conclusion: The new classification is easy to use and feasible in a large group population. It should be helpful driving the decision making process and especially in integrating the latest development in transcatheter therapies.

P-440

Feasibility and safety of cone beam CT during sclerotherapy for venous malformations

H. Ashida, Y. Matsui, Y. Munetomo, S. Kasaki, Y. Hasegawa, H. Ojiri
Department of Radiology, The Jikei University School of Medicine, Minato-ku, JP

Purpose: The aim of this study was to investigate the feasibility and safety of cone beam CT applied during sclerotherapy for venous malformations.

Material and methods: This study included 16 consecutive patients (24 sessions) with symptomatic venous malformation (VM) treated with percutaneous direct sclerotherapy with foam polidocanol using cone beam CT (CBCT) in our hospital from August 2016 to February 2018. Foam polidocanol was injected under fluoroscopy and acquired CBCT, and air distribution was evaluated in comparison with previous contrast-enhanced CT or MRI. In case air distribution was insufficient, additional injection was performed during the same session. The primary endpoint was evaluation of additional injection rate, including all sessions. The secondary endpoint was to investigate the total radiation dose, including fluoroscopy and CBCT, and the radiation dose of only CBCT.

Results: The study patients comprised 11 females and 5 males with a mean age of 32.4 (SD: 18.6) years and a median age of 28 years. Nine patients had VM in the extremity, six patients had VM in the head and neck and one patient had VM in the trunk. The additional injection rate was 25% (6/24). The mean and median total radiation doses, including fluoroscopy and CBCT, were 270.4 (SD: 293.9) and 182 mGy, respectively. The mean and median CBCT radiation doses were 84.7 (SD: 103.3) and 33.7 mGy, respectively.

Conclusion: The amount of CBCT radiation dose applied during sclerotherapy for VM was acceptable, and CBCT should be acquired because 25% of patients revealed insufficient air distribution only under fluoroscopy.

P-441

Correlation of tumor response on computed tomography with pathological necrosis in hepatocellular carcinoma treated by conventional transcatheter arterial chemoembolization: threshold value of intratumoral lipiodol deposition predicting tumor necrosis

H.H. Chu, C. Park, J.Y. Kim, M. Park, J. Hur, J.W. Kim, J.H. Kim, J.H. Shin, D.I. Gwon
Radiology, Asan Medical Center, Seoul, KR

Purpose: To evaluate associations between pathology and CT assessments made according to the modified Response Evaluation Criteria in Solid Tumor (mRECIST) guidelines in patients with hepatocellular carcinoma treated by conventional transcatheter arterial chemoembolization (cTACE), and to identify predictors of complete tumor necrosis.

Material and methods: From March 2016–July 2018, 83 patients (70 men, 13 women; mean age, 56.2 years; range, 34–75 years) with a total of 100 nodules were retrospectively included. Patients underwent sequential cTACE and portal vein embolization, and later hepatic surgery. Evaluation of treatment response and measurement of baseline lipiodol deposition as mean Hounsfield units (HU) was performed on CT at the time point closest to the time of operation (mean, 54.5 days after cTACE; range, 15–242 days). Significant predictors associated with complete tumor necrosis were identified by multivariate analysis. A receiver operating characteristic (ROC) curve was used to identify the optimal baseline lipiodol deposition HU threshold for predicting complete necrosis.

Results: According to mRECIST, complete response (CR) and partial response occurred in 70 (70%) and 30 (30%) nodules, respectively. On pathology, 24 of 70 (34.3%) nodules classified as CR on mRECIST were found to have incomplete (70–99%) necrosis. On multivariate analysis, mean HU of baseline lipiodol deposition was the only significant predictor of complete tumor necrosis ($p=0.003$, odds ratio=1.746, 95% CI: 1.201–2.539).

On ROC analysis, a threshold of 460 HU was significantly associated with complete tumor necrosis (67.4% sensitivity, 75.0% specificity).

Conclusion: Even in the presence of CR according to mRECIST, the value of baseline lipiodol deposition should be considered because it was the only significant predictor of complete tumor necrosis. A threshold value for lipiodol deposition > 460 HU was highly sensitive and specific for complete necrosis

P-442

Application of a metal artifact reduction algorithm for cone beam CT (CBCT) in the evaluation for radioembolization - preliminary results

M. Jonczyk, G. Böning, F. Feldhaus, D. Geisel, G. Wieners, B. Gebauer
Department of Radiology, Charité Berlin, Berlin, DE

Purpose: To evaluate the effect of metal artifact reduction (MAR) on the image quality of CBCT in patients undergoing evaluation angiography for radioembolization (RE).

Material and methods: In this retrospective study, 40 consecutive patients (age: 65 ± 13 ; m:23, w:17) undergoing evaluation for RE receiving 45 CBCTs (Allura FD 20, XperCT roll protocol, Philips Healthcare, Best, The Netherlands) were enrolled between 01/2017 and 12/2018. Artifacts caused by coils (gastroduodenal/right gastric artery), diagnostic catheters and surgical clips were scored using a 5-point system (1 = artifacts affecting diagnostic information – 5 = no artifacts) before and after applying the built-in MAR algorithm. Equally, tumor visibility (1 = artifact mimicking a lesion – 5 = well-seen lesion) and vessel discrimination (1 = unacceptable – 5 = excellent visualization) were rated. Mann-Whitney-U-Test was performed for statistical analysis with p-values <0.05 considered as significant.

Results: Artifacts caused by coils improved significantly from in median 2 (min 2 – max 2) to 4 (3 – 4, $p<0.001$) with MAR. Similarly, catheter artifacts were significantly reduced from 2 (2 – 4) to 3 (3 – 5, $p<0.001$). Clip artifacts showed no significant improvement from 3 (2 – 3) to 3 (3 – 4, $p=0.056$). The use of MAR did not affect tumor visibility (native: 4 (1 – 4), MAR: 4 (3 – 4), $p=0.650$) or vessel discrimination (3 (3 – 4), 3 (3 – 4), $p=1.000$) either.

Conclusion: MAR algorithm improved artifacts caused by diagnostic catheters and coils avoiding interferences of metal artifacts with adjacent major structures and ensured clearer depiction of the liver hilum.

P-443

Post procedural cone-beam-CT is able to evaluate the adjunctive value of balloon micro-catheter in trans-catheter-arterial-chemoembolization

P. Lucatelli¹, G. De Rubeis², B. Rocco¹, L. Ginanni Corradini¹, F. Basilio³, A. Cannavale⁴, P.G. Nardis⁵, M. Corona³, M. Bezzi⁶
¹Department of Radiological, Oncological and Pathological Sciences, "Sapienza" University of Rome, Rome, IT, ²Department of Radiological, Oncological and Pathological Sciences, Sapienza University of Rome, Rome, IT, ³Vascular and Interventional Radiology Unit, Sapienza University of Rome, Rome, IT, ⁴Vascular and Interventional Unit, Policlinico Umberto I, Rome, IT, ⁵Angiography and Interventional Radiology, Policlinico Umberto I, Rome, IT, ⁶Department of Radiological Science, University of Rome La Sapienza, Rome, IT

Purpose: To report the deposition analysis of polyethylene-glycol epirubicin-loaded drug-eluting microspheres (DEM), evaluated non-enhanced Cone-Beam-CT (ne-CBCT) performed at the end of the procedure, between DEM-TACE and balloon micro-catheter trans-catheter-arterial-chemoembolization (b-TACE)

Material and methods: Forty-four typical hypervascular Hepatocell Carcinoma (HCC) were treated (19 DEM-TACE and 22 b-TACE). Immediately at the end of the embolization procedure a ne-CBCT was performed to assess DEM deposition. HCCs' pseudoattenuation was measured with an arbitrary unit called HU* in different Region of Interest (ROI). ROI was

manually shaped in each nodule (to assess the signal), in three different hepatic parenchymal regions (HPR) (to assess liver residual enhanced) and in right rectus abdominis muscle [RRAM] (to assess the image noise). Signal of the nodule, signal to noise (SNR) ratio (signal/RRAM) and signal-parenchymal to noise ratio (SPNR) ([signal/(HPR/3)]/RRAM) was assessed.

Results: The average nodules' diameter was 19.4 ± 10.3 mm vs 25.5 ± 13.2 mm (DEM-TACE vs b-TACE; $p=0.1$).

The SNR was significantly higher in b-TACE treated nodules compared with DEM-TACE treated ones (7.4 ± 6.1 vs 12.3 ± 6.6 ; $p < 0.05$, respectively). No statistically significant differences were highlighted in signal and SPNR, between DEM-TACE vs b-TACE, (220.9 ± 174.4 HU* vs 321.5 ± 180.1 HU*, 5.7 ± 6.1 vs 9.1 ± 6.8 ; $p > 0.05$, respectively).

Conclusion: b-TACE significantly increase the deposition of polyethylene-glycol epirubicin-loaded drug-eluting microspheres comparing with standard DEM-TACE.

P-444

Visualization improvement of the Adamkiewicz artery using CT angiography with vasodilator

K. Nagai, M. Shimohira, K. Ohta, Y. Shibamoto

Radiology, Nagoya City University Graduate School of Medical Sciences, Nagoya, JP

Purpose: Thoracic endovascular aortic repair (TEVAR) has become the dominant treatment option for thoracoabdominal aortic disease over the past decade. Identification of the Adamkiewicz artery (AKA) is crucial in patients with thoracoabdominal aortic disease to prevent postoperative spinal cord injuries such as paraparesis or paraplegia. This study assessed the usefulness of computed tomography angiography (CTA) using nitroglycerin (NTG) on evaluation of the AKA and its origin.

Material and methods: We retrospectively analyzed 46 patients (35 males, 11 females; mean age 71) underwent CTA after administration of sublingual NTG, and compared the detectability of the AKA and the continuation from the aorta between CTA with NTG and conventional CTA without NTG of the same patients acquired within a year. The contrast media concentration and injection rate of that was 370mg/ml, 5ml/s in CTA with NTG and 300mg/ml, 3.5-4ml/s in CTA without NTG, respectively. All CT studies were performed with a 128-detector row dual source scanner. Arterial phase images were acquired with maximum intensity projection.

Results: The AKA was visualized by CTA with NTG in 39/46 cases (85%); in 25/39 (86%) cases, the continuity with the aorta was satisfactorily detected, while CTA without NTG presented the AKA in only 9/46 cases (20%); in 2/9 (22%) cases, the continuity with the aorta was detected.

Conclusion: CTA with NTG improved visualization of the AKA and the arterial continuity with the aorta. This method is useful and noninvasive procedure for evaluating the AKA as a part of the preoperative assessment of patients with thoracoabdominal aortic disease.

P-445

CT characteristics of right adrenal vein in predicting the technical success of adrenal venous sampling

I. Jurca, M. Prutki, E. Kresic, A.M. Alduk

Department of Diagnostic and Interventional Radiology, University Hospital Centre Zagreb, Zagreb, HR

Purpose: Adrenal venous sampling (AVS) is performed in order to determine whether autonomous hormone production is unilateral or bilateral. It is considered to be a technically challenging procedure, mainly because of difficult sampling of the right adrenal vein (RAV). The purpose of this study is to analyze the ability of contrast enhanced computerized tomography (CECT) in predicting the technical success of AVS.

Material and methods: Sixty nine patients who underwent AVS between November 2015 and January 2019 were included in this retrospective study. Preprocedural CECT was reviewed in order to analyze RAV diameter.

Blood samples were obtained from bilateral adrenal veins and the inferior vena cava for cortisol and aldosterone measurements. Successful AVS was determined by at least a threefold elevation in adrenal vein cortisol levels compared with IVC cortisol levels.

Results: RAV was not visible in 12 (17,4%) patients. Mean diameter of RAV was 2,6 mm (range: 0,7-4,1 mm; SD:0,8 mm). Technical success of AVS was obtained in 57 (82,6%) patients. CT visibility of RAV does not predict technical success of AVS ($p=0,44$). CT determined diameter of RAV positively correlates with successful AVS and cut-off value of 2,1 mm in diameter is a significant predictor of successful AVS with sensitivity of 100% and specificity of 51%.

Conclusion: CT is a valuable method for analysis of RAV and indispensable in planning of AVS. RAV diameter of 2,1 mm or more predicts AVS success.

P-446

Predictive value of MRI in diagnosing brain AVM recurrence 1-year after angiographically documented exclusion in children

A. Jhaveri¹, G.M.Y. Ma¹, A. Amirabadi¹, P. Dirks², A.V. Kulkarni², M. Shroff³, T. Krings⁴, V.M. Pereira⁵, V. Rea¹, N. Shkumat³, P. Muthusami¹

¹Image Guided Therapy, The Hospital for Sick Children, Toronto, ON, CA, ²Neurosurgery, The Hospital for Sick Children, Toronto, ON, CA, ³Diagnostic Imaging, The Hospital for Sick Children, Toronto, ON, CA, ⁴Medical Imaging, Toronto Western Hospital, Toronto, ON, CA, ⁵Neurosurgery, Toronto Western Hospital, Toronto, ON, CA

Purpose: This study aimed to determine the predictive value of MRI for bAVM recurrence in children, comparing with catheter angiography (CA).

Material and methods: This study included pediatric bAVM patients over an 18-year period, who had angiographically documented obliteration (after treatment with embolization, surgery, radiosurgery, or multimodal therapy) and were followed with MRI including CEMRI and TOF-MRA. These patients underwent CA at 1-year, with a subset receiving 3D-rotational angiography(3DRA). Predictive values of CEMRI and TOF-MRA for bAVM recurrence were determined. CT angiographic sections reconstructed from 3DRA were co-registered with and fused to 3D-T1-weighted MRI, followed by analysis for increased diagnostic confidence. MRI features predictive for bAVM recurrence were analyzed.

Results: From 236 patients with bAVM, 39 children (age 10.8 ± 0.6 year, range 2-17 years, M:F=19:21, Spetzler-Martin grade 1.9 ± 0.6) met inclusion criteria. Of these, 13 had angiographically confirmed bAVM recurrence, diagnosed by CEMRI in 11/13 (84.6%) and TOF-MRA in 6/12 (50%). Positive- and negative-predictive values (PPV, NPV) for bAVM recurrence were: CEMRI, 40.7% and 81.8%; TOF-MRA, 85.7% and 79.3%. 3DRA images, when available and fused with MRI, confirmed or excluded recurrence in all cases (13/13). Treatment by embolization-only was a significant predictor for recurrence (OR=3.9, $p=0.008$). MRI features predictive for recurrence included a tuft of vessels on TOF-MRA and nodular juxtamural enhancement with a traceable draining vein on CEMRI.

Conclusion: TOF-MRA and CEMRI sequences provide complimentary information for determining bAVM recurrence after angiographic cure in children. Certain imaging features can help select MRI-positive patients for CA. Co-registering 3DRA with MRI increases the diagnostic confidence regarding presence and location of bAVM recurrence.

P-447

IVUS in pelvic venography: radiation exposure, fluoroscopy times and contrast dose (a methodological comparison)

N. Anning¹, L. Villalba²

¹Dept of Vascular Surgery, The Wollongong Hospital, Bondi Junction, NSW, AU, ²Dept of Vascular Surgery, The Wollongong Hospital, Wollongong, NSW, AU

Purpose: Limited data is available of the impact of IVUS on radiation dose and fluoroscopy times in the endovascular treatment of May-Thurner Syndrome (MTS).

We sort to illustrate additional advantages IVUS has in the treatment of MTS.

This study establishes and compares radiation and contrast dose parameters between patients undergoing pelvic venography / ilio-caval reconstruction with and without IVUS.

Material and methods: Dose area product (DAP), fluoroscopy times and contrast were recorded for patients undergoing pelvic venography / treatment of MTS in a 3 month period. Two comparative cohorts of patients (IVUS and non-IVUS) were retrospectively analysed for the impact of IVUS on radiation and contrast dose using paired T-test analysis.

Results: Utilisation of IVUS in endovascular treatments of MTS resulted in significantly ($P = 0.0018$) longer fluoroscopy times ($M = 694.33s$, $SD = 141.69$) compared with standard pelvic venography ($M = 398.83s$, $SD = 92.13$). Overall radiation dose (DAP) was considerably less ($P = 0.016$) when IVUS was utilised ($M = 40345.5$, $SD = 69013.16$) than without IVUS ($M = 126358$, $SD = 60895.16$).

Similarly, contrast volume utilised in pelvic venography with IVUS ($M = 42.66$, $SD = 22.84$) was significantly less ($P = 0.0000265$) without IVUS ($M = 122$, $SD = 30.01$).

Conclusion: Pelvic venography with IVUS is gold standard in diagnosis of MTS. Ability to assess luminal diameter and wall characteristics aids endovascular treatment options.

Utilisation of IVUS reduction in radiation dose reduction of 65% - attributed to the reduced DSA exposures. Contrast volume is proportionately reduced utilising IVUS.

This small comparative study demonstrates a clinically and statistically significant reduction contrast and radiation dose in a relatively young cohort of MTS patients.

P-448

Significant quality reserve provided by digital variance angiography in lower limb angiography setting

V.I. Óriás¹, M. Gyánó², D. Szöllősi³, K. Szigeti³, S. Osváth³, J. Kiss⁴, Z. Ruzsa¹, P. Sótónyi¹

¹Heart and Vascular Center, Semmelweis University, Budapest, HU, ²Radiology, Semmelweis University, Budapest, HU, ³Department of Biophysics and Radiation Biology, Semmelweis University, Budapest, HU, ⁴Research Dpt., Kinepict Health Ltd, Budapest, HU

Purpose: Digital Variance Angiography (DVA) is a novel X-ray image processing method visualizing contrast motion by calculating the variance of each pixel intensity in a recorded series of images. Our aim was to determine the quality reserve of DVA in lower limb angiography setting.

Material and methods: Two observational studies enrolled 66 patients undergoing lower limb X-ray angiography due to symptomatic peripheral arterial disease. A subgroup of 24 patients received carbon-dioxide (CO₂) as contrast agent. We compared the signal-to-noise ratio (SNR) of Digital Subtraction Angiography (DSA) and DVA image pairs. Visual quality comparison was also performed by experts using a blinded form. Interrater agreement was characterized by Fleiss' kappa.

Results: A total of 6814 regions of interest were selected on image pairs. The ratio of SNR(DVA)/SNR(DSA) was calculated. DVA provided 3.3 times (median) higher SNR than DSA on angiograms obtained using iodinated contrast medium (ICM). The ratio was 3.0 times (median) higher in the

images of the CO₂ subgroup. In 69% of the ICM group comparisons it was judged that DVA provided higher quality images than DSA. Fleiss' kappa was 0.17 ($p < 0.001$). DVA was preferred over DSA in 85% of paired image comparisons in the CO₂ subgroup. Fleiss' kappa was 0.27 ($p < 0.001$).

Conclusion: DVA provides enhanced image quality compared to DSA in lower limb angiography setting. The enhanced image quality might help the widespread use of CO₂ angiography. The observed quality reserve provides numerous risk reduction possibilities, but further prospective studies are needed to determine the appropriate amount of radiation and contrast agent dose-reduction without significant image quality loss.

P-450

The possible application of digital variance angiography in prostatic artery embolization

T.J. Vogl¹, L.S. Alizadeh¹, M. Gyánó², D. Szöllősi³, K. Szigeti³, S. Osváth³, J.P. Kiss⁴, V.I. Óriás²

¹Institute for Interventional and Diagnostic Radiology Frankfurt, University Hospital Frankfurt, Frankfurt, DE, ²Heart and Vascular Center, Semmelweis University, Budapest, HU, ³Department of Biophysics and Radiation Biology, Semmelweis University, Budapest, HU, ⁴Scientific Dept., Kinepict Health Ltd, Budapest, HU

Purpose: Kinetic imaging is defined as a novel X-ray image processing method for the visualization of contrast motion. The algorithm produces so-called Digital Variance Angiography (DVA) images. The study objective was to compare the performance of DVA versus standard digital subtraction angiography (DSA) for vascular intervention in Prostatic Artery Embolization (PAE).

Material and methods: We evaluated angiographic acquisitions of 15 patients (mean age 67.47, SD 9.76, range 42-82) undergoing PAE at our institution. The signal-to-noise ratio (SNR) of DSA and DVA image pairs was compared using regions of interest. Visual comparison regarding image quality was also performed by three experienced interventional radiologists in a randomized blinded questionnaire, using clinically relevant criteria (e.g. visibility of feeding- and collateral-branches, size of examinable arteries). Fleiss' kappa-test was used to determine inter-rater agreement.

Results: DVA images provided 1.79 times higher SNR than DSA (median value, Q1-Q3 interval was 1.46-2-32). The visual evaluation indicated that DVA provided higher quality images than DSA, since in 90.6% of comparisons evaluators preferred DVA over DSA images. The interrater agreement was 93.8% and Fleiss's kappa was 0.38 ($p < 0.001$).

Conclusion: In PAE setting, DVA-imaging enhances visualization of anatomical structures, compared to DSA-imaging, via significant SNR increase, thereby the new technology might improve the safety and efficacy of the intervention. As an additional advantage, the observed quality reserve of DVA might provide opportunity also for the reduction of radiation-dose and the amount of contrast agent.

P-451

Effective signal-to-noise ratio improvement method for lower extremity kinetic imaging

D. Szöllősi¹, M. Gyánó², S. Osváth¹, K. Szigeti¹

¹Department of Biophysics and Radiation Biology, Semmelweis University, Budapest, HU, ²Heart and Vascular Center, Semmelweis University, Budapest, HU

Purpose: Kinetic imaging is an image processing method for time-series images based on calculating the standard deviation of the time-series at each pixel location. Digital variance angiography is the application of kinetic imaging to X-ray angiographic image series. Image enhancement methods are especially useful in angiography having the potential to allow contrast media or X-ray dose reduction while maintaining an image quality suitable for diagnostic purposes. We have developed an image enhancement method based on time differentiation and filtering (DVA+)

and our objective in this study was to evaluate this method by comparing its signal-to-noise ratio (SNR) to that of digital variance angiograms (DVA).

Material and methods: Abdominal and lower extremity X-ray angiographic acquisitions of 30 patients were used to create DVA and DVA+ images. Pairs of vascular and background regions of interest (ROIs) were selected by hand (n=3283). SNR was calculated as the ratio of the vessel-background difference and the background standard deviation.

Results: The median SNR of DVA images was 9.26 (Q1: 4.90, Q3: 15.86) while the median SNR of DVA+ images was 14.44 (Q1: 7.14, Q3: 26.00). The median ratio of the SNR values of the same ROI pairs was 1.49 (Q1: 1.12, Q3: 2.02).

Conclusion: Our pre-processing algorithm was effective at improving the signal-to-noise ratio by almost 50% in abdominal and lower extremity angiograms. This improvement can potentially enable the implementation of substantial X-ray and/or contrast media dose reduction protocols.

P-452

A pictorial review of aberrant coronary arteries arising from the opposite sinus (ACAOS) on coronary CT angiography

W.P. Ngu¹, V. Shrivastava²

¹Radiology, Hull Royal Infirmary, Hull, UK, ²Interventional Radiology, Hull Royal Infirmary, Hull, UK

Learning objectives: To describe aberrant coronary arteries arising from the opposite sinus (ACAOS) on coronary CT angiography and its clinical implications.

Background: Aberrant coronary arteries are rare and potentially lethal congenital malformations with an incidence of 0.3-2%. Most diagnoses are made incidentally during angiography or post-mortem. The most common anomalies are coronary arteries arising from the opposite sinus (ACAOS).^{1,2,3} Left ACAOS is more common than right ACAOS (where the right coronary artery arises from the left coronary cusp) and are generally considered more fatal due to the risk of myocardial ischaemia.³⁻⁴ There are no current guidelines for the management of ACAOS although left ACAOS are generally treated surgically whereas right ACAOS are treated conservatively. Such surgical interventions usually include a coronary artery bypass graft, reimplantation of the ACAOS to the appropriate sinus and unroofing of the ostium.

Clinical Findings/Procedure Details: A normal coronary artery originates at a perpendicular angle to the aorta whereas an ACAOS will have an acute angle as it curves through the heart to supply the contralateral side. The most common course for an ACAOS is an interarterial (between the aorta and pulmonary artery). Consequently, the normal circular ostium becomes narrow and slit-like. This is clinically significant as it drastically increases the risk of myocardial ischaemia or sudden cardiac death particularly during exercise due to the dilatation of the aorta and pulmonary trunk compressing the aberrant vessel and already narrowed ostium.^{1,3}

Conclusion: Although it does not automatically warrant surgical intervention, a good understanding of ACAOS is crucial in defining the patient's management.

P-453

Hepatocellular carcinoma (HCC) post locoregional treatment MR imaging spectrum: utilization of LI-RADS (liver imaging reporting and data system) classification

B.B.B. Shafi, L. Kania, F. Guglielmo, D. Mitchell

Radiology, Thomas Jefferson University Hospital, Philadelphia, PA, US

Learning objectives:

1. To familiarize the audience with the spectrum of HCC post treatment imaging appearances.
2. Illustrate utilization of LI-RADS with case examples.

Background: LI-RADS offers a comprehensive system for standardizing the terminology, technique, interpretation, reporting, and data collection

of liver imaging, and is gaining wider acceptance for assessing response of HCC to locoregional treatments.

Clinical Findings/Procedure Details:

- Pictorial review will include cases post locoregional treatments including chemoembolization, thermal ablation and radioembolization.

- Some case examples will include post treatment changes from multiple treatment modalities in the same liver.

The following cases will be presented:

1. LR-TR Non-viable: Treated cases which are probably or definitely not viable. Criteria for this category will be discussed with case examples including post treatment hemorrhagic necrosis and post treatment fibrosis.
2. LR-TR Equivocal: Treated cases which are equivocally viable. Criteria will be discussed with case examples.
3. LR-TR Viable: Treated cases which are probably or definitely viable. Criteria will be discussed with case examples.
4. Post treatment bland thrombosis of main and branch portal veins.
5. Imaging features depicting the difference between bland and tumor thrombosis.
6. Hepatic lobar atrophy after multiple treatment due to progressive fibrosis.
7. Tumor tract seeding.
8. Biliary necrosis.
9. Ischemic necrosis vs infection.
10. Post treatment perfusion abnormality.

Conclusion: Knowledge of post treatment imaging spectrum and utilization of LI-RADS Classification simplifies interpreting MR Imaging and multidisciplinary team management after loco regional treatments for HCC.

P-454

Basic arterial anatomy and interpretation of computed tomography angiography for intra-abdominal or gastrointestinal bleedings: correlation with conventional angiographic findings for beginners

S.H. Kwon¹, J. Yoon¹, T.-S. Seo², J.H. Oh¹

¹Radiology, Kyung Hee University Medical Center, Seoul, KR, ²Radiology, Korea University Guro Hospital, Seoul, KR

Learning objectives:

1. To review the basic arterial anatomy of abdomen and pelvis and basic CT findings for intra-abdominal or gastrointestinal bleedings.
2. To discuss the correlations of CT findings with conventional angiographic findings focused on intra-abdominal or gastrointestinal bleedings for beginners.

Background: Active bleeding is an emergency condition that can be encountered frequently and requires a quick diagnosis. Arterial embolization as intervention is a safe and effective method for the treatment of bleeding caused by trauma or other reasons. This intervention should be considered if there is an extravasation of the contrast agent on computed tomography (CT) or if active bleeding is suspected clinically. However, when angiography is performed prior to embolization, beginners do not readily understand the basic anatomy and imaging findings. The reason is that beginners see three-dimensional arterial structures mainly through two-dimensional fluoroscopy and also angiography images are unfamiliar and difficult to correlate with CT. Therefore, in order to better understand the embolization process, it is necessary to know about the angiographic findings of the blood vessels that cause active bleeding.

Clinical Findings/Procedure Details:

1. Basic arterial anatomy
 - abdominal aorta, celiac trunk, superior mesenteric artery, both renal arteries, inferior mesenteric artery, both iliac arteries.
2. Image findings of active bleeding
 - CT angiography, Conventional angiography
 - Signs of arterial bleeding
3. Case review with CT and conventional angiography
 - GI bleeding cases

- Intraabdominal bleeding cases

Conclusion: Knowledge of the arterial anatomy is essential to understand the relationship between the extravasation site on CT and the damaged artery visualized on angiography.

P-455

Vascular compression syndrome - clinical and imaging findings

S.H. Kwon, J.H. Oh, J. Yoon

Radiology, Kyung Hee University Medical Center, Seoul, KR

Learning objectives: To discuss the clinical and diagnostic features and pathophysiology of vascular compression syndromes (VCS) from all over the human body via a case-based approach.

Background: Vascular compression syndromes are caused by the entrapment of vessels between rigid or semi-rigid surfaces in a confined anatomic space. Vascular compression syndromes is a wide disease spectrum with various symptoms, signs, and clinical significance according to the location and underlying anatomical variations. Although in some cases, affected lesions without any specific symptoms can be found incidentally on the radiologic study, they may cause hemodynamically significant disease, including arterial ischemia and embolism, venous stasis and thrombosis, and hematuria.

Clinical Findings/Procedure Details: 1) Compression of a vascular structure: Eagle syndrome, Thoracic outlet syndrome, Nutcracker syndrome, Median arcuate ligament syndrome, Popliteal artery entrapment syndrome, Quadrilateral space syndrome, Paget-Schroetter syndrome, May-Thurner syndrome, Hypothenar hammer syndrome, Anomalous origin of a coronary artery

2) Compression by a vascular structure: Neurovascular compression syndrome (esp. CN V, VII, VIII), SMA compression disorders (Nutcracker & SMA syndrome), May-Thurner syndrome, Ovarian vein syndrome, Vascular rings (Double aortic arch, aberrant subclavian artery, pulmonary sling)

Conclusion: We have to understand the possible location of vascular compression syndrome and underlying patients' anatomic variations. It would be more helpful in the further management of vascular compression syndrome.

P-456

MRI-guidance for cardiovascular interventions - choices, chances, challenges

M.C. Gissler

Faculty of Medicine, University of Freiburg, Freiburg Im Breisgau, DE

Learning objectives:

1. To provide an overview about successful landmarks in the emerging role of vascular MRI interventions.
2. To learn about benefits and hurdles of the implementation of interventional MRI in modern cardiovascular patient care.
3. To discuss recent research advances in this field and resulting future implications.

Background: Magnetic resonance imaging (MRI) provides powerful, functional imaging properties that may prove useful for interventional practitioners. As compared to x-ray based fluoroscopic imaging, advantages include avoidance of harmful radiation exposure and nephrotoxic contrast media as well as the ability of structural analysis of the vessel wall beyond mere lumen diameter evaluation.

Clinical Findings/Procedure Details: The purpose of this poster is to illustrate the rationale for and key features of MRI Guidance for cardiovascular interventions and to outline the steps that had to be taken to advance this innovative approach from pre-clinical experiments to first clinical feasibility studies. Current challenges including technical issues and safety aspects are discussed and the latest literature involving material studies, animals and human subjects is reviewed. Finally, an outlook summarizing prevailing expectations with a focus on potential clinical relevance is provided.

Conclusion: The use of MRI-guidance could potentially take the quality and possibilities of cardiovascular interventions to a new level. Yet, more research involving multidisciplinary teams is needed to proof and establish its role in everyday practice. In these teams the role of the interventionalist as experienced clinician, profound imaging expert and creative medical innovator will remain crucial.

P-457

Imaging spectrum of vertebral artery dissection

D.Y. Lim¹, J.C. Ng²

¹Diagnostic and Interventional Radiology, Changi General Hospital, Singapore, SG, ²Department of Diagnostic Imaging, National University Hospital, Singapore, SG

Learning objectives:

1. Recognise the wide range of presentation and imaging features of vertebral artery dissection.
2. Review the current guidelines and literature for management of vertebral artery dissection.

Background: Vertebral artery dissection occurs when there is a tear in the intima of the vessel wall. Angiography morphology can grossly be classified into aneurysmal type or stenotic/occlusive type. Vertebral artery dissection may present with a myriad of imaging features, especially given the wide range of imaging modalities. Recognition of its clinical presentation, varied imaging findings - in plain CT, CT angiogram, MRI angiogram and conventional catheter angiogram is paramount for early treatment and management.

Clinical Findings/Procedure Details: We present a selection of cases of vertebral artery dissection in which prompt diagnosis was not made, some of which have or could have lead to adverse outcome. Clinical presentation of our patients include stroke or acute sub-arachnoid haemorrhage. The management options are largely divided into anticoagulation/antiplatelet therapy versus surgery (including endovascular therapy). Some of the considerations include whether the dissection extends intracranially, and the size of the contralateral vertebral artery.

Conclusion: Familiarity with the imaging findings of vertebral artery dissection is critical in the early recognition and subsequent management of these patients. Knowledge of the factors predicting outcome is important for the clinician and interventional neuroradiologist in deciding on the best management option of the patient.

P-458

Anatomical variants and anomalies of intracranial arteries

A. Boccuzzi¹, G.A. Lazzarotti², D.L. Lauretti², A. Grigolini², M. Cosottini²

¹Diagnostic and Interventional Radiology, University of Pisa, Pisa, IT,

²Operative Unit Neuroradiology, AOU PISA, Pisa, IT

Learning objectives: The purpose of this educational exhibit is to make a brief review of embryonic development of the circle of Willis and to show the typical CT findings of congenital anatomical variants and anomalies.

Background: Circle of Willis is an anastomotic ring that connects anterior circulation with the vertebral-basilar system. It is a polygon that has ten components: Internal Carotid Arteries (ICAs), Anterior Cerebral Arteries (ACAs), Anterior Communicating Artery (ACoA), Posterior Cerebral Arteries (PCAs), Posterior Communicating Arteries (PCoAs), Basilar Artery. Anatomical variations in the circle of Willis are very common. In fact, some authors say that anatomical variations are "the rule" and not the exception.

Clinical Findings/Procedure Details: Variants and anomalies are present in the majority of cases, especially in the posterior part of the circle. The principal variants are the absence or the hypoplasia of a vessel, followed by PCoA infundibulum, fetal origin of PCA with often P1 hypoplasia, isolated ICA. The most common anomalies are infraoptic origin of ACA, Azygos ACA and trigeminal artery.

Conclusion: CT angiography, particularly the multi planar reconstruction (MPR) and volume rendering (VR), is a powerful mean to analyze intracranial arteries variants and anomalies and can be helpful for the planning of neuroradiological endovascular procedures as well as surgical ones.

P-459

The accuracy of contrast-enhanced ultrasound (CEUS) for the detection of endoleak after endovascular aneurysm repair

G. Buccimazza

Radiology Department, San Paolo, Milan, IT

Learning objectives: Understanding the possibilities of using CEUS in the follow up after evar and accuracy of this method in endoleaks detection

Background: Endovascular aneurysm repair (EVAR), first described in 1991, is a widely used alternative to open surgical repair in patients with abdominal aortic aneurysm. Among EVAR complications one of the most significant is the endoleak. At present, computed tomography angiography (CTA) is the primary imaging modality for EVAR surveillance and endoleaks detection but also CEUS can play an important role

Clinical Findings/Procedure Details: Several studies compared CEUS with CTA (gold standard) in the evar surveillance demonstrating that CEUS has significant advantages as an additional test to CTA; it provides hemodynamic data and could be useful for the diagnosis or accurate classification of an endoleak.

Conclusion: CEUS has a high sensitivity and specificity in the detection of endoleaks after EVAR. CEUS is a useful and easily reproducible tool in EVAR surveillance.

P-460

Acute aortic syndrome: key image findings that determine treatment

P. Concejo Iglesias, J.M. Abadal Villayandre, W.A. Ocampo Toro, E. Galvez

Radiology, Hospital Universitario Severo Ochoa, Madrid, ES

Learning objectives:

1. Describe the entities included in AAS as well as predisposing factors and physiopathology. Correlation with drawing is added for a better understanding
2. Outline key imaging findings of AAS and pitfalls.
3. Resume optimal technical imaging protocols.
4. Review treatment indications and approaches.

Background: Acute aortic syndrome (AAS) is a cardiovascular emergency and includes aortic dissection, intramural hematoma and penetrating ulcer. To broaden AAS, acute aortic occlusion and aneurysmal rupture are included. Due to its high morbidity and mortality rate, early diagnosis and treatment is mandatory to improve the outcome.

Clinical Findings/Procedure Details: Clinical findings and the hemodynamic status of the patient determine urgent imaging techniques with validated protocols.

Tailored CT imaging is the essential tool to diagnose AAS and differentiate between these dynamic aortic pathologies. AAS has a high risk of life-threatening complications and featured image findings play a key role to indicate treatment and decide a medical or surgical/endovascular approach.

Imminent signs of aortic rupture, organ malperfusion must be clearly depicted.

If endovascular treatment is planned basic planification with lengths/diameters of the aorta and 3D reconstructions is needed for accurate sizing of stents.

Imaging follow-up is needed in both conservative and endovascular treatment. Some pathologies may require delayed follow-up during hospitalization.

Conclusion: Acute aortic syndrome is an emergency entity with a high mortality rate. CT is the main imaging technique and validated technical

protocol is mandatory. Radiologist should be aware of key imaging findings for an accurate and prompt diagnosis in order to decide the best management: conservative, endovascular or surgical repair.

P-461

Down but not out: review of common compensatory collateral pathways in arterial occlusion

J.J. Mahn¹, A. Aglan¹, B. DuBois², C.S. Branach³, R.W. Dougherty², R. Aronberg², M. Cline¹

¹Department of Radiology, University of Michigan Health System, Ann Arbor, MI, US, ²Department of Interventional Radiology, University of Michigan Health System, Ann Arbor, MI, US, ³Department of Vascular and Interventional Radiology, University of Michigan, Ann Arbor, MI, US

Learning objectives: After reviewing this exhibit, participants will become familiar with common and uncommon collateral pathways seen in occlusive arterial disease and their implications in arterial intervention.

Background: Arterial collateral pathways are a common occurrence in those with longstanding arterial disease with eventual arterial occlusion. It is important to identify these collateral pathways and consider them prior to arterial intervention, as exclusion of these vital pathways may result in catastrophe especially if recanalization and stenting of the native vasculature fails.

Clinical Findings/Procedure Details: This educational exhibit will review the most commonly seen collateral pathways in arterial occlusive disease and their imaging appearances on multiphasic computed tomography (CT) and fluoroscopic angiography. A case-based review will include various entities including: pathway of Winslow (reconstitution of the common femoral artery via the inferior epigastrics to the subclavian artery), a case of massive hypertrophy of the arc of riolan to reconstitute flow to the IMA from an aortic occlusion between the SMA and IMA, systemic-systemic intercostal and lumbar arterial pathways, and more. Relation of collateral pathways to treatment approach will also be discussed.

Conclusion: Arterial collateral pathways are a common occurrence in those with longstanding arterial disease with eventual arterial occlusion. It is important to identify these collateral pathways and consider them prior to arterial intervention, as exclusion of these vital pathways may result in catastrophe especially if recanalization and stenting of the native vasculature fails.

P-462

Hereditary hemorrhagic telangiectasia: pulmonary fistulas how we treat them

Q. Ordi-Camprubi

Interventional Radiology, Hospital Universitari de Bellvitge, Esplugues De Llobregat, ES

Learning objectives:

1. Follow up of Rendu - Osler disease
2. How to diagnose the pulmonary fistulas
3. When to treat pulmonary fistulas

Background: Hereditary hemorrhagic telangiectasia (HHT) is a rare autosomal dominant disorder, characterized by recurrent epistaxis, cutaneous and mucosal telangiectasias as well as arteriovenous malformations (AVM) in the lung, liver, brain and gastrointestinal tract.

AVM in the lung are frequent and cause cerebral infections.

Clinical Findings/Procedure Details:

- How we do the diagnose, young patients and radiation
- We use Plug dispositives to treat the AVM when it is possible.
- If the AVM is not completely treated we use coils.

Conclusion:

- The AVM embolization is a challenging procedure.
- If the interventional radiologist is experienced, it is a safe and definitive treatment.

- It is important to treat patients in reference hospitals with multidisciplinary teams.

P-463

Endovascular treatment of arterial complications after orthopedic surgery of the hip

J. Salvador¹, E. Lonjedo², J. Gomez¹, A. Ruiz¹, E. Casula¹

¹Radiology, University Hospital Dr Peset, Valencia, ES, ²Sección de Radiología vascular e intervencionista, Servicio de Radiología, Hospital Universitario Dr. Peset, Valencia, ES

Learning objectives: To illustrate the role of Interventional Radiology (IR) in the management of complications after orthopedic surgery of the hip.

Background: Iatrogenic vascular injuries associated with elective orthopaedic procedures are relatively rare, however when presented, they carry a risk of significant morbidity and mortality. Arterial lacerations, pseudoaneurysms, active bleeding and arteriovenous fistulas have been related complications. These patients present a higher risk of bleeding, due to the antithrombotic prophylaxis and most hip fractures occur in elderly patients. In cases of massive hemorrhage, aggressive therapy may become necessary. Medical support restoring haematologic disorder is mandatory and when persistent active bleeding, vascular surgical intervention has been historically the method of choice of treatment with compartmental decompression, stopping the hemorrhage and restoring distal flow.

Clinical Findings/Procedure Details: IR plays an increasing, crucial role in the diagnosis (CT for identifying the point of active bleeding and planning approaches) and as a treatment of arterial damage associated with this pathology. TAE, carried out as selectively as possible, may improve the chances of success and reduce the risk of complications such as ischemia of neighboring structures because it seems to be less invasive compared with a surgical approach. Coaxial technique with microcatheter allows precise localization and catheterization of the bleeding arterial branches with minimal tissue compromise.

Conclusion: Nowadays, minimally invasive endovascular procedures are considered to represent the first line therapy in the management of surgical arterial complications, showing high effectiveness, reducing hospitalization and recovery time, and avoiding the higher morbidity associated to re-interventions.

P-464

Giant right internal iliac aneurysm and spontaneous arteriovenous fistula combine with hydronephrosis

K. Li¹, B. Liu²

¹Vascular Surgery, Peking Union Medical College Hospital, Beijing, CN, ²Vascular Surgery, Peking Union Medical College, Beijing, CN

Clinical History/Pre-treatment Imaging: A 56-year-old woman was admitted to our hospital for discovery of a pelvic mass. The patient touched the mass about 5cm in diameter nearly two years ago, then she felt the mass gradually grew up with abnormal urination, mainly frequent micturition. Except the above signs, she hadn't experienced any cardiovascular symptoms with no history of hypertension or coronary heart disease. The initial diagnosis was gynecologic neoplasms, but gynecological ultrasonography suspected the huge mass to be hematoma with formation of pseudoaneurysm in right internal iliac artery with a size of 13x10cm. (Panel A). PET/CT revealed hydrocele and dilation in right renal pelvis, secondary to the mass, which had irregular slightly increased metabolism (Panel B1/B2). As what computed tomographic angiography showed (Panel C1/C2), possible diagnosis was changed to be a rupture of right iliac artery aneurysm which formed a giant pseudoaneurysm, but tumorous lesion was not completely excluded.

Treatment Options/Results: Confirmed to be right internal iliac aneurysm and secondary arteriovenous fistula (Panel D), the pelvic mass was embolized on right internal iliac aneurysm (Panel E) and aneurysmal

reflux vein (Panel F) successfully under local anesthesia. Post-operative enhanced CT (Panel G) indicated satisfying embolization with no formation of evident collateral circulation.

Discussion: Thus, we considered the formation of her AVF due to iliac aneurysm rupture to be a spontaneous chronic process. Compared with previous reported sudden onset cases, alertness of clinical characteristics of such chronic ones may allow early diagnosis and treatment.

Take-home points: Giant right internal iliac aneurysm and spontaneous arteriovenous fistula

Neuro and carotid intervention

P-465

Revascularization of the sole patent arch vessel in patients with non specific aortoarteritis with neurological symptoms - short term results

P. Jagia, N. Pandey

Cardiovascular Radiology and endovascular interventions, All India Institute of Medical Sciences, Delhi, IN

Purpose: Non specific aortoarteritis (NSAA) or Takayasu arteritis is a large vessel vasculitis involving aorta and its major branches. Patients with the steno-occlusive disease of all the arch vessels present with severe neurologic symptoms. There is hardly any literature regarding the role of endovascular revascularization in these cases. This paper describes immediate and short term follow-up results with plain balloon angioplasty of such severely stenosed single patent arch arteries.

Material and methods: Angioplasty was performed in 13 consecutive patients with NSAA (age, 18 – 52 years; mean, 29 ± 12.56 years) with cerebrovascular symptoms caused due to severe stenotic lesions of arch (ie, carotid, vertebral, brachiocephalic and 1st part of subclavian proximal to vertebral take-off) arteries.

Results: Angioplasty was done in 18 stenotic lesions: vertebral (n=8), carotid (n=3), brachiocephalic (n=3) and ostioproximal subclavian artery (n=4). Ten lesions were discrete while eight had diffuse stenosis. Balloon angioplasty was performed successfully in all patients without any complications. Improvement of luminal diameter from 1.611 mm ± 0.621 mm to 4.81mm ± 0.804 mm (P <.0001), and the reduction in diameter of stenosis from 72.318% ± 12.42% to 15.84% ± 8.21% (P <.0001) was observed. No procedure-related complication or neurologic deficits were reported. The presenting syncopal symptoms improved in all patients. At followup of 6-8 months, none of the patients had recurrence of neurologic symptoms and showed patent artery on Doppler.

Conclusion: Plain balloon angioplasty of a solitary patent arch artery in non-specific arteritis is safe and effective, and provides excellent symptomatic relief in such patients.

P-466

Preliminary experience of CAS with use of "edited" FlowGate2 device

A. Spinelli¹, T. Castrucci², R. Cancellieri¹, G. Sodani¹, N. Maltzef¹, M. Guazzaroni³, F. Accrocca², A. Siani², G. Smedile², G. Ianni², S. Bartoli²

¹U.O.S.D. Interventional Radiology, S. Eugenio, Rome, IT, ²U.O.S.D. Vascular Surgery, S. Eugenio, Rome, IT, ³U.O.C. Radiology, S. Eugenio, Rome, IT

Purpose: To assess safety and efficacy of CAS in patients with symptomatic carotid artery stenosis with use of edited FlowGate2 device

Material and methods: From September to December 2018, ten patients with symptomatic carotid artery stenosis, underwent CAS with use of an edited FlowGate2 device. All patients had no significant stenosis of the contralateral carotid axis or of the vertebralis system. The FlowGate2 protocol has been modified to achieve a flow inversion, without loss of

blood; in addition to the inflation of the distal balloon of the catheter, we connected the FlowGate2 with a peripheral vein. All patients performed a MSCT to plan the procedure and to evaluate the intracranial vascularization. A DWI- MRI was performed before and within 48 hours after the procedure. During the procedure the internal carotid flow was monitored with US-Doppler at different steps: before ICA catheterization; after inflating the distal balloon of the FlowGate2 in the CCA, after the opening of the connection to the peripheral vein and after stent deployment and deflated the system. Follow-up was performed with US-Doppler and neurological evaluation at 1 and 3 months.

Results: Technical success was obtained in all cases with no periprocedural neurological complication. In one patient DWI-MRI showed two small restricted diffusion lesions, asymptomatic. Follow UP did not show any neurological alteration with patency and good flow of the stent.

Conclusion: CAS with use of FlowGate2 allows safe and effective treatment of symptomatic carotid stenoses. Further large studies will be required.

P-467

Internal carotid artery stenting in high surgical risk patients

A. Ter-Akopyan

Endovascular Surgery, Persident's Hospital with Polyclinic, Moscow, RU

Purpose: The following retrospective trial's purpose was to evaluate the possibility and effectiveness of ICA stenting in high surgical risk patients.

Material and methods: Since 2012 till December 2018 stenting of 184 internal carotid arteries in 153 patients was performed. Technical success was achieved in 99.5% of interventions. Patients' age varied from 49 to 93 years. Bicarotid lesion diagnosed in 29 (15.7%) patients.

Most patients had comorbidities, associated with multifocal atherosclerosis. Class II stable angina was diagnosed in 59 (32%), Class III – in 39 (21.2%), Class IV – in 10 (5.4%) of cases. Prior to ICA stenting 21 (11.4%) patients have suffered myocardial infarction; 14 (7.6%) patients had a CABG. Subcompensated diabetes mellitus was diagnosed in 27 (14.8%) cases. 20 (10.9%) patients had documented atherosclerotic lesion of lower extremities. Stenting of both ICA and coronary arteries was performed in 81 cases (44%).

The sequence of endovascular interventions was determined by clinical presentation and severity of atherosclerotic lesion. 5 (2.7%) simultaneous stentings of ICA and coronary arteries were performed.

Results: Overall major complications occurred twice – 1 (0.54%) major stroke and 1 (0.54%) stent thrombosis. No myocardial infarctions or lethal outcomes were reported after performed interventions both in early and late observation period.

Conclusion: As this study shows, ICA stenting is a valid strategy and is highly effective in patients with high surgical risk.

P-468

Evaluate efficacy of endovascular management of intra-cranial arterio-venous malformation

N. Sharma

Interventional Radiology, Fellow IR, JNMC, DMIMS, Maharashtra, Wardha, IN

Purpose: My purpose is to evaluate the technical efficacy and outcome of endovascular management of intra-cranial arterio-venous malformation

Material and methods: This was Prospective study carried out at database of all neurointerventional cases performed by the interventional neurology team at AVBRH, Wardha, Maharashtra, India in 6 Months period i.e. April 2018 to September 18. A sample size of 25 was taken. Onyx® was used for embolization in all the cases

Results: In our study the majority of the patients were in the age group of 30-40 were 36%, 20-30- 24%, < 20-20%, 40-50- 21%, 50-60 and >60 were 4% each. Males- 68%, Females-32%. Most common symptom was Headache in 76%,Vertigo- 68%,Seizure- 44%,Tinnitus- 36%,Blurred

image- 32%, Difficulty in speaking-20% and Photophobia-12%. GCS scoring 9-12=48%, 12-15=28%, 6-9=16%, 3-6=8%. Hess and Hunt classification grading 3-44%,Grade 2-24% patients,grade 1-16% patients. Grade 4 & 5-8% patients each. Spetzler Martin grading scale,grade 4-36%. Grade 3-28%,grade 5-20%. Grade 2-12% patients and Grade 6-4% patients. Medium sized Cerebral AVMs-40% patients. Large AVMs-32% patients. 20% patients-small AVMs. Giant AVMs- 8% patients. Majority (40%) of Cerebral AVMs were located in the dominant cerebral hemisphere. 32%-non dominant cerebral hemisphere.12%-basal ganglia. 5 patients were referred for radiosurgery(20%).

Conclusion: Treatment of Cerebral AVM in modern times is a multimodality approach, with a team consisting of physicians with expertise in endovascular intervention, cerebrovascular neurosurgery, and radiation therapy. Endovascular embolization has become a crucial component of management of Intra-cranial AVM,either as a stand-alone curative method or as an adjunct to microsurgery or radiosurgery, with few complications.

P-469

Stenting of cervical internal carotid artery in patients with acute ischemic stroke due to tandem occlusion. Is antegrade approach safe?

M. Köcher¹, D. Sanak², M. Černá¹, T. Veverka², V. Prášil¹, M. Kral², J. Zapletalova³

¹Department of Radiology, University Hospital Olomouc, Olomouc, CZ, ²Comprehensive Stroke Center, Department of Neurology, Palacky University Hospital, Olomouc, CZ, ³Department of Biophysics, Palacky University, Olomouc, CZ

Purpose: Mechanical thrombectomy (MT) can be performed also in acute ischemic stroke (IS) patients with tandem occlusion (TO). The aim of our retrospective study was to evaluate safety of carotid artery stenting (CAS) and subsequent MT (antegrade approach).

Material and methods: All consecutive IS patients treated due to TO were enrolled into the retrospective analysis. Neurological deficit was scored using National Institutes of Health Stroke Scale (NIHSS). In all patients, occlusion of internal carotid artery was treated by CAS just before MT and MT was performed using stent-retriever. Achieved recanalization was rated using Thrombolysis in Cerebral Infarction (TICI) scale. Symptomatic intracerebral haemorrhage (SICH) was assessed according to the SITS-MOST criteria. Ninety day clinical outcome was scored using modified Rankin scale (mRS) with score 0-2 for good outcome.

Results: Out of 562 patients treated for IS, 40 patients (80% of males, mean age 66 years) had TO with a median of admission NIHSS 16.5 points. Overall recanalization (TICI2b/3) was achieved in 92.5% and complete (TICI 3) in 55% of patients. SICH after procedure was detected in 12.5% of patients. 55% of patients had good outcome after 3 months. 7-day mortality was 7.5 % and 15% of patients died within 3 months.

Conclusion: Antegrade approach for combination of CAS and MT is safe in patients with TO.

Acknowledgment: Supported by grant: RVO FNOL_00098892_2016

P-470

Treatment of essential tremor (ET) and Parkinson disease (PD) tremor with MRgFUS: preliminary results from 30 patients in a single center

F. Bruno¹, F. Arrigoni², L. Panebianco¹, M.V.M. Micelli³, M. Varrassi⁴, A. Catalucci⁴, A. Ricci⁵, P. Sucapane⁶, C. Masciocchi¹

¹Applied Clinical Sciences and Biotechnology, University of L'Aquila, L'Aquila, IT, ²Emergency Radiology, San Salvatore Hospital, L'Aquila, IT, ³Division of Radiology, Department of Biotechnological and Applied Clinical Science, University of L'Aquila, S. Salvatore Hospital, L'Aquila, IT, ⁴Neuroradiology and Interventional Radiology, San Salvatore Hospital, L'Aquila, IT, ⁵Neurosurgery, San Salvatore Hospital, L'Aquila, IT, ⁶Neurology, San Salvatore Hospital, L'Aquila, IT

Purpose: To report our experience in the treatment of ET and PD tremor using MRgFUS thalamotomy

Material and methods: In the period February-December 2018, we enrolled 30 patients (18 males, 12 females, mean age 65.2 years) with disabling and refractory tremor (16 ET, 14 PD tremor, mean duration of symptomatology 11.6 years) who were subjected to unilateral Vim ablation using MRgFUS. Clinical evaluation was performed using the Fahn-Tolosa-Marin scale (FTM) for tremor and the QUEST score for quality of life, assessed before treatment, immediately after treatment and with follow-up at 1 month and 3 months. Instrumental MRI follow-up was performed immediately after treatment and at 1-month and 3-months follow-up. Sonication parameters were recorded in all procedures.

Results: Treatment was effective (substantial and immediate reduction of tremor) in 28 out of 30 patients (93.3%). FTM scores decreased from mean values of 32.6 before treatment to 13.5 immediately after treatment. In patients followed-up at one month (18 patients), the clinical evaluation showed a minimal increase in mean FTM values due to the reappearance of tremor in 6 patients. At 3 months (12 patients), clinical evaluation showed a substantial stability of treatment effects. Quality of life evaluation showed substantial improvement (74% reduction of the QUEST scores). Temporary side effects and complications (dysarthria, perioral paresthesias, limb weakness) occurred in 4 patients.

Conclusion: In our experience with a relatively small number of patients and a short follow-up observation, MRgFUS thalamotomy resulted in a safe and effective treatment option for tremor in patients with ET and PD.

P-471

Ethanol ablation therapy for intracranial arteriovenous malformations: a preliminary study

Y. He¹, W. Bai², L. Tianxiao³

¹Interventional Neuroradiology, Henan Provincial People's Hospital, Zhengzhou University, Zhengzhou, CN, ²Zhengzhou University, Henan Provincial People's Hospital, Zhengzhou, CN, ³Department of Interventional Therapy, Henan Provincial Hospital, Zhengzhou, CN

Purpose: To discuss the safety of ethanol ablation therapy in treating brain arteriovenous malformation (bAVM).

Material and methods: Between September 3, 2018 and November 11, 2018, a total of 12 patients with bAVM received targeted endovascular ethanol ablation therapy. According to the type of targeted malformed nest-like aneurysm structure or arteriovenous fistula, mixed solution of different proportion of ethanol and iodohehexanol 320 was used to ablate the lesion. Imaging findings, clinical data, perioperative and procedure-related adverse events were analyzed.

Results: Ethanol ablation therapy was carried out on 19 arteries in 12 patients. A total of 13 target aneurysms and 6 target arteriovenous fistulae were ablated. Among the 19 target arteries, 15 were completely ablated by pure ethanol injection, 2 were cured by ethanol combined with Onyx glue injection, one was cured by ethanol injection of arteriovenous fistula together with transvenous embolization, and one was demonstrated mild contrast opacification within the target aneurysm after treatment. Eight

of the 12 patients developed different degrees of brain edema, and 5 of the 8 patients had newly-developed cerebral infarction, only one patient remained obvious neurological impairment at the time of discharge.

Conclusion: For the treatment of bAVM, endovascular ethanol ablation is technically feasible and clinically safe, although studies with large sample are still needed to further clarify its effect.

P-472

Clinical results of the intra-arterial thrombolysis and mechanical thrombectomy with stent retriever according to diffusion perfusion mismatching and intra-venous t-PA administration

H. Jang¹, Y. Won²

¹Radiology, Uijeongbu St. Mary's Hospital, College of Medicine, The Catholic University of Korea, Uijeongbu-si, Gyeonggi-do, KR, ²Interventional Radiology, Uijeongbu St. Mary's Hospital, Uijeongbu-si, Gyeonggi-do, KR

Purpose: We analyzed the clinical outcomes of additional intra-arterial thrombolysis (IA-Tx) with stent retrieval device, according to the combined intra-venous tissue plasminogen activator (tPA) administration and diffusion/perfusion mismatching or not.

Material and methods: Eighty-one treated IA-Tx with stent retriever device, diagnosed as anterior circulation larger vessel occlusion were included in this study. CT-angiography (CTA) was done as an initial diagnostic image and acute stroke MR image followed after the IV-tPA. Forty-two patients were in the tPA group and 39 patients were in the non-tPA group. Recanalization rate, clinically significant hemorrhagic (sICH) and clinical outcomes were recorded according to the IV-tPA and D/P mismatching.

Results: Recanalization rate was 81.0% in IV-tPA group, and it was 69.2% in non-tPA group ($p=0.017$). While sICH were 19.9% and 25.6%, respectively ($p=0.328$). Neurologic outcomes did not influence by IV-tPA administration or not. But according to the D/P mismatching, the recanalization rate and sICH were 91.9% and 16.7% in the mismatched group and 46.7% and 46.7% in the matched group ($p=0.008$ and $p=0.019$, respectively).

Conclusion: For patients treated with IA-Tx with retrieval stent, IV-tPA infusion does not influence on the sICH, recanalization rate and neurologic outcomes. But D/P mismatching was correlated well with sICH, recanalization rate and clinical outcomes.

P-473

Ruptured intracranial aneurysms treated with woven endobridge intrasaccular flow disruptor: a multicenter experience

V. Da Ros¹, A. Bozzi¹, C. Comelli², V. Semeraro³, S. Comelli², N.M. Lucarelli⁴, N. Burdi⁵, J. Scaggiante¹, A. Di Martino¹, F. Salimei¹, A. Raso¹, R. Gandini⁶

¹Department of Diagnostic Imaging, Molecular Imaging, Interventional Radiology and Radiation Therapy, University Hospital Policlinico Tor Vergata, Rome, IT, ²Interventional Radiology, ASL TO2 Giovanni Bosco Hospital, Turin, IT, ³Interventional Radiology & Neuroradiology, SS. Annunziata Hospital, Taranto, IT, ⁴Radiology, SS Annunziata Hospital, Taranto, IT, ⁵Radiology, U.O. Radiologia Taranto, Taranto, IT, ⁶Diagnostic and Interventional Radiology, Policlinico Tor Vergata, Rome, IT

Purpose: The woven endobridge intrasaccular flow disruptor (WEB) device for ruptured broad-based intracranial aneurysm (rBBA) remains underrepresented in existing studies. In this case series, safety and efficacy results of the use of WEB in rBBA were evaluated from a multicenter experience.

Material and methods: Between November 2014 and October 2017, data of all patients with rBBA (≥ 4 mm and/or dome/neck ratio ≥ 1 and ≤ 1.6) treated with WEB were prospectively collected and retrospectively analyzed from 3 Italian neurointerventional centers. The interventional procedures and the clinical and angiographic outcomes are reported for the periprocedural phase with midterm follow-up.

Results: 33 patients were included in this series (10 patients with Hunt-Hess scores 4-5; 23 patients with Hunt-Hess scores 1-3). Technical success was obtained for all 33 patients (100%). Adjunctive devices were used in 6% of patients. At the 1-month follow-up visit, the overall mortality was 33%. The overall rate of WEB-related complications was 27% (5 device protrusion, 2 sac perforation, 2 thromboembolism), with a WEB-related mortality of 12% and permanent neurologic deficit of 3%. At 14 months, the mean follow-up (range, 2-35 months), no early or delayed reruptured aneurysms were observed; complete occlusion was obtained in 7/21 patients (33%), neck remnant in 8/21 (38%), residual aneurysm filling in 6/21 (29%) patients, with a modified Rankin Scale of 0-2 observed in 17/21 patients (80%).

Conclusion: WEB device for rBBA is a fast and effective treatment, with a low rate of aneurysm rebleeding; however, procedure-related complications seem not negligible. Further evaluation comparing this device with other treatment options should be performed.

P-474

The safety of ticagrelor or prasugrel in intracranial flow-diverting stents: a systematic review and meta-analysis

A. Podlasek¹, A.A. Sultan², N. Kashani², M. Goyal², I.Q. Grunwald³, M. Almekhlafi²

¹Stroke Medicine, Southend University Hospital, Southend-on-Sea, UK, ²Calgary Stroke Program, University of Calgary, Calgary, CA, ³Radiology Department, Southend University Hospital, Southend-on-Sea, UK

Purpose: Thromboembolic complications are not uncommon in flow-diverting stenting despite antiplatelet use. We aim to summarize the evidence for alternative antiplatelet regimens use in flow-diverting stenting procedures.

Material and methods: We conducted a systematic review and meta-analysis of studies reporting on the mortality rate and complications of ticagrelor or prasugrel vs. clopidogrel (all with ASA) in flow-diverting stenting procedures by searching electronic databases and relevant references.

Results: Of 452 potentially relevant studies, we included 49 studies (2526 patients) for pooled analysis and 5 (1005 patients) which reported the safety of ticagrelor or prasugrel for meta-analysis. Clopidogrel was inferior to ticagrelor in mortality incidence (RR 4.57, 95% CI 1.23-16.99; $p=0.02$, $I^2=0\%$). For ischemic events, clopidogrel was similar to prasugrel (RR 0.55, 95% CI 0.11-2.74; $p=0.47$, $I^2=0\%$) and ticagrelor (RR 0.74, 95% CI 0.32-1.74; $p=0.49$, $I^2=0\%$). Ticagrelor had similar hemorrhagic complications to clopidogrel (RR 0.92, 95% CI 0.27-3.16; $p=0.89$, $I^2=0\%$). In the pooled analysis of literature, overall reported mortality was 2.14 %, ischemic complications were 6.89% and hemorrhagic complications were 3.68%.

Conclusion: Current evidence suggests that ticagrelor or prasugrel are safe for patients undergoing flow-diversion procedures. Ticagrelor is superior to clopidogrel in regards of survival.

P-475

The role of regional chemotherapy in organ-preserving treatment of the children with an intraocular retinoblastoma

I. Pogrebnyakov

Interventional Oncology, Federal State Budgetary Institution "N.N. Blokhin National Medical Research Center of Oncology" of the Ministry of Health of the Russian Federation (N.N. Blokhin NMRCO), Moscow, RU

Purpose: Improving of organ-preserving treatment results of the children with an intraocular retinoblastoma (IRB) with local selective intra-arterial (IAC) and intravitreal (IVIc) chemotherapy methods.

Material and methods: The research included treatment results of 110 children (129 eyes). All patients/eyes were divided into 2 groups. The first group (combined therapy) included 99 children/116 eyes where IAC±IVIc were performed due to insufficient efficiency of earlier treatment of RB

refractory forms. The 2nd group of IAC±IVIc monotherapy included 11 patients/13 eyes with initially identified one- and bilateral IRB where the local chemotherapy (IAC±IVIc) was the first treatment stage.

Results: In the first group 95 of 114 eyes were retained. One patient with a bilateral lesion left the study. The salvage of eyes by Kaplan-Meier was reached in 94,5% in 1 year, 88,5% in 2 years, 86,5% in 3 years, 82,9% in 4 years and 75,0% from 4th to 6th years. Patients were followed up to 30,3±16,81 month, and 23,74 ±12,45 months was the recurrence-free period. In group of IAC±IVIc monotherapy 11 of 12 eyes were retained. One patient with bilateral form left the study due to the presence of a second tumor. The salvage of eyes by Kaplan-Meier was reached in 92,3% in 1 and 2 years. Patients were followed up to 13,5±5,3 months, and 23,74 ±12,45 months was the recurrence-free period.

Conclusion: Local chemotherapy is an effective and perspective organ-preserving method. It can be used as a complex therapy part of advanced and refractory IRB forms and as a monotherapy of the primary identified IRB.

P-476

Relationship between DWI-FLAIR mismatch and clinical outcome in endovascular treatment for acute ischemic stroke: an initial experience

Y. Murakami, S. Fukumitsu, S. Kakeda, Y. Korogi
Department of Radiology, University of Occupational and Environmental Health, Kitakyushu, JP

Purpose: Recent evidence suggests that a mismatch between DWI and FLAIR imaging (DFM) could be used as a surrogate for the time of acute ischemic strokes (AIS) onset; however, no study has utilized the DFM as the selection criteria for endovascular treatment (EVT). The aim of this study was to evaluate if the DFM can be used to identify the patients with AIS who are more likely to benefit from early reperfusion.

Material and methods: We retrospectively collected the dataset of AIS patients who presented to the hospital within 7 hours of the onset due to large vessel occlusion, and underwent MRI including DWI and FLAIR as the initial imaging modality. A total of 22 patients who had achieved recanalization with EVT were included. Modified Rankin Scale (mRS) was used to measure clinical outcome.

Results: Seventeen (77.3%) of 22 patients were DFM-positive (DFM-P) and five (22.7%) were DFM-negative (DFM-N). The rate of favorable functional outcome as determined by a mRS score 0-2 were better for DFM-P group than for DFM-N group (47.0% vs. 20.0%), although the difference between two groups were not significant because of small sample size. The mean time from the onset to recanalization (O2R) was 222 minutes for DFM-P group and 354 minutes for DFM-N group ($p=.041$).

Conclusion: DWI-FLAIR mismatch model may identify the patients with AIS who are likely to benefit from reperfusion therapy administered. Our results may have been also affected by O2R.

P-477

Safety and feasibility study of transradial cerebral angiography

E. Serrano Alcalá¹, A. Vargas Solano², J. Moreno Negrete², Á. Marín Suárez², A. López Rueda², J.M. Macho Fernández³

¹Radiology, Hospital Sagrat Cor, Barcelona, ES, ²Interventional Radiology, Hospital Clinic Barcelona, Barcelona, ES, ³Angioradiology, Hospital Clínic, Barcelona, ES

Purpose: To analyze the efficacy and safety of transradial cerebral angiography performed in our center and to describe the technique, advantages and complications of radial arterial access.

Material and methods: We retrospectively review the cerebral angiograms performed between August 2018 and January 2019 in our center searching for patients with transradial access (TRA). All patients had signed informed consent documentation to perform digital subtraction angiography, CEIC was not necessary because of its retrospective nature.

Demographic, clinical, radiological and procedural technical variables were recorded. For safety and efficacy measurements we analyzed variables including number of vessels need it to visualize and the number obtained after TRA, the amount of procedures we transform from TRA to TFA, and the amount of major and minor complications, radial artery occlusion being visualize with follow-up ultrasound.

Results: 10 angiograms were performed in 10 patients during the study. Patients considered viable for TRA had a median age of 51.5 years old, ranging from 23 – 65 years, 50% were females. All patients were under Aspirin treatment, and 50% also with Clopidogrel. The radial artery was successfully catheterized in 100% of the patients. We were able to catheterized the preplanned vessels of study also in every case, without transforming any patient into a transfemoral angiography. There were no complications seen related to the procedure or immediately after the procedure. No patient presented occlusion of the radial artery in the follow-up ultrasound.

Conclusion: Transradial cerebral angiography is a safe and effective method, that allows adequate cerebral vascular diagnosis with apparent low risk of complications.

P-478

Thiel embalmed human cadaveric model for simulation training in endovascular stroke revascularization interventions

H. Donald-Simpson¹, A. Barclay², J.G. Houston³

¹Image Guided Therapy Research Facility, University of Dundee, Dundee, UK, ²School of Medicine, University of Dundee, Dundee, UK, ³Clinical Radiology, Ninewells Hospital, Dundee, UK

Purpose: The lack of skilled interventional neuro-radiologists to conduct mechanical thrombectomy in large vessel occlusive stroke is widely recognised. In the UK over 9000 people could have benefited from this procedure if there were sufficient trained practitioners to conduct the intervention. The purpose of this study was to develop a cerebral human Thiel embalmed cadaveric model with extra-corporeal cerebral perfusion to conduct this intervention in full simulation of the clinical experience for training purposes.

Material and methods: Two Thiel embalmed cadavers were prepared by placing ports (Check Flo, 12 Fr sheath, Cook Medical, Ireland) into the right common femoral artery and the right or left auxiliary artery. Retrograde extracorporeal perfusion was delivered continuously at 1 L/minute. Pre procedure contrast enhanced CT of the model facilitated intervention planning and discussion. Peripheral access via left femoral artery was used for intervention. Thrombectomy, conducted using Solitaire revascularization device (Medtronic, USA) in various cerebral locations under fluoroscopic guidance, in full simulation of clinical interventions.

Results: Teaching using this model was conducted during an interventional radiology training basics course (IRTB 2016 Cuschieri Skills Centre, Dundee). Two hands on training sessions provided ten untrained attendees hands on experience under expert guidance during a clinical simulation within a clinical interventional suite

Conclusion: Feedback from attendee's indicated that their knowledge was improved by this training. Further studies and development are required to develop this teaching model as a validated tool to meet the unmet training needs in stroke revascularisation interventions.

P-479

Endovascular treatment of anterior willis circulation occlusion in ischemic stroke - which variables can predict the outcome?

F. Schirru, A. Ferrari, S. Corraïne, F. Fusaro, C. Ganau, P. Enne, S. Comelli

Neuroradiology and Interventional Radiology, Azienda Ospedaliera Brotzu, Cagliari, IT

Purpose: Although over the last decade there has been a noticeable improvement in the therapeutic strategies, ischemic stroke is still one

of the leading causes of death and disability worldwide. The aim of the study is to evaluate which factors influence the outcome of patients who undergo endovascular treatment

Material and methods: A retrospective analysis was performed on 78 patients that undergone endovascular recanalization of the anterior circle of Willis between January 2016 and April 2018. A Logistic Regression Analysis were performed using 3-month Ranking scale as dependent variable; time stroke to reperfusion (TSTR), NIHSS at admittance, type of procedure, vascular hyperdensity at basal CT were considered as independent variable. A Cochran-Armitage was used to asses correlation between Careggi Collateral Score and mRS at 3 month.

Results: Of the four predictive variables, only three were statistically significant: NIHSS at admission, type of procedure used and TSTR. Higher NIHSS (>20) were associated with poor outcome, with Odd Ratio of 1,647 (p<0.003). The vascular hyperintensity were not statistically significant for the purposes of the model. The Cochran-Armitage test showed a statistically significant linearity trend between high CCS values and good outcome (p = 0.016).

Conclusion: High values of NIHSS at the admission and longer time between the onset of symptoms and the end of treatment were associated with a worse outcome (mRS 3- 6), while the presence of good leptomeningeal collaterals was associated with better outcome rates, with a statistically significant linearity trend between high CCS values and positive outcome percentages.

P-480

Vascular closure with Angio-Seal™ and StarClose™ at therapeutic endovascular interventional procedures under aggressive anticoagulation treatment

K.A. Gonen¹, B. Hakyemez², C. Erdoğan²

¹Radiology, Tekirdag Namik Kemal University, Tekirdag, TR, ²Radiology, Uludag University, Bursa, TR

Purpose: To evaluate the effectiveness of Angio-Seal™ and StarClose™ that are used to close access site in patients undergoing therapeutic interventional vascular procedures.

Material and methods: Medical records of patients who underwent therapeutic interventional vascular procedures were reviewed retrospectively. One hundred fifty-two patients were divided into two groups regarding vascular closure devices: Group 1, Angio-Seal™; Group 2, StarClose™.

Results: Eighty-four devices were used in 95 procedures to 77 patients in group 1. Eighty-two devices were used in 95 procedures to 75 patients in group 2. Procedure time was 1.52 ± 1.06 (0.75-4) hours in Angio-Seal™ group and 1.39 ± 0.90 (0.5-4) hours in StarClose™ group (P = 0.394). Hemostasis time was 2.07 ± 0.46 (2-5) minutes in Angio-Seal™ group and 2.77 ± 3.16 (2-20) minutes in StarClose™ group. The difference between groups was statistically significant (P = 0.047). No complications were seen in 77 (89.5%) procedures in Angio-Seal™ group and 68 (81.9%) procedures in StarClose™ group (P = 0.695). Prolonged hemostasis, hematoma, access site pain and access site infection were developed complications (P> 0.05). Another procedure was performed using the same access site to 5 patients in Angio-Seal™ group and 1 patient in StarClose™ group, and access sites of 3 patients in Angio-Seal™ group were closed with Angio-Seal™ and others were closed with StarClose™; there were no complications.

Conclusion: Although mean hemostasis time of patients closed with StarClose™ was longer than patients closed with Angio-Seal™, the difference is not clinically significant. Low complication rate and the reproducibility of the procedure are important advantages of both devices.

P-481

Carotid blow out syndrome. Endovascular management by stent-ing and embolization

J. Tisnado¹, M. Leyva Vásquez Caicedo², J. Tisnado³

¹Radiology/Vascular and Interventional, MCV Hospitals/VCU Medical Center, Richmond, VA, US, ²Radiology/Vascular and Interventional Radiology, Hospital Universitario Clínico San Carlos, Madrid, ES, ³Radiology, Sloan Kettering Medical Center, Weil Medical School, New York, NY, US

Learning objectives: Carotid blow out syndrome (CBOS) is a catastrophic emergency associated with high morbidity and mortality. The main causes are head and neck malignant tumor invasion, post operative, inflammation, trauma, etc. The conventional surgical management may be difficult with significant morbidity, mortality, complications and may be ineffective. With the advent of uncovered and covered stents with or without concomitant embolization, the emergent management of carotid blow out syndrome has improved and, perhaps, a desperately fatal disease can be now managed with success.

Background: We have managed several patients with carotid blow out syndrome of different etiologies, not considered ideal candidates for surgery, at least during the acute phase, with stents from different manufacturers, mostly covered. In addition, we have embolized some patients as well, and some other patients have had both methods.

Clinical Findings/Procedure Details: All procedures done in the interventional radiology suite were successful in temporarily managing the carotid blow out syndrome. No major complications of the endovascular management were encountered. No arterial rupture, occlusion, thrombosis, stroke or infection resulted in a short follow up. One patient had a hemorrhagic stroke due to anticoagulation.

Conclusion: CBOS is a catastrophic emergency associated with a high morbidity and mortality. The "conventional" surgical treatment may be difficult and ineffective. Endovascular treatment with emergent insertion of covered or uncovered, self-expanding or balloon-expandable stents, with or without concomitant embolization is a safe, effective alternative therapy to manage the CBOS and must be considered the "first choice" in some desperate situations. A longer follow-up is needed.

P-482

Extracranial to intracranial anastomosis hidden pathways of death

H.A. Al-Samahy¹, A. Abouelhoda², A.A.M.B. Okba³, A. Elserwi²

¹Interventional Radiology, Ain Shams University, Cairo, EG, ²Radiology Department, Ain Shams University, Cairo, EG, ³Diagnostic and Interventional Radiology Department, Ain Shams University Hospital, Nasr City, EG

Learning objectives:

1. Common sites of anastomosis between the extracranial and Intracranial circulations
2. How to avoid complications related to non targeted embolization

Background: Embolotherapy is a main line of treatment for many conditions including epistaxis, skull base tumors and Dural arteriovenous fistulas. Knowing extra-intra cranial anastomosis and choosing the appropriate embolizing agent is essential for successful treatment with no complications.

Clinical Findings/Procedure Details: A full diagnostic cerebral angiography is essential before the procedure of embolization. Angiography should be selective and includes both ECAs, ICAs and VAs.

The anastomotic routes between the extracranial and intracranial circulations could be classified into three regions the orbital, the petrocavernous, and the upper cervical regions.

The orbital region where the ophthalmic artery connecting the internal maxillary and internal carotid arteries. The petrous-cavernous region where the inferolateral trunk (ILT), the petrous branches of the internal

carotid artery (ICA), and the meningohipophyseal trunk with the carotid artery. The upper cervical region where the ascending pharyngeal, the occipital, and the ascending and deep cervical arteries communicating with the vertebral artery.

Conclusion: Extracranial embolization is an established method of treatment of multiple conditions. Knowing the anastomosis between both extra and Intracranial circulation and those embryological relationships, spotting them on angiogram is essential to avoid neurolog

P-483

Intra-arterial chemotherapy for retinoblastoma recognizing the basics

A.A.M.B. Okba¹, A. Abouelhoda², H.A. Al-Samahy³

¹Diagnostic and Interventional Radiology Department, Ain Shams University Hospital, Nasr City, EG, ²Radiology Department, Ain Shams University, Cairo, EG, ³Interventional Radiology, Ain Shams University, Cairo, EG

Learning objectives:

1. Anatomy of the ophthalmic artery
2. Technique of intraarterial chemotherapy.
3. Complications of the trans-arterial delivery of treatment.

Background: Retinoblastoma is a malignant tumor that arises from the retina and usually occurs before the age of 5 years. retinoblastoma is usually unilateral (60 % of cases). Bilateral tumors constitutes (40% of cases). Recent advances in the treatment of retinoblastoma resulted in high survival rates. Treatment options includes: external beam radiation (EBRT), laser photocoagulation therapy, thermotherapy and cryotherapy, enucleation, intravenous chemotherapy and intra-arterial chemotherapy. Treatment is selected based on the extent of the tumor, which is guided by the International Classification of Retinoblastoma.

Clinical Findings/Procedure Details: The ophthalmic artery arises most commonly from the internal carotid artery, however it sometimes also arises from the middle meningeal artery

Intra-arterial chemotherapy technique

Procedure is done under general anesthesia via transfemoral approach carotid angiography is done to identify the Ophthalmic artery origin. A microcatheter is used to selectively catheterize the ophthalmic artery then melphalan, is diluted in 30 ml of saline, and injected by in a pulsatile fashion over 30 minutes.

Complications

Periocular edema or redness, ptosis, loss of eyelashes, vitreous hemorrhage, chorioretinopathy, contrast allergy. nausea or vomiting, extraocular muscle weakness, choroidal atrophy, vasospasm, fever, dacryohemorrhage, bone marrow hypocellularity, eyelid function disorders, macular hemorrhage, alopecia, avascular retinopathy, retinal artery obstruction, optic neuropathy, phthisis bulbi, , transient pulse loss and thrombocytopenia.

Conclusion: Intra-arterial chemotherapy is a minimally invasive, safe and could be an effective approach to treating retinoblastoma. Yet additional studies are required to evaluate its long term outcome.

P-484

Pre-surgical embolization of head and neck lesions in children

G.M.Y. Ma¹, E. Kitamura¹, M. Shroff², J. Phillips³, V. Rea¹,

N. Shkumat², P. Muthusami¹

¹Image Guided Therapy, The Hospital for Sick Children, Toronto, ON, CA,

²Diagnostic Imaging, The Hospital for Sick Children, Toronto, ON, CA,

³Plastic Surgery, The Hospital for Sick Children, Toronto, ON, CA

Learning objectives:

1. Common indications for pre-operative embolization of cervico-facial lesions in children.
2. Biplane fluoroscopy techniques and procedural details.
3. Embolization approaches and materials.
4. Dose reduction strategies.

Background: Cervicofacial lesions in children, including vascular malformations and tumors, often require surgical removal due to concerns from bleeding, malignancy, pain or for cosmetic reasons. Due to surgical complications such as intra-operative haemorrhage and recurrence, embolization as a pre-surgical adjunct has been shown to significantly decrease intra-operative complications or, at times, even eliminate the need for surgery. Embolization procedures require meticulous planning for approach, devices and embolic material used. This requires a teamwork approach in the interventional radiology suite.

Clinical Findings/Procedure Details: We explore the pearls and pitfalls of performing pre-operative embolization on vascular lesions in the head and neck of children.

We discuss common indications that require presurgical embolization, and tips for procedural planning.

Through representative cases performed at our tertiary pediatric institute we demonstrate procedural techniques in the pediatric IR suite, including different methods and embolic agents (polyvinyl alcohol particles, gelfoam, coils, n-butyl cyanoacrylate glue and Onyx).

We also discuss specific factors to consider for these complex procedures in children that would not be routine in an adult IR setting, as well as technical factors for radiation dose reduction and image quality assessment.

Conclusion: Presurgical embolization has been shown to be advantageous for the eventual surgical outcome and, indirectly, the patient's quality of life. Through this educational/pictorial representation, we show how these procedures can be planned and executed effectively and safely in a pediatric population.

P-485

Transfemoral thrombectomy in the cavernous sinus and superior ophthalmic vein

J.L. Bauer¹, K. Kansagra², K. Chao¹, L. Feng¹

¹NeuroInterventional Radiology, Kaiser Permanente LAMC, Los Angeles, CA, US, ²Interventional Radiology, Kaiser Permanente LAMC, Los Angeles, CA, US

Clinical History/Pre-treatment Imaging: Cavernous Sinus Thrombosis (CST) is a rare condition that can cause death, neurologic disability, and visual loss. A 7-year-old boy with septic CST leading to ocular hypertension and acute visual loss (Figure 1) was treated at our institution with thrombectomy and thrombolysis of the cavernous sinuses and superior ophthalmic veins.

Treatment Options/Results: Successful recanalization of bilateral cavernous sinuses and superior ophthalmic veins was achieved in two separate procedures without complication (Figure 2). The patient showed immediate symptomatic relief. He was neurologically intact without visual deficits at two-month follow-up.

Discussion: This is the first report in the literature showing the feasibility of cavernous sinus thrombectomy using current devices and techniques. Early endovascular therapy may help preserve vision in patients with acute cavernous sinus thrombosis.

Take-home points: In the setting of acute symptomatology and threatened visual loss, endovascular treatment of a cavernous sinus thrombus can be considered.

P-486

Facing your arch-enemy: direct carotid artery puncture-facilitated cerebral thrombectomy in setting of situs inversus totalis

B. DuBois¹, J.F.B. Chick², J.J. Mahn¹, V. Vadlamudi²

¹Division of Interventional Radiology, University of Michigan Health System, Ann Arbor, MI, US, ²Department of Cardiovascular and Interventional Radiology, Inova Alexandria Hospital, Alexandria, VA, US

Clinical History/Pre-treatment Imaging: 90-year-old man with history of situs inversus totalis presenting with dysarthria and asymmetric weakness in left extremities. CT head showed hyper-dense vessel sign,

loss of gray-white differentiation in right insular cortex, large penumbra in the right middle cerebral artery distribution, and a type III aortic arch.

Treatment Options/Results: Transfemoral access was obtained, however the right common carotid artery could not be cannulated due to situs inversus totalis and type III aortic arch. The right common carotid artery was then directly punctured and, via this access, a Solitaire Revascularization Device was used through a Penumbra Catheter (Solumbra technique) to achieve successful revascularization.

Discussion: While transfemoral access is commonly used for stroke recanalization, it is influenced by aortic anatomy as well as the presence of atherosclerotic and thrombotic disease. Direct common carotid artery puncture represents a safe alternative that may reduce time to reperfusion in patients with unfavorable anatomy.

Take-home points: Direct common carotid artery access represents a safe alternative to transfemoral access that may reduce time to reperfusion in patients with unfavorable arterial anatomy.

P-487

Endovascular treatment of a V2 segment vertebro-vertebral arteriovenous fistula with covered stent

S. Varello¹, M.A. Ruffino², M. Fronda¹, R. Russo¹, E. Soncin¹, D. Righi², M. Bergui³, P. Fonio¹

¹Department of Surgical Sciences, Università degli Studi di Torino, Turin, IT, ²Vascular Radiology, AOU Città della Salute e della Scienza - San Giovanni Battista Hospital, Turin, IT, ³Interventional Neuroradiology, AOU Città della Salute e della Scienza, Turin, IT

Clinical History/Pre-treatment Imaging: We present a case of successful treatment of cervical vertebro-vertebral arteriovenous fistula (VVAVF) using a balloon-expandable covered stent.

A 51-year-old female presented to our hospital suffering from pulsatile tinnitus of the left mastoid secondary to traffic trauma 7 months prior. Computed tomography angiography (CTA) was performed and was indicative of VVAVF between the left vertebral artery (VA) and the surrounding venous plexus at the C6 level.

Treatment Options/Results: Under general anesthesia, a 6-F sheath and 5-F catheter were advanced into the left VA. Angiography confirmed the fistula with opacification of bilateral venous plexus. Intracranial arteries were not seen, as for complete arterial steal.

A 5-mm x 37-mm balloon-expandable stentgraft (BeGraft, Bentley) was delivered via the left VA. Post-stenting angiography demonstrated proper stent location without evidence of the fistula.

The patient had no bruit immediately after the intervention and was discharged 4 days after operation. She was prescribed dual antiplatelet therapy for first 3 months. Six-month CT scan demonstrated no leak from the fistula and patency of left VA. The patient was free from symptoms.

Discussion: VVAVF is a shunt created by abnormally high blood flow between the extracranial VA and venous system. When symptomatic immediate treatment of the fistula is mandatory. Endovascular occlusion of VVAVF (balloon-protected embolization with glue or coils, stentgraft) has become the preferred method of treatment.

Take-home points: -VVAVF embolization with stentgraft is safe and effective when a single orifice in the V1-V2 segment of the VA is present maintaining the patency of the vertebral artery.

- In this cases, DAT is mandatory.

P-488

Percutaneous trans-neuroforaminal assisted spinal epidural arteriovenous fistula (AVF) embolization

R.A. Pampati¹, J.J. Mahn¹, N. Chaudhary², J.J. Gemmete³

¹Radiology, University of Michigan, Ann Arbor, MI, US, ²Neuro Interventional Radiology, University of Michigan Health System, Ann Arbor, MI, US, ³Vascular and Interventional Radiology, University of Michigan Health System, Ann Arbor, MI, US

Clinical History/Pre-treatment Imaging: 46-year-old male with persistent left tinnitus, neck pain, and burning managed with gabapentin and opioids. MR cervical spine demonstrated long segment cervical spinal epidural AVF spanning C2-C4 with mass effect on the cervical cord.

Treatment Options/Results: The patient agreed to transvenous and transarterial embolization of spinal epidural AVF with possible percutaneous embolization.

Angiography demonstrated feeding vessels from the left vertebral artery with draining epidural venous pouch. The feeding arteries and venous channels could not be cannulated for safe embolization. A needle was advanced under fluoroscopy to the left C2-C3 neuroforamina and into the venous pouch. Multiple Axiom (Medtronic) coils and Onyx (Medtronic) embolic were delivered.

Follow-up confirmed resolution of AVF, and the patient no longer required pain medications.

Discussion: Spinal epidural AVFs are rare and can present with worsening neurologic symptoms due to congestive myelopathy. While transvenous approach is preferred in AVFs with access of the draining veins and avoidance of arterial embolization, complex AVFs may present as a challenge for endovascular approach. This case is unique as it utilizes a percutaneous trans-neuroforaminal direct puncture into the venous pouch.

Take-home points: Spinal epidural AVFs symptoms may progress if untreated. An endovascular approach is preferred, and a percutaneous approach may be taken if a transarterial or transvenous approach is unsuccessful.

P-489

Endovascular management of complex arteriovenous fistula of the brain

T. Garg, R. Saraf

Department of Interventional Neuroradiology, Seth GS Medical College & KEM Hospital, Mumbai, IN

Clinical History/Pre-treatment Imaging: A 22-year old male presented with history of headache followed by fall from the bed and an episode of generalized tonic-clonic seizure. CT scan showed IVH predominantly in the left lateral ventricle and third ventricle. MRA demonstrated deep AVM in the left thalamocapsular region with drainage in the deep venous system. CTA showed a complex midline pAVF with draining venous pouch located in the left lateral ventricle which is refluxing into the cortical veins and the arterial supply of the fistula through multiple hypertrophied thalamogeniculate and lenticulostriate perforators.

Treatment Options/Results: The treatment options are limited in deeply situated subependymal pAVF with perforator supply. Endovascular embolization is the best approach for the treatment of these lesions although it's technically challenging. Aim of the treatment is complete obliteration of the fistulous venous pouch. In our patient, Endovascular embolization was performed through the left lenticulostriate perforator and Onyx was injected under roadmap guidance with good penetration within the venous pouch leading to the angiographic cure.

Discussion: PIAL AVF is a rare cerebrovascular malformation which has recently been recognized as a distinct pathological identity from the other intracranial cerebrovascular malformations. Disconnection of the shunt by surgery or endovascular intervention have been suggested as treatment modalities which target the basic pathophysiology at work in pAVFs.

Take-home points: 1. Early identification with treatment gives better prognosis due to the high flow nature of pAVFs.

2. A multidisciplinary approach involving neuroendovascular and neurosurgical team is necessary to decide the best treatment modality on the basis of patient factors and angioarchitectural features.

Oncologic intervention

P-490

Survival, tumour response, safety and prognostic factors 70-150µm versus 100-300µm particles for Doxorubicin drug-eluting beads TACE chemoembolization in patients with unresectable hepatocellular carcinoma: a four year Australian experience

Y.R. Huo¹, H. Xiang², M.V. Chan², C. Chan²

¹Faculty of Medicine, UNSW Australia, Sydney, NSW, AU, ²Radiology, Concord Repatriation General Hospital, Sydney, NSW, AU

Purpose: The purpose of this study was to investigate the overall survival, efficacy and safety of 70-150µm and 100-300µm doxorubicin drug-eluting beads transarterial chemoembolisation (DEB TACE) in patients with unresectable hepatocellular carcinoma (HCC).

Material and methods: Retrospective, cohort study of 51 patients with unresectable HCC who underwent DEB-TACE over four years were studied; 23 treated with 100-300µm particles and 28 with 70-150µm particles.

Results: The median overall survival (OS) and median PFS for 70-150µm particles were not reached, whilst for the 100-300µm group, it was 29.2 months and 15.0 months, respectively. At 1-month follow up, patients treated with 70-150µm had significantly better mRECIST tumour response rates compared to 100-300µm (CR 38.5% vs 19%; PR 57.7% vs 42.9%; SD 0% vs 4.8%; PD 3.8% vs 33.3%, p=0.027). Patients treated with 100-300µm DEB particles were significantly more likely to have Progressive Disease on 1-month follow up tumour imaging compared those treated with 70-150µm DEB sizes (Odds Ratio 7.15, p=0.007). The 30-day mortality rate was similar between the two groups (3.6% for 70-150µm vs 4.3% for 100-300µm). Univariate analysis demonstrated significant prognostic factors affecting overall survival included BCLC radiology stage, portal vein thrombosis, bilirubin, albumin, ALP, AST and Creatinine in univariate analysis. Multivariate analysis with Cox Regression demonstrated overall survival was significantly associated with BCLC radiology stage (adjusted HR: 10.5, p=0.002), albumin (adjusted HR: 15.0, p=0.02) and ALP (adjusted HR 62, p=0.001).

Conclusion: DEB TACE with 70-150µm particles demonstrates improved 1-month objective tumour response compared to 100-300µm, whilst having a favourable safety profile, progression-free survival rate and overall survival.

P-491

Feasibility of ambulatory management in interventional oncology: percutaneous microwave liver ablation

J. Izaaryene, N. Daidj, G. Piana

Imaging Department, Institut Paoli Calmettes, Marseille, FR

Purpose: Outpatient shift is at the center of medical concerns. Interventional oncology appears particularly adapted. Nevertheless, there is no therapeutic IO procedure performed in ambulatory. The objective is to demonstrate the feasibility of liver microwave (MW) ablation and to determine the criteria for selecting patients.

Material and methods: We carried out an exploratory study simulating a discharge the very same day at H6 whereas the patients remained hospitalized until the following day. Collection data related to patients, lesions and interventions. Clinical reevaluation every 4 hours until discharge. Outpatient treatment was considered possible by the absence of incident, act or treatment after H6 and absence of early hospitalization (<1 month) related to MW.

Results: 53 patients included, 42 (79%) could have benefited from ambulatory care, 9 (18%) could not (6 pains with adaptation of the medical protocol, 2 hematomas, 1 respiratory decompensation). 43% of patients experienced pain with a peak at H3, 19% of patients with nausea all calmed. Significant criteria for failure were number of lesions ($p = 0.03$), lesion size, hydrodissection ($p = 0.05$) and pain ($p = 0.006$). Considering pain as a diagnostic test for ambulatory failure the negative predictive value would have been 96%. Considering patients with one or two lesions without hydrodissection, 85% could have benefited from outpatient management.

Conclusion: Liver micro wave ablations are feasible in ambulatory, patients with one or two lesions without hydro dissection seem more eligible. A systematic treatment of post-interventional pain appears necessary.

P-492

Response to treatment with selective internal radiation therapy Y90 (SIRT) in patients with unresectable multifocal intrahepatic cholangiocarcinoma: results of a preliminary study

A. Paladini¹, G.E. Vallati², G. Pizzi², F. Cappelli³, G. Guzzardi⁴, A. Carriero¹, F. Pane⁵, B. Del Sette⁶

¹SCDU Interventional Radiology, "Maggiore della Carità" Hospital, Novara, IT, ²Interventional Radiology, IFO Istituto Regina Elena National Cancer Institute, Rome, IT, ³Department of Diagnostic and Interventional Radiology, IFO Regina Elena Cancer Institute, Rome, IT, ⁴Institute of Diagnostic and Interventional Radiology, Ospedale Maggiore, Novara, IT, ⁵Advanced Biomedical Sciences, AOU Federico II Napoli, Naples, IT, ⁶SCDU Radiologia Diagnostica ed Interventistica, AOU "Maggiore della Carità" - Novara, Novara, IT

Purpose: To show our results of a study performed on 43 patients with unresectable intrahepatic cholangiocarcinoma (ICC) treated with TARE (Y-90) evaluating response and survival

Material and methods: Between 2011 and 2017 we treated 43 patients with unresectable bilobar intrahepatic cholangiocarcinoma diagnosed by contrast-enhanced CT. Patients with portal vein thrombosis were treated anyway. The dose administered was assessed by calculating the body surface area (BSA) and the percentage of the liver with disease. Response to therapy was assessed by at least two contrast-enhanced CT performed after 3 and 6 months post-dose and alphafetoprotein (AFP)

Results: Radiological assessment at 3 months was completed in 40 patients obtaining, regardless of the evaluation criteria, results that include: complete response (CR), partial response (PR), stable disease (SD), progressive disease (PD). Target lesion objective response (OR) rates (CR + PR) were 46,6 % for mRECIST. The overall median survival was 17.5 months (95% CI: 14.3–21.4 months). Significantly longer survival was obtained in naive patients as compared with patients in whom SIRT Y-90 was preceded by other treatments, including surgery (23,1 vs 14,4 months, $P = 0.009$). Treatment was well-tolerated, and no mortality was reported within 30 days. No complications related to the procedures were showed.

Conclusion: Treatment with SIRT showed excellent results in terms of efficacy, also for the control of portal vein thrombosis; it is safe and could be repeated if necessary. SIRT is a valid loco-regional therapy in Patients with unresectable ICC.

P-493

Efficacy of fiducial marker implantation in the liver using real-time image fusion technology for stereotactic body radiation therapy

K. Tokunaga¹, A. Furuta¹, Y. Someya¹, T. Sato¹, H. Nakai¹, S. Kohn¹, A. Ono¹, R. Imamine¹, T. Ono¹, S. Kawahara¹, H. Shimizu¹, S. Arizono¹, Y. Iizuka², H. Isoda¹, K. Togashi¹

¹Department of Diagnostic Imaging and Nuclear Medicine, Kyoto University Graduate School of Medicine, Kyoto, JP, ²Department of Radiation Oncology and Image-Applied Therapy, Kyoto University Hospital, Kyoto, JP

Purpose: To evaluate the utility and safety of fiducial marker implantation using real-time image fusion technology (Volume Navigation®; V-navi) on ultrasonography.

Material and methods: We retrospectively reviewed 29 patients (20 male; 9 females; mean age, 74 years) who underwent fiducial marker implantation in the liver for stereotactic body radiation therapy (SBRT) between January 2016 and December 2018. According to preprocedural contrast-enhanced CT or MRI, position of implantation was planned and set to 10mm cranial or caudal point from the tumor surface. Marker implantation was then performed using ultrasonography alone (US group) or V-navi (V-Navi group) with CT/MRI images. Contrast-enhanced CT images for SBRT-planning were analyzed to determine the technical success, distance between the tumor and the marker, distance between the planned and the actual positions of the marker, and whether the artifact caused by the marker obscures the tumor. Procedure-related complications were also evaluated. Results were compared between US and V-navi groups.

Results: Technical success was obtained in 27 patients (93.1%). The distance between the tumor and the marker was tended to be shorter in V-navi group (V-navi, 12.2mm; US, 19.2mm; $p = 0.159$). The distance between the planned and the actual positions of the marker was shorter in V-navi group (V-navi, 9.0mm; US, 17.6mm; $p = 0.033$). Beam-hardening artifacts obscuring the tumor were seen in 8 patients (V-navi, 1 [8%]; US, 7 [41%]; $p = 0.09$). The only complication was minor bleeding seen in 1 patient of US group (6%).

Conclusion: V-navi-guided procedure is useful for fiducial marker implantation in the liver.

P-494

CT-guided percutaneous cryoablation of T1b renal tumors: safety, functional and oncological outcomes

R. Grange¹, F. Tradi², J. Izaaryene¹, N. Daidj¹, S. Brunelle¹, J. Walz³, G. Gravis⁴, G. Piana¹

¹Imaging Department, Institut Paoli Calmettes, Marseille, FR, ²Bouches du Rhône, Hôpital de la Timone, Marseille, FR, ³Department of Urology, Institut Paoli Calmettes, Marseille, FR, ⁴Department of Medical Oncology, Institut Paoli-Calmettes, Marseille, FR

Purpose: We evaluated the safety, functional and oncological outcomes associated with percutaneous cryoablation (CA) of stage T1b renal cell carcinoma.

Material and methods: We reviewed a percutaneous cryoablation registry to identify patients treated between 2013 and 2018 for biopsy-proven renal cell carcinoma lesions measuring 4.1–7.0 cm. The main outcome parameters analyzed were primary and secondary technique efficacy, local tumoral control (LTC), cancer-specific survival (CSS), loss of estimated glomerular filtration rate (eGFR), and complications. LTC and CSS were estimated by the Kaplan–Meier method. Complications were graded by the Calvien–Dindo system.

Results: Twenty-three consecutive patients were included (mean tumor diameter: 45 ± 62 mm; mean RENAL score: 8.0 ± 2.4). The technical success rate was 95.7%. Primary and secondary technique efficacy rates were 86,3% and 100%, respectively. Three patients found to have incomplete

ablations at 3 months were successfully treated by repeat CA. Imaging showed LTC to be 85.7% at 6 months, 66.7% at 12 months and 66.7% at 24 months. One patient with a local recurrence at 12 months was treated by radical nephrectomy. One patient died from a local metastasis seen at 12-month follow-up. One patient reported a grade $\geq$ II complication (4.3%). Mean eGFR loss was 4.4 ml/min/1.73m², which was significantly higher among those treated for central lesions ($P < 0.05$).

Conclusion: Cryoablation for stage T1b renal tumors is technically feasible, with favorable oncological and perioperative outcomes. However, longer-term studies are needed to verify our findings.

P-495

Bland microspheres embolism plus SSA system therapy: safety and efficiency for massive tumor burden over 75% of neuroendocrine tumors liver metastasis (NETLM)

Y. Wang¹, F. Lian², Y. Liu³, H. Liu¹, W. Chen¹, J. Chen⁴

¹Interventional Oncology, 1st Affiliated Hospital of Zhongshan University, Guangzhou, CN, ²Rheumatology and Clinical Immunology, 1st Affiliated Hospital of Zhongshan University, Guangzhou, CN, ³The Department of Interventional Oncology, The First Affiliated Hospital, Sun Yat-Sen University, Guangzhou, CN, ⁴Gastroenterology, 1st Affiliated Hospital of Zhongshan University, Guangzhou, CN

Purpose: to evaluate safety and efficiency of bland microspheres embolism plus SSA for massive NETLM which tumor burden over 75%.

Material and methods: Twenty-two patients with massive liver metastasis of Neuroendocrine Tumors were enrolled in the present study. Baseline characteristics of patients, including primary site, pathological classification, Ki-67 index, etc. were analyzed. All patients confirmed by histological and imaging diagnosis including multi-slice enhanced computer tomography, ⁶⁸Ga-SSA PET-CT and ¹⁸F-FDG PET-CT. Stage and classification were performed by the criteria of WHO 2010. All patients underwent 3-4 times Trans-artery Embolization (TAE) every 4-6 weeks plus system therapy of somatostatin analogue. The interval time of first two TAE procedures should be 2-3 weeks. Radiological responses were assessed according to RECIST 1.1. Complications of TAE were assessed according to CTCAE 4.0.

Results: Primary site was pancreas in 11/22 patients, rectum in 8/22 patients and lung in 3/22 patients. All patients' liver tumor burden was over 75%. All patients underwent 72 times TAE totally. Bland embolization used during the TAE procedures by 40-120 μ m Embrospheres and 100 μ m PVA. The objective response rate was 90.9% after all procedures of TAE. Postembolization syndrome was the most common complication of TAE. One patient suffered Tumor lysis syndrome. There was no mortality in 30 days after TAE.

Conclusion: Bland embolization plus SSA was safety and efficiency for massive tumor burden patients of NETLM. The interval of first 2 procedures of TAE should be 2-3 weeks.

P-496

Percutaneous ablation of central renal tumors performed with pyeloperfusion: single center experience

L. Mascagni¹, P. Della Vigna², G. Mauri², G. Bonomo², G.M. Varano², D. Maletini², M. Rossi¹, F. Orsi²

¹Radiology, S. Andrea University Hospital, Rome, IT, ²Division of Interventional Radiology, IEO European Institute of Oncology, IRCCS, Milan, IT

Purpose: Evaluating the outcome of 64 percutaneous ablation procedures performed with simultaneous pyeloperfusion of renal lesions protruding into the hilar region and caliceal system.

Material and methods: From November 2011 to December 2018, 64 percutaneous ablations of central renal tumors (mean diameter 32,5 mm, range 16-65 mm, median 36,5 mm) were performed during protective pyeloperfusion in 54 patients (37 men; mean age 69 years), of which 7

were surgical single kidney. We performed RFA in 33 procedures (51,6%), MWA in 29 (45%) and MWA+RFA in two; the choice relied on the lesion's features, operator's preference and technological innovation. Patient and procedure data were collected, including hemoglobin and glomerular filtration rate (eGFR), histology, OS, PFS, CSS. Technical success, efficacy rate, residual tumor and complications were assessed at immediate and follow-up imaging.

Results: Out of 64 procedures, technical success was achieved in 56 cases (87,5%), tumor persistence was identified in 12 patients and 8 underwent a second ablation with secondary efficacy rate of 75%. Major complications occurred in 5 patients, 4 of them required major therapy/prolonged hospitalization time. Three-year PFS, CSS and OS were 91%, 98% and 90% respectively; mean follow-up was 30 months. No changes in hemoglobin/eGFR levels were noticed.

Conclusion: Percutaneous MWA/RFA of central renal tumors associated with protective pyeloperfusion is a safe and effective treatment option that might spare nephrectomy. Long-term follow-up is needed to establish durable oncologic efficacy and survival rate compared to surgical options.

P-497

Embolisation of bone metastases from renal cancer: palliation and local tumor control

G. Facchini¹, P. Spinnato¹, C. Errani², B.M.C. Colori³, U. Albisinni¹, G. Rossi⁴

¹Diagnostic and Interventional Radiology, The Rizzoli Orthopaedic Institute, Bologna, IT, ²Orthopaedic, The Rizzoli Orthopaedic Institute, Bologna, IT, ³Unit of Functional Recovery and Rehabilitation, The Rizzoli Orthopaedic Institute, Bologna, IT, ⁴Angiographic Interventional Radiology, The Rizzoli Orthopaedic Institute, Bologna, IT

Purpose: This study was done to evaluate embolisation for palliative or local tumor control treatment of bone metastases from renal cell carcinoma.

Material and methods: We retrospectively studied 210 patients with bone metastases from renal cell carcinoma treated from December 2002 to January 2018 with 310 embolisations using N-2-butyl cyanoacrylate (NBCA). Mean tumour diameter before embolisation was 9.3 cm and mean follow-up 5 years (range 12-72 months). Clinical and imaging effects of treatment were evaluated at follow-up examinations with a pain score scale, analgesic use for palliation and hypoattenuating areas, tumour size and ossification for LTC.

Results: A clinical response was achieved in 188/210 (89,6%). Mean duration of clinical response was 7 (range 1-12) months. Hypoattenuating areas at CT follow-up resembling tumour necrosis were observed in all patients. Variable ossification appeared in 72 patients (72/210 - 35%). Mean maximal tumour diameter after embolisation was 5.8 cm. Post-embolisation syndrome was present in 85% of patients recovered completely within 10-12 days. Transient paraesthesias in the lower extremities were observed after 25/210 embolisations (11,9%) of pelvis and sacrum metastatic lesions. In 3 patients we observed abscess inside the lesion, recovered with drainage.

Conclusion: Embolisation with NBCA is recommended as primary or palliative treatment of bone metastases from renal cell carcinoma. Strict adherence to the principles of transcatheter embolisation is important to avoid complications.

P-498**TACE with epirubicin and embosphere for locally or advanced recurrent breast cancer**

K. Hashimoto¹, S. Wada¹, J. Moriya¹, M. Yoshimatsu², S. Hamaguchi¹, H. Mimura¹

¹Radiology, St. Marianna University of Medicine, Kawasaki, JP, ²Radiology, St. Marianna University, Kawasaki, JP

Purpose: Although intra-arterial chemotherapy with implantable port system for locally or advanced recurrent breast cancer (LARBC) has been shown to have some role in the literature, some patients are not suitable for the port implantation due to severe arm swelling. TACE seem to have benefit for such a patient group. We sought to investigate the efficacy and safety of TACE for LARBC.

Material and methods: From January 2017 to December 2018, 11 female patients (aged 37-76) received TACE for LARBC. TACE was indicated when 1. failure after three/four regimens of systemic chemotherapy, 2. symptoms such as pain, odor, hemorrhage not effectively controlled by medicine or supportive care, 3. performance status less than 3, 4. preserved bone marrow function. TACE was repeated three times with three weeks interval unless the disease progression was apparent. Epirubicin 30mg/body and 100-300 micron Embosphere were used. Primary endpoint was tumor shrinkage, assessed by RECIST ver.1.1. Secondary endpoint was improvement of symptoms and grade 4 adverse effect (CTCAE ver.5). The results were compared with our previously reported results of intra-arterial chemotherapy.

Results: Complete response (CR):0, Partial response (PR):2, No change (NC):2, Progressive disease (PD):7. Three out of four PD was due to progression of distant metastasis. Relief of prominent pain:2, Reducing analgesics:0, remarkable reduction of hemorrhage:3. No grade 4 adverse effect was observed.

Conclusion: Although it is safe, TACE with epirubicin and embosphere is not as effective as intra-arterial chemotherapy for LARBC.

P-499**Imaging predictors of radiological response and tumor necrosis in patients with hepatocellular carcinoma undergoing trans-arterial chemoembolization**

A.H. Amer

General Surgery, Tanta University, Tanta, EG

Purpose: To evaluate the imaging and procedural factors affecting desirable radiologic and histopathologic response to trans-arterial chemoembolization (TACE) in patients with (HCC).

Material and methods: A total of 109 patients with HCC who had received super-selective TACE as the sole bridging therapy before liver transplantation between March 2002 and March 2017 were retrospectively studied. Index tumor parameters in pre-TACE multiphasic (CT) or (MRI) were evaluated to determine their correlation to radiological complete response as well as complete or near-complete tumor necrosis in histopathological analysis. TACE factors including bead size, doxorubicin dose, administered volume were studied with regards to treatment response in patients receiving (DEB)-TACE once only for solitary tumors (n=25).

Results: Complete (100%) or complete/near-complete ($\geq 90\%$) necrosis was achieved in 33% and 51% of the patients, respectively. In 61% of the cases, accurate correlation between radiological response to therapy and histopathological necrosis of tumor was observed. Necrosis over 90% was associated with typical enhancement ($p=0.0035$), smooth tumor margins ($p<0.0001$), and arterial phase enhancement (with or without washout) in tumors with distinct margins ($p<0.0001$). No significant correlation was found between tumor necrosis and tumor size, tumor number, unilobar or multilobar involvement, segmental spread, heterogeneous enhancement, (pseudo)capsule presence, and Child-Pugh classification. No meaningful correlation was observed between administered bead volume or doxorubicin dose and response to treatment.

Conclusion: Pre-TACE HCC imaging factors including smooth margin, typical enhancement, and arterial enhancement in well-defined tumors can predict superior response to therapy. Complete response to therapy observed in post-TACE imaging may not reliably rule out tumor viability.

P-500**Efficacy and safety of microwave ablation in hepatocellular carcinoma close to liver surface**

M.K. Yadav¹, M. Unni², V. H A¹

¹Interventional Radiology, Kerala Institute of Medical Sciences, Trivandrum, IN, ²Radiology, Kerala Institute of Medical Sciences, Trivandrum, IN

Purpose: To Evaluate the efficacy and safety of Microwave ablation of Hepatocellular carcinoma close to hepatic surface.

Material and methods: All the patient who underwent microwave ablation in our department over the period of November 2017 to November 2018 were studied. The ablations were performed according to the ablation chart provided by the OEM. Certain cases underwent overlapping ablations to achieve better lesion coverage.

All the patient with hepatocellular carcinoma within 2cm of the hepatic surface were evaluated for response on followup imaging using modified RECIST criteria. These cases were also recorded for any complications according to the SIR guideline for complication assessment.

Results: A total of 27 Patients underwent microwave ablation for hepatocellular carcinoma in the study period. 19 patient had tumour close to the liver surface (within 2 cm). Out of the 19 patient 18 patients had complete response on followup imaging done at 6 weeks following the initial ablation. Out of 19, 4 patients had thin rim of perihepatic fluid on immediate post procedure CT. 6 patients had significant post procedure patient requiring injectable analgesics. 2 patients required additional hospital stay of 1 day due to pain. None of the patients required any surgical procedure due to complications.

Conclusion: Proximity to liver surface was traditionally considered as relative contraindication for ablation. However in our experience with Microwave ablation shows good efficacy of ablation in lesions close to liver surface. Microwave ablation for surface lesions is safe and no major complications were encountered in our cohort.

P-501**Assessment of metastatic neuroendocrine tumor textural changes after liver transarterial chemoembolization on MRI**

M.G. Lapteva¹, O.N. Sergeeva², M.A. Shorikov¹, D.Y. Frantsev³, B.I. Dolgushin³, E. Virshke³

¹Radiology, Interventional Imaging Group, The Federal State Budgetary Institution "N. N. Blokhin National Medical Research Centre of Oncology" of the Health Ministry of Russia, Moscow, RU, ²Interventional Oncology Department, State Institution N.N.Blokhin Cancer Research Center RAMSci, Moscow, RU, ³Interventional Oncology, Radiology, N.N. Blokhin Cancer Research Center, Moscow, RU

Purpose: To identify MRI parameters suitable for assessment of metastatic neuroendocrine tumor (mNET) textural changes after liver transarterial chemoembolization (TACE) and their relationship with the progression-free survival.

Material and methods: Thirty-one hepatic mNET patients undergone 61 TACE procedures were enrolled in the study. One hundred eight pairwise (pre- and post-TACE) MRI studies were analyzed. Before and after TACE we measured apparent diffusion coefficient (ADC) and its standard deviation (SD), MR contrast agent (MRCA) uptake dynamics and signal intensity (SI) SD on portal phase T1-WI in the tumor solid component.

Results: The solid portions of target mNET demonstrate the following MRI-changes after TACE: increase of ADC values ($p=0.002$) and its SD ($p=0.006$), decrease of MRCA accumulation on arterial ($p=0.016$) and portal ($p=0.004$) phases, increase of both MRCA wash-out time ($p=0.016$) and

SI SD on portal phase T1-WI ($p = 0.026$). The increase of ADC values and its SD and decrease in MRCA accumulation on portal phase were significantly associated with increase to progression free survival.

Conclusion: Assessment of MRI parameters (ADC and MRCA accumulation) reflecting NET textural changes after liver TACE may be useful for accurate prediction of time to disease progression and personalization of MRI follow-up schedule.

P-502

Five year outcome analysis of consecutive intermediate HCC patients treated with HepaSphere Microspheres 30-60 μ loaded with doxorubicin

T. Kiakidis¹, H. Moschouris², K. Malagari³, A.D. Kelekis⁴, N.L. Kelekis⁵, S. Harward⁶, S. Vrakas⁷, D. Fillipiadis⁴, D. Kountouras⁸, G. Glantzounis⁹, E. Emmanouil⁴, A.N. Chatzioannou¹⁰, C. Vergadis¹¹, I. Elefsiniotis¹², J. Koskinas⁸, S. Dourakis⁸

¹2nd Department of Radiology, National and Kapodistrian University of Athens, Evgenideion Hospital, Athens, GR, ²Radiology, General Hospital "Tzanio", Piraeus, GR, ³2nd Dept. of Radiology, University of Athens Medical School, Athens, GR, ⁴2nd Department of Radiology, National and Kapodistrian University of Athens, ATTIKON University General Hospital, Athens, GR, ⁵2nd Department of Radiology, General University Hospital Attikon, Athens, GR, ⁶Internal Medicine, University of Massachusetts Medical School, Worcester, MA, US, ⁷Gastroenterology, General Hospital "Tzanio", Piraeus, GR, ⁸2nd Clinic of Medicine and Hepatology, Hippokraton Hospital, Athens, GR, ⁹Surgery, University of Ioannina, Ioannina, GR, ¹⁰Department of Radiology, Areteion Hospital, University of Athens, Athens, GR, ¹¹Department of Radiology, Laiko Hospital, Athens, GR, ¹²Internal Medicine and Hepatology Unit, Agioi Anargyroi General and Oncology Hospital, Athens, GR

Purpose: Prospective acquisition of results of doxorubicin-loaded HepaSphere 30-60 μ m (Dox HS/30-60) in consecutive patients with hepatocellular carcinoma (HCC) not amenable to curative treatments (NACT).

Material and methods: Over six-year period 151 patients were treated with loading at 37.5mg/ml. Liver function, local response (m RECIST), Time to Progression in the liver (LTTP), Progression Free Survival (PFS), Overall Survival (OS) and adverse events (AEs) were recorded.

Results: Final analysis included 142 patients with median follow-up of 46.8 months (range 4-72) who presented no grade 4/5 AEs and 30-day mortality was 0 %. Baseline status was: BCLC A/B 49.3%/50.7%, and median sum of tumor diameter 6.1cm (mean 6.7 $\pm$ 2.0). Mean number of scheduled/ on demand treatments was 2.6 (range 1-3) / 3 (range 1-8). Complete Response (CR) was more frequent in single tumors; for $\leq$ 5cm 75.0%/66.7% for Child A/B, while for > 5cm 28.6% /11.8% respectively. Overall OS was 31.0 months (mean 33.3 $\pm$ 15.2; range 8-69), notably for BCLC A/B 41 (mean 41.1 $\pm$ 15.3; range 13-69)/ 26.0 (mean 26.0 $\pm$ 10.5; range 8-51). OS for BCLC A at 1, 3, and 5 years was 95.8%,75.7% and 21.4%, and 94.4%, 36.1% and 2.7% for BCLC B. Median LTTP for BCLC A/B patients was 11 months (mean 11.9 $\pm$ 4.7; range 3-24) / 7.5 (mean 7.9 $\pm$ 2.9) respectively. Multivariate analysis demonstrated that local response was significant for OS and LTTP ($p < 0.0001$) while sum of diameters and lesion number significantly affected LPFS and OS ($p < 0.001$).

Conclusion: Dox HS/30-60 provides a safe and effective option for BCLC A and B in NACT HCC.

P-503

Large hepatocellular carcinoma with local remnants after TACE: treatment with Sorafenib+RFA or Sorafenib

H. Yuan¹, F. Liu²

¹Department of Interventional Radiology, People's Liberation Army General Hospital, Beijing, CN, ²Interventional Radiology, The First Medical Center of PLA General Hospital, Beijing, CN

Purpose: To investigate the efficacy and safety of sorafenib combined with RFA in the treatment of unresectable remnant large HCC after TACE.

Material and methods: A total of 229 consecutive patients with unresectable remnant large HCC who received sorafenib+RFA (RFA+Sor group, n=102) and sorafenib (Sor group, n=127) from January 2010 to January 2016 were included in the analysis. Complications and overall survival (OS) of the two groups were compared and subgroup analysis was carried out.

Results: The average OS was 18.3 $\pm$ 1.6 months in the RFA+Sor group and 14.1 $\pm$ 1.1 month in the Sor group, the Log-rank test showed that there was a significant difference between two groups in the survival time ($p=0.03$). The 1-, 2-, and 3-year survival rates of the two groups were 56.9%, 34.3%, 11.7%, and 42.5%, 22.0%, and 5.5%, respectively. Between the two groups. Subgroup analysis showed that the RFA+Sor group achieved more significant lifetime benefits than the Sor group in the subgroup of patients with tumors 5-10 cm in diameter (HR 0.42, 95% CI 0.21-1.06 vs HR 0.94, 95% CI 0.63-1.22), in the subgroup of patients with an isolated tumor (HR 0.36, 95% CI 0.19-0.81 vs HR 0.93, 95% CI 0.55-1.24) and in the subgroup of patients with remnant lesion volume <50% after TACE treatment (HR 0.47, 95% CI 0.21-1.12 vs HR 0.77, 95% CI 0.46-0.81)

Conclusion: RFA combined with sorafenib is safe and effective in the treatment of unresectable remnant large hepatocellular carcinoma, which can control tumor progression and prolong survival of related patients better than the sorafenib alone.

P-504

Safety of transarterial chemoembolization following radiation therapy for hepatocellular carcinoma

M.A.S. Hamada, Y. Koide, E. Ueshima, H. Horinouchi, K. Sasaki, R. Tani, T. Gentsu, T. Okada, K. Sofue, M. Yamaguchi, K. Sugimoto, T. Murakami

Department of Diagnostic and Interventional Radiology, Kobe University Hospital, Kobe, JP

Purpose: The aim of this study is assessment of the safety of performing TACE after radiation therapy (RT) of the liver for treatment of hepatocellular carcinoma.

Material and methods: Sixty-three patients (mean age 74 y/o, including 46 males) with HCC who underwent TACE after RT of the liver between January 2012 and September 2018 in our institutions were retrospectively evaluated. The safety was assessed according to the following criteria: biloma, liver abscess, acute liver toxicity within a week (grade $\geq$ 3 (CTCAE v5.0)), Child-Pugh (CP) score increase $\geq$ 2 after 1 month, death or shifting the patient to best supportive care (BSC) within 100 days. Patients' backgrounds, tumor thrombosis, biological effective dose of RT, types of RT (conventional / stereotactic RT) and TACE (drug eluting beads/ lipiodol), range of RT/TACE, RT-TACE time interval were evaluated for detecting possible risk factors with uni-/multivariate analysis.

Results: No biloma nor abscess, regardless of type, range or intensity of the treatments. Acute liver toxicity occurred in 19 patients. CP score increased in 6 patients (9.5%). Three patients died, and one patient was moved to best supportive care. RT biological effective dose > 19.7 Gy ($P=0.01$), RT of conventional type ($P=0.04$), CP class B before TACE ($P=0.001$), and TACE within 3 months after RT ($P=0.005$), TAI inside the radiated liver mass ($P=0.0009$) were statistically significant risk factors for early death or transferring the patient to BSC.

Conclusion: TACE following liver RT is generally safe. More care is needed in patients with impaired liver function and who received conventional or high dose of RT. It is also advisable to delay TACE for 3 months after RT.

P-505

Increase the overall survival after SRMs thermal ablation: the importance of complete ablation after the first treatment

F. Barbosa¹, A. Alfonsi², F. Di Bartolomeo³, E.M. Fumarola³, C. Migliorisi⁴, M. Solcia⁴, R. Vercelli¹, A.G. Rampoldi¹

¹Interventional Radiology, Ospedale Niguarda, Milan, IT, ²Radiology, Campus Biomedico University of Rome, Rome, IT, ³Radiologia, Università degli studi di Milano, Milan, IT, ⁴Interventional Radiology, ASST Grande Ospedale Metropolitano Niguarda, Milan, IT

Purpose: Assess the effect of primary complete thermal ablation (TA) of small renal masses (SRMs) on medium-term survival. Retrospective observational cohort study.

Material and methods: Ninety-seven patients (120 SRMs) undergone percutaneous TA (RF or MW) from July 2004 to May 2018 with follow-up imaging available were selected. Ablations were carried out under ultrasound or CT-guidance. After the first treatment, no residual lesion in the treated area was considered primary completed TA. Comorbidities were assessed by Charlson-Index. Shapiro-Wilk-test was used to check normal distribution, Levene-test to evaluate variance homogeneities. Comparisons of categorical or nominal data were done by Fisher's-exact-test, survivorships were analysed by product-limit-Kaplan-Meier-method, followed by logrank test, or by Cox semiparametric regression plus check of Schoenfeld residuals. Logistic regression was used to evaluate the dependence of binomial variables.

Results: Out of 97 patients (64% male), mean age 70,8years (34-96yo), 89% had Charlson-score-index > 5. Average follow-up time 35,6 months (1-151months). 24 were treated with MW, 68 with RF and 5 with both. Out of 120 lesions treated, mean tumor size was 24,89mm (8-67). Synchronous lesions were present in 22/97 patients. During follow-up 24/97 patients developed methachronous lesions. Nine patients presented local tumour progression. No major complications were observed. Primary completed TA was achieved in 70% of cases. No difference was observed considering lesions' size or type of ablation (RF or MW). Primary complete TA increases significantly the overall survival (p=0,0104)

Conclusion: The importance of complete primary ablation should be emphasized, taking into account that it impacts significantly in the overall survival.

P-506

The role of ultrasound and cone beam CT fusion for guidance of HCC thermal liver ablation

D. Rossi¹, G. Mauri², G. Bonomo³, P. Della Vigna⁴, F. Orsi³, L. Solbiati⁵, G.M. Varano³, L. Monfardini⁶

¹Radiology, IRCCS Policlinico San Donato, San Donato Milanese, IT, ²Interventional Radiology, IEO European Institute of Oncology IRCCS, Milan, IT, ³Interventional Radiology, European Institute of Oncology, Milan, IT, ⁴Radiology, European Institute of Oncology, Milan, IT, ⁵Division of Radiology, Humanitas University and Research Hospital, Rozzano (Milan), IT, ⁶Radiology, Interventional Radiology Unit, Fondazione Poliambulanza, Brescia, IT

Purpose: To assess the feasibility of intraprocedural ultrasound (US) and contrast-enhanced cone-beam CT (CBCT) fusion imaging for guiding thermal ablation of small (≤ 20 mm) hepatocellular carcinomas (HCC).

Material and methods: 12 patients (9 males, 3 female, age range 84-68, mean 75 years), were treated with percutaneous microwave ablation under US/CBCT fusion imaging guidance from September 2017 to January 2019 for 17 HCC nodule ≤ 20 mm (6-20, mean 13,9 mm) poorly visible at US. A contrast-enhanced CBCT with a dedicated active tracker placed on patients' upper abdomen was acquired immediately before treatment

and fused with real-time US images. Treatment was performed under fusion imaging guidance. Feasibility of fusion imaging, technical success, correct targeting (distance from centre of tumor and centre of ablation area ≤ 5 mm), immediate post-treatment and one-month technical efficacy were evaluated. Major and minor complications and overall procedural time were recorded.

Results: US/CBCT fusion was feasible in all cases, allowing to complete the treatment as preoperatively planned (technical success 100%). Correct targeting was confirmed in 14/17 (82%) cases. In the remaining 3/17 (18%) cases, the distance from centre of tumor and centre of ablated area was ≥ 5 mm but ≤ 8 mm. At one-month, complete tumor ablation was achieved in 16/17 (94%) cases. No major or minor complications occurred. Mean overall procedural time was 102,3 min.

Conclusion: US/CBCT fusion imaging represents a viable technique for liver ablation, and might represent a useful tool to increase the correct targeting of poorly US-visible small HCC nodules in the angio suite.

P-507

Chemoembolization of liver cancer with doxorubicin-loaded CalliSpheres microspheres: Plasma pharmacokinetics, intertumoral drug concentration and tumor necrosis in a rabbit model

B. Liang, D. Zhao, C. Zheng

Department of Radiology, Union Hospital, Tongji Medical College, Huazhong University of Science and Technology, Wuhan, CN

Purpose: To investigate the plasma pharmacokinetics, intertumoral drug concentration and tumor necrosis after transarterial chemoembolization (TACE) with doxorubicin-loaded CalliSpheres Microspheres (CSM).

Material and methods: Sixty rabbits with liver VX2 tumors were assigned into five groups of 12 rabbits each, which received 4 mg of doxorubicin via intravenous injection (IV group), hepatic arterial infusion (IA group), conventional TACE (cTACE group), CSM-TACE (CSM low-dose group), and 8 mg of doxorubicin via CSM-TACE (CSM high-dose group), respectively. Doxorubicin concentrations in plasma and tumor were measured after treatment, and tumor necrosis percentage and liver enzymes were also assessed.

Results: The peak plasma concentration of doxorubicin was significantly lower in CSM low-dose, CSM high-dose and cTACE group compared to IV and IA group, respectively ($P < 0.05$); while doxorubicin concentrations in tumor were higher in the two CSM groups compared with IV, IA and cTACE groups at 3 days and 7 days after treatment ($P < 0.05$). The percentages of tumor necrosis at 3 and 7 days after treatment were significantly higher in three TACE groups (all higher than 50%) compared with IV group and IA group (both lower than 25%) ($P < 0.05$), and the highest tumor necrosis percentage was achieved in CSM high-dose group. The three TACE groups showed transient increases in transaminases levels after treatment, in which the peak transaminases levels were significantly lower in the two CSM groups than those in cTACE group ($P < 0.05$).

Conclusion: CSM achieves an effective delivery of doxorubicin into liver cancer. Increasing doxorubicin dose loaded into CSM improves tumoricidal capacity while does not impair its safety.

P-508

Use of proximal side-hole micro-balloon catheter in embolization for tumors

R. Yoshimatsu, K. Kajiwara, T. Yamanishi, H. Minamiguchi, T. Yamagami

Radiology, Kochi University, Nankoku, JP

Purpose: To evaluate the usefulness of the newly developed catheter; the proximal side-hole micro-balloon catheter, at the time of embolization of tumors. With this catheter, infusion of the embolizing materials to the feeding artery which arises from the point proximal to the micro-balloon without distribution of the embolizing materials into the distal artery to the balloon would be possible.

Material and methods: For 5 tumors (hepatocellular carcinoma, n=3; ureteral carcinoma, n=1; renal cell carcinoma, n=1) in 4 patients, embolization was performed with the proximal side-hole micro-balloon catheter because of difficulty of insertion of the standard micro-catheter selectively into the feeding artery. Investigated parameters were rate of success in embolization of target tumor, existence of occlusion of distal artery to the balloon, and degree of distribution of the embolizing materials into non-target area.

Results: Embolization of the target tumor was successfully performed in all 5 tumors. Embolizing materials used were mixture of miriplatin and iodized oil and comminuted gelatin particles (for 3 hepatocellular carcinomas), iodized oil and comminuted gelatin particles (for renal cell carcinoma) and comminuted gelatin particles (for ureteral carcinoma). In no cases, the distal artery to the balloon was embolized. Distribution of the embolizing materials into non-target area via the communicating artery between liver segments was confirmed in 3 tumors of hepatocellular carcinoma although it was small area.

Conclusion: This newly developed catheter could occasionally be useful when selective advancement of the micro-catheter into the feeding artery is difficult.

P-509

Efficacy of transarterial lipiodol-marking before CT-guided cryoablation for renal cell carcinoma

Y. Ushijima, Y. Asayama, A. Nishie, D. Kakihara, Y. Takayama, K. Morita, K. Ishimatsu, S. Takao
Clinical Radiology, Kyushu University, Fukuoka, JP

Purpose: To retrospectively elucidate clinical significance of transarterial lipiodol-marking (LM) that was operated before CT-guided cryoablation for renal cell carcinoma.

Material and methods: One hundred thirty-three patients with single renal tumor measuring less than 4cm, who underwent initial cryoablation from April 2014 to Dec 2017, were enrolled. Transarterial lipiodol-marking (LM) was performed before CT-guided cryoablation for 38 lesions and 95 lesions were treated without LM. Operation time of cryoablation, definitive diagnosis rate of biopsy, complication of cryoablation, renal function reduction rate, and local control were compared between the two groups.

Results: Operation time of cryoablation was 124.4 min with lipiodol-marking and 129.4 min without lipiodol-marking. Definitive diagnosis rate was 86.1% and 85.9%, and renal function reduction rate were 4.9% and 7.7%, respectively. There were no statistically significant differences in these. Intestinal perforation as a procedure-related major complication occurred in 3 cases without LM. Local control rate of the patients with LM after 1 year (100%) was significantly better than that without LM (92.6%).

Conclusion: Transarterial lipiodol-marking before CT-guided cryoablation for renal cell carcinoma is able to provide us with reduction of complication and better local control.

P-510

Addition of NBCA-MS to bland microparticles transarterial embolization for unresectable hepatocellular carcinoma: a single center survival analysis of 159 patients

E. Lanza¹, I. Bolengo², R. Muglia², D. Poret¹, R. Ceriani³, G. Torzilli⁴, V. Pedicini¹

¹Diagnostic and Interventional Radiology, Humanitas Research Hospital, Rozzano, IT, ²Radiology, Humanitas University, Rozzano, IT, ³Hepatology, Humanitas Research Hospital, Rozzano, IT, ⁴Department of Hepatobiliary Surgery, Humanitas University, Milan, IT

Purpose: To evaluate overall survival (OS) of patients affected by unresectable HCC treated with transarterial embolization (TAE) and to test whether a modified TAE (TAE-g) with the addition of n-butyl-cyanoacrylate-methacryloxy-sulfolane (NBCA-MS) changed OS.

Material and methods: This is a single-center retrospective study including patients with histological or imaging diagnosis of unresectable HCC treated with one or more bland embolizations. TAE was performed administering 40/100µ calibrated microparticles, while TAE-g deploying microparticles plus NBCA-MS to seal the nodule feeding vessel (TAE-g) whenever feasible. A survival analysis using Cox Regression was performed.

Results: From 2011 to 2017 we included 159 patients (M=125, F=34, mean age=74 [48.2-87.6], SD=7.9) who underwent 339 embolizations (mean=2 [1-9], SD=1.3). Child-Pugh stages were A=120, B=32, N/A=7. BCLC stages were 0=20, A=71, B=68. The treatments were 170 TAE-g (50%) and 169 TAE (50%). Median survival was 25.9 months (mean 33.5, 0.03-86.3, SD=21.9). Survival rates at 1, 2, 3, 4 and 5 years were 86%, 57%, 33%, 25% and 17%.

Conclusion: In the setting of HCC embolization, the addition of NBCA-MS to small-sized microparticles did not predict an increase in OS. We reported a median of 25.8 months OS for a sizable cohort of unresectable HCC patients treated without the employment of any chemotherapeutic agent, to broaden the body of knowledge regarding transarterial therapies for HCC.

P-511

Comparison of microballoon-occluded transarterial chemoembolization versus transarterial chemoembolization with drug-eluting-bead for the treatment of patients with large and intermediate-stage hepatocellular carcinoma

M. Hirakawa¹, Y. Ushijima², Y. Asayama², A. Nishie²

¹Radiology, Kyushu University Beppu Hospital, Beppu City Oita, JP, ²Clinical Radiology, Kyushu University, Fukuoka, JP

Purpose: Microballoon-occluded transarterial chemoembolization (B-TACE) was developed in Japan. B-TACE induce dense lipiodol accumulation in targeted hepatocellular carcinomas (HCCs). To the best of our knowledge, no comparison study has yet analyzed outcomes after B-TACE and TACE with drug-eluting-bead (DEB-TACE). The purpose of this study is to evaluate the efficacy and safety associated with B-TACE versus DEB-TACE for large (maximal diameter > 5 cm) and intermediate-stage HCCs.

Material and methods: This retrospective study involved naïve 35 patients with large and intermediate-stage HCCs who underwent B-TACE (n = 18) or DEB-TACE (n = 17) between 2013 and 2016. Local control of largest tumor 3months after TACE, overall survival (OS) and adverse events (AEs) were compared between the two groups.

Results: The median duration of follow-up was 19 months (range, 8-48 months). Objective response rate analyzed with modified RECIST was 38.9% after B-TACE and 52.9% after DEB-TACE (P = 0.039). No significant differences could be detected between the B-TACE and DEB-TACE groups with regard to median OS analyzed with the Kaplan-Meier method (28 versus 30 months, respectively; p=0.77). The 1-, 2-, and 3-year OS rates were 72.2, 62.4, and 42.8%, respectively, for the B-TACE and 82.4, 50.2, and 31.4%, respectively, for the DEB-TACE group (p=0.77). No significant differences in severe adverse events were found, however, rate of AEs after DEB-TACE tended to be higher than B-TACE.

Conclusion: For the treatment of patients with large and intermediate-stage HCCs, DEB-TACE provided better tumor responses in comparison with B-TACE, which in turn DEB-TACE did not seem to improve survival.

P-512

Degradable radiopaque embolic glass microspheres: pre-clinical evaluation on imaging and histology

R. Abu Hana¹, G. Soulez¹, H. Héon¹, D. Trudel¹, F. Azzi¹, K. MacDonald², J. Doucet², D. Boyd²

¹CRCHUM - Centre de Recherche du Centre Hospitalier de l'Université de Montréal, Université de Montréal, Montréal, QC, CA, ²Biomedical Engineering, Halifax University, Halifax, NS, CA

Purpose: Evaluate the embolization effectiveness, visibility and degradability of embolic radiopaque glass microspheres (ERGM) in swine renal artery, as well as the recanalization of the embolized vessels.

Material and methods: Bilateral caudal renal artery embolization was conducted in 4 non-diseased pigs. Three of them received ERGM (100-300 µm) and one received Bead Blocks® (control). Imaging assessment was performed using Fluoroscopy Shoot, DSA, C-arm CT and histology at three different time points: 0h, 24h, 48h.

Results: Visualization of glass beads was possible on all imaging methods, however use of contrast was necessary to have a better embolization monitoring on fluoroscopy. The total time of the procedure was slightly longer for the tested particles (average 84 min) compared to the control (55 min). The volume of particles injected was higher for control, 1.5g versus 0.8g for tested. The volume of remaining degradable particles was clearly smaller over the time: 0h (100%), 24h (2%) and 48h (1.9%). The CBCT was able to visualize the particles with good resolution, being possible to verify the degradation progression of the glass microspheres over the time. The DSA was able to demonstrate the onset of vessel recanalization even just 24h and 48h after the procedure, which was confirmed by histology.

Conclusion: The ERGM have an excellent degradable capacity in an ideal average interval of 48 hours, without any impairment in the effectiveness of the embolization. The recanalization could be visualized even after a short period of time.

P-513

Parameters on ¹⁸F-FDG-PET/CT as response predictors of neuroendocrine tumor liver metastasis (NETLM) treated by transcatheter arterial embolization (TAE)

Y. Liu¹, F. Lian², H. Liu³, W. Chen³, M. Chen⁴, J. Chen⁵, Y. Wang¹

¹The Department of Interventional Oncology, The First Affiliated Hospital, Sun Yat-Sen University, Guangzhou, CN, ²Rheumatology and Clinical Immunology, 1st Affiliated Hospital of Zhongshan University, Guangzhou, CN, ³Interventional Oncology, 1st Affiliated Hospital of Zhongshan University, Guangzhou, CN, ⁴The Department of Gastroenterology, The First Affiliated Hospital, Sun Yat-Sen University, Guangzhou, CN, ⁵Gastroenterology, 1st Affiliated Hospital of Zhongshan University, Guangzhou, CN

Purpose: To evaluate whether parameters on ¹⁸F-FDG-PET/CT can be utilized as response predictors of NETLM Treated by TAE.

Material and methods: Twenty-four patients diagnosed as NET liver metastasis with ¹⁸F-FDG-PET/CT data within 1 month prior to initial TAE treatment were enrolled. A maximum of 3 largest, reproducibly measurable hepatic lesions treated by TAE in each patient were selected as target lesions. Maximal SUV of target lesions (TSUVmax) and mean SUV of normal liver (LSUVmax) were obtained on ¹⁸F-FDG-PET/CT data. The uptake ratio of SUVmax of target lesions to SUVmax of normal liver (TLR) was calculated (TLR = TSUVmax/LSUVmax). Radiological response of each target lesion was assessed on baseline and follow-up CT data according to RECIST 1.1.

Results: A total of 69 target lesions treated by TAE were selected, among which 52 lesions achieved CR/PR (response group) and 17 lesions remained SD (non-response group). Mean TSUVmax and TLR in response group were significantly higher than that in non-response group (TSUVmax: 14.37 ± 8.65 vs. 7.08 ± 5.23, p = 0.002; TLR: 6.41 ± 3.57 vs. 3.02 ± 1.83, p

< 0.001). The ROC analysis showed that TSUVmax (AUC: 0.783, optimal cutoff: 1.95, sensitivity: 86.5%, specificity: 76.5%, p < 0.001) and TLR (AUC: 0.754, optimal cutoff: 1.38, sensitivity: 80.8%, specificity: 64.7%, p = 0.002) were significant in predicting tumor response.

Conclusion: ¹⁸F-FDG-PET/CT TSUVmax and TLR can predict tumor response of NETLM treated by TAE.

P-514

Safety and efficacy of ablative techniques for primary and metastatic lesions in paediatric age group

R.S. Chivate¹, R. Gali², P. Thakrar³

¹Interventional Radiology, Jupiter Hospital, Thane, IN, ²Radiology, Jupiter Hospital, Thane, IN, ³Radiology, Nirman Diagnostic Centre, Mumbai, IN

Purpose: Minimal invasive techniques like radio frequency and microwave ablation are very beneficial in paediatric age group as it could prevent morbid surgery like hepatic and pulmonary metastectomy and prevent recurrence in diseases like fibromatosis.

Material and methods: 16 patients of age ranging from 4 to 12 years in a period of 2 years had undergone ablative procedure for metastatic as well as primary pathologies. 2 children operated for Wilm's tumour had hepatic metastatic underwent radio frequency and microwave ablation. 2 children with primary as rhabdomyosarcoma of prostate, urinary bladder had lung metastases underwent radio frequency ablation. 2 patients with lung metastases in operated cases for hepatoblastoma and 3 children having PNET as primary and lung disease underwent radiofrequency ablation. 7 patients had fibromatosis in gluteal, popliteal, shoulder, abdominal wall region for which they had multiple sessions of ablation. StarBurst Radiofrequency Ablation system, Acculis MTA system and RF3000 radiofrequency ablation system were used.

Results: Children with hepatic metastatic Wilm's tumour, lung metastatic and primary disease of hepatoblastoma, rhabdomyosarcoma and PNET showed complete response post ablation and follow up. 7 children having fibromatosis underwent multiple sessions depending on size of lesion and showed arrest in growth and activity of tumour component.

Conclusion: Ablative technique can be very efficiently and safely used in paediatric age group especially for palliation and to reduce tumour burden in cases of fibromatosis.

P-515

Pneumothorax prevention after lung thermal ablation using hydrogel plug

D. Monaco¹, M.P. Ganime¹, V. Gisone¹, N.M. Lucarelli¹,

A. Briatico Vangosa¹, R. Leggieri², P. Moda³, T. Iarussi², N. Burdi¹
¹Radiology, SS Annunziata Hospital, Taranto, IT, ²General and Thoracic Surgery, SS Annunziata Hospital, Taranto, IT, ³Nuclear Medicine, ASL Taranto, Taranto, IT

Purpose: Pneumothorax is the most common complication after lung malignancies thermal ablation.

Biosentry® consists in a self-expandable hydrogel-plug with a dedicated releasing system: it can be introduced by the coaxial needle used to advance the biopsy needle, allowing tract sealing after procedure. Several reports indicates hydrogel plug reduces pneumothorax incidence after lung biopsy. The maximum diameter of compatible coaxial needle is 18 G, inhibiting the use after RF or MW ablation.

We adopted a technique for idrogel-plug positioning after lung ablation too.

We present our preliminary experience.

Material and methods: From september 2018 to january 2019, 8 patients (6 male, mean age 77) affected by single lung lesion (5 NSSL, 3 CRC metastasis, mean diameter 26 mm, mean pleural distance 18 mm) underwent MW ablation. Comorbidities (6 COPD, 3 cardiac surgery) contraindicated surgery. Procedures were performed with CT-guidance under sedo-analgesia. We used a coaxial needle (14-15G) positioned close to the

lesion to advance MW antenna (4 Solero®, 4 Amica®) across the lesion and perform ablation. Then, by the same coaxial needle, we inserted a 18G needle used to deploy idrogel plug (Biosentry®) along the needle tract.

Results: No major complications occurred. During access, two patients developed thin pneumothorax (5-8 mm). Pneumothorax remained stable at final control and disappeared at the CT performed within few hours. All patients were discharged the same day. With a 3 months mean follow-up we observed neither complications nor recurrences.

Conclusion: Idrogel-plug tract sealant positioned with coaxial technique after lung ablation seems to offer efficient prevention of pneumothorax.

P-516

A phase 1 study using autologous natural killer cells in patients with haic-hepatocellular carcinoma

Y.J. Kang¹, B.C. Lee¹, N.Y. Yim², H.-O. Kim², J.K. Kim²

¹Radiology, Chonnam National University Hwasun Hospital, Jeollanam-do, KR, ²Radiology, Chonnam National University Hospital, Gwangju, KR

Purpose: To improve NK cells therapy, we focused to increasing delivery of NK cells and synergic effect combined with hepatic-arterial-infusion-chemotherapy (HAIC).

Material and methods: We did a prospective, open label, phase 1 trial of the safety and efficacy of autologous NK cells through HAI as sequential therapy after HAIC in advanced HCC patients. Between March 2016 and July 2017, 11 patients were included who showed favorable response more than stable disease (SD) after 2 sessions of HAIC. The peripheral blood mononuclear cells of patients by leukapheresis were obtained after 3rd HAIC and NK cells were expanded for 2 weeks under Current Good Manufacturing Practices (cGMP). Patients received planned dosage of NK cells through chemoport into hepatic artery for 5 days after 4th HAIC (3-patients; 2.5x10⁸, 3-patients; 5x10⁸, 5-patients; 10x10⁸ NK cells). The primary end point was safety of NK cell injection; secondary end-point included objective response rate, time to progression, duration of response and immunologic efficacy.

Results: Any adverse events of NK-cells injection were none according to dosage. An OR was observed in 7-patients (63.6%) included three CR and four PR. SD was observed in 2 patients and thus disease control rate was 81.8%. The mean duration of time to progression was 9.7±5.3 month and duration of response without chemotherapy was 6.1±5.2 month. The increasing immunologic response was observed in 5-patients (55 %) to evaluate cytotoxicity and NK cell proportion of peripheral mononuclear cells.

Conclusion: The HAIC and NK cells immunotherapy is safe and effective treatment in the advance HCC patient with favorable liver function. The additional studies are urgently required to establish the new novel treatment.

P-517

Y90-radioembolization in patients with hepatocellular carcinoma and portal vein invasion: external validation of the Milan prognostic score

P. Scalise¹, I. Bargellini¹, L. Crocetti², E. Bozzi³, O. Perrone¹, G. Boni⁴, R. Cioni¹

¹Diagnostic and Interventional Radiology, University of Pisa, Pisa, IT, ²Diagnostic and Interventional Radiology, Pisa University School of Medicine Cisanello Hospital, Division of Diagnostic Imaging, Pisa, IT, ³Oncology, Transplant and New Technologies in Medicine, Diagnostic and Interventional Radiology, Pisa, IT, ⁴Department of Nuclear Medicine, University of Pisa, Pisa, IT

Purpose: To validate the recently proposed Milan PVTT prognostic score by retrospectively analysing the clinical outcomes of a series of patients affected by hepatocellular carcinoma (HCC) and portal vein tumor thrombosis (PVTT) treated with yttrium-90 radioembolization (TARE).

Material and methods: We retrospectively reviewed laboratory, radiological and clinical data of all patients affected by HCC with PVTT who underwent TARE between 2012 and 2018. PVTT extension was classified according to the involvement of segmentary branch (PV1), secondary order branch (PV2), first order branch (PV3) and main portal trunk (PV4). According to the Milan PVTT score, patients were allocated in good, intermediate and dismal prognosis groups. Overall survival (OS) was estimated by Kaplan-Meier method and compared by log-rank test.

Results: A total of 70 patients (90 male; median age 67 years) was included in the study. According to the Milan PVTT score, 15 (21.4%) patients were in the good prognostic group, 33 (47.1%) in the intermediate group and 22 (31.4%) in the dismal group. Median OS was 11.6 months (95%CI, 9.1- 17.5), and one- and three-year survival rates were 47.9% and 11.2%, respectively. The Milan PVTT score was significantly associated to OS, with median OS ranging from 24.6 months in the favourable group, 13 months in the intermediate group (HR=3.2; 95%CI, 1.2-9.7; p=0.016) and 5.9 months in the dismal group (HR=4.1; 95%CI, 1.4-13.4; p=0.0096).

Conclusion: Our data support the use of the Milan PVTT score as an easy tool to select HCC patients with PVTT who may benefit more from TARE. It should also represent the basis for future trials.

P-518

Treatment outcomes in transarterial chemoembolization (TACE) refractory hepatocellular carcinoma patients converted to lenvatinib therapy

K. Murakami, K. Kamada, Y. Oonuma

Diagnostic Radiology, Hakodate goryoukaku hospital, Hakodate, JP

Purpose: To evaluate transarterial chemoembolization (TACE) refractory hepatocellular carcinoma (HCC) patient outcomes after conversion to lenvatinib.

Material and methods: This retrospective study reviewed intermediate-stage HCC patients who had previously undergone two rounds of TACE. TACE-refractory patients were identified from April 2017 to Dec 2018 and divided into two groups: (1) patients who transitioned from TACE to lenvatinib and (2) those who continued TACE therapy. We evaluated the overall survival (OS) and progression-free survival (PFS; the time patients reached progressive disease for all study patients).

Results: A total of 30 out of 48 HCC patients who underwent TACE were deemed refractory. Of the refractory patients, 10 were converted to lenvatinib treatment and 12 continued with TACE. We excluded patients with Child-Pugh scores of ≥8, those with advanced-stage HCC, those who had undergone hepatic arterial infusion chemotherapy or other systemic therapy, and those treated with best supportive care alone. The median FPS and OS were 510 and 550 days, respectively, in the conversion group, and 255 and 300 days respectively, in the continuing group (p = 0.082 and p = 0.045, respectively).

Conclusion: Lenvatinib conversion may prolong OS and FPS in TACE-refractory patients with intermediate-stage HCC.

P-519

Predictors of post-interventional occlusion of hepatic vessels after irreversible electroporation of liver

M. Tamura¹, F. Pedersoli¹, M. Schulze-Hagen¹, M. Zimmermann¹, P. Isfort¹, S. Keil¹, C.K. Kuhl¹, T. Schmitz-Rode², P. Bruners¹

¹Department of Diagnostic and Interventional Radiology, RWTH Aachen University Hospital, Aachen, DE, ²Institute of Applied Medical Engineering, RWTH Aachen University, Aachen, DE

Purpose: To determine predictors of long-term occlusion of portal and hepatic vein within or adjacent to ablation zone after irreversible electroporation (IRE) of liver.

Material and methods: Thirty-nine patients who underwent CT-guided liver IRE were included in this retrospective analysis. On CT-images acquired immediately after the procedure, vessels within or adjacent

to the ablation zone were identified, and the positional relationship with the ablation zone (within or adjacent), the location (proximal or distal), and the diameter ($<4\text{mm}$ or $\geq 4\text{mm}$) of each vessel was evaluated. Based on contrast-enhanced follow-up images, each vessel was classified as patent, stenosed, or occluded. The association of vessel occlusion and each variable was investigated.

Results: In total, 33 portal veins and 64 hepatic veins were identified. On follow-up images, 12/33 (36.7%) portal veins and 17/64 (26.6%) hepatic veins were occluded. Vessels within the ablation zone occluded significantly more frequently than those adjacent (55.6% [10/18] vs 13.3% [2/15] $p=0.04$ in portal vein and 45.4% [15/33] vs 6.4% [2/31], $p=0.011$ in hepatic vein). Vessels with a diameter $<4\text{mm}$ also occluded significantly more frequently than those $\geq 4\text{mm}$ (72.7% [8/11] vs 18.1% [4/22], $p=0.011$ in portal vein and 54.8% [17/31] vs 0% [0/33], $p<0.001$ in hepatic vein). The positive and negative predictive values for the occlusion of vessels categorized as both within and $<4\text{mm}$ were 88% (7/8) and 80% (20/25) in portal vein, and 79% (15/19) and 96% (43/45) in hepatic vein.

Conclusion: It seems possible to predict long-term vessel occlusion after liver IRE with relatively high diagnostic accuracy by assessing ablation pattern and diameter of vessels.

P-520

For patients with advanced hepatocellular carcinoma, are biopsies prior to TACE/TARE useful and safe?

J.K. Cho¹, J.X. Chen², D. Ackerman³, M. Mercadante³, M. Noji³, S. Hunt¹, G.J. Nadolski¹, T. Gade¹

¹Radiology, Hospital of the University of Pennsylvania, Philadelphia, PA, US, ²Radiology, Charlotte Radiology, Charlotte, NC, US, ³Radiology, University of Pennsylvania, Philadelphia, PA, US

Purpose: Percutaneous biopsy in the delineation of advanced hepatocellular carcinoma (HCC) is essential and projected to increase in the era of precision medicine. The purpose of this study was to detail the efficacy and safety profile of acquiring multiple HCC biopsies for "omic" profiling and precision medicine initiatives.

Material and methods: Between 04/2016 and 02/2019, 21 embolotherapy-naïve, advanced HCC patients were enrolled in this IRB-approved prospective trial. 18G core-biopsies of the dominant HCC were obtained prior to transarterial chemoembolization (TACE) or radioembolization (TARE). Cores were sent to pathology, Center for Personalized Diagnostics (CPD), prepared for cell culture, or implanted in NSG mice for patient-derived xenograft (PDX) generation.

Results: From 21 patients, 24 HCC tumors were biopsied. A median of 6.5 core biopsies were obtained on initial encounter. Eight tumors were biopsied a second time and 2 were biopsied a third time. Of 32 biopsy encounters, 14 (44%) minor and 0 major adverse events were reported during the post procedural period. One (5%) biopsy revealed discordant pathology of cholangiocarcinoma. Of 9 cores sent to CPD, 7 (78%) were adequate for analysis. All remaining cores were utilized for establishing cell lines, for which approximately half of attempted engraftments in NSG mice developed into PDXs. In 3 patients, primary cell cultures were successfully derived and subjected to a high-throughput chemical screen identifying FDA-approved drug sensitivities.

Conclusion: Obtaining multiple percutaneous biopsies of HCC tumors at the time of TACE/TARE is safe. Percutaneous biopsy samples can provide sufficient tissue to establish primary cell cultures via PDX surrogates.

P-521

Radioembolization of hepatocellular carcinoma in a large single center cohort: response and survival evaluation

G.M. Kim¹, J.Y. Won², K. Han¹, J.H. Kwon², J. Lee², S.H. Baek¹, M.D. Kim²

¹Radiology, Yonsei University Severance Hospital, Seoul, KR, ²Radiology, Severance Hospital, Yonsei University College of Medicine, Seoul, KR

Purpose: To evaluate objective response, progression-free survival, overall survival and prognostic factors of transarterial radioembolization (TARE) for hepatocellular carcinoma in a large single center cohort.

Material and methods: 169 HCC patients who underwent TARE in our institute and has at least 6-months follow-up data were included in this study. Patient, tumor, and treatment characteristics are retrospectively reviewed. Target lesion and overall response rates at 6 months after treatment were evaluated. Progression-free survival and overall survival rate were calculated. Univariate and multivariate cox regression model was applied to identify parameters affecting overall survival.

Results: Basic characteristics are as follows; mean age = 62.6 years; 81.1% are male; mean tumor size = 85.5mm; Child-Pugh classification (C-P) A=92.9% and B=7.1%, respectively; BCLC stage A=33.1%, B=34.9%, C=32.0%, respectively; 27.8% of patients has portal vein invasion; 26.6% has bilobar disease; 8.3% has distant metastasis; resin microsphere = 65.1% and glass microsphere = 34.9%, respectively.

6-months response rates were 67.9% for target lesion and 53.6% for overall, respectively. Median progression-free survival was 9.6 months. 1-, 2-, 3-year overall survival rates were 77.5%, 62.8%, and 54.7%, respectively. Poor prognostic factors include C-P B (hazard ratio (HR); 3.915), grade of portal vein invasion (HR; 2.427-2.698), presence of metastasis (HR; 8.009). Two major complications were noted.

Conclusion: TARE is an effective and safe treatment for HCC and shows comparable survival data. Poor hepatic function, portal vein invasion and distant metastasis worsen survival after TARE.

P-522

Estimation of tissue contraction in microwave ablation of lung nodules and its implications

A. Moussa¹, M. Drabkin², J.C. Camacho², S.B. Solomon³, E. Ziv²

¹Interventional Radiology, Memorial Sloan Kettering Cancer Center, New York, NY, US, ²Radiology, Memorial Sloan Kettering Cancer Center, New York, NY, US, ³Section of Vascular & Interventional Radiology, Memorial Sloan Kettering Cancer Center, New York, NY, US

Purpose: Accurate prediction of ablation zone is difficult in patients undergoing microwave ablation of lung nodules as it is influenced by many variables, the least studied of which is surrounding tissue contraction. The degree of tissue contraction and how it affects ablation zone measurements remain unknown

Material and methods: 20 patients who underwent microwave ablation of lung nodules were included. The distances between fixed anatomical landmarks encompassing the target nodule (branches of pulmonary vasculature or bronchi) in pre-procedure CT and 6 month follow up CT were measured and used to produce an average ratio of tissue contraction over time. The ablation zone on the day of the procedure and on 6 month follow up CT were also measured and used to calculate the involution of the ablation zone.

Results: The average tissue contraction was 10.1% [min -1% to max 25.7%, range 26.7%]. The average ablation zone involution was 76.2% [min 38.3% to max 93.5%, range 55.2%]. As ablation time increased, ablation zone involution increased [$R = 0.151$] and tissue contraction decreased [$R = -0.3012$], but this was statistically insignificant. Ablation zone size and degree of tissue contraction were weakly anti-correlated [$R^2 = 0.0554$]

Conclusion: In conclusion, tissue contraction is an important variable that can affect microwave ablation zone volume. A larger data set is needed to accurately investigate the true magnitude of its effect.

P-523

Oral sorafenib for closure of intratumoral shunts to enable transarterial treatment of patients with hepatocellular carcinoma

J. Thüring, M. Zimmermann, P. Bruners, F. Pedersoli, M. Schulze-Hagen, E. Barzakova, C.K. Kuhl, P. Isfort
 Department of Diagnostic and Interventional Radiology, RWTH Aachen University Hospital, Aachen, DE

Purpose: Significant intratumoral shunts between tumor-supplying arteries and portal or liver veins are a contraindication for transarterial therapy of HCC, because interventional treatment of these shunts is frequently insufficient. Sorafenib has anti-angiogenic effects and is indicated for palliative treatment of patients with HCC. Here, we report on our experience with the use of sorafenib for closure of intratumoral shunts in patients scheduled for transarterial treatment of HCC.

Material and methods: Three patients with HCC, aged 65, 82 and 79 years, 2 males, exhibited substantial intra-tumoral shunting from tumor artery to portal vein (n=1), or liver vein (n=2). In all cases, intratumoral shunting had already been suspected based on pre-interventional CTA, and was confirmed by DSA. Patients were put on oral sorafenib (800mg/d) for at least 4 weeks, only and specifically to close the shunt. Thereafter, sorafenib was discontinued, and patients were re-evaluated by CTA and DSA.

Results: All patients underwent sorafenib treatment for 4, 4 and 8 weeks, respectively. All patients tolerated the full prescribed dose for at least 4 weeks; dose has to be adapted (400 mg/d) for one patient after 4 weeks due to hand-feet-syndrome. After sorafenib treatment, the intratumoral shunts were completely closed on CTA and DSA. No tumor progression was observed compared to baseline CT. All 3 patients then underwent successful transarterial treatment by TACE (n=2) or Y90-RE (n=1) without complications.

Conclusion: Even short-term (4 weeks) oral sorafenib can be used to effectively close intratumoral shunts in patients with HCC, and thus enables transarterial treatment of these patients.

P-524

Preliminary results of chemoembolization alone or associated to Bevacizumab for the therapy of colorectal cancer metastases (CRC): a randomized study

G. Fiorentini¹, D. Sarti¹, M. Nardella², R. Inchingolo², M. Nestola³, C. Aliberti⁴, A. Rebonato⁵

¹Oncology-Hematology, Azienda Ospedaliera Ospedali Riuniti Marche Nord, Pesaro, IT, ²Radiology, Madonna delle Grazie Hospital, Matera, IT, ³Diagnostic and Intervention Department, "Madonna delle Grazie Hospital", Matera, IT, ⁴Radiology, Delta Hospital, Lagosanto, IT, ⁵Diagnostics for Images Unit and Interventional Radiology, Azienda Ospedaliera Ospedali Riuniti Marche Nord, Pesaro, IT

Purpose: The association of chemotherapy to Bevacizumab is a common clinical practice. The chemoembolization causes hypoxia and consequently neoangiogenesis, for this reason the association of chemoembolization to Bevacizumab could be a new avenue of study.

The aim of this study was to assess efficacy and safety of chemoembolization alone (TACE) or followed by Bevacizumab (TACE-Beva) for colorectal liver metastases (CRC-LM) treatment.

Material and methods: The study included 22 consecutive CRC-LM patients. They were informed about the types of treatment available: TACE with irinotecan loaded into polyethylene glycol embolics alone or followed by Bevacizumab therapy. Each patient received a self-made randomization and 13 choose TACE whereas 9 TACE-Beva.

Results: Tumor response (3months) was 1 (8%) and 1 (17%) complete response after TACE and TACE-Beva respectively; partial response in 2 (15%) and 3 (33%) patients after TACE and TACE-Beva respectively; stable disease in 6 (46%) and 3 (33%) patients after TACE and TACE-Beva respectively; progression in 4 (31%) and 2 (17%) after TACE and TACE-Beva

respectively. Disease control rate was 69% and 87% after TACE and TACE-Beva. Median follow-up was 6 months (1,3-6 range).

No complications were observed during TACE. Most TACE related adverse events were correlated with post-embolic syndrome (PES) and were of mild or moderate intensity. Bevacizumab related adverse events were pressure rise (G2) in 1 (17%) and skin rash (G2) in 2 (33%) patients.

Conclusion: The preliminary results of the study showed that the TACE-Beva is feasible and tolerable. This study will be continued in order have a larger number of patients and longer follow-up.

P-525

Irreversible electroporation versus radiofrequency ablation: comparison of systemic immune responses in patients with hepatocellular carcinoma

K. Sugimoto, H. Takeuchi, T. Itoi
 Gastroenterology and Hepatology, Tokyo Medical University, Tokyo, JP

Purpose: Irreversible electroporation (IRE) differs from thermal radiofrequency ablation (RFA), especially in terms of the reparative process in the ablation zone induced. To elucidate this, we evaluated the systemic immune responses after two mechanistically different types of ablation (IRE and RFA) in patients with hepatocellular carcinoma (HCC).

Material and methods: Twenty-one patients with HCC who underwent either RFA (n=11) or IRE (n=10) were studied. Peripheral blood samples were collected from all patients at 4 time-points: pre-ablation, within 1 hour post-ablation, 1 day post-ablation, and 4 days post-ablation. The phenotypes and functions of immune cells in peripheral blood and serum levels of cytokines and chemokines were monitored and analyzed using the mixed effects model. Follow-up radiological images were also obtained to assess temporal changes in the ablation zone.

Results: The most significant difference was seen in the levels of macrophage migration inhibitory factor (MIF) in the IRE group compared to the RFA group (P=0.0011): the serum levels of MIF in the IRE group significantly increased immediately after IRE and then rapidly decreased to the pre-ablation range 1 day after IRE, but in contrast, no consistent trend was observed in the RFA group. The axial diameter (P=0.0009) and area (P=0.0192) of the ablation zone of IRE were significantly smaller than those of RFA 1 year post-ablation.

Conclusion: IRE was found to be associated with a significant early increase in MIF levels, which may facilitate the early reparative process and result in significant shrinkage of the ablation zone.

P-526

EBUS-TBNA (Endobronchial ultrasound - transbronchial needle aspiration) and its role in mediastinal staging of NSCLC

N.S. Shetty¹, S.S. Kulkarni¹, C.S. Pramesh², M. Bhasker³, K. Deodhar⁴, K.B. Gala¹, S. Mohd¹, S. Rao¹

¹Interventional Radiology, Tata Memorial Hospital, Mumbai, IN, ²Thoracic Surgery, Tata Memorial Hospital, Mumbai, IN, ³Pulmonary Medicine, Tata Memorial Hospital, Mumbai, IN, ⁴Pathology, Tata Memorial Hospital, Mumbai, IN

Purpose: Lung cancer is the most common cause of cancer related death worldwide. Non-small cell lung cancer (NSCLC) accounts for 80% of all lung cancers. The 5-year survival rate of 16% for bronchogenic carcinoma with lymph node metastases is very low compared to the rate of 49% in lung cancer without lymph node involvement. Mediastinal staging is a crucial factor in the decision making in patients with non-metastatic NSCLC. Mediastinoscopy has been the gold standard for this purpose. This paper attempts to define the role of EBUS TBNA for mediastinal staging in comparison with mediastinoscopy.

Material and methods: After approval by ethics committee, retrospective analysis of data of patients who had undergone EBUS-TBNA was done. Data collected included all or part of the following:

Demographics, primary tumour and mediastinal node characteristics.

On site cytological and final pathology report for each station. Mediastinoscopy/ surgical specimen histopathology report correlation. Final plan of management, and any change due to EBUS evaluation.

Results: EBUS-TBNA was performed on 77 patients for mediastinal staging: 47 male and 30 female, average age 62.1 years (extremes 39-81). In 51% of patients (39/77) mediastinal lymph node metastasis were found and mediastinoscopy could be avoided. Sensitivity, specificity, positive predictive value, negative predictive value and diagnostic accuracy were 91%, 100%, 100%, 80% and 93% respectively. Complication rate was less than 2%.

Conclusion: Mediastinoscopy can be avoided in more than 50% of lung cancer patients when EBUS-TBNA is used as staging modality for mediastinal staging, leading to a significant reduction of health care costs.

P-527

Capembol: Safety, feasibility and early oncological outcomes of prostatic artery embolization as a focal therapy in the management of low grade localized prostate cancer in patients candidate to active surveillance. A monocentric pilot study. Preliminary results

H. Mohammad

Radiology, CHU Montpellier, Montpellier, FR

Purpose: We aim to assess the feasibility, safety, short-term oncologic and functional outcomes of unilateral prostate artery embolization (PAE) in patients with localized low-risk prostate cancer candidate to active surveillance (AS).

Material and methods: This first-results prospective monocentric pilot study enrolled patients with unilateral prostate cancer Gleason 6 (3+3), prostate specific antigen < 10ng/ml, stage < T2b clinical or < T2c radiological and concordant PIRADS ≥ 3 target lesion on multiparametric MRI (mpMRI). Primary endpoint was the feasibility defined by technical success of PAE and absence of severe adverse effects. Secondary endpoints were overall survival, need for radical treatment, necrosis of the treated lobe on mpMRI, histological, urinary and erectile functions evaluations after PAE.

Results: Six patients were included in the study from June 2018 to January 2019. Median age was 74,5 years, median initial prostatic specific antigen (PSA) rate was 6,9 ng/ml (3,2-10,14), all cancers were Gleason 6 (3+3) and T2a clinical. All lesions ranked PIRADS 4 on mpMRI. Technical success was 100%. Median procedure time was 40,5 minutes (35 – 48). No major complication occurred (Clavien-Dindo ≥ 3). No decrease in urinary and erectile functions was observed in the first four patients at 3-month follow-up. In one of the two patients followed 6 months, the target lesion was no longer visible on mpMRI and was negative on the targeted biopsy.

Conclusion: Unilateral PAE to manage localized low-risk prostate cancer is a feasible and well tolerated procedure. First early oncological results are promising. Further research are required to demonstrate its long-term oncologic and functional outcomes.

P-528

Performance of the Emprint and Amica microwave system in ex-vivo porcine livers: sphericity and reproducibility versus size

P. Hendriks, W.E.M. Berkhout, C.I. Kaanen, J.H. Sluijter, I.J. Visser, L.-F. De Geus-Oei, A.G. Webb, M.C. Burgmans
Department of Radiology, Leiden University Medical Center, Leiden, NL

Purpose: To evaluate two different microwave ablation (MWA) systems on tumor ablation shape and size in excised porcine livers.

Material and methods: In 25 porcine ex-vivo livers, two MWA systems (14G Amica (HS Health Service) and 11G Emprint (Medtronic)) were used to perform ablations at identical settings: 3 and 5 minutes at 60 and 80 Watt, each (six ablations per setting). MRI was acquired using 3D T1-weighted images on a 7T Philips Achieva for the evaluation of ablation volume and shape, using post-processing software (Vitrea, Vital Images inc). Ablation shapes were quantitatively evaluated for sphericity and qualitatively for

symmetry. Obtained diameters of short and long axes were compared to the reference diameters as stated by the manufacturers.

Results: Emprint ablations resulted in lower ablation volumes at each setting with higher reproducibility (median 11,08 mL (6,07-21,53, SD: 2,34), versus 21,05 mL (9,39-44,69, SD: 6,30) for Amica ablations ($p < 0,01$). The average sphericity index of Emprint ablations was significantly higher ($0.89 \pm 0,07$ versus $0.54 \pm 0,08$). In Emprint ablations, the ablation duration significantly influenced the sphericity index ($p = 0.023$), whereas in Amica ablations, no significant relationship between ablation duration and sphericity was found ($p > 0.05$). Asymmetric ablations were found in 50% of Amica ablations, versus 4,2% in Emprint ablations ($p = 0,001$). Amica ablations overlapped the reference ablation diameters in 37.5% of cases, whereas this was 87.5% for Emprint.

Conclusion: In this ex-vivo experimental setup, Emprint ablations are smaller, but more spherical and reproducible. Also, they meet the manufacturer reference diameters more often than Amica.

P-529

Effectiveness of trans-catheter arterial embolization for hemorrhage from pancreatic cancer

Y. Onishi, M. Sone, S. Sugawara, C. Ito, T. Hasegawa, S. Kimura, N. Umakoshi, S. Fujizuka, Y. Arai, M. Kusumoto

Department of Diagnostic Radiology, National Cancer Center Hospital, Tokyo, JP

Purpose: To evaluate effectiveness and safety of trans-catheter arterial embolization (TAE) for hemorrhage caused by pancreatic cancer.

Material and methods: Between January 2010 and December 2018, 11 patients (6 men and 5 women, mean 59 years old) underwent TAE for hemorrhage caused by pancreatic cancer invasion. Patients with postoperative hemorrhage were excluded. The site of bleeding was the duodenum in 5 patients, bile duct in 4 patients, stomach in 2 patients. Angiography demonstrated pseudoaneurysm in 8 patients, contrast medium extravasation in 3 patients, and neither of them in 2 patients. Technical success was defined as successful cessation of extravasation, disappearance of pseudoaneurysm, or stop of blood supply to the feeding arteries of the tumor. Clinical success was defined as bleeding-free survival for 1 month after TAE. Safety of TAE was evaluated using Clavien-Dindo classification.

Results: Technical success was obtained in 11/11 (100%). Embolized arteries included the pancreatic head arcade (anterior and posterior superior pancreaticoduodenal arteries, inferior pancreaticoduodenal artery), 5; arteries of the stomach (right and left gastric arteries, right gastroepiploic artery), 3; hepatic arteries (proper and common hepatic arteries), 2; jejunal arteries, 2; the splenic artery, 1. Coils were used in 6 patients, NBCA in 4 patients, gelatin particle in 3 patients. Clinical success was achieved in 8/11 (73%). One patient died due to liver failure (grade V) and one patient had transient increase of amylase (grade I).

Conclusion: TAE might be an effective and safe treatment for hemorrhage caused by pancreatic cancer.

P-530

Safety and effectiveness of percutaneous laser ablation of liver metastases from neuroendocrine neoplasm - a retrospective study

F. Ermili¹, A. Vizzuso¹, M. Graziano¹, F. Di Vecce², P. Tombesi², E. Salviato¹, R. Galeotti¹, S. Sartori²

¹Morphology, Surgery and Experimental Medicine, University of Ferrara - S. Anna Hospital, Cona, IT, ²Department Medicine, Section of Interventional Ultrasound, S. Anna Hospital, Ferrara, IT

Purpose: To retrospectively assess safety and efficacy of percutaneous laser ablation (LA) of multiple liver metastases (LM) from neuroendocrine neoplasm (NEN)

Material and methods: Twenty-one patients with at least 3 small LM (< 4 cm in diameter) from NEN underwent ultrasonography-guided LA. Up to seven LM were ablated in a single session; if the number of LM exceeded seven, the remaining LM were ablated in further LA sessions with a time interval of three-four weeks each other. LA was performed according to the multifiber technique. The patients underwent contrast-enhanced CT one month after LA, and were subsequently monitored every three months for the first two years, then every six months.

Results: On the whole, 189 LM were treated (mean per patient 9 ± 8.2 , median 6) in 41 LA sessions (range 1-5). One grade 4 complication was observed (0.53%): a bowel perforation successfully managed by surgery. Technical efficacy was 100%, primary efficacy rate 94.7%, and secondary efficacy rate 100%. Complete relief of hormone-related symptoms was obtained in all the 13 symptomatic patients. The median follow-up was 39 months (range 10 – 93). 1-, 2-, 3-, and 5-year survival rates were 95%, 86%, 66%, and 40%, respectively. Overall survival resulted significantly higher for patients with Ki-67 expression $\leq 7\%$ than for those with Ki-67 $> 7\%$ ($p = 0.0347$).

Conclusion: LA is a promising and safe technique to treat LM from NEN. Further prospective studies involving larger series of patients followed for a longer time are strongly needed to provide definitive information on the long-term efficacy of this liver-directed therapy.

P-531

Temporary nerve block reduces pain and the requirement for IV medication induced conscious sedation during thermal ablation of hepatic tumors

K.S. He, A.A. AlGharras, A. Shrivastava, K. He, D.A. Valenti, A. Bessissow, T. Cabrera, L.-M.N.J. Boucher
Radiology, McGill University Health Centre, Montreal, QC, CA

Purpose: To assess whether a temporary nerve block performed immediately prior to thermal ablation of hepatic tumors reduces the need for IV medication induced conscious sedation.

Material and methods: Retrospective study performed between September 2015 and July 2017 looking at all patients who underwent a hepatic tumour thermal ablation under conscious sedation who received either a celiac plexus or a hepatic hilar nerve block. Equal number of patients who underwent a hepatic ablation without nerve block were randomly chosen during the same time period, matching for sex and tumour type. Patients with incomplete files or those who underwent a simultaneous trans-arterial chemoembolization were excluded.

Results: 32 patients fit the inclusion criteria, 16 received a nerve block and 16 did not. The average age, BMI, tumour type, tumour size, procedure time, ablation time, distance from tumor and distance from tumour to hilum were similar between the groups. Patients who received a nerve block had lower requirement for IV Fentanyl ($115.6 \pm 53.9\text{mcg}$ vs $240.6 \pm 71.2\text{mcg}$, $p=0.000004$) and IV Midazolam ($1.59\text{mg} \pm 0.55$ vs $2.94\text{mg} \pm 1.33$, $p=0.0008$), as well as diminished visual analog pain scores ($2.9/10 \pm 2.1$ vs $5.9/10 \pm 2.6$, $p=0.002$). No major complications occurred in the nerve block group, whereas 2 patients had clinically significant respiratory depression in the control group.

Conclusion: Within the limits of this retrospective study, our data suggests that celiac plexus and hepatic hilar nerve blocks are safe and can reduce pain and the requirement for IV medication induced conscious sedation during thermal ablation of liver tumours.

P-532

The role of sarcopenia in patients with intrahepatic cholangiocarcinoma after TACE and SIRT

F. Hahn¹, L. Müller¹, C. Düber¹, A. Weinmann², R. Kloeckner¹, A. Mähringer-Kunz¹

¹Department of Diagnostic and Interventional Radiology, University Medical Center of the Johannes Gutenberg University Mainz, Mainz, DE,

²Internal Medicine, Universitätsmedizin der Johannes Gutenberg-Universität Mainz, Mainz, DE

Purpose: Sarcopenia has been proposed as a prognostic parameter for patients with intrahepatic cholangiocarcinoma (ICC). The aim of this study was to investigate the role of sarcopenia in patients with ICC undergoing TACE or SIRT.

Material and methods: Between 1997 and 2018, 417 patients with ICC were referred to our tertiary care center. A total of 45 patients received TACE or SIRT and could be included in this study. These were compared to 198 patients undergoing liver resection. Psoas muscle index (PMI) served as an easy-to-measure marker of sarcopenia. Cut-off values for PMI regarding overall survival (OS) prediction were calculated using sex-specific optimal stratification and were compared to indicators of tumor burden: number and size of intrahepatic tumor(s), translobar spread, and tumor volume.

Results: While optimal stratification yielded PMI cut-offs that led to significantly shorter OS in the subgroup undergoing liver resection (cut-offs $5.74\text{cm}^2/\text{m}^2$ in men and $5.19\text{cm}^2/\text{m}^2$ in women, log-rank $p=0.002$, median OS 20.4 months vs 30.2 months), no significant cut-off values for PMI could be calculated for the subgroup undergoing TACE/SIRT (best log-rank $p=0.15$, cut-offs $5.00\text{cm}^2/\text{m}^2$ in men and $3.45\text{cm}^2/\text{m}^2$ in women, median OS 9.4 months vs 15.0 months). Tumor burden was significantly higher in the TACE/SIRT subgroup in all categories: multifocality in 62% vs 22% ($p<0.001$), mean sum of intrahepatic lesions 14.6cm vs 8.2cm ($p<0.001$), translobar spread (50% vs 8%, $p<0.001$), and tumor volume (0%-25%/25%-50%/>50% in 19/16/10 vs 164/32/2, $p<0.001$).

Conclusion: In contrast to patients undergoing liver resection, sarcopenia was not predictive in patients with ICC undergoing TACE/SIRT. This finding is most likely due to higher tumor burden in the TACE/SIRT collective in combination with the aggressiveness of this tumor entity, resulting in poor survival regardless of PMI.

P-533

Influence of correct needle placement on ablation success of irreversible electroporation

R.M. Mathy¹, P. Tinoush¹, D. Da Florencia Ricardo¹, A. Braun¹, O. Ghamar Nejad², D.-H. Chang¹

¹Department of Diagnostic and Interventional Radiology, University Hospital of Heidelberg, Heidelberg, DE, ²Department of General, Visceral and Transplantation Surgery, University Hospital of Heidelberg, Heidelberg, DE

Purpose: To evaluate the impact of needle geometry in irreversible electroporation (IRE) of hepatocellular carcinoma (HCC) on ablation success.

Material and methods: Retrospective analysis of 15 patients with incomplete ablation after IRE of HCC in a tertiary care hospital (NanoKnife, angiodynamics) from 2013 to 2018. For comparison 30 patients with technical successful ablation after IRE were matched. Needle geometry was evaluated in each patient by measuring several parameters such as tumor-center-to-ablation-center distance (TACD), tumor-to-needle distance (TND), needle divergence (NDiv) or needle depth (NDep). To improve needle placement 10 of these IREs were performed under assistance of a stereotactic navigation system (Cas-one IR, Cascination). Technical success was defined as complete ablation and absence of local recurrence in the first follow-up MRI scan after 6 weeks.

Results: Statistical analysis revealed that the average NDiv (3.7° vs 7.0° , $p=0.02$), the TACD (3.2 vs 11.6mm , $p<0.001$), the average TND (1.9 vs 4.7mm ,

$p=0.04$) and the average tumor diameter per needle (5.9 vs 7.5 mm/needle, $p=0.01$) were significantly lower in patients with complete ablation. The average number of needles used was higher in the group without residual tumor post ablation (3.1 vs 2.4 , $p=0.04$). In many cases with incomplete ablation NDep was too short (2.1 vs 6.8 mm tumor overlap beyond most proximal needle tip, $p<0.01$). Assistance by Cas-one IR lead to lower NDiv (2.1° vs 5.6° , $p<0.01$).

Conclusion: In this analysis parameters of needle geometry like NDiv or TACD could be identified as important factors for ablation success. Stereotactic navigation systems might be helpful for correct needle placement.

P-534

Neutrophil lymphocyte ratio: a kind of response predictors of neuroendocrine tumor liver metastasis treated by transcatheter arterial embolization

H. Liu¹, Y. Liu², W. Chen¹, L. Jiaping³, J. Chen⁴, Y. Wang¹

¹Interventional Oncology, 1st Affiliated Hospital of Zhongshan University, Guangzhou, CN, ²The Department of Interventional Oncology, The First Affiliated Hospital, Sun Yat-Sen University, Guangzhou, CN, ³Interventional Radiology, 1st Affiliated Hospital of SUMS, Guangzhou, CN, ⁴Gastroenterology, 1st Affiliated Hospital of Zhongshan University, Guangzhou, CN

Purpose: To evaluate whether Neutrophil Lymphocyte Ratio (NLR) can be predictive of response for Neuroendocrine Tumor Liver Metastasis (NETLM) treated by Transcatheter Arterial Embolization (TAE).

Material and methods: The data of blood routine within 38 patients who diagnosed as G1/G2 NETLM and treated by TAE were reviewed. NLR was obtained from the blood routine examined 1d before TAE, and 1d, 1wk, 1mo after treatment, respectively. The tumor response was assessed on CT/MRI data according to RECIST 1.1.

Results: A total of 96 treatments were performed in 38 patients, in which 81 treatments achieved CR/PR (response group) and the others for SD (non-response group). Median pre-TAE NLR in response group was 3.56 vs. 4.41 in non-response group ($p < 0.05$). In response group, the number of treatments with median pre-TAE NLR ≤ 1 mo post-TAE NLR was 72 vs. 5 for the outcome was assessed as SD ($p < 0.05$). But 1d and 1wk post TAE NLR is not relative with the response for NETLM after TAE.

Conclusion: NLR relate to prognosis of patients with NETLM after TAE and can be a predictive parameter for this treatment.

P-535

Clinical application value of robot three-dimensional target positioning system in percutaneous CT-guided interventional operation

C. Liu¹, D. Li²

¹Interventional Therapy Department, Beijing Cancer Hospital, Beijing, CN, ²Interventional Therapy & Imaging Center, Beijing New Journey Cancer Hospital, Beijing, CN

Purpose: To evaluate the clinical application value of MAXIO™V2 robot three-dimensional target positioning system in percutaneous CT-guided interventional operation.

Material and methods: A retrospective analysis of 51 patients with a total of 55 interventional procedures, including 49 needle biopsies and 6 thermal ablations, were divided into two groups. 33 procedures were performed in positioning system (PS) and 22 procedures were operated freehand (FH). PS group was divided into two subgroups: using positioning system only (PSO) and combined minor freehand adjustment (CFA). Patient preparation time (PT), operation time (OT), number of puncture (NP), radiation dose (RD) and complication rate (CR) were analyzed in the study.

Results: Significant statistical differences were observed in PT (16.90 ± 3.89 minutes Vs. 12.18 ± 3.29 minutes, $p < 0.001$) and NP (4.41 ± 2.10 times Vs.

7.45 ± 4.06 times, $p < 0.001$) between PS group and FH group. Subgroup analysis showed there were statistical significances of PT (17.36 ± 4.9 minutes Vs. 12.18 ± 3.29 minutes, $p < 0.01$), OT (3.45 ± 2.54 minutes Vs. 8.36 ± 6.53 , $p < 0.01$), NP (2.36 ± 0.67 times Vs. 7.45 ± 4.06 times, $p < 0.001$) and CR (18.18% Vs. 59.1% , $p < 0.05$) between PSO group and FH group. There was also statistical significance of PT (16.61 ± 3.26 minutes Vs. 12.18 ± 3.29 minutes, $p < 0.001$) between CFA group and FH group.

Conclusion: The MAXIO™V2 robot three-dimensional target positioning system can accurately plan the puncture path before the operation of CT-guided interventional procedures, which has fewer puncture times. In some certain cases, less operation time and lower incidence of complications were observed. A proficient learning curve can reduce patient preparation time. Changing the CT scan modality can reduce the radiation dose.

P-536

Chemosaturation with percutaneous hepatic perfusion of melphalan for liver-dominant metastatic uveal melanoma: a single center experience

C. Artzner¹, R. Syha², R. Hoffmann³, U. Grosse⁴, A. Forscher⁵, T. Eigentler⁵, G. Grözinger¹

¹Diagnostic and Interventional Radiology, University Hospital of Tuebingen, Tuebingen, DE, ²Radiology, Prosper-Hospital, Recklinghausen, DE, ³Diagnostic and Interventional Oncology, University Hospital of Tuebingen, Tuebingen, DE, ⁴Diagnostic and Interventional Radiology, University Hospital Tuebingen, Tuebingen, DE, ⁵Dermatology, University Hospital of Tuebingen, Tuebingen, DE

Purpose: To investigate the outcome and safety data of chemosaturation with percutaneous hepatic perfusion (C-PHP) of melphalan in patients with liver-dominant metastatic uveal melanoma.

Material and methods: This is a HIPAA compliant, IRB approved, retrospective study. A total of 14 patients (six men, mean age 64.4 ± 8.2 years) were treated with 26 unique C-PHP procedures (one to six C-PHP per patient) for liver-dominant metastatic uveal melanoma between June 2015 and September 2018. All patients received cross-sectional imaging at baseline and during follow-up. C-PHP was performed with the Hepatic CHEMOSAT® Delivery System (Delcath Systems, Inc., NY, USA) facilitating extracorporeal filtration of hepatic blood for melphalan. Ideal body-weight adjusted melphalan doses were administered into the hepatic arteries over 20 minutes. Serious adverse events (SAE), progression-free survival based on response criteria in solid tumors and overall survival were noted. Survival data was analyzed with Kaplan-Meier estimates.

Results: Median overall survival was 27.4 months (95% confidence interval [CI] 5.2; 35.4 months) after first C-PHP. Median progression-free survival was 8.5 months (95% CI 2.3; 21.4 months). SAEs were noted in three patients with one patient dropping out due to cardiac arrest, one patient developing severe leukocytopenia and one patient developing a transient decline in renal function.

Conclusion: In our cohort, C-PHP is a promising and safe treatment for patients presenting with hepatic metastasized uveal melanoma. Overall survival exceeds standard treatment which reports overall survivals of 10.2 months.

P-537

Percutaneous thermal ablation of adrenal cell carcinoma (ACC) metastases

D. Basile¹, C. Bertaggia¹, M. Calandri², V. Basile¹, G. Stranieri³, M. Terzolo¹, A. Veltri¹

¹Department of Oncology, Diagnostic and Interventional Radiology Section, University of Turin, Orbassano, IT, ²Radiology Institute, Department of Surgical Sciences, University of Torino, Turin, IT, ³Department of Oncology, University of Turin, Orbassano, IT

Purpose: Adrenal Cell Carcinoma (ACC) is a rare but very aggressive disease. Few data are present in the literature regarding the multidisciplinary management of the metastatic disease. Our purpose is to provide pertinent information about the role of percutaneous thermal ablation in this setting.

Material and methods: All patients underwent adrenalectomy followed by mitotante treatment. Radiofrequency and microwave ablation were used as part of multidisciplinary management for ACC in 16 patients (10F; mean age 42 years) in an attempt to provide locoregional control of metastatic disease and avoid additional surgery. Twenty-eight liver and four lung metastases were treated (mean size 26 mm). Hepatic procedures were performed under US guidance and lung procedures under CT guidance. We evaluated safety, local efficacy, clinical outcomes and their correlation with known prognostic factors.

Results: The periprocedural mortality was nil. A single adverse event occurred (3,1% of lesions), classified as major. It consisted of an intrahepatic haematoma. Complete ablation was achieved in 97% of cases. During the follow up (mean 46 months) local tumor progression was registered in 23,3% of lesions. Size resulted statistically significant in differentiating local outcome (p.009) and as a predictive factor with an AUC of 0.905 (p.0009). Hepatic progression was registered in 66% of patients, mainly due to new liver metastasis, with a median time of disease free survival of 25 months. The OS was 54% and 43% at 3 and 5 years, respectively, with a median time of survival of 48.6 months.

Conclusion: Thermal ablation provides a safe and effective reiterative treatment option in the complex multidisciplinary management of metastatic ACC.

P-538

Expression of VEGFR as response predictors of neuroendocrine tumor liver metastasis (NETLM) treated by transcatheter arterial embolization (TAE)

W. Chen¹, Y. Liu², H. Liu¹, L. Jiaping³, J. Chen⁴, Y. Wang¹

¹Interventional Oncology, 1st Affiliated Hospital of Zhongshan University, Guangzhou, CN, ²The Department of Interventional Oncology, The First Affiliated Hospital, Sun Yat-Sen University, Guangzhou, CN, ³Interventional Radiology, 1st affiliated hospital of SUMS, Guangzhou, CN, ⁴Gastroenterology, 1st Affiliated Hospital of Zhongshan University, Guangzhou, CN

Purpose: To evaluate whether expression of VEGFR can be used as a response predictor of NETLM Treated by TAE.

Material and methods: Thirty-three patients with G1 and G2 NET liver metastasis diagnosed by pathology and VEGFR was detected in primary or metastatic lesions before TAE treatment were enrolled. Repeatable measurements of hepatic lesions treated with TAE were used as target lesions in each patient. Radiological response of each target lesion was assessed on baseline and follow-up CT data according to RECIST 1.1.

Results: Thirty-three patients treated by TAE were selected. There were 24 patients with positive expression of VEGFR, among which 21 patients achieved CR/PR (response group) and 3 patients remained SD (non-response group). There were 9 patients with negative expression of VEGFR, including 5 patients in the CR/PR response group and 4 patients in the SD non-response group. This means that patients with

positive expression of VEGFR were significantly higher than those with negative expression of VEGFR in the response group (P=0.02).

Conclusion: The expression of VEGFR can be used to predict the tumor response to TAE in the treatment of NETLM.

P-539

Imaging response of selective balloon-occluded drug eluting beads - transarterial chemoembolization (bDEB-TACE) in hepatocellular carcinoma

A. Kohli, G. Schlaphoff, Y. El Hgar

Department of Interventional Radiology, Liverpool Hospital, Liverpool, NSW, AU

Purpose: Selective balloon-occluded drug eluting beads transarterial chemoembolization (bDEB -TACE) is potentially beneficial in the treatment of hepatocellular carcinoma (HCC). Theoretically this technique alters flow-dynamics, ideally improving therapeutic effect of drug-eluting beads (DEB). We describe imaging response in our single center experience utilizing bDEB-TACE.

Material and methods: Retrospective analysis was performed from May to December 2018 in which 19 HCC lesions in 13 patients (9 males, 4 females) with mean age 65 [50-82 years] and Child-Pugh A/B/C (12/1/0) were embolised with bDEB-TACE using Doxorubicin DEB therapy delivered utilizing a balloon occluding microcatheter (Occlusafe – Terumo, Japan). Target lesion imaging response was evaluated using Modified Response Evaluation Criteria for Solid Tumors (mRECIST) using multiphase contrast enhanced CT. Patient demographics, lesion characteristics, lab results, technical success and adverse events were recorded.

Results: A total of 15 bDEB-TACE procedures were performed and technical success was 100%. Mean follow-up time was 9 weeks [5-28 week]. Mean target lesion diameter was 41 mm [15-90 mm]. No patients demonstrated progression of disease at follow-up. 46% (6/13) of patients demonstrated a complete response and 54% (7/13) demonstrated partial response on follow-up. 60% (9/15) of procedures were performed via radial access. There were no intraprocedural complications. Statistical analysis of serum biochemistry demonstrated no significant difference in pre- vs post-procedure parameters.

Conclusion: bDEB-TACE is a feasible technique with good therapeutic effect and favourable safety profile in therapeutic embolisation of HCC. Our small subset of patients demonstrated a promising role for this technique with good outcomes, however further investigation with direct comparison to conventional therapies is warranted.

P-540

Cone beam CT assisted ablation of renal tumours: technical note and preliminary results

D. Rossi¹, G. Mauri², G. Bonomo², P. Della Vigna³, F. Orsi², L. Solbiati⁴, G.M. Varano², L. Monfardini⁵

¹Radiology, IRCCS Policlinico San Donato, San Donato Milanese, IT, ²Interventional Radiology, IEO European Institute of Oncology, Milan, IT, ³Radiology, European Institute of Oncology, Milan, IT, ⁴Division of Radiology, Humanitas University and Research Hospital, Rozzano (Milan), IT, ⁵Radiology, Interventional Radiology Unit, Fondazione Poliambulanza, Brescia, IT

Purpose: Renal ablation is a recognized treatment modality for small renal masses. Cone beam CT (CBCT) has been recently used in interventional oncology as a promising new guidance device, but this technology still needs to be validated for renal ablations. We aimed to assess technical feasibility of CBCT applications in renal ablative treatments.

Material and methods: From March 2016 to June 2018, 14 patients (7 female, 7 male, age range 54-83, mean 69 years) underwent 21 renal ablations for histologically proven renal cell carcinoma (RCC). All treatments were performed with ultrasound (US) and CBCT guidance under general anesthesia in a dedicated angiography room setting. CBCT was mainly

used to assess needle placement and to exclude complications at the end of the procedure. In two small lesions (< 1 cm) pre-acquired CBCT was co-registered with real-time US to obtain a US-CBCT fusion image-guidance for tumor ablation. One-month technical efficacy was evaluated. **Results:** Either alone or combined with US, CBCT was proved to be technically feasible in all 21 cases to guide or assist tumor ablation. Primary technical efficacy of thermal ablation was reached in 19 out of 21 ablations (90,1 %) at 1 month. Mean procedure duration was 100,2 minutes (range 160-64). Mean hospital staying was 2 days (range 1-10 days). All patients are still under active surveillance for a mean follow up of 14,5 months (range 4-26 months).

Conclusion: CBCT is a viable technique for renal ablation guidance. Larger series are needed to compare it to MDCT.

P-541

Does beads size change patient outcome for patients with liver-dominant colorectal cancer referred to DEBIRI plus systemic chemotherapy?

T. Boeken¹, N. Moussa¹, S. Pernot², C. Déan³, A. Abed¹, M.R. Sapoval¹, O. Pellerin¹

¹Interventional Radiology, Hopital Européen Georges Pompidou, Paris, FR, ²Gastroenterology and GI Oncology Unit, Georges Pompidou European Hospital, APHP, Paris, FR, ³Interventional Radiology, Hôpitaux de Paris, Hôpital Européen Georges Pompidou, Paris, FR

Purpose: The goal of the study is to assess whether DEBIRI beads size affect patient clinical outcomes.

Material and methods: Between Mar. 2009 and Jan. 2018 all consecutive patients referred to DEBIRI were included in this observational study. Patients were referred to 75-100µm or 100-300µm irinotecan loaded DC-beads. All patient clinical outcomes were monitored. Liver tumor response rate at 3 months (RECIST 1.0), liver, overall progression free survival, and overall survival was estimated with Kaplan Meier curves.

Results: 84 colorectal liver-dominant consecutive patients in a progressive disease (RECIST 1.0) status underwent 232 DEBIRI sessions. All patients had prior systemic treatment, from 2 to 5 lines of chemotherapy including oxaliplatin and irinotecan based chemotherapies. 54 and 30 patients received respectively 75-100µm or 100-300µm DC beads loaded with 100mg of irinotecan per vial. Systemic chemotherapy was given 15 days following DEBIRI. The 3 month overall tumor response rate was: progressive disease n=15 (18%); stable disease n=46 (55%) and partial response n=23 (27%). No complete response was observed. The median liver-PFS and overall-PFS were 230 days (±141). The median overall survival was 445 days (±229). When analyzing liver-PFS and overall survival by beads size groups, no significant difference was observed between groups.

Conclusion: DEBIRI with 75-100µm or 100-300µm did not show significant difference in patient outcome.

P-542

Efficacy and safety of percutaneous computed tomography guided radiofrequency ablation for treating metastatic lymph nodes

G. Iliadis¹, D.K. Filippiadis¹, A. Mazioti-Filippiadis¹, E. Alexopoulou², S. Argentos¹, A.D. Kelekis³, N.L. Kelekis¹

¹2nd Department of Radiology, University General Hospital ATTIKON, Athens, GR, ²Radiology Dept., Eugenidion University Hospital, Athens, GR, ³2nd Department of Radiology, National and Kapodistrian University of Athens, ATTIKON University General Hospital, Athens, GR

Purpose: To assess effectiveness and safety of computed tomography guided percutaneous radiofrequency ablation (RFA) of metastatic lymph nodes (LN) in a group of consecutive patients

Material and methods: Institutional database research identified 12 oligometastatic patients with pathologic solitary lymph nodes who underwent percutaneous computed tomography guided radiofrequency

ablation. All patients were evaluated prior to ablation either with MRI (including diffusion weighted imaging) or PET-CT and underwent biopsy on the same session with ablation using an 18 G semi-automatic soft tissue biopsy needle. Contrast-enhanced computed tomography or magnetic resonance imaging was used for post-ablation follow-up. Patient and tumor characteristics, radiofrequency ablation technique and complications were evaluated.

Results: Mean patient age was 67.66 years (male-female: 8-4). Average lesion size was 2 cm (range 1.2-3 cm). Malignant substrate included RCC (n=2), HCC (n=2), and colorectal carcinoma (n=2). Technical success was feasible in all 12 lymph nodes (100%); there were no complications reported according to the CIRSE classification reporting system. With a mean follow-up of 9.3 months (range 1-19 months), there was evidence of recurrence at ablated sites in 2/12 patients with lymph nodes of 3 cm in diameter. Both patients were retreated with no signs of local recurrence thereafter. After RFA, 5/12 metastatic LN completely disappeared and 7/12 remained as small scar-like lesions at the last follow-up visit.

Conclusion: Computed tomography guided percutaneous RFA for metastatic LNs is a feasible, safe and effective therapy. With this nonsurgical percutaneous therapeutic option metastatic lymph nodes can be eradicated with a very low complication rate.

P-543

Stressing the specific aspect of irinotecan loaded beads chemo-embolization post embolization syndrome

T. Boeken¹, A. Abed², N. Moussa¹, C. Déan³, J. Taieb⁴, M.R. Sapoval¹, O. Pellerin¹

¹Interventional Radiology, Hopital Européen Georges Pompidou, Paris, FR, ²Interventional Radiology, Gustave Roussy - Cancer Campus, Villejuif, FR, ³Interventional Radiology, Hôpitaux de Paris, Hôpital Européen Georges Pompidou, Paris, FR, ⁴Digestive Oncology, Hôpital Européen Georges Pompidou, Paris, FR

Purpose: Post-embolic syndrome is usually described as an association of pain, fatigue and hyperthermia. However, patients undergoing DEBIRI procedures seem to have a different clinical presentation. The goal of our study is to describe intra-procedural post embolization syndrome in patients and to set a systematic approach for its management.

Material and methods: Between Mar. 2009 and Jan. 2018 all consecutive patients referred to DEBIRI were included in this observational study. All patient adverse events were monitored until discharge. All procedures were performed under local anesthesia patient control anesthesia pump (morphine + ketamine). We hypothesized that when the treatment is fragmented into 4 sessions post-embolization syndrome would decrease by 20%.

Results: 84 consecutive colorectal liver-dominant disease patients underwent 232 DEBIRI sessions. 38 and 46 patients were assigned to a 2- and a 4- session liver treatment program respectively. 54 and 30 patients received 75-100µm and 100-300µm DC beads loaded with 100mg of irinotecan per vial respectively. All patients experimented a maximal pain on the VAS scale of 7.4 (±1.8), a maximal median arterial pressure of 127mmHg (± 15), and a minimal body temperature of 35.7°C (±1.1). When patients were assigned to a 4-session program (one lobe treated per session) compared to a 2-session program (both lobes treated during the same session) adverse event did not result in a significant difference.

Conclusion: Post embolization syndrome including pain, hypothermia and high blood pressure occurred in all patients undergoing DEBIRI and should be closely monitored and managed. Dose fragmentation did not lower the severity of the syndrome.

P-544

Percutaneous microwave ablation for the treatment of sarcoma lung metastases: a retrospective single-centre experience

C.S.J. Yeung¹, E. Lim¹, I. Mandal¹, W.Y. Quak¹, S. Bandula²

¹Centre of Medical Imaging, University College Hospital, London, UK, ²UCLH Interventional Oncology, University College London, London, UK

Purpose: Surgical resection is the established treatment for limited sarcoma lung metastases but is associated with significant morbidity and complications. Focal lung tumour thermal ablation has emerged as an effective minimally invasive alternative to surgery. Several series have demonstrated the safety and efficacy of radiofrequency ablation. Microwave ablation (MWA) is a more recent technology that offers more consistent tissue heating and lower susceptibility to heat sink cooling around pulmonary vessels. We report safety and efficacy outcomes of MWA for treatment of sarcoma lung metastases.

Material and methods: Retrospective study of 63 patients (28 male, 35 female; median age, 57 y; range, 11-85 y) treated with MWA for 156 pulmonary sarcoma tumours at a single tertiary centre between 06/2012 to 09/2017. 16 cases of bone and 47 of soft tissue sarcomas. Median tumour size was 17 mm (range, 8-45 mm). Technical success, complications, overall and progression-free survival were recorded.

Results: Primary technical success achieved in 97% of ablation sessions. Median CT follow-up interval was 17 months (range, 25 days-60 months). Median, 1-year, and 2-year overall survival were 34 months, 92%, and 73%. Post-procedure complications (Society of Interventional Radiology adverse event classification) were one severe (Takotsubo cardiomyopathy requiring transfer to cardiac unit); one moderate (delayed presentation one-week post-procedure with pneumothoraces needing drainage) and three mild (temporary urinary retention requiring catheterization and consolidation in the ablation zone necessitating oral antibiotics). Only one treatment session (out of 150) required an inpatient stay of >48 hours.

Conclusion: Small volume sarcoma pulmonary metastases can be managed safely and effectively with MWA.

P-545

The use of elastography to determine the radiofrequency ablation zone

O.I. Sukhodolska¹, D. Vieriemi¹, S. Balaka²

¹Medical Faculty No.1, Kharkiv National Medical University, Kharkiv, UA, ²Minimally Invasive Surgery, Endoscopy and Interventional Radiology, Grigoriev Institute for Medical Radiology, Kharkov, UA

Purpose: To evaluate the feasibility of real-time elastography of ablation size during RFA of liver tissue

Material and methods:

- 4 samples of ex-vivo bovine liver tissue
- Heating to 40° - 92°C by RF generator (COVIDIEN Cool-tip E Series)
- B-mode and pSWE imaging (ultrasonic scanner Soneus P7)
- Two thermocouples are located at 10-20 mm from the ROI
- The ablation zone is up to 15 mm

Results:

- SWV at room temperature 25°C: 1.4 m/s
- SWV decrease at 42°C
- Gradual SWV increase at 50-60°C
- Steep SWV increase at 64°C: mean value of 3.37 m/s

This table shows different ablation zones time after RFA

Ablation zones	At 0 min	At 15 min	At 30 min	At 60 min
Central necrotic zone	7.95 ± 1.38	7.78 ± 1.59	7.82 ± 1.43	7.63 ± 1.4
Lateral necrotic zone	5.32 ± 0.96	5.18 ± 1.26	5.23 ± 0.87	5.19 ± 0.99
Transitional zone	3.49 ± 0.63	3.35 ± 0.52	3.46 ± 0.56	3.39 ± 0.61
Unablated liver parenchyma	2.2 ± 0.38	2.11 ± 0.33	2.1 ± 0.35	2.09 ± 0.33

Conclusion:

- The use of elastography after the procedure of radiofrequency ablation is perspective immature technique that allows us to determine the zone of coagulation tissue necrosis and differentiate from healthy tissues, unlike other diagnostic methods
- An increase SWV leads to irreversible protein denaturation and necrosis of liver tissue
- SWV is useful for monitoring thermal effects made by RFA at temperatures > 45°C
- The possibilities of elastography require further study

P-546

Primary technical efficacy of stereotactic microwave ablation compared to non-navigated conventional MWA for ablation of liver malignancies

J. Schaible, L. Luerken, L.P. Beyer, C. Stroszczynski
Radiology, University Hospital Regensburg, Regensburg, DE

Purpose: To compare the primary technical efficacy of stereotactic microwave ablation (SMWA) with non-navigated conventional MWA (CMWA) for percutaneous ablation of liver malignancies.

Material and methods: We performed a single-center evaluation of 142 patients (117 male) who underwent MWA of primary or secondary liver malignancies. Median age was 65 years (range: 30 - 84). In total, 172 ablation sessions were performed with a median number of treatment sessions per patient of 1 (range: 1 - 9). Treated tumors were matched in terms of tumor size, entity, and liver segment. Endpoints were primary technical efficacy and complication rate.

Results: 236 tumors spread across all liver segments were treated using SMWA (118) or CMWA (118). The most frequent tumor entities were HCC (162) and colorectal liver metastasis (42), followed by CCC (14). Median tumor size was 16 mm, with 44 tumors being 30 mm or larger. The primary technical efficacy using stereotactic guidance was 90 %, i.e., 105 of the 118 tumors were covered entirely by the ablation volume. Primary technical efficacy for freehand ablation was 77 % (91 of 118 tumors). Tumor size wasn't a significantly unfavorable prognosticator of primary technical efficacy (p = 0.09). Compared with freehand antenna placement, stereotactic guidance was a highly significant favorable prognostic factor (odds ratio 3.3; p < 0.01). There was no significant difference in the frequency of adverse events (p = 0.07) between the two groups.

Conclusion: SMWA is superior to CMWA for percutaneous ablation of liver malignancies in terms of primary technical efficacy while maintaining a low complication rate.

P-547**Segmental chemoembolization versus superselective micro-embolization in well-defined primary hepatocellular carcinoma**A.A. Bessar¹, N.-E.A. Nour-Eldin²¹Radiology, Zagazig University, Zagazig, EG, ²Interventional and Diagnostic Radiology Department, Johann Wolfgang Goethe University, Frankfurt, DE

Purpose: To compare two methods of transarterial lipiodol - doxorubicin chemoembolization by either segmental chemoembolization or superselective micro-chemoembolization in well-defined primary hepatocellular carcinoma

Material and methods: Between January 2017 and June 2018, 120 patients with non-resectable primary hepatocellular carcinoma on top of cirrhosis were candidates for chemoembolization we included in our study. All lesions were well-defined according to contrast-enhanced studies. The patients were randomly assigned to the segmental chemoembolization group (A) and the superselective micro-chemoembolization group (B). Sixty patients were treated in each group. For all patients we inject same dose of lipiodol mixed and Doxorubicin.

Results: The patterns of lipiodol concentration and residual enhancement were equal in both groups being 31.7%, 23.3%, 15%, 13.3%, 11.7% and 5% for group A, and 36.7%, 18.3%, 13.3%, 15%, 13.3% and 3.3% for group B regarding six patterns of lipiodol concentration which are ranging from complete lipiodol concentration to absence of any evidence of lipiodol concentration. No significant differences in the cumulative new local peri-lesional recurrence rates in the both groups. In group A (8.3% at 1 month, 25% at months and 33.3% at 3 months) and in group B (16.7% 25% and 36.7%, respectively).

Conclusion: TACE yielded better outcomes with a non-resectable single tumors larger than 4 cm or lesions that couldn't be ablated, Further advancement of Microcatheter into the small sub-segmental vessels supplies the tumor has an advantage of avoiding non-target embolization of healthy tissues, however the segmental injection has more benefit for possible peri-lesional satellites that couldn't be discovered on routine practice.

P-548**Risk of pneumothorax and chest drain insertion following microwave lung ablation**

F. Parvulescu, J. Evans

Dept. of Radiology, Royal Liverpool University Hospital, Liverpool, UK

Purpose: Retrospective analysis to assess potential risk factors for developing pneumothorax and requiring intercostal chest drain insertion during microwave ablation (MWA) of lung tumours.

Material and methods: We analysed all MWA procedures of lung tumours performed at our institution over a 6-year period. 137 procedures were performed in 95 patients (58 men, 37 women; mean age 68 years, range 30-87), all under general anaesthesia, treating a total of 252 tumours (average 1.8 lesion per procedure, range 1-8). Electronic records and imaging were reviewed to evaluate the incidence of pneumothorax (PTX), the need for intercostal chest drain (ICD) insertion and potential risk factors for developing these complications.

Results: Pneumothorax requiring ICD insertion occurred after 71 procedures (52%); another 25 (18%) resulted in small PTX that resolved spontaneously. The risk of PTX was increased by treating multiple tumours (87% vs. 54%, RR 1.48; 95% CI [1.18-1.87]; $p = 0.0009$) and no history of previous ipsilateral ablation (78% vs. 42%, RR 1.87; 95% CI [1.22-2.86]; $p = 0.0041$). The need for ICD insertion was higher when treating multiple lesions (74% vs. 30%, RR 2.42; 95% CI [1.65-3.55]; $p < 0.0001$). Male gender and age were not significant risk factors for either PTX ($p = 0.31$ and $p = 0.17$ respectively) or ICD insertion ($p = 0.41$ and $p = 0.10$ respectively).

Conclusion: Pneumothorax requiring chest drain insertion after MWA of lung tumours is common, especially when multiple tumours are treated.

Previous ipsilateral ablation significantly reduces the risk of developing pneumothorax.

P-549**Detectability of target lesion during CT-guided tumor ablations: impact on ablation outcome**

E. Barzakova, F. Pedersoli, N. Senthivel, S. Keil, M. Schulze-Hagen, M. Zimmermann, P. Bruners, C.K. Kuhl, P. Isfort

Department of Diagnostic and Interventional Radiology, RWTH Aachen University Hospital, Aachen, DE

Purpose: Small hepatic malignancies scheduled for CT-guided percutaneous ablation may have been visible on liver MRI with liver-specific contrast agent, or in a specific phase of multi-phase CT, but may be occult on unenhanced CT used for ablation planning. We evaluated whether visibility of the target lesion would impact the treatment efficacy of CT-guided hepatic tumor ablations.

Material and methods: We included 48 patients with 79 liver cancers (30 primary, 49 metastases) who underwent IRE (n=33), RFA (n=25) or MWA (n=21) between 01/2015 and 04/2017. All ablations were performed under unenhanced-CT guidance. Non-visible lesions (NVL) were targeted through identification of anatomical landmarks on preinterventional contrast-enhanced CT or MRI. Rate of incomplete ablation, local recurrence rate, as well as local-recurrence-free survival were compared between visible lesions (VL) vs. NVL, as well as lesion and ablation zone size.

Results: 28 lesions were NVL, 51 lesions were VL on unenhanced CT. Mean follow-up was 15.3 months (14.3 for VL and 16.8 for NVL). Mean diameter of NVL and VL was similar (13.4 mm vs. 15.6 mm). Mean ablation zone size was similar (40 mm vs. 41 mm). Incomplete ablation was seen in similar frequencies (NVL: 11% [3/28] vs. VL: 4% [2/55]), as was local recurrence rate (NVL: 14% (4/28) vs. VL: 18% (9/55). Median local-recurrence-free-survival was (not statistically significantly) longer in NVL vs. VL (20.4 months vs. 14.0 months).

Conclusion: Tumor detectability on unenhanced planning CT does not have a significant impact on outcome after percutaneous liver ablations when known anatomical landmarks are used to guide needle placement.

P-550**Short-term effects of PRRT post hepatic embolization on liver function in mNET patients**D. Sikaria¹, J. Jesurajan¹, J. Smith², G. El-Haddad²¹School of Medicine, Morsani College of Medicine, USF, Tampa, FL, US,²Diagnostic Imaging and Interventional Radiology, Moffitt Cancer Center and Research Institute, Tampa, FL, US

Purpose: Evaluate liver toxicity in patients who received Peptide Receptor Radionuclide Therapy (PRRT) with ¹⁷⁷Lu-DOTATATE and hepatic embolizations for metastatic neuroendocrine tumors (mNET).

Material and methods: Retrospective review of mNET patients who had prior hepatic embolization [bland embolization (TAE), radioembolization (TARE), chemoembolization (TACE)] and got early access to PRRT including the first 6 months after US FDA approval. Patients who completed PRRT had at least 1 month follow up. Clinical, imaging and laboratory findings of last follow up were compared to pre-PRRT, and hepatic Common Terminology Criteria for Adverse Events (CTCAE) v5.0 grading post-PRRT was recorded.

Results: 33 patients (21 M, 12 F) with mNET (primary tumor: 4 Pancreas, 1 unknown, 23 small bowel, 3 rectum, 2 Cecum) completed 4 PRRT cycles. 17/33 had prior embolizations (13 TAE, 1 TACE, 1 TARE, 1 TAE+TACE, 1 TAE+TARE). Mean follow-up from last PRRT: 66+/-24 days. 1/17 patient developed short-term G3 liver toxicity with elevated ALT. None of the non-embolized 16/33 patients had hepatic CTCAE >G2. 14 patients could not complete PRRT, 5 of them had prior embolization (4 TAE, 1 TACE). PRRT discontinued due to: tumor progression (n=7), deterioration in performance status (n=2), frozen abdomen in the setting of extensive

peritoneal carcinomatosis (n=2), progression of non-mNET melanoma metastases (n=1), neutropenia (n=1). One patient (1/14) who had prior TAE discontinued PRRT for dehydration and G3 liver toxicity.

Conclusion: There is low risk of high-grade hepatotoxicity in mNET patients who received hepatic embolization followed by PRRT. Most common cause for a serious adverse event in this group of patients is tumor progression.

P-551

Stereotactic microwave ablation (SMWA) of invisible liver lesions using MRI fusion

M.H. Maurer¹, M. Cathomas², D. Candinas², P. Tinguely², J. Heverhagen³, A. Lachenmayer²

¹Radiology, Bern University Hospital, Bern, CH, ²Surgery, Bern University Hospital, Bern, CH, ³Radiology, Inselspital, Bern, CH

Purpose: Thermal ablation is an increasingly accepted option for treating primary liver tumors or hepatic metastases as an alternative to liver resection or as part of a multi-modality treatment concept. The objective of our study was to access technical feasibility and technical success of patients treated with stereotactic microwave ablation (SMWA) using MR/CT fusion for "invisible lesions" in a prior CT planning scan.

Material and methods: Radiological reports and imaging data during SMWA at the Department of Radiology of the University Hospital in Bern from January 2015 to December 2018 were retrospectively analyzed.

Results: A total of 236 patients received 312 SMWAs with 496 lesions being ablated. In 22 (7.1%) of these interventions, a total of 43 (8.7%) hepatic lesions were not visible on the pre-interventional CT scan. Sixteen patients had hepatocellular carcinoma, 5 hepatic metastasis and 1 an intrahepatic cholangiocarcinoma metastasis. Following image fusion, 40 (8.5%) lesions were sufficiently visible to perform SMWA. Thirty (75%) of the 40 lesions were located in the right liver. Mean tumor size was 12 (3 - 28) mm. The mean follow-up of the lesions was 321 (81-779) days. Two lesions (5%) showed an incomplete ablation in the first follow-up imaging and were re-ablated. Five lesions (12.5%) showed a local recurrence, 3 of them were successfully re-ablated, 2 lesions will be radiologically controlled in 3 months.

Conclusion: SMWA with CT/MR fusion offers an efficient and safe treatment option for patients with small malignant liver lesions not detectable on pre-interventional CT imaging and not amenable to surgery.

P-552

Validation of PADUA and R.E.N.A.L. nephrometry scoring systems in percutaneous ablation for renal cell carcinoma

K. Mahmoud¹, A.J. Gunn¹, W. Joe¹, H. EL Khudari¹, A. Salei¹, E. Keasler¹, E. Bready¹, P. Patten¹, R. Oser², A.K. Abdel Aal¹

¹Interventional Radiology, University of Alabama at Birmingham, Birmingham, AL, US, ²Radiology, University of Alabama at Birmingham (UAB), Birmingham, AL, US

Purpose: To investigate the ability of R.E.N.A.L. nephrometry and PADUA scoring systems to predict the complications and survival outcomes in patients who underwent image-guided renal tumor ablation regardless of the ablation modality used.

Material and methods: We retrospectively reviewed the medical records of 206 patients who had renal cell carcinoma that was treated with thermal or non-thermal ablation. The data on demographics, modality of ablation and tumor characteristics were reported. The RENAL and PADUA scores were calculated. Technical success and complications were analyzed. Kaplan Meier curves for recurrence free, cancer specific and overall survival were obtained.

Results: The study included 206 patients, 123 (59.7%) males, with a mean age of 64.8 (SD=11.4) years. There were 69 (33.5%) patients with CKD stage 3. Mean tumor size was 2.6 (range= 0.6-6.7 cm) cm, with 121 tumors (58.5%) located posteriorly. Technical success was seen in 190(92.2%)

patients. Thirty-day complications was 27.2%. Recurrence free and overall survival at 1 year was 92% and 98.2% respectively. There was no correlation between the RENAL and PADUA scores with the occurrence of complications, recurrence free survival or overall survival. The nearness to the collecting system, involvement of renal sinus and biopsy before the procedure were correlated with the occurrence of complications (p=0.01, p=0.03 and p=0.018 respectively).

Conclusion: RENAL and PADUA scores did not correlate with the occurrence of complications, recurrence free survival or overall survival in patients with renal cell carcinoma treated with percutaneous ablation. However, preprocedure biopsy, involvement of renal sinus and displacement/infiltration of the collecting system were independent predictors of complications.

P-553

Safety and efficacy of intra-arterial calcium stimulation for preoperative localization of occult functional neuroendocrine tumors: a 15-year single-center multi-hospital experience

M.S. Patil¹, N. Kokabi², L.G. Martin¹, S. Dariushnia¹, M. Xing¹, Z.L. Bercu¹

¹Interventional Radiology, Emory University School of Medicine, Atlanta, GA, US, ²Division of Interventional Radiology and Image Guided Medicine, Department of Radiology, Emory University School of Medicine, Atlanta, GA, US

Purpose: Surgical resection is the first-line treatment for neuroendocrine tumors (NET). Cross-sectional imaging is unreliable in localizing lesions <1cm. This study investigated the safety and efficacy of intra-arterial calcium stimulation testing in preoperative localization of functional NET within the pancreas.

Material and methods: Retrospective review of patients referred for localization of radiologically occult functional NET from 2004-2019 was performed at a single institution. The technical and clinical success and periprocedural complications of the test were evaluated.

Results: Twenty-two (N=22) consecutive patients referred to interventional radiology for calcium stimulation test were included. Mean age was 53 years. Nineteen (86%) were female and 16 (73%) were Caucasian. An average of 1.8 alternate imaging modalities including octreoscan, CT, MRI and endoscopic ultrasound were performed prior to calcium stimulation without definitive localization of the lesion. The procedure was technically successful in 100% of patients. Hypoglycemia managed without admission was observed in 2 patients. No major complications were observed. Occult NET was localized in 16 (76%) patients. Tumor blush was seen in 1 patient. The test accurately predicted the location of the lesion in 14 (88%) of the patients. Of note, in all six patients in whom the test did not localize a tumor, alternate etiologies/diagnoses were eventually made. Sensitivity, specificity and positive predictive value of the stimulation test for occult functional NET localization were 100%, 75%, and 88%, respectively.

Conclusion: Intra-arterial calcium stimulation is a safe and efficacious procedure to localize radiologically occult functional NET within the pancreas. Lack of tumor blush did not preclude presence of occult NET.

P-554

Ablation therapy for early stage non-small cell lung cancer: a National Cancer Data Base study

H.X. Bai¹, J. Wu², Z.-S. Zhang³

¹Department of Radiology, Hospital of the University of Pennsylvania, Philadelphia, PA, US, ²Radiology Department, The Second Xiangya Hospital, Changsha, CN, ³Department of Radiology, The Second Xiangya Hospital of Central South University, Hunan, CN

Purpose: This study is to evaluate the overall survival (OS) outcomes of ablation for patients with early stage non-small cell lung cancer (NSCLC).

Material and methods: Patients with stage I (T1-T2aN0M0) NSCLC from 2004 to 2014 who were treated with ablation, SLR or SBRT as the sole treatment were identified from the National Cancer Data Base. Overall survival (OS) was estimated using the Kaplan-Meier method and evaluated by log-rank test, univariate and multivariate Cox proportional hazard regression, and propensity score-matched analysis. Relative survival analyses compared to age- and gender-matched US population were performed. **Results:** A total of 54,595 patients were identified. The 1-, 2-, 3- and 5-year relative survival rates were 89%, 72%, 57% and 36% for ablation (n=774), 93%, 78%, 65% and 46% for SBRT (n=23,078), and 96%, 90%, 84% and 73% for SLR (n=30,743). Propensity score matching resulted in 639 patients in the ablation group versus 1203 in the SLR group, and 674 patients in the ablation group versus 1346 in the SBRT group. After matching, ablation was associated with shorter OS when compared to SLR (HR, 2.092; 95% CI, 1.842-2.376; $p < 0.001$) or SBRT (HR, 1.322; 95% CI, 1.183-1.477; $p < 0.001$). These results persisted in patients with tumor size ≤ 1 or 2 cm. **Conclusion:** Preliminary results suggest ablation may be associated with decreased OS in patients with early stage NSCLC compared with SLR or SBRT.

P-555

The hepatic hilar block, a new technique aimed at improving pain management during transarterial chemoembolization of liver lesion

A. Shrivastava¹, D.A. Valenti¹, D.M. Liu², K.S. He³, T. Cabrera¹, R. Abu Hana³, L.-M.N.J. Boucher³

¹Radiology, McGill University, Montreal, QC, CA, ²Interventional Radiology, Vancouver General Hospital, Vancouver, BC, CA, ³Radiology, McGill University Health Centre, Montreal, QC, CA

Purpose: To describe the technique used to perform a hepatic hilar block and assess its performance in pain control related to transarterial chemoembolization of hepatic tumours.

Material and methods: Technique involved the ultrasound guided placement of a 22G needle between the hepatic artery and portal vein, and infusion of 10 ml of 1% ropivacaine after confirming the absence of any potential intravascular leakage. Retrospective audit from January 2016 to December 2018 was conducted for the cases receiving hepatic hilum block immediately before the transarterial chemoembolization (TACE) for pain control (n=5). Patients with similar tumour burden and demographic profile that did not receive a block were selected as controls (n=5). Only cases exclusive to TACE and having had preemptive blocks were included. Use of fentanyl and midazolam was audited during the procedure and compared between both groups.

Results: Of 5 cases who received the block, 3 patients did not require any IV medication for pain control. The average consumption of midazolam was 1mg (± 1.4 SD) in block group and 2.8 (± 0.83 SD) mg in control group. Fentanyl consumption was 70 micrograms (± 97.5 SD) in block group and 220 micrograms (± 160 SD) in control group. There were no complications from the block. These differences were statistically significant for decrease use of both midazolam and Fentanyl in the block group (one-tailed t-test, $p=0.04$, $p=0.05$ respectively)

Conclusion: Given the limitations of this small sample, hepatic hilar blocks are safe and feasible in reducing IV sedation needed during the chemoembolization.

P-556

Complications after 100 sessions of cone beam computed tomography-guided lung radiofrequency ablation: a single center's experience

M.S. Kim, H.P. Hong, M.H. Rho

Radiology, Kangbuk Samsung Hospital, Sungkyunkwan University School of Medicine, Seoul, KR

Purpose: To evaluate complications after consecutive 100 sessions of cone beam computed tomography (CBCT)-guided lung radiofrequency ablation (RFA).

Material and methods: Complications were evaluated for each RFA session in 63 consecutive patients with 121 lung tumors who underwent 100 sessions of CBCT guided lung ablation with an internally cooled RFA system. A major complication was defined as a grade 3 or 4 adverse event.

Results: There was no mortality. The major and minor complications were 5% and 29%. The major complications were pneumonia (2%), bleeding requiring transfusion (2%), and bronchopleural fistula. The minor complications were pneumothorax (14%), self-limiting hemoptysis (10%), effusion (3%), and subcutaneous emphysema (2%). Immediate, periprocedural and delayed complications were 21%, 12%, and 1%

Conclusion: CBCT- guide lung RFA is a safe procedure with acceptable morbidity.

P-557

The efficacy of Yttrium-90 radioembolization of hepatocellular carcinoma as a bridge to liver transplantation

A. Villalobos¹, J. Zhang², M. Ermentrout³, Z.L. Bercu⁴, N. Kokabi²

¹Department of Radiology, Emory University Hospital, Atlanta, GA, US, ²Interventional Radiology, Emory University School of Medicine, Atlanta, GA, US, ³Radiology and Imaging Sciences, Emory University School of Medicine, Atlanta, GA, US, ⁴Division of Interventional Radiology and Image-Guided Medicine, Emory University School of Medicine, Atlanta, GA, US

Purpose: To evaluate the efficacy of Yttrium-90-radioembolization (Y90-RE) to either maintain potential candidacy or downstaging patients with hepatocellular carcinoma (HCC) who do not meet Milan Criteria (MC) for liver transplantation (LT).

Material and methods: Retrospective analysis of a single-institution electronic medical record was performed to identify patients with HCC who received Y90-RE. Only patients within MC at baseline or those with downstaging potential confirmed by multidisciplinary tumor board were included. Prognostic factors potentially affecting candidacy status were determined using chi-square analysis.

Results: Between 2014 and 2017, 79 patients received Y90-RE. Of those, 32(41%) and 47(59%) were within and outside MC at the time of Y90-RE, respectively. In the within MC group, eligibility was maintained in 27(84%) patients, lost in 3(9%) patients, and 2(6%) patients were lost to follow-up. Of the 30(94%) patients who were followed-up, 10(33%) patients received LT. In the outside MC group, eligibility was attained in 24(51%) patients and unchanged in 23(49%) patients. Within this group, 14(30%) patients received LT. Sub-analysis of the within MC group demonstrated a higher MELD score and alkaline phosphatase prior to Y90-RE in the group who lost eligibility as compared to the group that maintained eligibility ($p < 0.05$). Sub-analysis of the outside MC group revealed a lower BCLC stage, higher sodium, lower alkaline phosphatase, and lower INR prior to Y90-RE in the down-staged/attained eligibility group as compared to the unchanged eligibility group ($p < 0.05$).

Conclusion: Y90-RE is effective in bridging HCC patients to transplantation. Certain patient characteristics, such as favorable baseline liver and renal functions, likely predict successful bridging to LT.

P-558

Radiotherapy concomitant selective transarterial cisplatin infusion therapy (RADPLAT): clinical results evaluated with anatomical and technical aspects

S. Tanoue¹, N. Tanaka², M. Koganemaru¹, A. Kuhara¹, T. Kugiyama¹, T. Abe¹

¹Radiology, Kurume University School of Medicine, Kurume, JP,

²Radiology, Kurume University, Fukuoka, Kurume, JP

Purpose: Radiotherapy concomitant selective transarterial Cisplatin infusion therapy (RADPLAT) is a well-established treatment for laryngeal carcinoma owing to high rates of functional preservation. Most laryngeal carcinoma is fed by the superior laryngeal artery (SLA), however we sometimes encounter technical difficulty and/or procedure-related complication depending on the anatomical configuration of the feeders. In this study, the clinical results of RADPLAT were evaluated with focusing on the anatomical and technical aspects.

Material and methods: Forty patients, who had undergone RADPLAT between 2009 and 2018, were retrospectively evaluated. Depending on the relationships with superior thyroidal artery (STA), branching patterns of SLA were classified into four types including independent type, origin, proximal and distal part of STA on selective angiography. The tumor control and complication rate were evaluated in each type.

Results: The types of SLA were distal type in 22, proximal type in 12, origin type in four, and independent type in one. In distal type group, grade 3 mucositis was seen in one (4.5%). In contrast, grade 3 mucositis was seen one of origin type (25%) and one independent type (100%). All of grade 3 mucositis case had undergone selective infusion into SLA. The overall survival was 34 patients (85%). There was no significant difference among each anatomical type of SLA.

Conclusion: The proximal and origin type of SLA requires selective cannulation of SLA to stabilize the catheter, however it might be risk of mucosal adverse effect. The technical improvement of catheterization without selective SLA injection should be considered to avoid severe complication.

P-559

Outcomes of manual aspiration thrombectomy for symptomatic ilio-femoral venous thrombosis in cancer patients

H.S. Kim, E.H. Kim, H.G. Lee, H.J. Chun, B.G. Choi, J.S. Oh, K.H. Lee
Radiology, Seoul St. Mary's Hospital, College of Medicine, The Catholic University of Korea, Seoul, KR

Purpose: To determine the outcomes and feasibility of manual aspiration thrombectomy (MAT) for treatment of symptomatic ilio-femoral deep vein thrombosis (IFDVT) in cancer patients.

Material and methods: In this retrospective study, one hundred and thirty-five consecutive patients (56 men; mean age, 63 years; 149 limbs) with acute (n=113; 83.7%), subacute (n=14; 10.4%), and chronic (n=8; 5.9%) symptomatic IFDVT underwent MAT-based endovascular treatment, with adjunctive balloon angioplasty and stent placement performed in 94 patients. Degree of thrombus removal on venography and symptom improvement was assessed for evaluation of technical and clinical success, respectively.

Results: Technical success (thrombus removal > 50%) was achieved in 90.4%, and clinical success was observed in 71.5%. The primary patency rates were 88.1%, 81.6%, 76.0%, 74.1% and 69.1% at 1, 3, 6, 12, and 30 months, respectively. Recurrent IFDVT occurred in 19.3% of patients, 0.79 cases per patients-years of follow up. According to the analysis by causes of IFDVT, recurrent rate was 19.3%, 21.2%, and 14.3% in unknown, compression/invasion of the vein by cancerous mass, and May-Thurner syndrome groups, respectively (p=0.798). No procedure-related complication developed.

Conclusion: MAT is a feasible treatment option with favorable outcomes and minimal risk of complication in cancer patients with symptomatic IFDVT.

P-560

Transarterial chemoembolization of liver metastatic neuroendocrine tumors

J. Izaaryene, N. Daidj, G. Piana

Imaging Department, Institut Paoli Calmettes, Marseille, FR

Purpose: To evaluate tumor response and clinical outcome of Transcatheter arterial chemoembolization for patients with neuroendocrine tumors (NET).

Material and methods: We reviewed clinical data related to TACE and radiological response in all patients treated in our center from 2009 to 2018.

Results: 39 patients underwent 72 interventions (64.7 years [9.7], 54% females). 21 patients (54%) treated with 1 session, 11 (28%) with 2 sessions, 4 (10%) with 3 sessions, 1 (2.6%) with 4 sessions, 1 (2.6%) with 6, 1 (2.6%) with 7 sessions. NET originated from pancreas (31%), small bowel (41%), colon (3%), lung (18%), unknown localization (7%). Average percentage of Ki67 was 10% [SD=0.1]. All session included, one technical failure (dissection), no digestive perforation, 22 procedures with pain (30%), fever following 20 procedures (28%), asthenia after 21 (29%), 15 sessions with nausea or vomiting (20%), 15 alopecia (25%). 24 (61%) were symptomatic before and 18 (75%) were relieved the 1er TACE. Among all TACE procedures, 9 caused (12.5%) a grade 1 cytotoxicity, 12 (17%) a grade 2 cytotoxicity, 11 (15%) a grade 3 cytotoxicity and 15 (20%) a grade 4 cytotoxicity. 6 TACE caused hepatic cell failure (8%). After the first TACE, 26 patients (70%) presented a PR, 7 (19%) a SD, 4 (11%) a PD. After second TACE, 12 patients (70%) presented a PR, 2 (12%) a SD, 3 (18%) a PD. 1, 2, and 5 year overall survival of 87%, 51% and 33% respectively.

Conclusion: TACE appears to be effective for controlling liver metastases in patients with NETs.

P-561

Efficacy of percutaneous microwave ablation of histologically proven T1 renal cell carcinoma

B.M. Aarts¹, W. Prevoo², M.A.J. Meier³, A. Bex⁴, R.G.H. Beets-Tan¹, E.G. Klompenhouwer¹, F.M. Gómez⁵

¹Department of Radiology, The Netherlands Cancer Institute, Amsterdam, NL, ²Radiology, OLVG, Amsterdam, NL, ³Department of Radiology, Isala Hospital, Zwolle, NL, ⁴Department of Urology, The Netherlands Cancer Institute, Amsterdam, NL, ⁵Vascular & Interventional Radiology, Hospital Clinic de Barcelona / The Netherlands Cancer Institute, Barcelona / Amsterdam, ES/NL

Purpose: To assess the safety and efficacy of percutaneous microwave ablations (MWA) of histologically proven T1a and b Renal Cell Carcinoma (RCC).

Material and methods: We performed a retrospective analysis of patients with histologically proven RCC (<7 cm), treated by means of percutaneous MWA from 2012-2017. We reported primary and secondary efficacy, one-year success rate, local tumour progression (LTP), morbidity and mortality. Efficacy was defined as no residual enhancement in the ablation zone on follow-up imaging 1 month after the first ablation (primary efficacy) and second ablation (secondary efficacy). Complications were registered according to the Clavien Dindo classifications.

Results: A total of 107 histologically proven lesions in 100 patients were ablated with MWA. Median size was 3.2 cm (R 1.1-6.7cm) with 85 T1a and 22 T1b lesions. Median follow-up time was 24 months (R:0.4-63 months). Primary efficacy was 89% for T1a lesions and 55% for T1b lesions (p=0.001). Fourteen lesions were re-ablated by MWA with a secondary efficacy of 86% (T1a) and 57% (T1b) (p=0.569). One year treatment success was 96% (T1a) and 77.8% (T1b) (p=0.021). LTP was observed in 4 patients of which

2 were successfully treated by MWA. Major complications consisted of one death (cardiac failure) and four ureter pelvic junction stenosis that resulted in loss of the kidney.

Conclusion: Microwave ablation is effective for T1a RCC lesions with a significant lower primary efficacy for T1b lesions.

P-562

Intra-arterial Mitomycin C infusion in advanced liver metastatic breast cancer: factors influencing outcome

B.M. Aarts¹, E.G. Klompenhouwer¹, R.C. Dresen², A. Laenen³, R.G.H. Beets-Tan⁴, K. Punie⁵, P. Neven⁵, H. Wildiers⁵, G. Maleux²
¹Radiology, Antoni Van Leeuwenhoek, Amsterdam, NL, ²Radiology, University Hospitals Leuven, Leuven, BE, ³Biostatistics and Statistical Bioinformatic, University Hospitals Leuven, Leuven, BE, ⁴Department of Radiology, The Netherlands Cancer Institute, Amsterdam, NL, ⁵Department of Oncology, University Hospitals Leuven, Leuven, BE

Purpose: The aim of this study was to determine the safety and efficacy of Mitomycin C (MMC) infusion in chemo resistant liver metastatic breast cancer patients (LMBC) and to determine factors influencing overall survival.

Material and methods: We retrospectively analysed LMBC patients, treated with MMC infusion between 2000 and 2017. Hepatic response was measured with baseline CT scans and first available CT scan after MMC infusion by RECIST 1.1 criteria. Adverse events were registered by the CTCae version 5.0. Overall survival (OS) and hepatic progression free survival (hPFS) were evaluated using Kaplan Meier estimates. After univariable analysis, a stepwise forward multivariable (MV) prediction analysis was developed to select independent pre-treatment factors associated with OS.

Results: We included 176, mostly heavily pre-treated patients with a median time from diagnosis of MBC to MMC infusion of 36.9 months. RECIST evaluation of liver lesions (n=132) showed a partial response rate 15% (n=26), stable disease of 43% (n=76) and progressive disease in 17% (n=30). Adverse events grade 3 and 4 were reported in 17.5%. Median PFS was 5.5 months and median OS was 7.8 months. Significant independent baseline predictors of worse OS on MV analysis included number of prior systemic chemotherapy lines, prior liver ablation, higher liver tumour burden, elevated levels of bilirubin and ALT.

Conclusion: MMC infusion was safe and effective in advanced LMBC patients. MV analysis showed a worse OS in patients with increased number of prior systemic chemotherapy lines, prior liver ablation, higher liver tumour burden and elevated levels of bilirubin and ALT.

P-563

Prospective, mono centre pilot study of sequential intra-arterial infusion of Y90-labeled microspheres and Mitomycin C in chemo refractory liver metastatic breast cancer

B.M. Aarts¹, E.G. Klompenhouwer¹, R.C. Dresen², C. Deroose³, R.G.H. Beets-Tan¹, K. Punie⁴, P. Neven⁴, H. Wildiers⁴, G. Maleux²
¹Department of Radiology, The Netherlands Cancer Institute, Amsterdam, NL, ²Department of Radiology, University Hospitals Leuven, Leuven, BE, ³Department of Nuclear Medicine, University Hospitals Leuven, Leuven, BE, ⁴Department of Oncology, University Hospitals Leuven, Leuven, BE

Purpose: In this pilot study we evaluated the safety of intra-arterial Mitomycin C (MMC) infusion after intra-arterial radioembolization with Yttrium (Y90) in chemo refractory liver metastatic breast cancer (LMBC).

Material and methods: Sixteen LMBC patients were included in this pilot study from 2012-2018 and first received Y90. The response after Y90 was evaluated with MRI, PET and laboratory tests. After assessment of no progression of disease, Mitomycin C infusion was administered in different dose cohorts; A: 6mg in 1 cycle, B: 12 mg in 2 cycles, C: 24 mg in 2 cycles and D: max 72 mg in 6 cycles. In cohort D the response was evaluated after every 2 cycles and continued if no disease progression

occurred. Adverse events (AE) were measured according to common toxicity criteria adverse events (CTCae) version 5.0.

Results: Sixteen patients received Y90 treatment. Three patients showed disease extra hepatic progression and 1 patient had serious side effects of Y90, and consequently, were excluded for further intra-arterial therapy. The intended dose of MMC was adjusted in 5 out of the 12 patients due to progressive disease (n=3) and biochemical toxicities (n=2). No grade 3 AE or higher were reported after MMC infusion. Three grade 2 AE were reported consisting of thrombocytopenia (n=1), leukopenia (n=1) and increase in bilirubin levels (n=1).

Conclusion: The combined treatment of intra-arterial MMC infusion after Y90 is safe with low grade adverse events when MMC is administered in different escalating dose cohorts and adjusted based on clinical, radiological and biochemical parameters.

P-564

Renal tumours ablation: the potential role of laser ablation

G. Mauri¹, S. Sartori², P. Tombesi³, C.M. Pacella⁴, G. Bonomo¹, P. Della Vigna⁵, F. Orsi¹

¹Interventional Radiology, IEO European Institute of Oncology, Milan, IT, ²Department of Internal Medicine - Section of Interventional Ultrasound, St. Anna Hospital, Ferrara, IT, ³Interventional Ultrasound, Sant'Anna Hospital, Ferrara, IT, ⁴Interventional Radiology, Ospedale Regina Apostolorum, Albano Laziale, IT, ⁵Radiology, European Institute of Oncology, Milan, IT

Purpose: To retrospectively evaluate feasibility, safety and efficacy of percutaneous laser ablation in the treatment of renal tumours.

Material and methods: 13 patients (10 males and 3 females, age range 51 – 82 years) with a primary (10 patients) or recurrent (3 patients) renal cell carcinoma (RCC) underwent treatment with percutaneous laser ablation with a laser operating at 1.064 nm. In 9 cases patients were judged to be at high surgical risk due to comorbidities or advanced renal failure. 21 G needles (one to three according to lesion size) were inserted under US and CT guidance at the level of the lesion to be treated and than 300 µm bare optical fibers were inserted. Ablation was performed with a 3-SW fixed protocol, for a maximum of 1800J each illumination. Technical success, technique efficacy, and major complications were recorded.

Results: All procedures were completed as planned (technical success 100%). No major complications occurred. A small asymptomatic haematoma occurred in one case. At 1month complete ablation was observed in 12/13 lesions cases (92.3%). In one case of primary RCC residual vital tissue was recognised, and successfully treated in a second session. At a median follow-up of 21months (range 2-49 months) no local recurrence occurred.

Conclusion: laser ablation appear to be feasible, safe and effective in the treatment of RCC, even in cases at increased risk due to severe comorbidities.

P-565

Selective internal radioembolization therapy with yttrium-90 resin microspheres in metastatic colorectal cancer: impact of primary tumor site and mutational status

M. Koehler¹, K. Rahbar², L. Stegger², F. Haders¹, W. Heindel¹, M. Wildgruber¹

¹Department for Clinical Radiology, Universität Münster, Münster, DE, ²Nuclearmedicine, Universitätsklinikum Münster, Münster, DE

Purpose: To investigate the impact of the location of the primary tumor and mutational status in unresectable metastatic colorectal on survival treated with Y-90 radioembolization.

Material and methods: 63 patients (mean age 64 years, range 38-83 years) with biopsy proven metastatic colorectal cancer were treated using Y-90 resin microspheres. A retrospective monocenter observation was performed. In 16 (25,4%) the tumor was in the right side of the colon while in 43 (68,3%) the tumor was located on the left side. KRAS Status

was wildtype for 47 (74,6%) and KRAS mutation in 16 patients (25,4%). All patients treated with Y-90 resin spheres had an approval of the multidisciplinary gastrointestinal tumor board. Partition model was used for Y-90 dose calculation. Clinical, laboratory and cross-sectional imaging follow-ups were scheduled 12 weeks after treatment. Radiological response was evaluated via CT or MRI imaging using the mRECIST criteria. **Results:** 30 patients (47,2%) had a tumor burden below 25%, 31 (49,2%) had a tumor burden between 25-50%, and two (3,2%) of more than 50%. 23 patients (36,5%) were treated on the right lobar, while forty patients (63,5%) were treated bilobar. Overall survival following radioembolization was significant longer when the tumor was located in the left colon: 11,1 months (range 1,1 to 21,1 months) compared to 6,2 months (range 5,7-6,6) $p=0,031$. The KRAS status had no impact on the overall survival. **Conclusion:** We conclude that Y-90 radioembolization in mCRC patients treated with Y-90 shows improved outcome in patients with tumors in the left colon. KRAS mutation did not have an impact on overall survival.

P-566

Selective internal radioembolization therapy with yttrium-90 resin microspheres in unresectable intrahepatic cholangiocarcinoma

M. Koehler¹, K. Rahbar², L. Stegger², F. Harders¹, W. Heindel¹, M. Wildgruber¹

¹Department for Clinical Radiology, Universität Münster, Münster, DE, ²Nuclearmedicine, Universitätsklinikum Münster, Münster, DE

Purpose: To evaluate safety and effectiveness of Y-90 radioembolization in unresectable intrahepatic cholangiocarcinoma.

Material and methods: The study was a single-center retrospective observation in 25 patients (mean age 58 years, range 29-77 years) with biopsy proven cholangiocarcinoma. Each patient was treated with 1 cycle of Y-90 embolization. All patients treated had an approval of the multidisciplinary gastrointestinal tumor board. Partition model was used for Y-90 dose calculation. Clinical, laboratory and cross-sectional imaging follow-ups were scheduled 12 weeks after treatment. Radiological response was evaluated via CT or MRI imaging using the mRECIST criteria. **Results:** Fifteen patients (60%) had a tumor burden between 25-50%, three (12%) had a tumor burden of more than 50% and seven patients (28%) had a tumor burden below 25%. Ten patients (40%) were treated right lobar, while fifteen patients (60%) were treated bilobar. No procedure related major or minor complication were observed. A partial response was seen in nine patients (36%), a stable disease in four patients (16%) and a progressive disease in eight patients (32%) after three months. The median overall survival was 11 months (range 5,6-16,5). The longest survival range of a patient was 42,3 months.

Conclusion: We conclude that Y-90 radioembolization with resin microspheres in unresectable cholangiocarcinoma is safe and a potential therapy option in cholangiocarcinoma lacking further therapeutic options. However, prospective multicenter randomized trials are needed to better understand the potential role of radioembolization in this disease.

P-567

Cryoablation provides excellent mid and long term local control rate for lung metastasis

B. Moulin¹, T. de Baère¹, F. Deschamps², L. Tselikas²

¹Interventional Radiology, Institut Gustave Roussy, Villejuif, FR,

²Interventional Radiology, Gustave Roussy - Cancer Campus, Villejuif, FR

Purpose: To evaluate mid and long-term results of lung metastasis treatment with cryoablation.

Material and methods: Our prospective database was studied for all consecutive patients treated with cryoablation for lung metastasis from January 2012 to October 2017.

Results: 131 patients, (67 women, 51%), 63 [5-87] years old, were treated under either local (N=23) or general (n=168) anaesthesia with MDCT

guidance, using 1 to 4 17 gauge cryoprobes. Overall 284 metastases (1- 8 per patient) with a median diameter of 11 mm [2-60], were treated during 191 cryoablation procedures. Primary cancer was colorectal (54), sarcoma (17), kidney (5) or miscellaneous (55). 50 patients had a previous lung focal treatment including surgery or radiotherapy. After a median follow up of 37,9 months, median overall survival was 53.2 months. Median pulmonary recurrence free survival was 15 months, and median pulmonary recurrence free survival uncontrollable by local treatment (thermal ablation, surgery) was 32,9 months. Local control rate was respectively 94 and 92% at 1 and 3 years. Local control failure was associated with size ($p=0.002$), contact with superior to 3mm diameter vessels ($p<0.0001$) in global population, and in addition with BRAF mutation ($p=0.017$) in the colo-rectal subpopulation. Pneumothorax occurred during 34 procedures (17,8%). Overall 22 complications were reported (11 CTCAE grade 1, 4 grade 2, 4 grade 3, and 3 grade 4).

Conclusion: Cryoablation is a valid option for local control of lung metastasis with results superimposable to other thermal ablation treatments.

P-568

Treatment of benign prostatic hyperplasia (BPH) with transperineal laser ablation (TPLA): our preliminary experience

G. Manenti¹, T. Perretta¹, S. Marsico², A. Turbanti³, D. D'Amato¹, M. Nezzo², E. Finazzi Agrò³

¹Diagnostica per Immagini e Radiologia Interventistica, Policlinico Tor Vergata, Rome, IT, ²Diagnostic and Molecular Imaging, Radiation Therapy and Interventional Radiology, University Hospital Policlinico Tor Vergata, Rome, IT, ³Urology, Policlinico Tor Vergata, Rome, IT

Purpose: This is a pilot study aimed to assess safety and efficacy of transperineal laser ablation (TPLA) for treating benign prostatic hyperplasia (BPH).

Material and methods: Twelve patients (age 73.4 ± 8.4 years) with LUTS underwent TPLA under local anesthesia. Under US guidance, up to four 21G applicators were inserted in the prostatic tissue. Primary endpoint was absence of relevant complications intra and early (15 days) post-op. Secondary endpoints included operation time, ablation time, energy deployed, observation time, catheterization time, IPSS, Quality of Life (QoL), peak urinary flow rate (Q max), post-void residual (PVR), and prostatic volume, evaluated with 3T multiparametric MRI at 3 months.

Results: No intra or early post-op complications occurred. Mean ablation time was 33.3 minutes (range 25.3 min - max 42.4), mean energy deployed 12.137 J (range 7204.4 - max 14348.3 J), mean hospital stay 113 minutes, and mean catheterization time 7.1 days (range 1.1- max 9.3 days). At 3 months, mean IPSS improved from 22.3 to 7.4 ($P < 0.001$), mean QoL from 3.4 to 1.7 ($P < 0.001$), mean Q max from 5.1 to 12.5 mL/s, mean PVR from 148.3 to 87.1, and mean prostate volume from 54.9 to 42,3 mL.

Conclusion: TPLA is feasible and safe in the treatment of BPH. Our preliminary data show significant clinical results at 3 months with an excellent performance of 3T multiparametric MRI to detect morphological and functional changes after the procedure.

P-569

Peritoneal port-systems for abdominal carcinomatosis control: single-centre experience

M.A. Cherkashin, E. Naperov, N. Nikitina, D. Puchkov, N. Berezina, K. Suprun

Radiology, Dr.Sergey Berezin Medical Center, Saint-Petersburg, RU

Purpose: The aim of this study was to assess tolerability, complications rate and clinical efficacy of peritoneal port-systems in patients with abdominal carcinomatosis.

Material and methods: In our study 10 patients with abdominal carcinomatosis were included. Ovarian cancer n=3, stomach cancer n=7. The main indication was ascites control deterioration. Mean age was 47 y.o. Implantation performed as follows: peritoneal puncture under ultrasound

(US) control and ascites evacuation (mean volume - 11 litres); by US navigation the safe "window" on the abdominal wall was detected and marked; by surgical incision catheter was admitted into peritoneal cavity on the left paraumbilical area; port capsule was implanted on the left costal arch; to assess catheter tip localisation abdominal CTs or X-Ray examinations was performed. Every patient was included in observational program.

Results: In all cases there weren't technical difficulties during surgery. Mean time for ascites disappearance was 4 weeks and it was assessed as a good disease control. Mean time for disease progression was 3 months (2 - 5). In 1 case patient still alive more than 9 months (on the Feb 2019). In 2 cases at month 2nd after implantation local infection was revealed and devices were explanted.

Conclusion: Peritoneal port-system is a useful device for supportive and palliative care in patients with abdominal carcinomatosis and ascites progression.

based on our experience we suggest to active use presurgery CT (MRI) and intraoperatively ultrasound to identify safe incision acces.

In most cases peritoneal port-a-cath provide patient with applicable quality of life and potentially may increase time to systemic disease progression.

P-570

Imaging-guided percutaneous microwave ablation of colorectal cancer liver metastatic lesions: local response and survival with up to 5 years follow-up

M. Tsitskari¹, D.K. Filippiadis¹, C. Konstantos¹, K. Palialexis¹, P. Zavridis², N.L. Kelekis¹, E. Brountzos¹

¹2nd Department of Radiology, Unit of Interventional Radiology, ATTIKON University General Hospital, Athens, GR, ²Anesthesiology Department, American Medical Center, Nicosia, CY

Purpose: The present study aimed to assess the safety and efficacy of image guided percutaneous microwave ablation of liver metastases from colorectal cancer.

Material and methods: Institutional database research identified 32 patients with 58 metachronous colorectal metastatic lesions (diameter of the lesions ranged between 0.8-3.9 cm) that were not surgical candidates or refused surgery, who underwent percutaneous MWA. All patients were followed up for a period of 5 years. Overall survival and disease-free survival analysis was performed.

Results: Primary local tumor control was achieved in 91.3% of the treated lesions. In three patients MWA was proven incomplete and it was repeated 1 month later. Secondary local tumor control was achieved in 100% of the retreated lesions. Overall survival in 1, 3 and 5 years was 96.8%, 68.7% and 34.3% respectively. A statistically significant difference in the 5 year overall survival was noticed in patients with a solitary hepatic metastasis (n=13) versus patients with more than one hepatic metastases. Also patients with at least one metastasis greater than 2cm had statistically significant lower disease free survival than patients with metastases less than 2cm in diameter at the time of presentation. No complications were reported.

Conclusion: Percutaneous MWA is safe and efficient technique for the treatment of colorectal liver metastatic lesions with 5-year survival rates comparable to that of surgical treatment.

P-571

Scottish multicenter retrospective study investigating the survival outcomes in patients receiving doxorubicin-eluting beads (DEB) versus conventional transarterial chemoembolization (cTACE) for the treatment of hepatocellular carcinoma

S.H. Lim¹, P. Douglas², R. Kasthuri², J. Anwar², I. Zealley³, D. Reynolds⁴, R.P. Yadavali², A. Todd⁵, J. Gordon-Smith¹

¹Department of Radiology, Edinburgh Royal Infirmary, Edinburgh, UK, ²Radiology, Queen Elizabeth University Hospital, Glasgow, UK, ³Radiology, Ninewells Hospital, Dundee, UK, ⁴Radiology, Aberdeen Royal Infirmary, Aberdeen, UK, ⁵Radiology, Raigmore Hospital, Inverness, UK

Purpose: To compare overall survival in patients with hepatocellular cancer (HCC) treated with conventional lipiodol transarterial chemoembolisation (CTACE) with patients treated with doxorubicin eluting bead transarterial chemoembolisation (DEB-TACE) in Scotland.

Material and methods: 461 patients, across Scotland, who had undergone TACE for HCC, were identified using local databases. 63 patients who had received adjuvant treatment (transplant or ablation) were excluded. Therefore, 398 patients were finally included for comparative analysis (n=215, CTACE; n=183, DEB). Disease classified according to Barcelona-Clinic Liver cancer classification (BCLC).

Results: The 2 groups were matched for gender, age or BCLC score. Childs-Pugh scoring was better in the CTACE group with more patients in category A (174 vs 121 patients). Median survival time was 2.5 years for CTACE and 1.8 years for DEB in our univariate analysis (p=0.13). Multivariate analysis involving BCLC classification, showed no significant difference in median survival either (CTACE vs DEB: BCLC A, 2.9 years vs 2.8 years, p=0.68; BCLC B, 2.1 years vs 1.5 years, p=0.09).

Conclusion: There is no significant difference in survival between patients receiving either CTACE or DEB for HCC, in Scotland. Study results compare favourably with published RCT data. Further health economic analysis required.

P-572

Safety and outcomes of microwave ablation of stage T1 renal cell carcinoma

K. Mahmoud¹, A.J. Gunn¹, H. EL Khudari¹, W. Joe¹, A. Salei¹, E. Keasler¹, E. Bready¹, P. Patten¹, R. Oser², R. Varma¹, A.K. Abdel Aal¹

¹Interventional Radiology, University of Alabama at Birmingham, Birmingham, AL, US, ²Radiology, University of Alabama at Birmingham (UAB), Birmingham, AL, US

Purpose: To evaluate clinical and technical factors associated with treatment outcomes of microwave ablation (MWA) for renal cell carcinoma.

Material and methods: We retrospectively reviewed medical records of 28 patients who underwent MWA for stage 1 RCC. Patient demographics, tumor characteristics, technical success defined as absence of residual tumor within 3 months of procedure and complications were reported. The recurrence-free, cancer-specific and overall survival rates were analyzed. A univariate analysis was performed to identify any potential predictors of complications, local recurrence, or survival.

Results: Mean age of the patients was 64.9 (SD=10.6) years with 50% males. Chronic kidney disease (CKD) at the baseline was seen in 46.4% of patients. The median Charlson comorbidity index was 6.1 (range: 2-12). The median tumor size was 2.6 cm (range: 1.0 - 6.1) with 17 (60.7%) posterior tumors. Stage T1a tumors were seen in 93% of patients. Median number of probes was 1 (range: 1-3) and biopsy was performed in 20 (71.4%) tumors. Technical success rate was 92.2%. Minor and major complications were seen in 5 (17.8%) and 1 (3.6%) patients respectively. There was no significant change in mean creatinine levels before 1.5 mg/dl and after 1.7 mg/dl the procedure, (p=0.31). No local recurrence was reported. The overall survival was 100%, 84% and 84% at 1, 3 and 5 years. Cancer specific survival was 100% at 5 years. There were no predictors for complications or survival outcomes.

Conclusion: Percutaneous MWA is a safe and efficacious thermal ablation modality for treatment of stage 1 RCC with acceptable outcomes despite the presence of CKD.

P-573

Chemosaturation percutaneous hepatic perfusion (CS-PHP) with melphalan in patients with hemihepatectomy: a retrospective analysis

C.L.A. Dewald¹, B.C. Meyer¹, M. Kirstein², F. Wacker¹, T.C. Meine¹, S.K. Maschke¹, A. Vogel², J.B. Hinrichs¹

¹Institute for Diagnostic and Interventional Radiology, Medizinische Hochschule Hannover, Hannover, DE, ²Department of Gastroenterology, Hepatology and Endocrinology, Hannover Medical School, Hannover, DE

Purpose: CS-PHP is a novel therapeutic concept providing selective intrahepatic delivery of high dose melphalan in patients with unresectable hepatic malignancies. Purpose of this study is to evaluate frequency and severity of peri-procedural complications and post-procedural adverse events in patients with hemihepatectomy undergoing CS-PHP.

Material and methods: Overall, 7 patients (4 females, mean age 49±11 years) with right side hemihepatectomy underwent 21 CS-PHP interventions in our institution between 10/2014 and 06/2018. To determine peri-procedural safety, we screened the interventional protocols. Moreover, we categorized haematological, hepatic and biliary function up to 45 days after CS-PHP using Common Terminology Criteria for Adverse Events (AE) Version 5.0 (grades 1-5; mild-death) in order to assess post-procedural adverse events.

Results: In total, 21 CS-PHP (mean melphalan dose 174±24 mg) in 7 patients with hemihepatectomy were included. There were no AEs during CS-PHP procedure. Following CS-PHP, moderate changes in blood count and liver enzymes were recorded in nearly all procedures (AE grade 1-2). Post-procedural AEs grades 3-4 were as follows: severe decreases of platelet count (10/21; 48%) and white blood cells (4/21; 19%), anemia (5/21; 24%), increased liver enzymes (3/21; 14%). Cardiovascular changes occurred in 2/21 patients (10%) and tumor lysis syndrome in 1/21 patient (5%). Furthermore, sepsis developed in 2 patients (10%). A stroke with transient mild perceptual disorders occurred in 1/21 patient (5%) in the later course of the observational period. There was no treatment related death (AE grade 5).

Conclusion: CS-PHP can safely be performed in patients with right side hemihepatectomy.

P-574

Impact of percutaneous cryoablation on renal function for T1 renal cell carcinoma: single center cohort study

K. Mahmoud, H. EL Khudari, A.J. Gunn, W. Joe, A.K. Abdel Aal
Interventional Radiology, University of Alabama at Birmingham, Birmingham, AL, US

Purpose: To assess short- and long term changes in renal function after percutaneous cryoablation (PCA) for renal cell carcinoma (RCC).

Material and methods: A retrospective review of patients who had RCC that was treated with PCA from september 2007 to January 2018 was performed. Patients with solitary kidney or those treated by other ablative or surgical therapies were excluded. Demographics, tumor characteristics, technical success and complications were reported. Creatinine (Cr) and chronic kidney disease (CKD) stage were recorded at short-term (1day- 6 months) and long-term (6- 18months) follow up, and were compared to baseline measurements.

Results: The study included 66 patients with 38(57.6%) males. The mean age was 65.9(SD=11) years. The technical success rate was 94%. Mean tumor size was 3.0 cm(SD=1.2) and TNM stage was T1a in 50(75.6%) of patients. At baseline, there were 40(60.6%) patients with eGFR >60 ml/min, 14 (21.2%) CKD stage 3A, 6 (9.1%) 3B and 6 (9.1%) stage 4 and 5. There was significant increase mean Cr at in short-term follow up (1.5, SD=1.3

mg/dl) compared to baseline (1.35, SD=1.1 mg/dl, p= 0.001). However, the mean Cr did not significantly change on long-term follow up (p= 0.18). There was no significant increase in CKD stage at short-term (3A; p=0.71, 3B; p=0.76, 4/5; p=0.32) or long-term (3A; p=0.53, 3B; p=0.99, 4/5; p=0.16) follow up. Five (7.6%) patients had major complications.

Conclusion: Although, significant increase in mean Cr level during 6 months post-procedure follow up was seen, PCA for renal cell carcinoma had minimal impact on the renal function at long-term follow up.

P-575

CT-guided percutaneous microwave ablation combined with chemoradiation has improved survival of non small cell lung cancer patients in Bangladesh

A.S. Murshed

Oncology, Anwer Khan Mordern Hospital, Mohammadpur, Dhaka, BD

Purpose: Microwave ablation is a technique that employs high-energy micro waves to destroy malignant tumors. Our study was aimed to explore the efficacy of the procedure on various tumor sizes and stages and find out its out come after combining radiation and/or chemotherapy to treat various stages of NSCLC.

Material and methods: 400 inoperable NSCLC Patients who could not receive SBRT yet have ECOG status 0-1 were selected in 3 different centers of Bangladesh from 2014 to 2018. Patients were divided into 3 groups on the basis of disease stages. Group 1 (n=191): Stage IA and IB treated with MWA followed by radiotherapy, Group 2(n=120): Stage IIA & IIB: treated with MWA followed by chemotherapy and/or radiation and Group 3(n=89): Stage IIIA & IIIB treated with Neoadjuvant Chemotherapy followed by MWA only or with radiation. Patients mean survival were measured and compared.

Results:

Mean Survival of patients in months according to stages					
Stage	MWA	MWA Plus EBRT	MWA plus Chemo-therapy	EBRT	Chemo-radiation
Stage IA & IB	28 ± 4.3	32 ± 4.8	-----	22 ± 4.5	
Stage IIA & IIB	16 ± 4	20 ± 4.4	22 ± 4	13 ± 5	15 ± 4.3
Stage IIIA & IIIB	12 ± 3	15 ± 3.3	17 ± 4.3	9 ± 4.1	10 ± 3.3

Conclusion: NSCLC patients treated with MWA followed by EBRT along with adjuvant or neo adjuvant chemotherapy have relatively higher rate of treatment response, better disease free survival and lower rate of complications that are easily managed than the patients treated with conventional chemoradiation.

P-576

Simultaneous microwave ablation using multiple antennas for the treatment of liver malignant lesions

G. Pacella, E. Faiella, C. Altomare, D. Santucci, L. Scarcia, B. Beomonte Zobel, R.F. Grasso
Radiology, Campus Biomedico University of Rome, Rome, IT

Purpose: To evaluate efficacy and safety of percutaneous microwave ablation (MWA) using simultaneous activation of two antennas for the treatment of liver malignant lesions.

Material and methods: 21 MWA procedures of liver malignant lesions were performed: 5(24%) HCC, 9(43%) unresectable liver metastases and 7(33%) recurrences of treated liver metastases. MWA was performed with simultaneous activation of two antennas with a spacing of 1.5 or 2.0. Microwave energy was applied for 10 min with a power of 65 W. The sizes of the ablative zones created were recorded. Technical success was defined as complete target devascularization at the immediate post-procedural

CT. One, 3 and 6 months post-procedure follow-up was performed and major and minor complications were reported.

Results: Mean tumor size was 3.5cm(2.5-7cm). Full technical success was achieved in all treated liver malignant lesions. Mean short-axis diameter of the ablation zone was 6.0cm(4.8-9cm). All ablative zones were spherical or ellipsoid in both the axial and transverse planes with an antenna spacing of 2.0 cm or less. Artificial dissection was performed in one case (4.8%) due to diaphragm proximity. In three cases (14%) peri-procedural complications were observed: one subcapsular hemorrhage, one biloma and one peripheral portal thrombosis. Recurrence of disease was reported in three cases (14%) at 3 months follow-up. All recidivated lesions had a maximum size ≥ 5 cm(5-7cm).

Conclusion: Our results provide preliminary evidence of efficacy, creating a larger necrotic area, and safety, for the low complication rate, of simultaneous MWA using multiple antennas for local control of liver malignant lesions.

P-577

Evaluation of VPCT (Volume Computed Perfusion Tomography) for early diagnosis of local residual disease in patients with HCC or metastases nodules treated with RTA

C. Altomare, E. Faiella, G. Pacella, D. Santucci, L. Scarcia, B. Beomonte Zobel, R.F. Grasso

Radiology, Campus Biomedico University of Rome, Rome, IT

Purpose: The purpose of our study was to determine the role of VPCT in evaluation of tumor-related neoangiogenesis, for the early diagnosis of local residual in patients with nodules of HCC or metastases treated with RTA.

Material and methods: 20 patients with HCC or liver metastases, treated with RTA. We performed a VPCT imaging study immediately after the RTA treatment and to evaluate: blood flow(BF), blood volume(BV), time to peak(TTP) and permeability(PMB). The perfusion parameters were measured by manually drawing multiple ROIs: at the center of the necrotic area and the periphery of the lesion in two zones: Periphery 1(<1cm from ablation), Periphery 2(> 1 cm from ablation).

After one month every patient underwent MRI examination for assessment of therapeutic response after RTA.

Results: The RTA induced necrotic area shows a total absence of vascularization in all patients.

In 16 patients, perfusion values at the margins of the necrotic region were overlapping and relatively low, indicating poor vascularization.

In 4 patients, these values were higher than average, especially for TTP, indicating a high rate of vascularization. In these 4 patients, one month MRI showed a recurrence of disease.

The VPCT perfusion data are perfectly compatible to the one-month MRI follow up; where we observed that an increase vascularization corresponds to residual disease.

Conclusion: VPCT could be a reliable tool to predict any disease residue in advance, in patients with HCC nodules or metastases, after treatment with RTA; by quantitative evaluation of tumor vasculature in the periphery of the ablated area.

P-578

Efficacy of bridging/downstaging treatments for hepatocellular carcinoma before liver transplantation

G. Puntel¹, G. Puppini¹, R. De Robertis¹, C.C. Zingaretti², A. Carraro³, A. Tomezzoli⁴, S. Montemezzi¹

¹Radiology, Azienda Ospedaliera Universitaria Integrata Verona, Verona, IT, ²Pancreatic surgery, Azienda Ospedaliera Universitaria Integrata Verona, Verona, IT, ³Unit of liver transplantation, Azienda Ospedaliera

Universitaria Integrata Verona, Verona, IT, ⁴Pathology, Azienda

Ospedaliera Universitaria Integrata Verona, Verona, IT

Purpose: To analyze the outcomes of bridging/downstaging treatments before liver transplantation in patients with hepatocellular carcinoma (HCC).

Material and methods: Data from 22 patients with HCC that underwent liver transplantation were analyzed. The following features were recorded: a) protocol of bridging/downstaging; b) imaging findings before treatment, before liver transplantation and during follow-up; c) duration of follow-up; and d) histopathological findings on the explanted liver.

Results: Before treatment, the mean number of HCC nodules per patient was 2 (range, 1-4), with a mean liver disease burden (LDB) of 32 mm (range, 12-76 mm). Most patients underwent lipiodol TACE (40.9%) or combined TACE and RFA (31.8%) for downstaging/bridging. In the last imaging examination before transplantation, the mean number of HCC nodules per patient was 1 (range, 0-3), with a mean LDB of 12 mm (range, 0-32 mm), with a significant decrease in the mean LDB after intervention ($p < .0001$). The mean interval between the end of treatments and liver transplantation was 372 days (range, 34-3971 days). At pathological examination there was a mean number of HCC nodules of 2 (range, 0-6). The comparison between pre-transplantation imaging and the histopathological examination of the explanted liver reported the following results: concordance in 14 patients (63.6%); underestimation of tumor stage by imaging in 7 patients (31.8%); and overestimation by imaging in 1 patient (4.6%). Over a median follow-up of 8 months all patients are alive, without disease recurrence.

Conclusion: Tumor-directed treatments are effective bridging/downstaging options for patients with HCC candidate for liver transplantation. Imaging examinations may underestimate the real tumor stage.

P-579

Miniinvasive treatment with ablation technique of adrenal metastatic disease

G. Pacella, E. Faiella, C. Altomare, D. Santucci, A. Alfonsi, B. Beomonte Zobel, R.F. Grasso

Radiology, Campus Biomedico University of Rome, Rome, IT

Purpose: Treatment of adrenal metastasis prolong survival in selected patients. In this retrospective study indication, patient selection and technique of adrenal metastasis ablation are retrospective evaluated.

Material and methods: 20 ablative procedures of adrenal metastasis were performed: 8 Radiofrequency Ablation (RFA), 8 Cryoablation (CA) and 4 Microwave Ablation (MWA). Cruel blood pressure intraoperative monitoring was always performed.

Results: The mean of used probes was 1.5 for RF (1-2), 1 for MWA and 4 for CA (2-5). Technical success was achieved in 100% of cases. The average procedural time was 120.7 minutes (100-150). Lesions maximum diameter ranged from 1.6 cm to 7 cm. Artificial dissection was performed in 30% of cases due to colon (4), pancreas (1), and kidney (1) proximity. In 50% of cases a hypertensive peak ($> 200/100$ mmHg) was observed and promptly regressed by α -blockers ev administration. 45% of cases didn't have any complications. Mean hospitalization time was 2.7 days (2-5). Recurrence was recorded in 5 (25%) cases: 4 at short-term FUP, 3 RFA (efficacy 62.5%, 95% IC: 24,5%,91,5%) and 1 MWA (efficacy 75%; 95% IC: 19,4%,99,4%), and 1 patient at 1 year FUP, treated with CA (87.5% efficacy, 95% IC: 47.3%, 99.7%). All recidivated lesions had a maximum size

> 3.5 cm (3.5-7). In 50% of patients systemic chemotherapy was used for systemic disease progression.

Conclusion: Ablative techniques, especially MWA and CA, allow local control of adrenal tumor disease in almost all cases. Lesion size is the determining factor to obtain disease local control.

P-580

Toxicity and survival of patients with non-alcoholic steatohepatitis (NASH) cirrhosis undergoing Yttrium-90 radioembolization for hepatocellular carcinoma: a 15-year experience

C.A. Morton¹, A. Gabr², A. Riaz², S. Mouli¹, R. Salem³, R.J. Lewandowski¹

¹Interventional Radiology, Northwestern University, Chicago, IL, US,

²Interventional Radiology, Northwestern Memorial Hospital,

Chicago, IL, US, ³Radiology, Northwestern University, Chicago, IL, US

Purpose: To evaluate outcomes of patients with cirrhosis secondary to non-alcoholic steatohepatitis (NASH) undergoing Yttrium-90 (Y-90) radioembolization for hepatocellular carcinoma (HCC).

Material and methods: An IRB approved single institution prospectively maintained Y-90 database (2003-2018) was searched for patients with NASH as the only risk factor for cirrhosis. Toxicities per CTCAE v.5 were assessed within 60 days of Y90. Survival was calculated by Kaplan-Meier method on intention-to-treat (ITT) and censored bases, then stratified by Child-Pugh (CP) and BCLC criteria. Univariate and multivariate analyses of predictors of censored survival were conducted using log-rank test and Cox proportional hazards, respectively. Statistical significance was set at (p<0.05).

Results: 62 patients with NASH underwent Y-90 for HCC; CPA (43%), B (50%), C (7%); BCLC A (35%), B (8%), C (50%), D (7%). Post-treatment grade 3/4 toxicities included albumin (5%), bilirubin (3%), AST (5%), and ALT (3%) and Alkaline phosphatase (2%). Median censored OS was 16.3 months; CPA (22.6), B (15.0), and C (6.0); BCLC A (31.6), B (24.0), C (7.7), and D (6.0). Median ITT survival was 22.6 months; CP A (24.0), B (17.0), and C (6.0); BCLC A (36.3), B (32.4), C (14.3), D (6.0). Tumor size (p<0.0001), Alpha-feto protein (AFP) (p<0.0001), ECOG (p=0.04), and portal venous thrombus (p=0.001) were predictors of censored survival in univariate analysis. AFP, tumor size, and ECOG remained significant predictors on multivariate analysis with hazard ratios 3.3, 3.8, and 2.4 respectively.

Conclusion: Y-90 appears safe and effective for select patients with HCC secondary to NASH cirrhosis. This is an important concept as NASH increases in prevalence.

P-581

Multiphase intra-arterial CT angiography vs 99mTc-MAA as a surrogate to Y90 radioembolization treatment planning

A. Mahvash¹, G. Chintalapani², B.C. Odisio³, M. Abdelsalam¹, J. Kuban⁴, R. Avritscher⁵, R. Murthy⁶, S.C. Kappadath⁷

¹Interventional Radiology, UT MD Anderson Cancer Center, Houston, TX, US, ²Siemens Healthineers, Siemens Healthineers, Houston, TX, US,

³Interventional Radiology, The University of Texas MD Anderson Cancer Center, Houston, TX, US, ⁴Interventional Radiology, MD Anderson Cancer Center, Houston, TX, US, ⁵Radiology, UT MD Anderson Cancer Center,

Houston, TX, US, ⁶Diagnostic Imaging, MDACC, Houston, TX, US, ⁷Imaging Physics, MD Anderson Cancer Center, Houston, TX, US

Purpose: To determine the correlation of tumor-to-normal (T:N) relative enhancement on multiphase intra-arterial computed tomography (CT) as a surrogate to 99mTc-MAA for Y90 radioembolization treatment planning.

Material and methods: A single institution retrospective study was performed from January 2018 to January 2019. All patients with well-defined tumors 2 cm or greater receiving MAA for Y90 treatment planning were eligible. Eleven patients with 18 tumors (HCC, NET, CRC) were investigated. All patients had intra-arterial CT angiography with a microcatheter in the

hepatic artery with non-contrast, early arterial (CT-EA, 8s delay) and late arterial (CT-LA, 10s post-injection) imaging with a Siemens hybrid-angiography suite using sliding-CT gantry. SPECT/CT imaging was performed using a Siemens SymbiaT16 after MAA injection. The images were fused and the individual tumors and normal livers were contoured using MIM software. The mean relative enhancement from non-contrast to EA and LA imaging was calculated and compared to the T:N from MAA images.

Results: The median T:N (range) were 4.95 (1.57-to-18.11) on MAA, 4.41 (1.04-to-19.01) on CT-EA, and 3.36 (1.21-to-7.55) on CT-LA. T:N from CT-EA were linearly correlated with MAA (r=0.98, p<0.001); Bland-Altman analysis yielded a mean T:N bias and 95%CI of 0.03 ± 0.46 (consistent with zero) and 95% limits-of-agreement of ± 1.94. T:N from CT-LA were also linearly correlated with MAA (r=0.68, p<0.001); Bland-Altman analysis yielded a mean T:N bias and 95%CI of 2.24 ± 1.40 (not consistent with zero, p=0.001) and the 95% limits-of-agreement of ± 5.93.

Conclusion: The MAA T:N correlated better with CT-EA than CT-LA imaging, suggesting feasibility of CT-EA based dosimetry.

P-582

Combination of transarterial chemoembolization and irreversible electroporation decreases tumor relapse in hepatocellular carcinoma

P. Tinoush¹, D. da Florencia Ricardo¹, R.M. Mathy¹, A. Braun¹, O. Ghamar Nejad², D.-H. Chang¹

¹Department of Diagnostic and Interventional Radiology, University Hospital of Heidelberg, Heidelberg, DE, ²Department of General, Visceral and Transplantation Surgery, University Hospital of Heidelberg, Heidelberg, DE

Purpose: Evaluating the impact of irreversible electroporation (IRE) with or without previous transarterial chemoembolization (TACE) in treatment of hepatocellular carcinoma (HCC).

Material and methods: Data of the consecutive IREs performed on HCC patients between 2012 and 2018 were retrospectively included. Descriptive data were presented as mean ± standard error. Univariate and multivariate logistic regression analysis was performed to determine the independent predictive role of combination therapy (TACE + IRE) compared to IRE only on outcomes after IRE. Outcomes were chronologically analyzed using Kaplan-Meier method and differences compared using log-rank test.

Results: Overall 49 patients with 54 HCC lesions underwent IRE. TACE was performed on 17 tumors prior to IRE. During the follow-up period of 21.5 ± 2.8 months tumor relapse in same or neighboring segment occurred in 2 tumors in the "TACE+IRE" group (11.8%) and in 17 of 37 tumors treated with IRE only (45.9%) (OR 0.179, 95% CI 0.035-0.922, p=0.040). The 6-month and 1-year recurrence free survival in the patients receiving IRE only was 80.6% and 58.1%, respectively. No tumor relapse occurred after 1 year in patients with previous TACE. There was no significant difference between the groups in major complications, metastasis in other liver segments, distant metastasis or death. Sixteen patients received liver transplantation 6.4 ± 2.3 months after IRE.

Conclusion: Combination therapy of TACE prior to IRE significantly decreases the rate of tumor relapse in the same or neighboring liver segments in patients with HCC. Further prospective trials are necessary to evaluate its role in prolonging overall-survival and bridge-to-transplantation time.

P-583

Fast-track two-stage hepatectomy using a hybrid IR/OR suite: a safe and effective alternative to ALPPS procedure

E.A. Vega¹, J. Velasco¹, E.Y. Lin², S. Gupta³, J.-N. Vauthey¹, **B.C. Odisio**⁴

¹Surgical Oncology, MD Anderson Cancer Center, Houston, TX, US,

²Interventional Radiology, The University of Texas MD Anderson Cancer

Center, Sugar Land, TX, US, ³Interventional Radiology, MD Anderson

Cancer Center, Houston, TX, US, ⁴Interventional Radiology, The University of Texas MD Anderson Cancer Center, Houston, TX, US

Purpose: Bilobar colorectal liver metastasis (CLM) can be managed by two-stage hepatectomy (TSH). However, delay between the two stages can be concerning for potential drop-out and failure to complete TSH. We present our experience with fast-track TSH (FT-TSH) with simultaneous first-stage hepatectomy and portal vein embolization (PVE) performed in a hybrid interventional radiology/operating room suite (hybrid IR/OR). **Material and methods:** A prospective database is maintained for patients scheduled in the hybrid IR/OR for CLM. Following preoperative chemotherapy, patients with bilobar CLM underwent first-stage resection of left-sided liver lesions immediately followed by percutaneous PVE. Medians and ranges of continuous variables were compared using the Wilcoxon rank-sum test, and categorical variables were compared using the Pearson χ^2 test or Fisher exact-test, as appropriate.

Results: A total of 9 patients were scheduled for the first stage of FT-TSH; it was completed in 7(77%), while the hepatectomy was aborted in 2(22%) due to chemotherapy-associated-hepatotoxicity. Total operative time was 260(218-312) min (FSH: 120(90-155)min; PVE: 96(64-180)min). Segment IV embolization was performed in 4(57%) patients. No severe postoperative complications occurred. Median length of stay(LOS) was 4(2-4) days. Liver volumetry demonstrated a median standardized FLR volume increase of 42.6%(31.3%-47.2%) with a median kinetic growth rate of 2.7% per week. Three patients completed TSH; none had postoperative complications or liver dysfunction. The median LOS for second-stage hepatectomy was 7(range, 5-8).

Conclusion: FT-TSH is an efficient strategy to reduce time between stages, number of hospital encounters, and allows early return to intended oncologic treatment. It provides an alternative to ALPPS procedure in patients with advanced bilobar CLM.

P-584

Incidence and clinical significance of bile ducts changes after multibipolar radiofrequency ablation for hepatocellular carcinoma

E. Varin¹, G. N'Kontchou², A. Petit¹, J.C. Nault², O. Seror¹, O. Sutter¹

¹Radiology, Jean Verdier Hospital (APHP), Bondy, FR, ²Hepatology, Jean Verdier Hospital (APHP), Bondy, FR

Purpose: Bilomas within the ablation zones and upstream biliary dilatations are regularly observed after radiofrequency ablation (RFA) of hepatocellular carcinoma (HCC). The purpose of this study was to assess the incidence, risk factors and clinical impact of these bile ducts changes after multibipolar-RFA (mbpRFA).

Material and methods: Radiological, clinical and biological data of 231 consecutive cirrhotic patients, who underwent 266 mbpRFA procedures as first line therapy for naïve single HCC ≤ 5 cm (median diameter: 26mm; range: 10-50mm), were retrospectively recovered. Factors associated with bile duct changes were assessed using univariate and multivariate analysis. Baseline and 6 months liver function tests were collected along with the occurrence of complication, cirrhosis decompensation and death during follow up.

Results: One-third (76/231) of patients developed bile ducts changes with only one case of symptomatic complication (abscess formation). Irregular shape of the nodule, segment VIII location, proximity of a main portal branch, tumor size ≥ 3 cm, multiple sessions of mbpRFA and the amount of energy delivered were significantly associated with bile duct

changes ($p < 0.05$). On multivariate analysis, segment VIII location ($p < 0.01$) and irregular shape ($p = 0.035$) were the only independent factors linked with the occurrence of bile duct changes. Total bilirubinemia was significantly more increased at 6 months in patients with bile duct changes ($+2.9$ vs. $+0.4$ mg/mL; $p = 0.03$) but there were no differences in cirrhosis decompensation and overall survival between the two groups.

Conclusion: Bile duct changes are frequent after mbpRFA but do not seem to have a pejorative impact on the course of cirrhosis and on overall survival.

P-585

Intra-arterial peptide receptor radionuclide therapy for neuroendocrine tumor liver metastases

S.C. Ebberts, M.W. Barentsz, A.J.A.T. Braat, M.G.E.H. Lam

Department of Radiology and Nuclear Medicine, University Medical Center Utrecht, Utrecht, NL

Purpose: The current treatment of neuro-endocrine neoplasms (NEN) with peptide receptor radionuclide therapy (PRRT) consists of multiple cycles of intravenously administered lutetium-177 (¹⁷⁷Lu)-DOTATATE. This study investigates whether intra-arterial (IA) administration of ¹⁷⁷Lu-DOTATATE increases the delivered dose to intrahepatic metastases of NEN.

Material and methods: A systematic review was conducted of available evidence on IA PRRT using PubMed and Embase. Included studies were original research publications focusing on absorbed tumor dose or tumor response after IA administration of PRRT for NEN.

Furthermore, a multicenter randomized controlled trial is currently being conducted in The Netherlands to assess the added benefit of IA PRRT, in which the first patients have been included (LUTIA trial).

Results: Seven publications were included in this review, including 114 NEN patients treated IA with different therapeutic radiopharmaceuticals. Objective response was seen in 13-69%, disease stabilization in 18-52% and disease progression in 0-29% of patients. IA administration resulted in a 1.06-9.2 fold increase in tumor-to-non-tumor dose ratios in liver tumors, while normal liver and kidney doses remained within expected ranges. In the LUTIA trial, first results show promising benefits, with no added toxicities. Recruitment is ongoing and final results will be presented once the trial is completed.

Conclusion: There is limited but promising evidence that IA PRRT results in higher tumor-to-non-tumor dose ratios and a higher absorbed tumor dose compared to IV. Currently a multicenter RCT on IA PRRT is performed and first results look promising.

P-586

Non-surgical management for hepatocellular carcinoma with vascular tumor thrombus

M. Tsurusaki, T. Oda, I. Numoto, A. Suzuki, T. Kadoba, Y. Yagyu,

N. Kashiwagi, K. Ishii

Radiology, Kindai University, Faculty of Medicine, Osakasayama, JP

Learning objectives:

1. To discuss the various forms of non-surgical management for unresectable hepatocellular carcinoma (HCC) with vascular tumor thrombus (VTT).
2. To present HCC with VTT cases demonstrating various treatment techniques, complications, response and survival.

Background: Patients with BCLC stage C (advanced HCC) with venous tumor thrombus such as portal vein tumor thrombus (PVTT), or hepatic vein/IVC tumor thrombus (HVTT/IVCTT) are not good candidates for TACE, and the evidence-based treatment of them is decided as oral anticancer drug, however, it might be still controversial. In Japan, various non-surgical treatments for advanced HCC with PVTT including TACE, hepatic arterial infusion (HAI), and/or radiotherapy (ion-beam therapy) are performed. HCC with venous tumor thrombus such as portal vein tumor thrombus (PVTT), or hepatic vein/IVC tumor thrombus (HVTT/IVCTT) has been a

treatment challenge, because most cases are either unresectable or difficult to treat with locoregional therapy.

Clinical Findings/Procedure Details:

A. Epidemiology of HCC with VTT

B. Various non-surgical treatments for HCC with VTT, including transcatheter arterial chemoembolization (TACE), transcatheter arterial embolization (TAE) using gelatin sponge cubes only, radiotherapy combined with TACE or TAE, hepatic arterial infusion (HAI), and systemic chemotherapy

C. Interventional management of complications caused by VTT, such as portal obstruction and portal hypertension

D. Cases.

Conclusion: Our results of both HAI and radiotherapy combined with TACE for HCC with VTT suggest that are tolerable and increase tumor response rate. This exhibit reviews the methods and outcomes of non-surgical treatments of HCC with VTT.

P-587

SMART Ablation – a novel technique for lesion ablation or biopsy under CT guidance

A. Cullen, C. Farrelly

Radiology, Mater Misericordiae University Hospital, Dublin, IE

Learning objectives:

1. Technical challenges during CT guided biopsy and ablation.
2. CT guided method for percutaneous targeting of difficult to access lesions for ablation or biopsy.
3. Outcomes using this technique in a cohort of 47 consecutive cases performed at a single institution.

Background: Ablation is an important potentially curative therapeutic option for many primary and secondary tumours. Accurate tissue diagnosis is crucial to modern cancer care. Lesion location may mean an entirely "axial" percutaneous tract to ablate or biopsy a lesion is not possible or safe. Inaccurate targeting can lead to insufficient ablation zones and poor patient outcomes.

Clinical Findings/Procedure Details: This exhibit will provide detailed explanations and images of the SMART technique as follows:

S: Sagittal reformat is performed of CT images acquired on day of procedure. This allows a trajectory to be drawn from the lesion to the skin. M: Mark skin at the entry point on axial image. This can be achieved by using the CT axial localizer laser.

A: Advance a 22 gauge needle from skin entry site obliquely to the lesion. The tract trajectory is estimated from prior sagittal line.

RT: Repeat Tract. Advance ablation probe or biopsy needle alongside and parallel to the 22 gauge needle until in lesion. Remove 22 gauge needle. 47 consecutive cases using this technique for ablation (N=30), or biopsy (N=17), will be analysed for technical success and safety.

Conclusion: This technique is a quick and reliable method to enable safe and accurate targeting of difficult to reach lesions under CT guidance.

P-588

Stereotactic navigation system for liver ablation: learning process from theory to practical application

P. Scalise¹, R. Scandiffio¹, A. Boccuzzi¹, E. Bozzi², C. Cappelli³, L. Crocetti⁴, I. Bargellini¹, R. Cioni¹

¹Diagnostic and Interventional Radiology, University of Pisa, Pisa, IT, ²Oncology, Transplant and New Technologies in Medicine, Diagnostic and Interventional Radiology, Pisa, IT, ³Department of Radiology, Diagnostic and Interventional Radiology, Pisa, IT, ⁴Diagnostic and Interventional Radiology, Pisa University School of Medicine Cisanello Hospital, Division of Diagnostic Imaging, Pisa, IT

Learning objectives: To illustrate our experience with a commercially available stereotactic navigation system (CAS-One IR, CAScination AG, Bern, Switzerland) from learning to application in clinical practice in microwave (MW) ablation of liver tumors.

Background: In case of percutaneous treatments, stereotactic guidance systems represent a useful aid to improve accuracy, especially in difficult locations and/or when complex multiple treatments are needed.

Clinical Findings/Procedure Details: This was a two-phases learning process. First, a team from interventional radiology (IR) unit (an interventional radiologist, a resident, a technician and a nurse) was introduced about CAS-one IR at the parent company in Bern, Switzerland. The training process included theoretical lectures, practical hands-on application and attendance to live clinical sessions. Then, CAS-one IR was implemented in our Unit: two nodules of cholangiocarcinoma were percutaneously ablated with MW under CAS-one IR guidance due to difficult lesions location. Location, dimensions and morphology of the target were assessed by pre-procedural CT scans and automatically acquired by the navigation system to perform preoperative planning. Before placing the antenna, needle trajectories and ablation zones were evaluated in both 2D and 3D images. Then, the antennas were placed through CAS-one IR guidance. MW ablation was performed and treatment efficacy was validated by fusion of pre-treatment planning images and post-treatment control images.

Conclusion: In our experience, the CT stereotactic guidance system was easy to use and helpful to accurately plan and perform percutaneous treatment of liver nodules in difficult location. The familiarity of the staff with the system, acquired during the training, prompted the good results obtained in clinical practice.

P-589

Interventional radiological management of uveal melanoma hepatic metastases with review of pre and post treatment MR imaging spectrum

B.B.B. Shafi, L. Kania, F. Guglielmo, D. Mitchell

Radiology, Thomas Jefferson University Hospital, Philadelphia, PA, US

Learning objectives:

1. To present case examples of different locoregional techniques to treat uveal melanoma hepatic metastases, via transarterial (chemoembolization, immunoembolization, radioembolization) and percutaneous (hepatic perfusion, thermal ablation) routes.
2. To show case examples of the pre and post treatment MR Imaging spectrum in these patients.

Background: Uveal melanoma has a propensity to metastasize to the liver, with poor prognosis. Systemic therapies in these patients are relatively ineffective and patient survival correlates with disease control in the liver. Locoregional therapies provide means of prolonging survival. We review techniques including chemoembolization, immunoembolization, radioembolization and hepatic perfusion with pre and post treatment MR Imaging spectrum in these patients.

Clinical Findings/Procedure Details:

1. Indications for following treatment modalities in uveal melanoma hepatic metastases will be presented with case examples:

- a). Transarterial chemoembolization.
- b). Transarterial immunoembolization.
- c). Transarterial radioembolization.
- d). Percutaneous hepatic perfusion.

2. Role of pre-treatment imaging in assessing tumour burden and varied MR imaging patterns of melanoma hepatic metastases will be discussed.

3. Post locoregional treatment imaging spectrum will be presented with the following case examples.

- a). Non-viable tumour with stability.
- b). Viable tumour with stability.
- c). Progressive disease.
- d). Limitations of CT evaluation vs MRI.
- e). Change in imaging characteristics of different lesions with new T1W hyperintensity.
- f). Post treatment perfusion abnormality.
- g). Post treatment fibrosis/pseudocirrhosis.
- h). Multinodular, confluent, and infiltrating appearances

Conclusion: Uveal melanoma hepatic metastases are a unique pathology where multiple locoregional therapies can increase survival. Understanding the role of different techniques and familiarization with pre and post treatment MR Imaging spectrum is key in multidisciplinary management of these patients.

P-590

Utilisation of a stereotactic navigation system for ablation of hepatic tumours that are difficult to treat using conventional percutaneous methods

S. Butt, N. Shaida

Radiology, Cambridge University Hospitals, Cambridge, UK

Learning objectives: Understand the technique and consider situations where a stereotactic navigation system can be used for the ablation of hepatic lesions that are difficult or not amenable to treatment using conventional percutaneous methods.

Background: Percutaneous ablation of hepatic tumours can be performed using ultrasound (US), computed tomography (CT) or fusion techniques. Lesions difficult to treat include those invisible on US and CT, in difficult locations e.g hepatic dome and multiple complex lesions.

Clinical Findings/Procedure Details: Pictorial review and discussion of cases where stereotactic guided liver ablation was performed using CAS-ONE system from CAscination, including:

- 65 year old male with colorectal liver metastases that were invisible on CT
- 65 year old female with hepatocellular carcinoma (HCC) at the dome of the liver

- 70 year old male with new segment VIII HCC identified on departmental US, ablated using US guidance in theatre. Follow up imaging revealed ablation zone adjacent to HCC, insufficiently treating lesion. Patient then treated using stereotactic guided ablation.

- 70 year old male with HCC barely visible on arterial phase CT but invisible on portal venous phase CT and ultrasound

- 70 year old male with previous pancreatectomy, splenectomy and partial colectomy due to a neuroendocrine tumour with multiple bi-lobar hepatic metastases that were invisible on ultrasound

Conclusion: Stereotactic navigations systems are a valuable tool for ablating difficult to access hepatic lesions, complex multiple lesions and also those not visible on CT or ultrasound.

P-591

Hepatic flow redistribution by embolisation of variant hepatic arteries in same-day workup angiography and Yttrium 90 microsphere radioembolisation: how we do it

I. González-Huebra¹, A. Ezponda Casajús¹, M. Calvo Imirizaldu¹, M.I. Morales², M. De La Torre³, I. Vivas¹, M. Rodríguez-Fraile², B. Sangro³, J.I. Bilbao¹

¹Radiology, Clínica Universidad de Navarra, Pamplona, ES, ²Nuclear Medicine, Clínica Universidad de Navarra, Pamplona, ES, ³Hepatology, Clínica Universitaria de Navarra, Pamplona, ES

Learning objectives: To explain how we perform vascular flow redistribution in transarterial radioembolisation with 90Y-microspheres (90YRE) for hepatic malignancies in a single-day session.

Background:

- Same-day 90Y evaluation and treatment is feasible and effective.
- Embolization of variant hepatic arteries can be used to consolidate hepatic supply in 90YRE.

Clinical Findings/Procedure Details:

- From November 2015 to September 2018, 16 of our patients underwent same-day workup angiography with embolisation of accessory tumour arteries, cone-beam CT (CBCT), ^{99m}Tc-MAA SPECT-CT and 90YRE.

- Flow redistribution can be achieved by embolisation of intrahepatic or extrahepatic branches.

- According to our experience, CBCT provides additional information of arterial tumour perfusion.

- Perfusion of the lesions in the redistributed and non-redistributed segments can be qualitatively compared by assessing the distribution of ^{99m}Tc-MAA.

Conclusion: Hepatic flow redistribution by embolisation of variant hepatic arteries in same-day workup angiography and Yttrium 90 microsphere radioembolisation is feasible.

P-592

Cool tips for cryoablation of small renal masses

T.J. Cavenagh¹, V. Patsiogiannis¹, M. Gonsalves²

¹IR, St George's Hospital, London, UK, ²Radiology, St. George's Hospital, London, UK

Learning objectives:

1. Basic principles and indications for cryotherapy of small renal tumours
2. Important technical points in the planning and performance of cryoablation
3. Follow up imaging – modality and timing, appearance of successful ablation, residual unablated tumour and local recurrence

Background: Due to incidental detection of renal masses by cross sectional imaging, the incidence of renal cell carcinoma has increased by one third over the past decade. Image guided cryoablation of renal cell carcinoma is a well established, safe and effective treatment of early stage renal cell carcinoma. The drive towards image guided ablation of renal cell carcinoma is likely to increase in the future.

Clinical Findings/Procedure Details: How to perform cryoablation of small renal masses:

1. Pre-procedural imaging – Technique, nephrometry and case selection
2. Intraprocedural imaging and technique:
 - a. Patient positioning
 - b. Optimal cryoprobe positioning
 - c. Important anatomical relationships – protective hydrodissection and CO₂ dissection
 - d. Freeze-thaw cycles
 - e. Evaluation of ice ball and assessment of ablation zone
3. Follow-up imaging
 - a. Technique and timing
 - b. Expected post ablation findings
 - c. Residual unablated tumour & local tumour progression

Conclusion: This exhibit provides a summary of cryoablation with focus on pre-procedural planning and intra-procedural technique. Basic principle, indications and follow up imaging with also be covered.

P-593

CT guided positioning of self-expandable Idrogel plug as intraoperative marker for lung nodule resection

D. Monaco¹, A. Briatico Vangosa¹, N.M. Lucarelli¹, V. Gisone¹, M.P. Ganimede¹, R. Leggieri², T. Iarussi², N. Burdi¹

¹Radiology, SS Annunziata Hospital, Taranto, IT, ²General and Thoracic Surgery, SS Annunziata Hospital, Taranto, IT

Learning objectives: To show a new technique helping thorascopic lung nodule resection.

Background: Uniportal Video-Assisted Thoracic Surgery (UniVATS) represents the new frontier of minimally invasive surgery.

UniVATS major issue is to localize small or impalpable target lesion. Therefore, various materials (hookwires, methylene-blue-solution, microcoils, fiducial-markers, radiotracers) are used for percutaneous nodules localization under CT-guidance before surgery. Due to possible displacement of markers, surgery needs to be planned shortly after their placement.

BioSentry® is a self-expandable polyethylene glycol hydrogel plug (2.5cm length; 0.1cm diameter). The plug is deployed coaxially within the biopsy system, allowing a single pleural transection. This device, designed for pneumothorax prevention, is proposed as surgical marker.

Clinical Findings/Procedure Details: Patients affected by small lung nodules, especially ground-glass ones, candidate to VATS can be managed as follows.

Under CT guidance a 18G coaxial needle is placed face to the lesion, choosing trajectory on the base of VATS access. Then we perform biopsy and deploy hydrogel-plug. BioSentry® hydrogel-plug is positioned to a predetermined depth, allowing protrusion of its tail into pleural cavity. UniVATS could be performed also several days later. The proximal tip of hydrogel-plug can be visualised with scope on pleural surface and be used for nodule localization and perform wedge resection in the right place (sometimes segmental or lobar one were preferred based on the biopsy result).

Conclusion: Hydrogel-plug tract sealant seems to be safe and useful for intraoperative detection of pulmonary nodule. Surgery can be planned also several days after positioning, allowing a resection based on definitive biopsy result.

P-594

Cone beam computed tomography (CBCT) in interventional oncology of the liver

L. Maggi¹, G. Gorga¹, S. Tortora¹, E. Valconi¹, C. Floridi¹, G. Carrafiello²

¹Radiology, San Paolo Hospital, Milan, IT, ²Diagnostic and Interventional Radiology, University of Milan, Milan, IT

Learning objectives: Role and benefits of Cone Beam Computed Tomography (CBCT) in interventional oncology procedures of the liver.

Background: Cone beam computed tomography (CBCT) is an imaging modality that provides computed tomographic images using a rotational C-arm equipped with a flat panel detector as part of the Angiography suite. CBCT reduces the gap between the typical three-dimensional diagnostic imaging and the two-dimensional imaging of interventional procedures. This imaging technique is essential to provide more information than standard two-dimensional angiography (DSA) in order to improve the performance of interventional liver oncology procedures for both intraarterial treatments such as transcatheter arterial chemoembolization (TACE), and percutaneous tumor ablation such as radiofrequency ablation (RFA) and microwave ablation (MWA).

Clinical Findings/Procedure Details: The introduction of CBCT in interventional oncology results in a modification of treatment in a significant number of cases with a remarkable improvement of feasibility, effectiveness, safety of these image-guided procedures and clinical outcome with longer overall survival and lower local recurrence.

CBCT can be performed during intraarterial or intravenous contrast agent administration with different acquisition protocols in order to determinate and localize liver tumors and the feeding tumor vessels. It is capable of providing precise tumor detection ("seeing" the tumor), accurate planning and guidance for catheterization ("reaching" the tumor), monitoring during procedure and specific post-procedural evaluation ("assessing" treatment success).

Conclusion: Use of CBCT is a fundamental tool in lots of interventional liver oncology procedures and it is currently recommended as part of the CIRSE/SIR protocol guidelines for selective TACE.

P-595

Colorectal cancer (CRC) biomarkers in oligo-metastatic disease: a guide for interventional radiologists

D. Basile¹, M. Calandri², G. Stranieri³, A. Veltri¹

¹Department of Oncology, Diagnostic and Interventional Radiology Section, University of Turin, Orbassano, IT, ²Radiology Institute,

Department of Surgical Sciences, University of Torino, Turin, IT,

³Department of Oncology, University of Turin, Orbassano, IT

Learning objectives: To provide a comprehensive state of the art in the field of biomarker of colo-rectal cancer and how they influence the management and the outcome in the oligo-metastatic setting.

Background: Recently 2016 ESMO guidelines identified a group of patients with limited metastatic disease burden, the so called "oligo-metastatic disease", potentially treatable with a more aggressive local/locoregional approach. Oligometastatic disease is defined as the presence of metastasis at up to 2 or occasionally 3 sites and with up to 5 lesions. Biomarkers can be generically defined as a biological molecule that is a sign of a normal or abnormal process, or of a condition or disease. Many biomarkers have already showed their prognostic and predictive role both in the clinical oncology and surgical field.

Clinical Findings/Procedure Details: From the review of the literature the biomarkers seems to have similar role in interventional radiology field if compared with surgical and oncologic series.

The CEA levels seems to have a role both as a predictive and prognostic factors on clinical outcomes after TA. RAS mutation is increasing its role as an independent factor with major impact in higher incidence of metastatic spread, affecting both local control (requiring wider ablation margins) and overall survival. These findings are observed regardless the ablation technique used (RFA, MWA or radio-embolization).

There are other, less studied, biomarkers both with prognostic and predictive value (such as TP53, HMGB1, embryonic origin and PI3K) which still require more investigation.

Conclusion: Biomarkers, in oligometastatic disease, can differentiate and predict the biological behaviour and aggressiveness, leading to a more accurate and tailored interventional treatment.

P-596

The emerging role of high dose rate brachytherapy for the treatment of liver metastases from colorectal carcinoma

J. Stringam¹, F. Collettini², J. Kuban¹

¹Interventional Radiology, MD Anderson Cancer Center, Houston, TX, US,

²Klinik für Radiologie, Charité - Universitätsmedizin Berlin, Berlin, DE

Learning objectives:

1. Review etiology and epidemiology of liver metastasis from colorectal carcinoma
2. Review the literature regarding current methods of treatment including medical management, surgical management, percutaneous interventions, endovascular interventions, and external beam therapies
3. Review current literature regarding High Dose Rate Brachytherapy (HDRBT) for the treatment of liver metastasis from colorectal cancer
4. Describe and discuss optimal HDRBT technique with regards to tumor characteristics

Background: Liver metastasis from colorectal cancer are currently treated with multiple approaches including medical management, surgical management, percutaneous techniques, endovascular techniques, and external beam treatments. HDRBT is an emerging minimally invasive therapy especially suited for treating tumors with challenging characteristics such as large tumor size, close proximity of a target lesion to large vessels and sensitive structures, inability to access all of a tumor's feeding vessels endovascularly, and lesions associated with a large shunt fraction to other vital structures.

Clinical Findings/Procedure Details: This educational exhibit will present:

- Etiology, epidemiology, and pathophysiology of liver metastasis from colorectal cancer
- Clinical indications to suggest HDRBT when other therapies are contra-indicated
- The role of HDRBT in a multimodal approach with other existing therapies
- Technical considerations based on anatomical and tumor characteristics
- Review of current literature as well as specific cases

Conclusion: HDRBT is an emerging therapy for the treatment of liver metastasis from colorectal carcinoma. As its use becomes more wide spread, it will be increasingly vital for interventional radiologists to possess an understanding of this therapy, with special focus on appropriate patient selection and optimal technique.

P-597

10 years, 140 patients: when, why, and how of gastric conditioning

Q. Ordi-Camprubi¹, J. Valcarcel², J. Joudanin Seijoo², E. Alba Rey², D. Leon Guevara², E. Escalante Porrua²

¹Interventional Radiology, Hospital Universitari de Bellvitge, Esplugues De Llobregat, ES, ²Interventional Radiology, Hospital Universitari de Bellvitge, Hospitalet De Llobregat, ES

Learning objectives:

1. Review the normal and variant anatomy of gastric arterial supply.
2. Outline the indications for conditioning.
3. Describe intra-procedural techniques.
4. Discuss technical endpoints and complications.

Background: Esophageal resection is a high-risk procedure associated with considerable morbidity and mortality. Among all elective gastrointestinal surgical interventions, esophagectomy has the highest mortality rate. Gastric ischemic conditioning prior to esophagectomy can increase neovascularization of the new conduit. Studies of ischemic conditioning show reductions in anastomotic leaks as well as overall morbidity.

Clinical Findings/Procedure Details: Patients underwent ischemic conditioning two weeks before surgery. Physicians performed an angiogram of the celiac trunk via a femoral access pre- and post-procedure. Three arteries were embolized:

Proximal portion of the splenic artery (most of them with a vascular occluder / Amplatzer plug),

Right gastric artery. Superselective catheterization with a microcatheter must usually be performed, and can be challenging.

Left gastric artery. This is the most important vessel to be embolized and it can be performed with coils and/or an Amplatzer plug. When accessory left gastric branches (LGA origin from the left hepatic artery being the most common) were present, they were also catheterised and embolized. Final celiac angiography confirmed both embolization and the lack of gastric blood supply from arteries other than the right gastroepiploic artery.

Conclusion: Gastric conditioning is a challenging technique. But when performed by an expert interventional radiologist it is a safe procedure, with a low morbidity rate.

P-598

Everything you want to know about thermal ablation of breast tumors

J.B. Battistuzzi¹, J. Guigui¹, J. Ribette¹, V. Catena², X. Buy³, J. Palussière¹

¹Radiology, Institut Bergonié, Bordeaux, FR, ²Imagerie Médicale, Institut Bergonié, Bordeaux, FR, ³Interventional Radiology, Institut Bergonié, Bordeaux, FR

Learning objectives: Thermal ablation TA (radiofrequency ablation, cryoablation, high-intensity focused ultrasound) is used to treat breast

tumors. To know specificities of TA applied to breast tumors, indications, limits, complications

Background: key points are presented concerning: indications, contraindications and criteria for eligibility specificities of breast tissue following heating, freezing, technical skills with protection measures of vulnerable structures specific complications and their treatment, the follow up results of the different TA techniques,

Clinical Findings/Procedure Details: a review of the literature with the most valuable articles will be detailed

Conclusion: TA is a useful technique to treat breast tumors

P-599

Current status and challenges of radial access in trans arterial embolisation of hepatic neoplasms

R. Sundareyan¹, W.R. Thomas², S. Walker³, C. Aleman³, S. Karkhanis⁴

¹Interventional Radiology, Queen Elizabeth Hospital, University Hospitals Birmingham, Birmingham, UK, ²Radiology, University of Wales Hospital Cardiff, Cardiff, UK, ³Interventional Radiology, University Hospital Birmingham, Birmingham, UK, ⁴Interventional Radiology, University Hospital of Birmingham NHS Foundation Trust, Birmingham, UK

Learning objectives:

1. To understand the advantages of utilizing transradial (TR) access for transarterial embolization (TAE) of hepatic neoplasms, compared to transfemoral (TF) access
2. To understand potential logistical challenges faced with this and their solutions.

Background: TAE has become one of the standard therapeutic modalities in the management of primary (HCC) and secondary (neuroendocrine metastases) liver neoplasms. Despite growing evidence in the cardiology literature on benefits of TR approach, this technique is sparingly used during interventions in the systemic circulation. This may be especially useful in patients with low platelet count or high BMI.

There are, however, few important challenges to carrying out a successful TAE through this route. These include, significant learning curve associated with this technique for operator and the support team, limited current catheter options to deal with variant anatomies, relatively longer initial screening time and radiation exposures during learning curve, to name a few.

Higher patient satisfaction, reduced complication rates and hospital stay costs are the major advantages.

Clinical Findings/Procedure Details: Retrospective analysis of institutional cohort of TAE patients with TR access.

Identify commonly occurring logistical pre-procedural problems such as room set-up, patient preparation, staff education etc and their solutions. Identify challenging intra-procedural scenarios (anatomical variations, cone-beam CT to visualize tumours etc) and their solutions.

Conclusion: TR access for TAE remains safe and as effective as TF access, at least in our institutional cohort. With staff education and logistical alterations, many pre-procedural challenges posed by TR access can be successfully overcome. Specific cases highlight tips and tricks for successful procedural outcome.

P-600

Lung ablation - a pictorial review of the post-procedural appearances including complications

A. Shawyer¹, C. Bent², N. Hennessy³

¹IR, RBCH, Bournemouth, UK, ²Interventional Radiology, Royal Bournemouth and Christchurch Hospitals, Bournemouth, UK, ³Radiology, RBCH, Bournemouth, UK

Learning objectives:

1. To demonstrate the typical imaging findings and their evolution over time following both Radiofrequency and Microwave ablation in the lung.
2. Illustrate the range of atypical, but acceptable appearances following thermal ablation.
3. Review the imaging findings associated with the complications of lung ablation.

Background: There is growing evidence to support the use thermal ablation in the treatment of both primary and secondary malignancies in the lungs. It is a safe technique with lower mortality and serious complication rates than lung resectional surgery.

Knowledge of the range of expected imaging findings following ablation is vital in the interpretation of post-procedural follow-up imaging. Awareness of the potential complications of thermal ablation and their appearances in both the acute setting and as part of follow-up imaging allows prompt treatment and reduced morbidity.

Clinical Findings/Procedure Details:

1. Typical Appearances post-Radiofrequency Ablation
2. Typical Appearances post-Microwave Ablation
3. Atypical but acceptable appearances post-thermal ablation
4. Imaging features of post-thermal ablation complications (pneumothorax; abscess, B-P Fistula, Vascular, Chest wall injuries, recurrence)

Conclusion: The use of thermal ablation to treat pulmonary oligometastatic disease and certain primary lung cancers is increasing.

A good knowledge of the range of typical imaging findings in this patient group allows accurate interpretation of these, often complex, appearances and guides further follow-up or treatment.

P-601

Feasibility of intra arterial LU-177 DOTA TATE therapy in metastatic neuroendocrine tumors with liver dominant disease - "a novel theranostic approach to augment therapeutic potential"

S. Kalmath¹, M. Palaniswamy¹, A. Rajan², S. Sundaraiya², M. Uthappa³

¹Interventional Radiology, Gleneagles Global Health City Chennai, Chennai, IN, ²Nuclear Medicine, Gleneagles Global Health City Chennai, Chennai, IN, ³Interventional Radiology, BGS Global Hospital, Bangalore, IN

Learning objectives: The aim of this study was to assess the safety, tolerability and efficacy of intra arterial Lu-177 DOTA TATE therapy in patients with liver dominant metastasis in well differentiated NETs.

Background: Few recent preclinical and clinical studies have demonstrated a higher first pass effect with a higher tumoral uptake in the early phases of intra arterial administration of Ga-68 DOTANOC and In-111 DOTANOC imaging of liver metastasis in neuroendocrine tumors. It has been hypothesized that this novel approach could be translated into theranostics.

Clinical Findings/Procedure Details: Four patients with well differentiated NET liver dominant metastasis were given 4 cycles of 200mCi of Lu-177 DOTATATE therapy intra arterially at interval of 8 weeks through selective hepatic arterial catheterization. All patients received bilateral hepatic arterial infusions. Their labs were assessed within 2 weeks prior to each treatment cycle, in the immediate post therapy period and within 6 weeks post treatment.

Significant reduction in serum chromogranin A levels with partial reduction in size and tracer uptake in all patients were noted. None of the

patients experienced any acute side effects or unexpected complication during therapy or in the immediate post therapy period. N. Liver functions remained stable with improved quality of life

Conclusion: Our initial experience of intra arterial administration of Lu-177 DOTA TATE therapy in patients with liver dominant metastasis is promising, feasible, safe and tolerable treatment. Two patients showed partial response. Survival benefits will be evaluated after 1 year of follow up.

P-602

Disseminated peritoneal carcinomatosis after percutaneous radiofrequency ablation with artificial ascites technique

C.-C. Huang, R.-H. Wu, H.-M. Cheng, J.-Y. Liou

Department of Medical Imaging, Chi-Mei Medical Center, Tainan City, TW

Clinical History/Pre-treatment Imaging: The 67 year-old male had history of chronic hepatitis B complicated with cirrhosis and hepatocellular carcinoma. He underwent several sessions of percutaneous radiofrequency ablation of liver tumors. A new hepatocellular carcinoma recurrence was found on follow-up MR scan, and the 2.2cm tumor was located in subcapsular region of segment VI.

Treatment Options/Results: Percutaneous radiofrequency ablation was performed under sonography and CT guidance. Artificial ascites technique was performed to prevent thermal injury of nearby colon, and the tumor was ablated using single internal-cooling electrode with a 3-cm active tip. We performed two ablations for sufficient ablative margin. Immediate CT showed complete coverage of target tumor. There was no severe adverse event after the procedure.

There was no viable tumor on follow-up CT scan at 3 months. But on CT scan at 6 months, there were disseminated tumor seedings of electrode tract, peritoneum, and right pleural space. Metastatic hepatocellular carcinoma was confirmed by further pathologic result.

Discussion: Ablation of subcapsular tumor was reported to have higher risk of tumor seeding, and artificial ascites technique was more often performed during subcapsular tumor ablation. Based on previous literature review and the follow-up image, we believed that the tumor cells might be carried into the tract due to needle retraction or increase in intratumoral pressure during ablation. Furthermore, the tumor cells could be driven into the ascites and this resulted in disseminated tumor seeding in peritoneal cavity.

Take-home points: In such situation, alternative approaches such as multipolar radiofrequency ablation with non-touch technique or surgical resection can be considered.

P-603

Transvaginal stent as an effective drainage route for refractory infection of a pelvic tumor

Y. Onishi, M. Sone, S. Sugawara, C. Ito, T. Hasegawa, S. Kimura,

N. Umakoshi, S. Fujizuka, Y. Arai, M. Kusumoto

Department of Diagnostic Radiology, National Cancer Center Hospital, Tokyo, JP

Clinical History/Pre-treatment Imaging: A 44-year-old woman underwent total hysterectomy and radiotherapy for cervical cancer. Chemotherapy was started for local recurrence of the tumor, but the tumor enlarged. The recurrent tumor in the pelvis communicated with the urinary bladder and the rectum. A percutaneous nephrostomy catheter was inserted for hydronephrosis. Continuing infection in the tumor caused by the fistula to the rectum resulted in severe anal pain and impaired quality of life (QOL) of the patient.

Treatment Options/Results: Antibiotic therapy and percutaneous drainage of the infected tumor could not control inflammation and pain. To eliminate the communication between the tumor and the digestive tract, ileostomy was performed followed by placement of a covered stent in the rectum. Output from the percutaneous drainage catheter decreased but persisted. To further improve QOL by removing the drainage catheter, a

covered stent was placed between the tumor and the vagina. As a continuous drainage route into the vagina was established, symptoms of the patient improved and the drainage catheter was removed. The patient was discharged home 2 days after placement of the transvaginal stent.

Discussion: Refractory infection of a pelvic tumor is an important clinical problem. Multidisciplinary treatment including antibiotic therapy, bowel diversion surgery and interventional radiology is needed. In this patient, continuous drainage of the infected pelvic tumor with a transvaginal stent was effective.

Take-home points: Drainage with a transvaginal stent is a treatment option for refractory infection of a pelvic tumor.

P-604

Feasibility of 320-detector row 4D-CT angiography in transarterial chemoembolization for hepatocellular carcinoma: a rare variation of the hepatic falciform artery originating from the right gastric artery

J. Matsumoto, T. Ogi, T. Sugiura, K. Okumura, D. Inoue, W. Koda, S. Kobayashi, T. Gabata
Radiology, Graduate School of Medical Sciences, Kanazawa University, Kanazawa City, JP

Clinical History/Pre-treatment Imaging: 320-detector row 4-dimensional CT (4D-CT; Aquilion ONE, Canon medical systems) can acquire one-second interval images for whole liver due to high temporal resolution with up to 160 mm coverage.

We hereby report a case of hepatocellular carcinoma (HCC) fed by the hepatic falciform artery (HFA) with an anomalous origin for which 4D-CT was essential for effective transarterial chemoembolization (TACE).

A 72-year-old male with histories of autoimmune hepatitis and liver cirrhosis referred to our hospital for treatment of HCCs. Dynamic CT demonstrated multiple hypervascular tumors throughout his liver.

Treatment Options/Results: We performed multiple courses of lipiodol TACE for those tumors. After embolization for tumors at segment 3, we found on lipiodol CT that one of those tumors located on the liver surface showed a lack of lipiodol accumulation. We reviewed 4D-CT hepatic arteriography before the additional TACE, and detected a feeding artery which unexpectedly became apparent at 11 seconds after the contrast media injection via the hepatic artery. Subsequently, we successfully embolized two falciform arteries, one which arose from the right gastric artery (RGA) and the other from the hepatic artery of segment 4.

Discussion: Few reports are available on HFA originating from the RGA. Because of rare prevalence and delayed visualization, it is easily overlooked with ordinary angiography or CT angiography. However, due to its higher temporal resolution with wide coverage, 320-detector row 4D-CT angiography is more feasible to detect such unusual extra-hepatic feeders leading to successful tumor embolization.

Take-home points: 320-detector row 4D-CT makes it feasible for us to perform TACE effectively.

P-605

Hepatocellular carcinoma chemoembolization by right internal mammary artery

D.M. Caravasilie, M.C. Grasu, R. Dumitru, M. Toma, I. Lupescu
Interventional radiology, I.C Fundeni, Bucuresti, RO

Clinical History/Pre-treatment Imaging: A 68-year-old patient, with a history of hepatitis C related liver cirrhosis, was admitted for initiation of interferon-free antiviral treatment. Blood tests reveal marked hepatocytolysis. Abdominal US detects a suspicious left lobe focal lesion. MRI scan confirms liver cirrhosis with HCC nodule in the IVa segment.

Treatment Options/Results: In the first TACE session, we used a 60 cm Cobra C2 4F catheter to catheterize the common hepatic artery and a 2,8 F microcatheter, for the arterial branch supplying segment IV. One month follow-up CT scan shows viable tumor tissue on the anterior half

of the nodule, supplied by the right internal mammary artery (RIMA). For the second TACE session, we used a 100 cm Cobra C2 4 F catheter, to catheterize the right brachiocephalic trunk and a 1.7 F, 150 cm long microcatheter, for RIMA catheterization. Postprocedural CT scan demonstrates good retention of lipiodol in tumor tissue, with no complications.

Discussion: Although most HCC are vascularized by the hepatic artery or its branches, extrahepatic parasitic arteries can "feed" tumoral lesions especially when they develop on the marge of the liver. RIMA accounts for 8% of the extrahepatic collaterals supplying HCC, in particular, tumors developing in segment IV and can be depicted on a thorough evaluation of the CT scan.

Take-home points: Extrahepatic arterial feeders of HCC must be checked before TACE for improved therapeutic results.

P-606

Image-guided ureteral reconstruction with rendezvous technique for post-operative ureteric injury

S. Balaka¹, H. Hrechikhin¹, M. Krasnoselskyi¹, A. Panov¹, V. Sukhin¹, O.I. Sukhodolska², D. Vieriemiei²
¹Minimally Invasive Surgery, Endoscopy and Interventional Radiology, Grigoriev Institute for Medical Radiology, Kharkov, UA, ²Medical Faculty #1, Kharkiv National Medical University, Kharkiv, UA

Clinical History/Pre-treatment Imaging: A 56-years-old woman underwent laparoscopic hysterectomy for cervical cancer. 6 days after operation urine leak through vagina was revealed. A computed tomography demonstrated destruction of the right ureter in supravescical part caused by thermal injury, pelvic collection of urine 7-8 cm in diameter and ureterovaginal fistula.

Treatment Options/Results: Cystoscopy was done, and after ureteric cannulation introducer sheath 7Fr 35 cm was placed into the pelvic collection over the guidewire. Percutaneous nephrostomy access was obtained. A 0.035 hydrophilic guidewire was passed through the nephrostomy access across the ureter into the pelvic collection. Distal end of the guidewire was captured by 15 mm gooseneck snare inserted via sheath and was retrieved out. Amplatz Ureteral Stent 8,5 Fr 28 cm was inserted over the guidewire. Follow-up ureterogram showed no urine leak.

Discussion: Injury to ureter is a known complication of pelvic or abdominal surgery. Usually injuries treated by open surgery. Ureteral stenting could improve this situation. However, in case of integrity violation of the ureter and pelvic collection formation it becomes difficult and challenging task. Interventional radiology using rendezvous technique may offer an alternative minimally invasive approach to repair the integrity of the ureter and avoid open surgery in such cases.

Take-home points: Postoperative ureteral injury with ureterovaginal fistula and pelvic collection can be successfully treated by interventional radiology team.

It requires simultaneous usage of cystoscopy, ultrasonography and fluoroscopic guidance.

Rendezvous technique should be used to succeed in intervention.

P-607

Emergent pulmonary artery stenting in massive hemoptysis: what we have learnt about a case

J. Codina, D. Preciado, M.A. Gelabert, L. Paúl
Radiology, Hospital Dr. Josep Trueta, Girona, ES

Clinical History/Pre-treatment Imaging: 74 yo man with squamous lung carcinoma in chemotherapy and radiotherapy treatment is admitted on the emergency department after massive hemoptysis.

CT scan shows shrinkage of the tumor and severe irregularity of the arterial pulmonary wall.

Treatment Options/Results: Various options were considered to treat the massive hemoptysis in a patient with partial response to chemotherapy and radiotherapy.

1. Embolization
2. Stent
3. Bronchoscopy intervention
4. Abstinence
5. Surgery.

Interventional radiology was chosen with stent as a first option and embolization if it was not possible to control massive bleeding in order to exclude the artery eroded by the tumor to the airway.

With femoral access we were able to deploy a covered stent from the main left artery to the inferior left lobar artery, covering the irregularity of the vessel, the amputated lobar superior and a little pseudoaneurysm.

As a complication a self limited pericardial effusion of 10-15mm was developed after small pericardial perforation.

The patient died 23 days after the procedure for infection on upper left side lobe. The pleural effusion resolved in 15 days and there were no more hemoptysis to the day.

Discussion: Tumoral vascular invasion and effective treatment which shrinks the lesions is controversial as opposed are shown. On the one hand the tumor is reponding but with potential lifethreatening complication. Complications in the literature are reported in high percentatge. In our case the small pericardial perforation.

Tailored decisions are recommended.

Take-home points: Pulmonary artery stent is effective to massive bleeding control. High complications rates and patient stage should be taken account to the indication.

P-608

Complete response of multiple hepatic cellular carcinomas after high-dose hepatic arterial infusion chemotherapy

B.C. Lee¹, Y.J. Kang², J.K. Kim³, N.Y. Yim⁴, H.-O. Kim³, H.D. Jung⁵

¹Radiology, Chonnam National University Hwasun Hospital, Jeollanam-do, KR, ²Diagnostic Radiology, Chonnam National University Hwasun Hospital, Jeollanam-do, KR, ³Radiology, Chonnam National University Hospital, Gwangju, KR, ⁴Diagnostic Radiology, Chonnam National University Hospital, Gwangju, KR, ⁵Radiology, Human Medical Imaging and Intervention Center, Seoul, KR

Clinical History/Pre-treatment Imaging: A 58 year old male patient with past history of chronic hepatitis B and heavy alcohol drinker visited our hospital for management of hepatic cellular carcinoma (HCC). Liver enzymes were mild elevated and bilirubin levels were within normal range. On initial dynamic enhanced CT showed multiple HCCs (<12cm) and tumoral rupture in both hepatic lobes.

Treatment Options/Results: High-dose hepatic arterial infusion chemotherapy (HAIC) was planned for treatment. The patient was treated 5 cycles of HAIC. On 6 months follow up image, most of HCCs were necrosis, but small tumoral enhancement remained in hepatic angle. Additional TACE was performed after removal of hepatic arterial infusion chemoport due to catheter occlusion. There was no tumoral staining on common hepatic artery angiogram, but small tumoral staining was seen on right inferior phrenic artery angiogram. Conventional TACE was performed through right inferior phrenic artery and there was no tumoral recurrence for 12 months.

Discussion: HAIC can deliver anticancer drugs directly to tumoral feeding vessels and minimize systemic toxicity through first pass effect. Since the hepatic artery is not embolized, it can be safely used in patients with portal vein thrombosis. If there is an extrahepatic tumoral feeder, it is difficult to expect complete remission by HAIC alone.

Take-home points: HAIC could be an effective treatment for advanced HCC patients with favorable liver function.

P-609

Hepatic transarterial chemoembolization (TACE) for transformed insulinoma metastases with recurrent hypoglycaemia

H. Ng, J. Zhong

Diagnostic and Interventional Radiology, St James' Institute of Oncology, Leeds, UK

Clinical History/Pre-treatment Imaging: 55 year old male. Moderately differentiated pancreatic neuroendocrine tumour (PNET) with widespread liver metastases. The PNET liver metastases were initially non-functional but the patient started suffering from recurrent hypoglycaemia indicating malignant transformation to insulinoma.

Treatment Options/Results: Following MDT discussion, transarterial chemoembolization (TACE) undertaken to reduce the large tumour burden (>50% liver volume) and control the recurrent hypoglycaemia. TACE to segment 5, 7 and 8 with 20mg/20 ml of cisplatin/lipiodol and 1 vial PVA 300-500 microns. Mild post-embolisation syndrome after procedure. Further TACE 4 weeks later to treat left lobe. At 2 months the patient had stable blood sugars, better mental state and was able to have a normal diet without excessive eating.

Discussion: We opted to treat the liver in 2 sessions due to the large tumour volume and risk for prolonged post-embolisation syndrome and liver failure. Currently the evidence base is unclear on the most appropriate embolotherapy technique such as bland embolisation or TACE. The timing with embolisation is also unclear, with many studies advocating early embolisation treatment to reduce tumour burden before initiating systemic therapy. The natural history of PNETS remains unpredictable however the upcoming Randomized Embolization Trial for NeuroEndocrine Tumor Metastases to the Liver (RETNET) will shed more light on the subject.

Take-home points: Patient's with >50% of liver involvement from PNET metastases can be treated safely and effectively by splitting treatment sessions.

P-610

Hepatic artery embolization of post-TACE HCC rupture via collateral supply

A. Alsherbini¹, A.M.A.A. Elmahdy², A. Barah³, A. Omar²

¹Radiology, Hamad General Hospital, Doha, QA, ²Clinical Imaging, Hamad General Hospital (HGH), Hamad Medical Corporation, Doha, QA, ³Clinical Imaging, Hamad Medical Corporation, Doha, QA

Clinical History/Pre-treatment Imaging: 60 years old gentleman, known case of HCV related Liver cirrhosis with HCC. Status post multiple sequential Trans-Arterial Chemo-Embolization (TACE) and radiotherapy, presented with abdominal pain and distension with 3g/d hemoglobin drop over 5 days. Abdominal CECT showed large hematoma abutting the caudate lobe of the liver and extending into the lesser sac with extravasation noted only in the venous phase.

Treatment Options/Results: A decision was made to perform empiric hepatic artery embolization using 355-500 embosphere as patient is on palliative therapy despite not having evident arterial bleeding. Post-embolization CECT showed significant reduction of the perihepatic hematoma and normalizing of hemoglobin level.

Discussion: This case is unique as it combines multiple clinical and technical Challenges including post-TACE HCC rupture, technical challenge due to anatomical variation and a debatable indication for empiric embolization.

Empiric embolization when no evidence of arterial extravasation has been always a controversial issue. While some interventional radiologists advocate that such embolization may benefit the patient, other believe that it will not affect the prognosis.

A technical difficulty that you may encounter during such procedure is anatomical variations of the hepatic artery along with post chemoembolization vascular changes.

Take-home points: It is crucial to always check the vascular anatomy of the patients before vascular interventional procedures. Anatomical variations can be challenging to figure out during the procedure. Post-TACE HCC rupture is a rare but potentially fatal complication that requires prompt treatment.

Empiric arterial embolization with no evidence of arterial extravasation in diagnostic imaging remains controversial and should be decided on a case-by-case bases.

P-611

Pushing-guidewire technique for making the distance between ureter and tumor to prevent ureteral injury in percutaneous cryoablation for renal cell carcinoma (RCC)

S. Kimura¹, M. Sone, S. Sugawara, C. Itou, T. Hasegawa, Y. Onishi, N. Umakoshi, S. Fujizuka, Y. Arai, M. Kusumoto

Diagnostic Radiology, National Cancer Center Hospital, Tokyo, JP

Clinical History/Pre-treatment Imaging: Two patients with RCC located at the inferior pole of the right kidney were planned percutaneous cryoablation.

Treatment Options/Results: Case1: A 50s years male with 20mm-RCC being adjacent to the ureter was tried to secure the safe distance between ureter and tumor to prevent the ureteral injury. However, the safe distance could not be obtained with various previously reported techniques. Therefore, we performed percutaneous nephrostomy, and inserted a stiff guidewire (Amplatz Extra Stiff, CookMedical, Bloomington) into the ureter to displace it medially. With the safe distance between ureter and tumor, cryoablation was successfully performed. No injury to the ureter was observed. Case2: A 50s years male with 30mm-RCC being adjacent to the ureter was performed cryoablation using same technique as Case 1, because, the safe distance between ureter and tumor could not be obtained with previous techniques. No ureteral injury occurred.

Discussion: Ureteral injury by cryoablation causes refractory ureteral stricture or urinoma. Various techniques such as hydrodissection, pneumodissection, change of body position, etc. have been reported to secure the safe distance between ureter and tumor. With this pushing-guidewire technique, we successfully completed cryoablation for two cases in whom the safe distance could not be secured with previously reported techniques. Although this technique is more invasive than other techniques, it may be a useful option when the other techniques failed.

Take-home points: Pushing-guidewire technique may be a useful option for making the safe distance between ureter and tumor in renal cryoablation.

P-612

Magnetic resonance-guided focused ultrasound treatment of a desmoid tumor in the abdominal wall in analgesia without sedation

L. Leifels¹, N. Bailis¹, B. Maiwald¹, S. Strocka¹, H. Busse¹, A. Melzer², T.-O. Petersen¹

¹Department of Diagnostic and Interventional Radiology, Leipzig University Hospital, Leipzig, DE, ²University Leipzig, Innovation Center Computer Assisted Surgery (ICCAS), Leipzig, DE

Clinical History/Pre-treatment Imaging: 30-yo patient with Gardner-syndrome with desmoidal soft tissue tumors in the groin region and in the right abdominal wall with infiltration of the M. rectus abdominis and long-stretched walling of the right lower costal arch. The desmoid in the abdominal wall was symptomatic and due to this partial resected, but recurrent growth in short term was observed. Complete resection due to surrounding tissue was not possible.

Treatment Options/Results: Another surgical resection was rejected due to short term recurrent and poor response rate in the absence of possibility of in-toto resection. Chemotherapy showed no effect. Radiotherapy was also rejected due to adjacent risk structures and side effects. Thus

therapy decision to multistaged MRgFUS (magnetic resonance controlled focused ultrasound treatment) as compassionate use was made - with an initially good result of 80 ml treated volume of initial 400 ml volume measuring tumor (24% NPV (Non-perfused-Volume)) without any side-effects. Already one week after therapy subjective reduction of symptoms was observed. Further MRgFUS are planned.

Discussion: Desmoid tumours are locally infiltrative and may cause pain and dysfunction. Standard therapies, including surgical resection, radiation and systemic chemotherapy, suffer from excessive side effects when considering their limited efficacy for treating desmoid tumors. This case demonstrates that MRgFUS treatment of desmoids is feasible and that this technique may be used to control the growth of symptomatic desmoid tumours, even off the abdomen and in analgesia without sedation.

Take-home points: MRgFUS can provide safely and effectively durable control of tumour growth and is an alternative to operative resection, radiation therapy, systemic chemotherapy.

P-613

First radiofrequency ablation of metastatic cervical lymph node in Hungary

A.P. Deak¹, A. Bibok¹, F.V. Varga², A. Doros¹

¹Transplantation and Surgery, Radiology Unit, Semmelweis University, Budapest, HU, ²Oncology, National Institute of Oncology, Budapest, HU

Clinical History/Pre-treatment Imaging: In 12.2017 51 y.o. female presented with FNAB proven metastatic cervical lymph nodes. Total thyroidectomy was performed in 2011, followed by 3 cycles of radioiodine therapy. Suspected lymph nodes were found in 06.2017, close to the right carotid artery. Before the treatment PET-CT and US (with CEUS) were performed.

Treatment Options/Results: The standard treatment of metastatic cervical lymph nodes is surgery. However, in this case, surgeons declined the therapy because of the previous surgery and the location of the lymph nodes. Thermal ablation can be an alternative, minimal invasive therapy, but as of 12.2017 no such a procedure was performed in Hungary. The US-guided procedure was uneventful, under local anesthesia. After the treatment, follow-up US/CEUS was done in 1, 3, 6, 12 months. No signs of recurrence found so far.

Discussion: RF ablation is widely used on the neck region, mainly to treat benign thyroid lesions. It is also possible to treat malignant lesions like recidive tumors or lymph node metastasis. Unfortunately in Hungary, these options were not available that time, due to financial reasons.

Take-home points: RF ablation of metastatic lymph nodes is a viable option, that should gain more interest in the future.

P-614

Yttrium-90 (TARE-Y90) transarterial radioembolization for the treatment of hepatic malignancies in children

M.A. Rios-Vives¹, M. Gonzalo Carballes¹, I. Díez Miranda², C. Gonzalez-Junyent², J.C. Correa Zapata², D. Barnés², G. Guillén³, J.A. Molino³, I. Navales⁴, M. Pérez Lafuente²

¹Radiology, Hospital Universitari de la Vall d'Hebrón, Barcelona, ES, ²Interventional Radiology, Hospital Universitari de la Vall d'Hebrón, Barcelona, ES, ³Pediatric Oncology Surgery, Hospital Universitari de la Vall d'Hebrón, Barcelona, ES, ⁴Nuclear Medicine, Hospital Universitari de la Vall d'Hebrón, Barcelona, ES

Clinical History/Pre-treatment Imaging: (Case1) Thirteen year old male, diagnosed with small round cells desmoplastic (EWS-WT1 mutation) liver tumour with pulmonary metastases.

Initial CT demonstrated a large (19x16x19cm) highly heterogeneous, necrotic, liver mass affecting both lobes.

The patient received a first chemotherapy cycle (Vincristine, Doxorubicin, ifosfamide), with poor response and rapidly evolving clinical-radiological

worsening. Palliative Y90 radioembolization was proposed. Bridge chemotherapy was administered (Irinotecan, temozolomide).

(Case2) 14 year old female, with a large, multicentric Grade II (Edmondson-Steiner) hepatic cell carcinoma affecting diffusely the liver and with large abdominal lymphadenopathies and pulmonary metastases.

The patient received SIOPEL 5 (Cisplatin, Doxorubicin and Thalidomide) chemotherapy-7 cycles, with partial response. Second line chemotherapy (Sorafenib, Oxaliplatin and Gemcitabine) was initiated, with poor response. Liver transplantation was refused.

Treatment Options/Results: (Case1) There was poor clinical and radiological response (albeit reduction of the targeted lesions) and died of multiorgan failure three months after the procedure.

(Case2) Y90-TARE was administered without complications with good clinical-radiological response. Supportive radiofrequency ablation was required for the right lobe secondary nodule.

The patient is still alive 23 months after the procedure and is actually undergoing evaluation for treatment with regorafenib or afatinib.

Discussion: TARE-Y90 has been widely used in adults to treat hepatic malignancies, but very scarce experience is available in children. Our limited practice improved palliative care, was technically feasible, safe and well tolerated. The very limited treatment tools and ominous prognosis of these patients should prompt research in order to improve experience treating hepatic malignancies with TARE.

Take-home points: TARE-Y90 is feasible in children, but further experience should be researched.

P-615

A challenging DEB-TACE for liver tumors, with a retrograde, pancreaticoduodenal approach

P.C. Chişcariu¹, L. Mărginean², R.C. Filep²

¹General Medicine, The University of Medicine, Pharmacy, Science and Technology of Târgu Mureş, Targu Mures, RO, ²Radiology and Imaging, University County Hospital Targu-Mures, Targu-Mures, RO

Clinical History/Pre-treatment Imaging: A 58-year-old man presented with nausea, regular vomiting, flatulence, upper right quadrant pain and a history of chronic viral hepatitis B with delta-agent and cirrhosis. The ultrasound and CT findings showed two lesions in the segments IV and VII of the liver. Laboratory tests revealed elevated levels of alpha-fetoprotein and cancer antigen 19-9.

Treatment Options/Results: DEB-TACE of the tumors was decided. The arteriography of the celiac axis (CA) revealed normal filling of the left gastric and splenic arteries, but no filling of the common hepatic artery (CHA). At this site, any other attempted catheterization of the CHA was unsuccessful. The arteriography of the superior mesenteric artery (SMA) revealed the filling of the pancreaticoduodenal arcade arteries which supply the distribution of the CA by means of retrograde flow from the SMA. DEB-TACE via this collateral route was successfully achieved for both tumors by superselective embolization, using a microcatheter. One month after the chemoembolization, the control CT scan showed a hypodense lesion in the 4th hepatic segment, of equal size compared to the first scan and a well-defined, slightly increased, heterogeneous hepatic lesion with central necrosis in the 7th hepatic segment.

Discussion: Despite the small size of the CA, the entity and its branches may pose several challenges to interventional radiologists, given the context of arterial anatomic variants or aberrant anatomy.

Take-home points: A sound appreciation of the vascular structures facilitates the effective planning of endovascular interventional procedures, lowering the risk of inadvertent, iatrogenic vascular injury.

Others

P-616

Clinical feasibility of snuffbox transradial access for coronary and non-coronary interventional treatment: a single center study

S. Cho¹, M.U. Kim¹, S.E. Park²

¹Department of Radiology, Ewha Womans University, Seoul, KR,

²Radiology, Gyeongsang National University Changwon Hospital, Changwon-si, Gyeongsangnam-do, KR

Purpose: Transradial access (TRA), a well-known transarterial approach, is an alternative to conventional transfemoral approach for coronary and non-coronary interventional procedure. Recently, distal TRA at the "Snuffbox" that lies in the dorsum of hand has been introduced as a new technique with versatility in positioning. To evaluate the clinical feasibility and safety of snuffbox TRA for endovascular treatment in a single center.

Material and methods: Snuffbox TRA was attempted in 22 patients (17 men and 5 women; mean age, 63.2 years) who underwent 22 consecutive procedures from January 2018 to June 2018, including chemoembolization (5/22, 22.7%), bronchial artery embolization (3/22, 13.6%), renal intervention (3/22, 13.6%), arteriovenous fistula angioplasty (3/22, 13.6%), subclavian artery stenting (3/22, 13.6%), other embolization (3/22, 13.6%), and uterine artery embolization (1/22, 4.5%). Exclusion criteria were: procedures requiring sheath > 6 Fr, Barbeau D waveform, distal RA diameter < 2 mm on ultrasound, and unstable vital sign or massive bleeding on computed tomography. Patients were evaluated for complications during follow-up of 171.2 ± 72.4 days (range, 27~264 days).

Results: Technical success was 95.5% (21/22) without major complication. Of these 21 patients with successful snuffbox TRA, one patient (4.8%) had a minor complication (a thrombotic segmental occlusion of the distal radial artery). In a single case with technical failure of snuffbox TRA (1/22, 4.5%), conventional transfemoral access was performed due to proximal subclavian artery occlusion. Mean hemostasis time was 147.3 minutes (range, 120-360 minutes).

Conclusion: Snuffbox TRA can be a viable option for various endovascular treatments with technical feasibility and safety.

P-617

Management of rectal bleeding due to internal hemorrhoids with arterial embolization: a single-center experience and protocol

S. Xingwei, J. Yong

Department of Intervention, The Second Affiliated Hospital of Soochow University, Suzhou, Jiangsu, CN

Purpose: To evaluate the safety and efficacy of arterial embolization for rectal bleeding due to internal hemorrhoids.

Material and methods: Twenty-three patients received arterial embolization for rectal bleeding due to internal hemorrhoids. Clinical records, technical success and complications were retrospectively analyzed.

Results: Good short-term outcomes were achieved with no ischemia or pain. Regarding symptom resolution, such as irritation, discomfort and bloody discharge, satisfaction was observed in 6/6 (100%) patients with grade II hemorrhoids and 14/17 (82.35%) patients with grade III hemorrhoids. In the study, 9 of the 10 patients (10/23, 43.48%) whose superior rectal artery (SRA) had a connection with the inferior rectal artery (IRA), either unilaterally or bilaterally, had embolization of the IRA performed. Re-bleeding was observed in 2 (2/23, 8.70%) patients, including one whose connection between the right SRA and right IRA was not previously noted. A reduction in the size of the hemorrhoid was observed by rectoscopy one month later (mean 1.91 cm vs 1.23 cm) ($P < 0.05$). The contractility of the internal and external sphincters was normal in all cases.

Conclusion: Coil embolization of the hemorrhoid arteries for rectal bleeding is technically feasible, safe and well tolerated. It is proposed that embolization of the SRA and IRA are necessary in cases where

connections between the arteries are noted. It is recommended that intraoperative IRA angiography should be routine. This study may well stimulate future research in this area.

P-618

Visibility of DC Bead™ bound with Fe²⁺ or Ca²⁺ ions on low keV monochromatic images from dual energy computed tomography

K. Tanitame¹, T. Fuji², T. Kurose¹, K. Chosa³, E. Tamai⁴, Y. Takahashi³, N. Kishida¹, Y. Tsuchida¹, M. Kobayashi¹, K. Awai³

¹Diagnostic Radiology, Hiroshima Prefectural Hospital, Hiroshima, JP, ²Diagnostic Radiology, Institute and Graduate School of Biomedical Sciences, Hiroshima University, Hiroshima, JP, ³Radiology, Hiroshima University Hospital, Hiroshima, JP, ⁴Radiology, Hiroshima Prefectural Hospital, Hiroshima, JP

Purpose: DC Bead™ (DCB) cannot be visualized on X-ray fluoroscopy and computed tomography (CT) scan, and it makes the embolization procedure somewhat difficult. We thought that Fe²⁺ or Ca²⁺ ions could bind DCB in FeSO₄ or CaCl₂ solutions, and DCBs bound with these cations could be radiopaque. The purpose of this study is to evaluate the visibility of Fe²⁺- and Ca²⁺-bound DCBs on low keV monochromatic images from dual energy CT (DECT).

Material and methods: We added DCBs of 100-300 µm in diameter to 0.1 mol/l FeSO₄ and CaCl₂ solutions. Using a DECT scanner, these solutions and fresh blood were scanned at 10 and 30 minutes, 1, 3, 6, 9, 18 and 27 hours after mixture. The CT values of DCBs settled down in these solutions and blood on 40 and 70 keV monochromatic images and their spectral HU curves were compared.

Results: The CT values of DCBs in Fe²⁺ and Ca²⁺ solutions gradually increased in processing time, and at 27 hours after mixture, which were 113.3 and 43.1 (blood: 7.8) HU on 40 keV image and 60.5 and 24.4 (blood: 31.9) HU on 70 keV image, respectively. The difference of CT values between Fe²⁺-bound DCB at 27 hours and blood on 40 keV image was largest. On the spectral HU curves, as the keV decreased, the CT values of DCBs bound with these cations increased, but that of blood decreased.

Conclusion: DCBs bound with Fe²⁺ and Ca²⁺ ions are radiopaque, and Fe²⁺-bound DCB is best discriminated from blood on 40 keV monochromatic images from DECT.

P-619

An attempt to create a hollow blood vessel model by direct inkjet 3D printing with nano-composite hydrogel for IR

T. Komada¹, T. Kamomae¹, T. Matsumura², T. Saito², T. Niimi², M. Matsushima¹, R. Hyodo¹, S. Naganawa¹

¹Radiology, Nagoya University Hospital, Nagoya, JP, ²Additive Manufacturing Business Group, Ricoh Company, Ltd, Ebina, JP

Purpose: The use of 3D printed organ models is already established in aiding planning of surgical and interventional procedures. The type of materials used when creating models is an important consideration. Many hard materials such as plastic are not suitable for the formation of meandering blood vessels. Nano-composite hydrogel is a soft material that allows the production of models of fine meandering hollow vessels. The purpose of this study was to fabricate hollow vessel models by direct inkjet 3D printing with this nano-composite hydrogel and evaluate the feasibility of their use as a simulator for interventional radiology (IR) procedures.

Material and methods: We used DICOM data of MRA and CT angiography, performed a surface rendering process, and converted it to Standard Triangulated Language (STL) format. We created hollow vessel models of a basilar artery aneurysm and an internal iliac arteriovenous malformation using an in-house developed direct inkjet 3D printer with nano-composite hydrogel. We inserted a catheter and wire into the model under fluoroscopy and confirmed their feel.

Results: This material could create a hollow structure with a minimum diameter of 0.5 mm. It was directly moldable without a mold. Meandering structures including a siphon part and a sacculus structure like an aneurysm could be reproduced in actual size; a microcatheter and a coil could also be inserted into the models.

Conclusion: We used a direct inkjet 3D printer with nano-composite hydrogel and fabricated patient-specific 3D-printed blood vessel models. Our results demonstrate the feasibility of the 3D-printed blood vessel models for pre-treatment simulation and planning in IR.

P-620

Effect of endovenous caval stent placed across the renal veins in patients with chronic venous obstruction

M.E. Barbati¹, A. Gombert¹, H. Jalaie²

¹Vascular and Endovascular Surgery, RWTH University Hospital Aachen, Aachen, DE, ²Vascular Surgery, Universitätsklinikum der RWTH Aachen, Aachen, DE

Purpose: To investigate the renal vein patency and renal function after stent deployment covering the renal veins.

Material and methods: We retrospectively analyzed all patients who has been treated for chronic caval or ilio caval obstructions between December 2013 and December 2017. Stenting of the inferior vena cava was performed with large self-expandable stents covering the ostia of renal veins. Technical success, stent type, glomerular filtration rate (GFR) and creatinine before and after stent placement, renal vein patency, and complications were recorded.

Results: This study includes 48 patients who had chronic venous obstruction involving juxtarenal IVC. Mean overall pre-stent placement GFR (mL/min/1.73 m²) and creatinine (mg/dL) were 57 (range: 50-63) and 0.8 (range: 0.5-1.2). Mean post-stent placement GFR and creatinine were 58 (range: 42-60) and 0.7 (range: 0.5-1.7). There was no difference between mean pre- and post-stent placement GFR (P=0.32) or creatinine (P=0.41). None of the patients developed renal vein thrombosis. All stent occlusions were lysed successfully. Overall primary, assisted-primary, and secondary cumulative patency rates at 30 months were 75%, 84% and 92%, respectively.

Conclusion: Contrary to arterial stenting, braided stainless stents can be safely placed in the venous system across the collateral vein, probably without risk of their occlusion. Stent placement in IVC covering the ostia of renal veins has no effect on their function and patency of renal veins.

P-621

Understanding the awareness, knowledge and perceptions of interventional radiology amongst undergraduates in the United Kingdom

S. Muzumdar¹, A.H. Brown²

¹Radiology, Leeds Teaching Hospitals Trust, Leeds, UK, ²Radiology, Royal Free Hospital, London, UK

Purpose: The role of interventional radiology (IR) in healthcare is rapidly expanding in the United Kingdom. However, the presence of IR in the current undergraduate curriculum is lacking, with no established syllabus. This study investigates the awareness, knowledge and perceptions of IR in undergraduates through the clinical years of medical school to suggest future interventions.

Material and methods: A total of 360 questionnaires, designed to test undergraduates' knowledge of, and exposure to, IR were distributed over a fourteen-day period in a UK medical institution.

Results: Of the 312 respondents (86.7%), the majority had never formally shadowed a radiologist (65.4%) or encountered teaching from an interventional radiologist (54.5%). Most students (88.5%) felt their knowledge of IR was lower than other specialties. Students' knowledge of IR procedures did not statistically increase through the clinical years. Students were most cognisant of vascular procedures, and least aware

of IR's role in oncology and neuroradiology. Only 10.9% would consider a career in IR, with 39.7% citing the lack of knowledge and 18.6% citing patient contact as the top reasons for this.

Conclusion: Current students have poor exposure to IR through the undergraduate curriculum. Consequently, there is no increase in knowledge of IR clinical practice through the clinical years. Multi-level interventions, incorporating universities and radiological societies, are required to increase undergraduate awareness and promote IR as a career. This study makes a strong case for increased uptake of the Cardiovascular and Interventional Radiological Society of Europe (CIRSE) curriculum, to increase students' awareness and knowledge of an IR career.

P-622

The benefit of transradial approach in patients with obesity undergoing peripheral embolization

E. Khayrutdinov, D. Gromov

Endovascular Diagnostic and Treatment, RNRMU, Moscow, RU

Purpose: We aimed to assess whether radial approach (RA) was superior to femoral approach (FA) in patients with obesity undergoing peripheral embolization.

Material and methods: 589 peripheral artery embolization procedures were done from October 2013 to November 2018. Uterine fibroid embolization was done in 168, transarterial chemoembolization - in 251, prostate artery embolization - in 85, bronchial artery embolization - in 31, epistaxis embolization - in 32, bariatric embolization - in 22 patients. RA was used in 296 patients and FA - in 293 patients. Obesity was found in 47 patients in the RA group and 45 patients in the FA group. Clinical characteristics of the patients were comparable between the two groups.

Results: Embolization procedures were successfully performed in all patients. The duration of the procedure (36.2 vs 51.5 minutes, $p=0.003$), time needed for catheterization of target arteries (18.1 vs 29.1 minutes, $p=0.004$) and radiation exposure (0.87 vs 1.21 mZv, $p=0.001$) were significantly lower in the RA group. Major vascular complications (0 (0%) vs 3 (6.6%), $p>0.05$) were comparable between the two groups. RA was associated with a statistically significant reduction in all parameters of procedural discomfort.

Conclusion: Clinical success of the procedure and rate of major vascular complications are comparable between the patients with obesity undergoing peripheral embolization using transradial and transfemoral approach. RA is associated with a significant reduction of the duration of the procedure, radiation exposure and all parameters of procedural discomfort.

P-623

For an anesthesiologist-free radiofrequency ablation of thyroid nodules: comparison of a standardized protocol in bland sedation with subcapsular anesthesia versus deep sedation with anesthesiologist support

F. Morelli¹, A.M. Ierardi², P. Biondetti³, S. Zannoni², G. Rodà³, A. Sacrini², G. Pompili², G. Carrafiello⁴

¹Radiology, Università degli Studi di Milano, Milan, IT, ²Radiology, University of Milan, San Paolo Hospital, Milan, IT, ³Diagnostic and Interventional Radiology, University of Milan, San Paolo Hospital, Milan, IT, ⁴Diagnostic and Interventional Radiology, University of Milan, Milan, IT

Purpose: Radiofrequency ablation (RFA) is a new promising technique to treat benign thyroid nodules causing compressive symptoms/cosmetic concerns. Since it's a benign condition, tolerability is fundamental; nonetheless, intraprocedural pain is reported as one of the major concerns. We developed an anesthetic protocol with lower systemic sedation trying to demonstrate that, on equal terms of tolerability, thyroid RFA can be performed without the presence of an anesthesiologist in deep sedation, thus reducing hospital costs and sedation-related risks for the patient.

Material and methods: 14 patients (mean age 60.1 years, male:female ratio 5:9) were submitted to RFA. The first seven underwent systemic sedoanalgesia [intravenous (IV) remifentanyl/fentanyl/propofol ± IV midazolam ± IV acetaminophen/nonsteroidal anti-inflammatory drugs] + subcutaneous anesthesia, with anesthesiological support.

The second seven patients underwent bland systemic sedoanalgesia (oral solution morphine sulphate + IV midazolam + IV acetaminophen) + both subcutaneous and subcapsular anesthesia, without anesthesiological support. Tolerability (0-10 cm visual analogue scale), sedation grade (Ramsay sedation scale), total opioid dose (TOD) and complications were analyzed and compared between the two groups.

Results: Mean tolerability was 9.4 in group A and 8.9 in group B ($p: 0.786$). Mean sedation grade was 3.86 in group A and 2.71 in group B ($p: 0.016$). Mean TOD was 70.9 mg in group A and 10 mg in group B ($p: 0.00015$). No complications were observed.

Conclusion: In thyroid RFA, the addition of subcapsular anesthesia can decrease both TOD and the sedation grade of the patient without significant differences in tolerability, allowing to perform ablation without the anesthesiologist.

P-624

Efficacy and clinical outcomes of transcatheter arterial embolization for gastrointestinal bleeding associated with pancreatic cancer

S.M. Lee¹, J.H. Shin²

¹Radiology, Gyeongsang National University Hospital, Jinju, Gyeongsangnamdo, KR, ²Radiology, Asan Medical Center, Seoul, KR

Purpose: To evaluate the efficacy and safety of transcatheter arterial embolization (TAE) for managing pancreatic cancer-related gastrointestinal (GI) bleeding, and to determine the factors associated with clinical outcomes.

Material and methods: From 2001 to 2017, this retrospective study included 58 patients (mean 61 years of age) who underwent TAE for pancreatic cancer-related GI bleeding. The technical and clinical success of TAE, clinical factors including patient characteristics and embolization details, complications, and the 30-day mortality were evaluated. Univariate analyses were performed to determine the factors related to the clinical outcomes.

Results: Technical and clinical success was achieved at 98% and 79%, respectively. On angiography, bleeding foci were observed in 47 patients (47/58, 81%), while the other 11 patients showed tumor staining. N-butyl cyanoacrylate (NBCA) was the most commonly used embolic agent (53%, 31/58) alone or in combination with other agents. All 22 patients with stent-related bleeding showed active bleeding foci with arterial cut-off (59%, 13/22) and arteriovenous fistula (23%, 5/22) as a unique angiographic finding. Regarding a bleeding artery, the superior mesenteric artery was associated with a poor outcome and a high 30-day mortality rate (75%, 3/4). Complication occurred in two patients, such as ischemic hepatitis and severe small bowel infarction. Univariate analysis showed that massive transfusion and TNM stage 4 were related to clinical failure.

Conclusion: TAE was safe and effective for pancreatic cancer-related GI bleeding. All stent-related bleeding showed active bleeding foci such as an arterial cut-off sign and arteriovenous fistula. Massive transfusion and TNM stage 4 were related to clinical failure.

P-625

#IRAD: Correct application of the 'hashtag' could improve twitter profiles in interventional radiology societiesS. Rostampour¹, B. Pitrola¹, N.R. Patel², A. Alsafi³, M.S. Hamady⁴¹Interventional Radiology, Imperial College Healthcare NHS Trust, London, UK, ²Radiology, Imperial College Healthcare NHS Trust, London, UK, ³Radiology, Imperial College, London, UK, ⁴Interventional Radiology, Imperial College-London - St Mary's Campus, London, UK

Purpose: Twitter usage in Interventional Radiology is on the increase, with surges in number of users and tweets by both individuals and societies. Twitter is an exciting platform to advertise what the speciality has to offer and share ideas with others in the IR community. We aim to compare the use of Twitter by CIRSE with other similar societies including BSIR, SIR and VSGBI

Material and methods: Twitter analysis was performed using a twitter analytics platform Twitonomy using publicly available data.

Results: CIRSE increased its number of followers by 34% in 2018 compared with increases of 53% by BSIR, 24% by SIR and 13% by VS. CIRSE has reduced its number of Tweets from 151 in 2017 to 138 in 2018 (-8%), nonetheless it saw an increased number of followers. BSIR increased their twitter output by 39% whereas SIR also reduced their twitter output by 6%. CIRSE averaged 0.38 tweets/day compared with 1.73 tweets/day by BSIR, 4.2 tweets/day by SIR, 0.01 tweets/day by VSGBI. CIRSE used the less popular Hashtag #irads more frequently than the more widely used Hashtag #irad (54 times compared with 12 times respectively).

Conclusion: Twitter usage in Interventional Radiology is on the increase. While CIRSE reduced its number of daily tweets, it has seen an increase in followers. CIRSE may raise its twitter profile by both increasing the volume of high-quality tweets and also changing its use of hashtags to more popular ones to ensure wider visibility

P-626

Diffusion-weighted MRI assessment of adjacent disc degeneration after thoracolumbar vertebral fracturesD.C. Noriega¹, S. Marcia², L. Saba³¹Orthopedic Unit, Hospital Clinico Universitario de Valladolid, Valladolid, ES, ²Radiology SS Trinita' Hospital, ATS Sardegna, Cagliari, IT, ³Radiology, Policlinico Universitario di Monserrato, Cagliari, IT

Purpose: The assessment of disc degeneration by diffusion-weighted MR imaging after a vertebral fracture has not been previously reported. Through the use of the mean apparent diffusion coefficient (ADC), the intent of this study was to determine if a relationship exists between disc ADC and MR findings of adjacent disc degeneration following anatomic reduction of thoracolumbar fractures using vertebral augmentation (VAP).

Material and methods: Twenty non-consecutive patients (mean age 50.7 years; age range 45-56) were treated for vertebral fractures using either VAP (n=14) or conservative treatment (n=6). This included ten A3.1 and ten A1.2 fractures per AO classification. After a mean follow-up of 32 months, MRI T2-weighted images and mapping of the ADC for the inter-vertebral disc adjacent to the fractured segment were performed. A total of 60 discs (3 per patient) were analyzed, which included infra-adjacent, supra-adjacent and a control disc one level above the supra-adjacent disc.

Results: Across all discs evaluated, the average ADC in the supra-adjacent level was lower than that in the infra-adjacent level (1.35 ± 0.12 vs. 1.53 ± 0.06 ; $p < 0.001$). Average ADC values of the discs used as controls were similar to those at the infra-adjacent level (1.54 ± 0.06). When compared to surgically treated patients, discs at the supra-adjacent fracture level showed statistically significant lower values in patients treated conservatively ($p < 0.001$).

Conclusion: ADC measurements of the supra-adjacent disc following thoracolumbar fractures showed that, after a mean follow-up of 32 months, restoration of vertebral collapse by minimally invasive VAP may prevent posttraumatic disc degeneration.

P-627

Long-term safety and clinical performance of kyphoplasty and SpineJack® procedures in the treatment of osteoporotic vertebral compression fractures: a pilot, monocentric

D.C. Noriega

Orthopedic Unit, Hospital Clinico Universitario de Valladolid, Valladolid, ES

Purpose: Patient follow-up rarely exceeds 2 years in clinical trials comparing vertebral augmentation procedures for the treatment of painful osteoporotic vertebral compression fractures (VCFs). This pilot, investigator-initiated, prospective study aimed to compare long-term results of SpineJack® (SJ) system and balloon kyphoplasty (BKP).

Material and methods: Thirty patients (80.0% female; 68.1 ± 5.3 years old) were randomized to SJ (n=15) or BKP (n=15). Clinical endpoints were analgesic consumption, back pain intensity (visual analog scale (VAS)), Oswestry Disability Index (ODI), and quality of life (EQ-VAS score). These measures were recorded preoperatively, at 5 days (except EQ-VAS), 1, 3, 6, 12, and 36 months post-surgery. Spine X-rays were taken 48 hours prior to procedure and 5 days, 6, 12, and 36 months after.

Results: Clinical improvements were observed with both procedures over the 3-year period without significant inter-group differences, but the final mean EQ-5D_{index} score was significantly in favour of the SJ group (0.93 ± 0.11 vs. 0.81 ± 0.09 ; $p=0.007$). Vertebral height restoration/kyphotic correction was still evident at 36 months with a greater mean correction of anterior ($10 \pm 13\%$ vs. $2 \pm 8\%$ for BKP; $p=0.007$) and central height ($10 \pm 11\%$ vs. $3 \pm 7\%$ for BKP; $p=0.034$) and a larger correction of the vertebral body angle ($-5.0^\circ \pm 5.1^\circ$ vs. $0.4^\circ \pm 3.4^\circ$; $p=0.003$) for SJ group.

Conclusion: Both techniques displayed very good long-term clinical efficiency and safety in patients with osteoporotic VCFs. Over the 3-year follow-up, vertebral body height restoration/kyphosis correction was better with the SpineJack® procedure.

P-628

The role of thrombolysis in pulmonary embolism: a re-audit of our current practiceJ.I.F. Jackson¹, A.K. Gupta², A. Diamantopoulos³, N. Thulasidasan³, K.A. Breen⁴, A. West⁵, N. Karunanithy⁶¹Intensive Care Department, Guy's and St Thomas' Hospitals NHS Foundation Trust, London, UK, ²Interventional Radiology, Guy's and St. Thomas' Hospitals NHS Foundation Trust, London, UK, ³Interventional Radiology, Guy's and St. Thomas' NHS Foundation Trust, King's Health Partners, London, UK, ⁴Haematology, Guy's and St. Thomas' Hospitals NHS Foundation Trust, London, UK, ⁵Respiratory Medicine, Guy's and St. Thomas' Hospitals NHS Foundation Trust, London, UK, ⁶Department of Interventional Radiology, Guy's and St. Thomas Hospitals NHS Foundation Trust, London, UK

Purpose: Pulmonary embolism (PE) is a common and potentially fatal condition for which there are now many possible treatments, ranging from oral anticoagulation to systemic or catheter-directed thrombolysis. It is important that patients presenting with PE undergo full risk-assessment so that they receive appropriate treatment. An audit from September 2015 to April 2016 showed that only 37% of patients were fully risk assessed according to international guidelines with 7% referred to the pulmonary embolism lysis team (PELT) for consideration of thrombolysis. Re-audit was carried out following targeted departmental teaching to raise clinician awareness of PE assessment and PELT.

Material and methods: Data were collected retrospectively to identify all patients within a twelve-month period from April 2016 to 2017 who had a positive CT diagnosis of PE. These patients were risk-stratified according to ESC guidelines and those who may have benefited from thrombolysis were identified.

Results: 261 patients had PE diagnosed on CT pulmonary angiography. 54% of patients were fully risk assessed according to ESC guidelines. 44

patients with significant pulmonary embolism were identified as being high or intermediate-high risk and could have benefited from referral for thrombolysis. Of these patients, 41% were referred to PELT and 23% received thrombolysis.

Conclusion: The number of patients with PE undergoing full risk assessment and being referred for thrombolysis has increased since the first audit cycle after departmental education. However, with audit standards set at 100%, there is significant improvement yet to be made as the role of PELT is developed within the hospital.

P-629

Use of lusutrombopag, a thrombopoietin receptor agonist, for management of thrombocytopenia in patients with hepatocellular carcinoma undergoing planned invasive procedures

N. Alkhour¹, M. Imawari², N. Izumi³, Y. Osaki⁴, T. Ochiai⁵, R. Bentley⁶, T. Baykal⁶, T. Kano⁷

¹Department of Metabolic Center, Texas Liver Institute, San Antonio, TX, US, ²Institute for Gastrointestinal and Liver Disease, Shin-Yurigaoka General Hospital, Kawasaki, JP, ³Department of Gastroenterology and Hepatology, Musashino Red Cross Hospital, Tokyo, JP, ⁴Department of Gastroenterology and Hepatology, Meiwa Hospital, Nishinomiya, JP, ⁵Biostatistics Center, Shionogi & Co., Ltd., Osaka, JP, ⁶US Global Market Access, Shionogi Inc., Florham Park, NJ, US, ⁷Global Project Management Department, Shionogi & Co., Ltd., Osaka, JP

Purpose: Thrombocytopenia may interfere with performance of invasive procedures in patients with chronic liver disease (CLD), including hepatocellular carcinoma (HCC). Lusutrombopag is a thrombopoietin receptor agonist approved in Japan and US for treatment of thrombocytopenia in patients with CLD undergoing invasive procedures. We assessed efficacy and safety of lusutrombopag in patients with HCC and those with other CLD diagnoses.

Material and methods: This integrated analysis incorporated data from 2 Phase 3 randomized, double-blind, placebo-controlled studies (L-PLUS 1; L-PLUS 2). Adults with CLD and baseline platelet counts (PC) $<50 \times 10^9/L$ received lusutrombopag 3 mg once daily or placebo for ≤ 7 days prior to an invasive procedure scheduled 9–14 days after randomization. Platelet transfusion (PT) was mandated for pre-procedure PC $<50 \times 10^9/L$. Efficacy endpoint was the proportion of patients (per-protocol population) who required no PT prior to procedure and no rescue therapy for bleeding from randomization through 7 days post-procedure.

Results: Of 312 randomized patients, 270 comprised the per-protocol population (95 HCC; 175 other CLD). The efficacy endpoint was met for 68.0% (34/50) of HCC patients who received lusutrombopag vs 8.9% (4/45) who received placebo, compared to 77.0% (67/87) and 21.6% (19/88), respectively, among patients with other forms of CLD. In HCC patients, PCs remained $>50 \times 10^9/L$ for a median 16.6 days with lusutrombopag vs 3.8 days with placebo. One patient treated with lusutrombopag experienced treatment-emergent portal vein thrombosis but never exceeded PC $>200 \times 10^9/L$.

Conclusion: Lusutrombopag was similarly efficacious in managing thrombocytopenia in patients with HCC, as well as other forms of CLD, undergoing invasive procedures.

P-630

Pooled safety analysis of bleeding-related adverse events in studies of lusutrombopag for treatment of thrombocytopenia in patients with chronic liver disease who are undergoing planned invasive procedures

E.G. Giannini¹, T. Kano², T. Ochiai³, R. Bentley⁴, P. Shrestha⁵

¹Dipartimento di Medicina Interna e Specialità Mediche, Università Degli Studi Di Genova, Genoa, IT, ²Global Project Management Department, Shionogi & Co., Ltd., Osaka, JP, ³Biostatistics Center, Shionogi & Co., Ltd., Osaka, JP, ⁴US Global Market Access, Shionogi Inc., Florham Park, NJ, US, ⁵Product Safety and Pharmacovigilance, Shionogi Inc., Florham Park, NJ, US

Purpose: Thrombocytopenia (TCP) is a common complication in patients with chronic liver disease (CLD). Lusutrombopag (LUSU) is a thrombopoietin receptor agonist approved in Japan and US for patients with TCP-CLD undergoing an invasive procedure. A pooled safety analysis was performed to assess differences in bleeding events (BE) following LUSU treatment, with or without platelet transfusion (PT).

Material and methods: Safety data were pooled from 3 double-blind, placebo-controlled studies, in patients with TCP-CLD undergoing planned invasive procedure (Phase 2b: M0626; Phase 3: L-PLUS 1, L-PLUS 2). Patients enrolled in these studies were randomised to LUSU 3 mg or placebo (PBO) for up to 7 days prior to procedure. PT was administered if platelet count was $<50 \times 10^9/L$ prior to procedure. Patients were classified into 1 of 4 subgroups: LUSU with or without PT or PBO with or without PT. BE were summarized pre-, during, and post-procedure.

Results: Lower BE rates, regardless of severity and timing of onset, were observed with LUSU-only vs PBO+PT. Percent of patients with BE was numerically higher with PBO+PT vs LUSU-only, both during (4.8% vs 3.2%) and post-procedure (7.1% vs 4.0%); 3 moderate/severe BE occurred with PBO+PT compared to 1 with LUSU-only. Percent of patients with BE in liver-related procedures was greater in the PBO+PT (16.1%) vs LUSU-only arm (11.1%), and a larger difference was seen with gastrointestinal-related procedures with PBO+PT (8.9%) vs LUSU-only (2.0%).

Conclusion: In this post-hoc analysis, a trend toward lower BE rates was observed with LUSU-only vs PBO+PT, regardless of type of invasive procedure.

P-631

Prevalence of non-alcoholic fatty liver disease in patients with cardiovascular diseases

A. Kryveshko

Internal Medicine, Ukrainian Military Medical Academy, Kiev, UA

Purpose: There is strong interaction between non-alcoholic fatty liver disease (NAFLD) and cardiovascular diseases (CVD). The relationship between these diseases is due to the components of the metabolic syndrome: insulin resistance, elevation of blood glucose levels, atherogenic dyslipidemia. The aim were to demonstrate prevalence of NAFLD in patients with CVD.

Material and methods: Examination involved 203 patients, who were treated at the cardiological department of National Military Medical Clinical Centre during 2017–2018 years. There were three groups: the 1st group consisted of 38 patients (18.7%) who doesn't have NAFLD, 2nd group – of 58 patients (28.6%) who have a high risk factor to develop NAFLD, 3rd group – of 103 patients (52.7%) with NAFLD.

Results: We have established that the 3rd group have a significantly higher systolic and diastolic blood pressure (SBP/DBP) at the admission to the hospital: the 1st group SBP/DBP – $138,1 \pm 6,9/84,1 \pm 3,7$ mmHg; the 2nd – $143,8 \pm 5,5/89,8 \pm 3,8$ mmHg; 3rd – $151,2 \pm 4,4/93,0 \pm 2,5$ mmHg ($p_a \leq 0,01$). BMI were: $24,2 \pm 0,88$ kg/m²; $27,7 \pm 0,78$ kg/m²; $32,2 \pm 0,8$ kg/m²; accordingly ($p_a \leq 0,01$). Blood glucose level was: 1st group – $5,18 \pm 0,27$ mmol/L; 2nd – $5,91 \pm 0,42$ mmol/L; 3rd – $6,38 \pm 0,23$ mmol/L ($p_a \leq 0,01$). We revealed significant difference between the levels of triglycerides:

the 1st group – $1,13 \pm 0,2 \text{ mmol/L}$; the 2nd – $1,53 \pm 0,2 \text{ mmol/L}$; the 3rd – $2,06 \pm 0,25 \text{ mmol/L}$ ($p_a \leq 0,01$).

Conclusion: The prevalence of NAFLD among patients with CVD constitute 81,3%. The patients with CVD who have NAFLD characterize higher SBP and DBP at the admission, excessive weight or obesity, impaired glucose tolerance and hypertriglyceridemia. Currently, treatment is limited to weight loss, exercise, and the control of blood pressure and metabolic risk factors.

P-632

Correlation between infra-red thermography and conventional angiography on lower limb ischemia: based on angiosomal concept

J.M. Lee, Y. Kwon, J. Kim, J.H. Won

Department of Radiology, Ajou University Hospital, Suwon, KR

Purpose: To establish the efficacy of infra-red thermography as a non-invasive screening tool, pre- and post- treatment evaluation method on lower limb ischemia, clinical correlation investigated with conventional angiography.

Material and methods: From January 2016 to October 2017, eleven patients were enrolled in this study. Based on the conventional interventional treatment of lower limb ischemic disease, additional various thermographic views of foot and ankle using infra-red thermography were carried out. Just before procedure and one hour after treatment of lower limb ischemia with conventional angiography, we took thermographic view by total six region of interest which was placed in angiosomal territories of treated vessel. The quantitative parameters were statistically evaluated between pre-treatment and post-treatment test by Wilcoxon signed strength test, and p-values less than 0.05 were considered significant.

Results: Temperature change in pre- and post-treatment study was appeared all the eleven patient. Temperature range of pre- and post-treatment test were 25.77-29.98 and 25.71-30.08. Each of eleven cases, the mean temperature with standard deviation were 27.08 ± 1.16 and 27.62 ± 1.21 . There was statistically significant difference of the mean surface temperature between pre- and post- stress test ($P < 0.05$). Nine of the eleven (81.8%) patient had significant temperature difference only in treated vascular territory.

Conclusion: Infra-red thermography based on angiosomal concept and its quantitative measurement demonstrate correlation with conventional angiography which golden standard of diagnostic tool of lower limb ischemia.

P-633

Sclerotherapy using sclerosant sodium tetradecyl sulphate for treatment of slow flow venous vascular malformation of face, neck, oral and pharyngeal region

A.M. Lahoti

Department of Interventional Radiology, under Dept of Radiology, Ltmgh, Sion, Mumbai, IN

Purpose: Venous vascular malformations in the head and neck region are difficult to manage as external pressure cannot be applied after injection of sclerosant. We describe our experience of using sodium tetradecyl sulphate injection sclerotherapy to treat children presenting with slow flow venous malformations of the face, neck, oral and pharyngeal region.

Material and methods: Patient notes were analysed for demographic details, site and size of lesion, number and duration of treatments, treatment response and complications. USG and MRI were done before deciding the plan of management. 30 patients were included. Sites of lesions included tongue, floor of mouth, hard and soft palate. All patients were treated with 3 % sodium tetradecyl sulphate (STS) foam injected trans-orally or percutaneously under fluoroscopic guidance

Results: Those patients requiring multiple treatments, a mean of 4 treatments were required over an average period of 6-8 months. The overall response rate was 83 %. Complete resolution was achieved in 4 cases (10 %) with a significant reduction in size in a further 18 cases (60%). Larger lesions generally require more session of treatments than low volume lesions. One patient suffered minor bleeding, 2 local bruises and hematoma formation following transcutaneous injection which were resolved soon. However, using STS, good cosmetic and therapeutic results are obtained.

Conclusion: Injection sclerotherapy using STS foam offers an effective treatment option when managing children presenting with slow flow venous malformations in the oral and pharyngeal.

P-634

Australian surgical and medical trainees' perspective on IR education (ASPIRE-2)

M. Foo¹, J. Maingard², M. Wang¹, K. Phan³, R. Lim⁴, H.K. Kok⁵,

R. Chandra⁶, M.J. Lee⁵, H. Asadi⁷, M. Brooks⁸

¹Department of Radiology, Austin Health, Heidelberg, VIC, AU,

²Department of Radiology, Monash Health, Clayton, VIC, AU,

³Department of Neurosurgery, Liverpool Hospital, Liverpool, AU,

⁴Department of Surgery, Peninsula Health, Frankston, AU, ⁵Radiology,

Beaumont Hospital, Dublin, IE, ⁶Interventional Radiology

Service - Department of Radiology, Monash Health, Clayton, VIC, AU,

⁷Neurointervention, Monash Health, Clayton, VIC, AU, ⁸Interventional

Neuroradiology Service, Austin Hospital, Heidelberg, AU

Purpose: Junior doctors are increasingly expected to interact with, refer to, and pursue careers in interventional radiology (IR). However, our previous study (ASPIRE-1) demonstrates poor representation of IR in Australian medical schools. Thus, we aim to assess exposure, awareness and interest in IR amongst Australian interns and residents, as to determine whether perceptions of IR improve with clinical practice, and whether the negligence of IR in medical school is reflected in weaknesses as junior doctors.

Material and methods: Multicentre cross-sectional study using in-person and web-based distribution of a voluntary, anonymous questionnaire. 333 complete responses were received from 11 health services across 2 states.

Results: Consistent with ASPIRE-1, almost all junior doctors believed they received insufficient teaching of IR in medical school (5.7%), with 31.8% reporting no exposure and 42.2% simply learning IR via self-study throughout medical school. 87.1% were interested in learning more about IR. When offered several means of learning IR, most candidates stated the following would be ideal: internship/resident curriculum (74.5%), medical school curriculum (55.6%) or watching IR procedures (50.8%). Most respondents had made a referral to IR before (73.9%), however, less than half believed they had sufficient IR knowledge for their role (41.7%); felt confident referring to IR (48.9%) or had the knowledge to prepare a patient for an image-guided biopsy (33.0%).

Conclusion: Australian junior doctors have strong interest and frequent interactions with IR, yet are rarely taught IR throughout medical school, internship or residency. Formal IR teaching and curricula are required to counteract this significant unmet demand.

P-635

Development of a support system capable of rapid and precise analysis of cortisol and aldosterone in adrenal venous sampling

K. Seiji¹, Y. Tezuka², K. Omata², Y. Ono², R. Morimoto², F. Satoh², K. Takase¹

¹Diagnostic Radiology, Tohoku University Hospital, Sendai, JP, ²Division of Nephrology, Endocrinology and Vascular Medicine, Tohoku University Hospital, Sendai, JP

Purpose: The success or failure of adrenal venous sampling (AVS) is decided according to concentration of cortisol of blood sample, and

diagnosis of localization of aldosterone hypersecretion is decided according to concentration of aldosterone. If the time required for analyzing concentration of cortisol and aldosterone is reduced, we can perform AVS promptly and accurately. Purpose of our study is to provide a support system capable of rapid and precise analysis of concentration of cortisol and aldosterone in AVS.

Material and methods: We developed a rapid and precise analysis system of concentration of cortisol and aldosterone by using the liquid chromatograph mass spectrometry (LC-MS) system. This system needs blood sample less than 0.5 ml and can analyze of concentration of cortisol and aldosterone within 15 minutes. Moreover, this system can display the results of analysis on a monitoring screen at angiography room. We valued this system in regard to both accuracy by comparing with existing other analysis system and saving of time in AVS.

Results: The support system was accuracy on an equality with existing other analysis system. This system also reduces the time taken for AVS, especially in complicated cases due to difficulty to identify adrenal vein of the right side.

Conclusion: The support system capable of rapid and precise analysis of concentration of cortisol and aldosterone with LC-MS is reliable, and is useful in AVS especially in complicated cases.

P-636

Computed tomography-guided, percutaneous interstitial HDR brachytherapy (CT-HDRBT) in patients with irresectable adrenal metastasis

F. Feldhaus¹, M. Jonczyk¹, U. Fehrenbach¹, F. Colletini¹, D. Schnapauff¹, T. Denecke¹, B. Gebauer²

¹Department of Radiology, Charité Berlin, Berlin, DE, ²Klinik für Strahlenheilkunde, Charité Universitätsmedizin Berlin, Berlin, DE

Purpose: Study purpose was to investigate clinical outcome of patients with irresectable adrenal metastasis treated with computed tomography (CT)-guided High-dose-rate-brachytherapy (CT-HDRBT) for local tumour ablation.

Material and methods: Eleven consecutive patients with histologically proven metastasis were included in this retrospective study. Indication was adrenal metastasis only in 4, further extraadrenal metastasis in 7 cases. HDRBT was pursued using an Iridium-192 source in afterloading technique through CT-guided percutaneous placed catheters. A total of 14 brachytherapy treatments were performed, median tumour enclosing target dose was 20 Gy, mean target volume of the radiated tumours was 45.9 ($\pm$ 30, range, 9.5-100.1 ml) and mean diameter was 42.8 ($\pm$ 12.4; range, 28-64mm). Follow-up examinations consisted of clinical visits and magnetic resonance imaging of the abdomen. For statistical evaluation survival analysis was performed by using the Kaplan-Meier method.

Results: After a median follow-up of 6 (range, 1-19) months after local ablation, 4 of the 11 patients are still alive; 4 of them did not get further chemotherapy and are regarded as disease-free. In all 14 ablations (two bilateral) local tumour control (LTC) with CT-HDRBT could be achieved. Median survival after local ablation was 6 months. No severe complications or systemic side effects occurred in our study population.

Conclusion: In view of current clinical data and the clinical outcome of adrenal metastasis, locally ablative treatment with CT-HDRBT can be a promising technique for selective and individual treatment of patients with adrenal metastasis in a multidisciplinary treatment, if patients are not eligible for tumour resection.

P-637

Endovascular simulation training: a tool to increase enthusiasm for interventional radiology among medical students

R. Kloeckner¹, F. Stöhr¹, S. Schotten², C. Düber², M.B. Pitton², F. Schmidt³, D. Pinto dos Santos⁴

¹Department of Diagnostic and Interventional Radiology, University Medical Center of the Johannes Gutenberg University Mainz, Mainz, DE,

²Diagnostic and Interventional Radiology, University Medical Center Mainz, Mainz, DE, ³Center for Quality Assurance and Development,

Johannes Gutenberg University, Mainz, DE, ⁴Radiology, University of Cologne, Cologne, DE

Purpose: Interventional radiology (IR) is a growing field. However, in most medical schools it is underrepresented in the curriculum. Therefore, we aimed to test whether endovascular simulator training improves the attitude towards IR among medical students.

Material and methods: This prospective study is conducted at two university medical centers. In both, a dedicated 90-minute course on IR is given. The course is split into two halves: One theoretical 45-minute part about IR and one practical 45-minute part using endovascular simulators. Questionnaires are completed before the course, after the theoretical part, and after the practical part using smartphones/tablets. Students are asked to rate their knowledge and interest in IR, the attractiveness of IR, and their willingness to potentially work in IR on a 7-point scale. A cross-over design was used to prevent position-effect bias.

Results: As of the abstract deadline, 124 students completed the questionnaires in center A. Seminar and simulator led to an increase in knowledge about IR (pretest: 1.64 vs. post-seminar/post-simulator: 4.08/4.32), interest in IR (4.16 vs. 4.47/4.66), attractiveness of IR (3.47 vs. 3.66/3.78), and the likelihood to choose IR in the future (2.33 vs. 2.70/2.89) (all $p < 0.05$). Although both parts led a significant improvement, the effect was significantly stronger for the simulator part compared to the theoretical part regarding all items (all $p < 0.05$).

Conclusion: Endovascular simulator training in medical school significantly increases the knowledge about IR and the willingness to potentially choose IR in the future. In March 2019 the second part will be conducted in center B, hopefully confirming these initially positive results.

P-638

UK radiology and IR career promotion on the RiISE: two years of Radiological Imaging and Intervention Symposium Edinburgh – an annual event for medical students and foundation doctors

N.P. Burke¹, K. Kind²

¹Edinburgh Medical School, University of Edinburgh, Edinburgh, UK,

²Radiology Department, Royal Hospital for Sick Children Edinburgh, Edinburgh, UK

Purpose: Increasing demands on radiology services and the growth of interventional radiology (IR) has led to radiology staffing shortfalls in the UK. In order to ensure that interested medical students and junior doctors get the opportunity to explore and demonstrate their interest in radiology and IR careers, an annual symposium – Radiological Imaging and Intervention Symposium Edinburgh (RiISE) – was established.

Material and methods: RiISE is a student-coordinated radiology project which is supported by a range of Scottish and UK stakeholders. Several stages of outreach were integral to the project; this included working with medical student radiology societies to raise the profile of the event and enlisting the assistance and expertise of local radiology consultants, trainees and academics. Radiology representation bodies and societies were also approached to support and promote the symposium.

Results: The inaugural event – RiISE18 – was a success; 43 delegates attended from across the UK. The day consisted of morning keynote talks on radiology and IR topics, a careers session and afternoon workshops. Feedback was universally positive with the delegation particularly

enjoying the 'hands-on' IR workshops. RiiSE was awarded a grant from The University of Edinburgh to run another event in April 2019.

Conclusion: A long term solution to workforce issues is to increase the number of radiology training posts; increased exposure to radiology and IR during undergraduate medical education is also important. The RiiSE project team are working hard to develop a sustainable event which will continue to engage with the next generation of radiologists into the future.

P-639

Ultrasound-guided steroid injection of painful cervical neuromas – a pilot study

H.G. Campos¹, V.N. Marcos², M.A.V. Kulcsar³, A.G. Campolina⁴, A.O. Hoff⁵, M.C. Chammas², R.M.C. Freitas²

¹Radiology Unit, ICESP, São Paulo, BR, ²Radiology Institute, Universidade de São Paulo, São Paulo, BR, ³Head and Neck Surgery Department, Universidade de São Paulo, São Paulo, BR, ⁴Technical Innovation Lab Unit, ICESP, São Paulo, BR, ⁵Endocrinology Unit, Instituto do Cancer do Estado de São Paulo - Universidade de São Paulo Medical School, São Paulo, BR

Purpose: To evaluate the efficacy of steroid injection (SI) in patients with cervical pain related to post-operative neuromas after lateral neck dissection.

Material and methods: Patients with neuroma-suspected cervical level III nodules underwent ultrasound (US)-guided fine-needle aspiration biopsy followed by SI with dexamethasone (1.0 mL, 4 mg/mL). Visual Analog Scale (VAS) evaluated the pain degree immediately before SI (baseline), and 1-week, 1-, 3- and 6-month follow-up. All medications taken by the patients were recorded during each visit. Univariate statistics analyzed two groups according to the pain score levels: group 1 (mild pain score, <4) and group 2 (moderate to severe pain scores, ≥4). Pain scores and consumption of analgesics were evaluated over time.

Results: Twenty-nine patients (23 women) underwent SI; group 1 (n=9) had an average VAS score (±SD) of 1.0±0.9 and group 2 (n=20) of 6.0±1.8 at baseline; the group 1 had a follow up average VAS score (1-w; 1-mo; 3-mo; 6-mo), respectively, of 2.0±2.3; 0.6±1.0; 0.5±1.5; and 0.5±1.5; whereas the group 2 had respectively scores of: 8.0±1.3; 4.8±2.4; 3.4±2.5; and 3.8±3.1. VAS score of the group 2 dropped more than 2 points at 6-month follow up (3.8) compared to baseline (6.0, p<0.05), while only five patients (25%) received medications such as codeine or tramadol without consumption increase over time; one additional patient was non-responsive and required morphine plus carbamazepine over time.

Conclusion: US-guided steroid injection of cervical neuromas may add significant pain relief in post-operative lateral neck dissection in patients with moderate/severe cervical pain.

P-640

Transpedal lymphangiography (TL) in the management of post-operative lymphatic leakage - a 25-year experience in 372 consecutive patients

C.M. Sommer¹, F. Pan², T.D. Do², G.M. Richter¹, H.U. Kauczor³, T. Hackert⁴, M. Loos⁴

¹Diagnostic and Interventional Radiology, Klinikum Stuttgart, Stuttgart, DE, ²Diagnostic and Interventional Radiology, University Hospital Heidelberg, Heidelberg, DE, ³Department of Radiology, German Cancer Research Centre, Heidelberg, DE, ⁴Surgery, University Hospital Heidelberg, Heidelberg, DE

Purpose: To report our 25-year experience on transpedal lymphangiography (TL) in the management of postoperative lymphatic leakage.

Material and methods: A review of all patients undergoing TL in the management of postoperative lymphatic leakage was performed. Study goals included analyses of patient demographics, technical and clinical results, and complications.

Results: Between 1993 and 2018, a total of 372 patients underwent TL for the management of postoperative lymphatic leakage. Therapy-refractory lymphatic leakage resulted from a variety of complex surgical procedures including oncologic surgery, transplantation surgery, and vascular surgery. Accordingly, there were different locations of the postoperative therapy-refractory lymphatic leakage including neck, thorax, abdomen, pelvis, and lower extremity. The interval between causal surgery and TL was 60±169 days. Technical success rate of, amount of injected iodized oil for, and major and minor complication rates were 87.8%, 10.3±4.3 ml, and 0% and 0.3%, respectively. Clinical success rates were as follows: Complete response in 41.6%, partial response in 14.9%, and clinical failure in 43.5% of patients.

Conclusion: TL is feasible, safe and effective for imaging diagnosis and radiological therapy of postoperative lymphatic leakage. In case of clinical failure, lymphatic second-line interventions such as percutaneous sclerotherapy and interstitial or thoracic duct embolization are indicated to further improve the clinical success rate. These different and complex lymphatic second-line interventions should be planned specifically on the basis of CT imaging after TL and in close consultation with surgical partners to determine a standardized prospective treatment plan.

P-641

Interest of real time fluoroscopy guidance and Dyna-CT acquisition in hybrid electro-acoustic cochlear insertion

C. Perazzini¹, M. Puechmille², T. Mom², L. Cassagnes¹, P. Chabrot¹, L. Boyer¹

¹Radiology, University Hospital Gabriel-Montpied, Clermont-Ferrand, FR,

²Otolaryngology and Cervico-facial Surgery, University Hospital Gabriel-Montpied, Clermont-Ferrand, FR

Purpose: The advent of hybrid electro-acoustic (EA) implants requires precise positioning of the electrodes within the cochlea. Insertion and right position of EA has always been firstly dependent on the surgeon's proprioceptive abilities. We tried to demonstrate that a cooperation between otorhinolaryngology and radiology department to treat our patients in a hybrid endovascular radiology suite allows to better verify the EA insertion and position.

Material and methods: 34 EA in 32 patients (61 y/o) were implanted from November 2014 to December 2018. Three different criteria of enrollment have been considered: anatomic reasons (variants or difficult anatomic access) (n = 9); hearing preservation (n = 14); standard surgically difficulty cases (n = 11). Surgery was carried out by trans-mastoid access with posterior tympanotomy. The insertion of EA was guided under real time fluoroscopy, and at the end of the procedure, a syngo DynaCT acquisition (Siemens, Artis zee) has been performed to verify the EA position.

Results: In all cases, the insertion of the EA has been easily and correctly guided. The fluoroscopy guidance was very useful in all cases of anatomic variants or difficult anatomic access, has allowed a very precise EA positioning in all cases of residual hearing preservation. Furthermore the X-ray exposition was always low (karma-area product = 297 mGy.cm²).

Conclusion: An easier insertion and a more precise positioning of the EA within the cochlea can be obtained under real time fluoroscopy and verified by a syngo DynaCT acquisition at the end of the procedure carried out in a hybrid endovascular radiology suite.

P-642

Interventional radiology equipment: would you open it if you knew the cost?

R.H. Kassamali¹, K. Burlak², G.S. Goh³, J. Koukounaras³

¹Department of Radiology, University Hospitals Birmingham, Heartlands Hospital, Birmingham, UK, ²Imaging, Alfred Health, Melbourne, VIC, AU,

³Radiology, The Alfred Hospital, Melbourne, VIC, AU

Purpose: To evaluate interventional radiology staff's knowledge on costs of commonly used equipment, in order to optimise its use.

Material and methods: A survey was conducted on 33 interventional radiology staff in a large tertiary hospital (sample: 5 consultants, 4 registrars, 10 radiographers, 14 nurses). Staff were asked to estimate the cost of 24 commonly used disposable interventional radiology equipment items (price range AU\$7-1,600).

Further questions assessed the main sources of information used and whether staff felt that cost was an important factor in device selection.

Results: A significant difference was found between the estimated cost and the actual costs. On average, the estimated price was overestimated by 156%, with the least error ratio of 0.99 (micropuncture kit) and the greatest error ratio of 19.35 (histoacryl glue). Lower-cost equipment was more likely to be overestimated in cost. Nurses and consultants had the closest error ratio to 1, with error ratios of 2.04 and 2.24 respectively. Majority of staff indicated that they would like to have more information regarding the cost of devices.

Conclusion: Patient safety and outcome should be at the forefront of equipment choice. If there are 2 options with varying prices and the same outcomes, knowledge of cost becomes important. A more formal knowledge of cost via education and labelling on the shelf would be beneficial. Overestimation of cost can potentially make staff less likely to use certain devices and underestimation can lead to wastage. With tight budget in public healthcare systems staff should know the cost of equipment they are using.

P-643

Pulmonary arterial occlusion treatment in patients with hemoptysis: a 32 cases single-center study

C. Zadro

Department of Radiology, Centre Hospitalier Universitaire Rangueil, Université Paul Sabatier, Toulouse, FR

Purpose: Pulmonary arterial bleeding is a rare cause of hemoptysis, which requires a specific endovascular treatment. Herein we report the feasibility and effectiveness of pulmonary artery occlusion treatment (PAOT) in our center.

Material and methods: Thirty-two patients treated by PAOT between January 2010 and May 2017 in Toulouse Rangueil University Hospital were retrospectively included. We had performed a thoracic angioscan to each patient looking for an argument pointing to a pulmonary arterial origin (PAO) of the bleeding.

Results: Nineteen patients (59 %) had a neoplasia and seven (22%) an active infectious disease. Signs arguing with a PAO were irregularities (88%) and occlusion (31%) of pulmonary artery, a lung parenchyma necrosis (59%) and pseudoaneurysms (44%).

We used steel coils in 23 cases (72%) and plugs in 12 (38%).

The feasibility of PAOT was 100% and the clinical efficacy, defined by early and sustained interruption of bleeding for 1 month, was 78% with a recurrence rate at last follow up of 31%. Seven patients had recurrence in the first month, three later with additional embolization (5) or surgery (2). Only one patient with active infection experienced recurrence.

Twenty-five patients (78%) had received an exclusive PAOT and 7 (22%) a combined occlusion of pulmonary and bronchial or systemic non-bronchial arteries. There was no significant difference between the two interventions concerning recurrence or survival.

Conclusion: PAOT by steel coils or/and plug is feasible and efficacious with little recurrence in the long term.

P-644

Flow-controlled angiography for the assessment of vascular patency, permeability and leakage in decellularized kidneys

S. Hirschberg¹, S. Cohen², S. Partouche², M. Gurevich², V. Mezhybovsky², V. Tennak², S. Eisner², E. Nesher², E. Mor², E. Atar¹

¹Radiology, Rabin Medical Center, Petach Tikva, IL, ²Organ Transplantation, Rabin Medical Center, Petach Tikva, IL

Purpose: Perfusion decellularization has been proposed as a promising method for the generation of non-immunogenic organs from allogeneic or xenogeneic donors.

A number of imaging modalities have been used to assess vascular patency in bioengineered kidneys, including fluoroscopic angiography. However, none of these studies addressed changes in vascular permeability, while demonstration of patency was limited to visualization of the arterial tree only.

The aim of this study is to present a detailed methodology to image these parameters in decellularized and normal kidneys and present flow-controlled model.

Material and methods: Harvested porcine kidneys underwent ex-vivo fluoroscopic angiography before and after perfusion decellularization process, under controlled flow conditions.

Arterial and venous patency was defined as combination of visualization of contrast media in distal capillaries and renal vein, respectively. Time of visualization was also recorded.

For permeability assessment, a region of interest (ROI) representing renal parenchyma was selected and greyscale intensity within this ROI was measured at several time points.

Extravasation of contrast media was checked following iatrogenic injury in both groups.

Results: No difference in patency was detected both in native and decellularized kidneys. However, up to 50% increase in greyscale intensity was measured after 6min washout in decellularized kidneys, indicating increased vascular permeability.

Iatrogenic leakage was equally detected in both groups.

Conclusion: Vascular permeability, rather than patency, should be assessed to quantify the effect of perfusion decellularization on kidney vasculature. Fluoroscopic angiography based on the proposed model is a readily accessible, accurate method that should be adopted as method of choice for vascular assessment in bioengineered organs.

P-645

Uniportal VATS coil-assisted resections of unpalpable GGO pulmonary lesions: our preliminary experience

F. Carchesio¹, R. Iezzi¹, A. Posa², M.T. Congedo³, S. Margaritora³, R. Manfredi¹

¹Dipartimento di Diagnostica per Immagini, Radioterapia Oncologica e Ematologia, Fondazione Policlinico Universitario A. Gemelli - IRCCS, Università Cattolica del Sacro Cuore, Rome, IT, ²Department of Radiology, AFaR-IRCCS Fatebenefratelli Hospital Foundation for Health Research and Education, Rome, IT, ³Department of General Thoracic Surgery, Fondazione Policlinico Universitario A. Gemelli - IRCCS, Università Cattolica del Sacro Cuore, Rome, IT

Purpose: To prospectively assess the safety and effectiveness of CT-guided fiber-coated coils localization (CTCL) to guide uniportal video-assisted thoracoscopic surgical (VATS) excision of GGO pulmonary nodules

Material and methods: Twenty consecutive patients with newly detected GGO pulmonary nodules (mean diameter: 11mm; range: 7-16mm) underwent CTCL prior to VATS resection. A 14-cm-long fiber-coated coil was deployed with the proximal end of the microcoil coiling beyond the parietal pleura while the distal part anchoring in the lung parenchyma, serving as a guidance for the surgeon. All clinical and CT-data, as well as intra-periprocedural complications were collected and reviewed.

Histopathological analysis was performed for the resected pulmonary lesions.

Results: CT-guided microcoil localization was successful in all patients. No significant procedural complications were registered; asymptomatic pneumothorax not requiring chest tube placement was detected in all patients. Mean distance from visceral pleura to the deep edge of the nodule was 38.3 +/- 18.1 mm; mean length of needle tract was 72.58 +/- 11.99 mm; mean CT-procedural time was 26 +/- 11 minutes. VATS resection of the nodules was successful in all patients. All patients underwent VATS within 3 hours from the procedure with an adequate visualization of the coil allowing a thorascopic wedge resection, without conversion to thoracotomy. Among the 20 coil-labelled lesions, a diagnosis of early lung cancer (AIS, MIA, AAH) was made in 7 patients (35%) with invasive adenocarcinoma detected in 10 patients (50%).

Conclusion: CT-guided coil localization prior to VATS resection is a feasible, safe, and effective method for localization of GGO pulmonary nodules

P-646

Radiofrequency vs. microwave ablation for patients with benign thyroid nodules

D. Solís-Gutiérrez¹, I. Sainz-Sánchez², R. Navas-Campo¹, E. Aguillo³, J.A. Guirola¹, M.A. de Gregorio²

¹Interventional Radiology - GITMI, Hospital Clínico Universitario Lozano Blesa, Zaragoza, ES, ²Interventional Radiology, University of Zaragoza, Zaragoza, ES, ³Nutritional and Endocrine Disease Department, Hospital Clínico Universitario Lozano Blesa, Zaragoza, ES

Purpose: To compare the safety and efficacy of radiofrequency vs. microwave ablation for the treatment of benign thyroid nodules

Material and methods: A prospective study was performed in all consecutive patients who were treated either by radiofrequency or microwave ablation in benign thyroid nodules. All patients were assessed by the same interventional radiologist in the pre-consultation procedure. Volumen reduction, therapeutic success rate, symptoms, major and minor complications were compared between the two groups at 1, 3, and 6 months after treatment.

Results: A total of 16 patients were recruited from January 2017 to December 2018. No significant differences were found regarding the median volume reduction ratio at 6 months: 82.17% RF vs. 72.67% MW, P=0.889; therapeutic success rate 100% RF vs 100% MW P=0.999; symptoms disappearance in 75.0% RF vs. 87.5% MW, P=0.999; 2 minor complications in MW group.

Conclusion: No significant differences were found between RF vs. MW concluding that is a safe and effective procedure to treat benign thyroid nodules. However, MW had better results in patients with mixed cystic nodules compared with RF.

P-647

Radiofrequency ablation for benign cystic thyroid nodule: analysis on early efficacy

D. Maresca¹, L. Tofanelli¹, F. Di Bartolomeo¹, A. Sacchini¹, G. Pompili¹, C. Floridi², G. Carrafiello³

¹Radiology, University of Milan, San Paolo Hospital, Milan, IT, ²Radiology, San Paolo Hospital, Milano, IT, ³Diagnostic and Interventional Radiology, University of Milan, Milan, IT

Purpose: Radiofrequency ablation has been advocated as an alternative to surgery in the treatment of benign thyroid nodules.

The purpose of this article was to evaluate the 12- months efficacy and safety of a single session of radiofrequency ablation (RFA) used as treatment of benign cystic thyroid nodules.

Material and methods: Between September 2015 and October 2017, twenty patients (13 women and 7 men) with 13 benign cystic nodules

(n=13) causing cosmetic problems and pressure symptoms, were treated with RFA.

The procedure consists of evacuation of internal colloid material before thermo-ablation of solid component.

RFA used a cooled-electrode RFA system and 17- or 18-gauge internally cooled electrodes. Nodule volume, symptom score (1-10) and cosmetic score (1-4) were evaluated before the treatment and after 1, 3, 6 and 12 months.

Results: The average baseline diameter of nodules was 30, 4 ± 27,4 mm. No major complications were encountered. A single session of radiofrequency ablation reduced thyroid nodule diameter by 50, 62, 69, and 72% after 1, 3, 6 and 12 months, respectively (p<0,05). This was associated with a significant and progressively improvement of local cervical discomfort and cosmetic score.

Conclusion: RFA combined with cystic component evacuation is an effective and well tolerated alternative treatment for benign cystic thyroid nodules.

This study shows that a single session of radiofrequency ablation was able to reduce lesion diameter more than 70% after 1 year and the results have been progressive during this time. It is possible that longer follow-up studies might show greater response rates.

P-648

Effectiveness of percutaneous scleroembolization of varicocele in pediatric patients

S.N. Orellana Gonzalez¹, I. Paladini¹, C. Marcato², E. Epifani¹, A. Andreone¹

¹Radiologia Interventistica, Azienda Ospedaliero-Universitaria di Parma, Parma, IT, ²Department of Radiology, University of Parma, Parma, IT

Purpose: Varicocele consists of abnormally dilated veins within the pampiniform plexus. The purpose of our retrospective study is to evaluate the success of the percutaneous sclero-embolization.

Material and methods: Between January 2017 and December 2018, 35 pediatric patients (age range 13 to 19, mean value 15,6, SD 1,81) with left varicocele were treated using endovascular percutaneous sclero-embolization with right transfemoral access under local sedation. Study inclusion criteria were varicocele grade III (20 patients) and IV (15 patients) according to Sarteschi classification, symptomatic or with evident testicular asymmetry. Lauromacrogol 400 foam (Atossisclerol 3%) was injected in left pelvic internal spermatic vein as sclerosing agent avoiding pampiniform plexus.

Results: 87,5% of the group has no residual disease, 3 patients showed a residual varicocele grade II, 1 grade I according to Sarteschi classification. In three cases the procedure was not feasible due to the presence of insuperable continent valves.

The US follow up was programmed at 9,6 months after the procedure. Neither postoperative pain nor epididymitis were noted.

Conclusion: Percutaneous sclero-embolization of grade III and IV varicocele is efficient, successful and repeatable; moreover its minimally invasiveness makes it suitable for pediatric patients.

P-649

Non-stimulated adrenal venous sampling in primary hyperaldosteronism: the value of partial data after failed cannulation of the right adrenal vein and ways to structure interdisciplinary communication

W.M. Luedemann¹, P. Podrabsky², B. Gebauer³, D. Geisel², G. Wieners¹

¹Diagnostic and Interventional Radiology, Charité University Medicine, Berlin, DE, ²Department of Radiology, Charité Berlin, Berlin, DE, ³Klinik für Strahlenheilkunde, Charité Universitätsmedizin Berlin, Berlin, DE

Purpose: The purpose of the study is to evaluate the benefit of partial data for lateralisation of primary hyperaldosteronism in non-stimulated

adrenal venous sampling. Furthermore, a template for structured, interdisciplinary communication is suggested.

Material and methods: Between 11/05/2008 and 01/19/2017 139 cases of adrenal vein sampling were reviewed. The validity of the indication, technical success and the therapeutic consequences were analyzed. SPSS was used for scatterplot and receiver operator curve analysis to evaluate the potential of combining aldosterone-cortisol ratios in the left adrenal vein and inferior vena cava for subtype prediction of primary aldosteronism.

Results: Out of 139 cases initially included into the study 25 patients were excluded because pre-interventional diagnostic requirements were not met or laboratory values were missing. Bilateral selective adrenal vein sampling was feasible in 49% of the cases, unilateral vein sampling in 27%. With respect to differentiating unilateral and bilateral disease receiver operator curve analysis revealed that a left adrenal vein/ inferior vena cava cutoff >4 showed 60 % sensitivity and 60 % specificity for an aldosterone producing adenoma on the left side. On the other hand, a cutoff <0,76 showed 85 % sensitivity and 79 % specificity for an adenoma on the right side.

Conclusion: In a non-stimulated setup, the cortisol-corrected adrenal vein/inferior vena cava aldosterone index shows statistically significant differences between unilateral and bilateral disease in case of failed cannulation of the right adrenal vein, although the clinical relevance is questionable. A checklist based on current guidelines can make the diagnostic and therapeutic efforts of all disciplines involved more effective.

P-650

FemoSeal® closure device in acute ischemic stroke

A. Iturralde Garritz¹, F.J. Maynar Moliner¹, F. López Zárraga¹, E. Pampín Álvarez¹, R. Bastida Torre¹, D. Quintana Blanco²

¹Interventional Radiology, Hospital Universitario Álava, Vitoria, ES,

²Muskuloskeletal Radiologist, Hospital Universitario Álava, Vitoria, ES

Purpose: Although manual compression is the gold standard it is limited by various factors including the interruption of anticoagulation.

We want to evaluate the use of a vascular closure device for 8F sheath punctures in a population of 60 patients after endovascular thrombectomy in acute stroke.

Material and methods: We analysed 60 patients.

The vascular access was closed with an active closure device (FemoSeal®). We recorded demographic data and variables such as fibrinolysis before the procedure and clinical data regarding coagulation (platelet count, APTT, INR and haemoglobin). We included their usual pharmacological treatment (anticoagulation and anti-platelets) as well as the antecedent of previous inguinal surgical procedure.

The follow up included all the complications related with vascular access till hospital discharge.

Results: Patients aged between 36-98 years old, 45% female, 12% with fibrinolysis before the procedure, 20% with previous treatment with antiaggregants and 25% with anticoagulants. Average value of platelets (181 plq); INR (3,16); and hgb (13,6)

10% of the vascular closures failed and needed manual compression. The most frequent complication was haematoma on the puncture site (5%) which sometimes occurred secondary to anatomical difficulties with the vascular access.

(1,6%) needed surgical repair due to lateral vessel access and impossibility of manual compression.

Complications mainly occurred in patients with basal low platelet count (< 150.000) secondary to coagulopathies, or with pre-treatment fibrinolysis. Basal pharmacological treatment (either antiplatelet or anticoagulant) was related with capillary bleeding not coming from the arterial light itself, which stopped with soft compression.

Conclusion: Femoseal is safe and has a fast learning curve.

P-651

Treatment of the benign multinodular thyroid disease, with improvement of the symptom and cosmetic scores through radio-frequency ablation of the dominant nodule

G.M. Rodà¹, P. Grillo¹, A.P. Savoldi², A. Sacrini³, G. Pompili³, C. Floridi⁴, G. Carrafiello⁵

¹ASST Santi Paolo e Carlo, Università degli studi di Milano, Milan, IT,

²Radiologia Diagnostica ed Interventistica - Ospedale San Paolo,

³Università degli studi di Milano - Scuola di specializzazione in radiodiagnostica, Milan, IT, ⁴Radiology, University of Milan, San Paolo

Hospital, Milan, IT, ⁵Radiology, Fatebenefratelli Hospital, Milan, IT,

⁵Diagnostic and Interventional Radiology, University of Milan, Milan, IT

Purpose: To evaluate the safety and efficacy of ultrasound-guided radio-frequency ablation (RFA) of a single benign predominantly nodule in patients with multinodular goiter.

Material and methods: 80 patients (54 women, 26 men mean age 43,5) with multi-nodular goiter causing cosmetic problems and pressure symptoms, were enrolled in our study between September 2015 and February 2018. All patients underwent to a diagnostic fine needle biopsy before the treatment. For each patient was identified a dominant nodule (the biggest in size, the most vascularized, causing most symptomatic impairment), and it was treated with a single session of RFA. The procedure was performed by using an 18-gauge internally cooled electrode under ultrasonography guidance. Volume reduction, Cosmetic score and Symptom score, were evaluated before ablation and after 1,3,6 and 12 months.

Results: Technical success was obtained in all cases. No major complications were observed. The mean initial nodule size was 3,5±2,5 cm.

Thyroid nodule volume decreased significantly, from 12±7,5 ml before ablation to 1,5±3ml (P<0.05) at 12 months follow-up.

The symptom score and cosmetic score were significantly decreased after the procedure.

Conclusion: The RFA of dominant nodule in a multinodular goiter is feasible and safe, rapidly reducing the discomfort related to the goiter. The decrease in volume and symptoms is only appreciable from the 3rd month onward, therefore follow up at 1 month is unnecessary.

P-652

1 month imaging response following drug-eluting bead and drug-eluting microsphere chemoembolization: a comparative study

D. Klass¹, D.M. Liu², J. Chung³, A. Hadjivassiliou³, S. Ho³, G. Legiehn¹, L. Machan⁴

¹Interventional Radiology, University of British Columbia, Vancouver, BC,

CA, ²Interventional Radiology, Vancouver General Hospital, Vancouver,

BC, CA, ³Radiology - Interventional Radiology, University of British

Columbia, Vancouver, BC, CA, ⁴Radiology, University of British Columbia

Hospital, Vancouver, BC, CA

Purpose: Evaluate the imaging response following Transarterial Chemoembolization using Drug-Eluting Beads (DEB) 70-150, 100-300 and Drug-Eluting Micropsheres (DEM) 30-60 and 50-100.

Material and methods: Retrospective single-center study from June 2010 to October 2017. Patients undergoing drug-eluting bead (DCB) or drug-eluting microsphere (DEM) TACE were evaluated. CT scan performed at 1 month using modified RECIST (mRECIST) criteria for response.

Results:

mRECIST response					
Treatment	CR	PR	SD	PD	DCR
DEM 30-60	27 (51.9%)	18 (34.6%)	3 (5.8%)	4 (5.7%)	48 (92.3%)
DEM 50-100	3 (21.4%)	7 (50%)	1 (7.1%)	3 (21.4%)	11 (78.6%)
DEB 100-300	9 (19.6%)	13 (28.3%)	0	24 (52.2)	22 (47.8%)
DEB 70-150	1 (11.1%)	3 (33.3%)	1 (11.1%)	4 (44.4%)	5 (55.5%)

91 Patients (17 female and 74 male), mean age 65.3 years (48-88 years) were included. Etiologies: 36 Hepatitis C, 5 Non-alcoholic steatohepatitis (NASH) and 50 Hepatitis B. Response rates including disease control rate (DCR): DEB group 70-150; 11.1% CR, 33.3% PR, 11.1% SD, 44.4% PD, 55.5% DCR, DEB group 100-300; 19.6% CR, 28.3% PR, 24% PD, 47.8% DCR, DEM group 50-100; 21.4% CR, 50% PR, 7.1% SD, 21.4% PD, 78.6% DCR, DEM 30-60; 51.9% CR, 34.6% PR, 5.8% SD, 7.7% PD, 92.3% DCR.

Objective tumor response rates were significantly higher in the DEM 30-60 vs DEB 70-150 and 100-300 ($P < 0.0001$). DCR was significantly higher in the DEM 30-60 group vs DEB 100-300 ($P < 0.00001$) and DEB 70-150 group ($P = 0.013$).

Conclusion: Drug-eluting microspheres 30-60 demonstrate a significant improvement in disease control rate and overall response rates compared to drug-eluting beads 70-150 and 50-100.

P-653**Preoperative CT-guided marking of pulmonary micronodules with EVOH (Onyx®)**

E. Cruces Fuentes, A.J.M. Pinilla, S. Gil Sánchez, M.D. Pascual Robles, D. Contreras Padilla, J. Irurzun
Interventional Radiology, Hospital General de Alicante, Alicante, ES

Purpose: The high-resolution CT involves the detection of small metastatic lung nodules or primary tumors in early stages. The resection of this nodules is difficult because they are small and not palpable.

We describe a new method for preoperative CT-guided marking (MCTP) of small and not palpable pulmonary nodules (NP) and pleura with Onyx®. It allows resection and location of nodules during video-assisted thoracoscopic (VATS) or conventional surgery.

Material and methods: Between April 2017 and November 2018 we performed MCTP in 8 patients (6 males and 2 females, median age 65 years). Cases included, 9 NP, were marked with Onyx®.

A 20G needle in 2 cases and 17G in 6 cases were used, both 11 cm lengths. We inject the volume of the dead space needle (0,10-0,30 cc) with Onyx 34° (8% EVOH) (this concentration avoid distal propagation) into the nodule. After, Onyx® injection is performed in the needle-tract (approximately 0,05 cc for each cm) and in the visceral pleura (aprox. 0,10-0,20 cc). Finally, we mark on the skin puncture site. The solvent DMSO was not used by small amount of embolizing agent used and low dead space of needle.

Results: All marked lesions were identified with VATS or conventional surgery. Onyx® does not avoid the adequate anatomopathological diagnosis. No complications were found.

Conclusion: The MCTP of small NP with Onyx® facilitates surgical resection because it is visible, permanent in the puncture site and allows to acquire a palpable volume of nodule.

P-654**Readability of CIRSE online patient information for interventional radiology procedures**

C. Rowlands¹, I. Zealley², R.D. White¹

¹Department of Clinical Radiology, University Hospital of Wales, Cardiff, UK,

²Radiology, Ninewells Hospital, Dundee, UK

Purpose: Patient information leaflets (PIL) are a useful resource in informed consent for Interventional Radiology (IR) procedures. PIL usefulness is determined by their readability, a measure of the complexity of language used. This study aimed to evaluate the readability of the PILs for IR procedures provided on the CIRSE website.

Material and methods: All PILs were accessed via www.CIRSE.org (n=72). Readability was assessed using the Flesch Reading Ease score (FRES), a validated measure of comprehensibility, using automated readability tools. FRES <30 is considered very difficult to read, 30-50 difficult, 50-60 fairly difficult, and 60-70 standard 'plain English'. A FRES >70 is considered easy to read.

Results: Overall, CIRSE PILs were considered difficult to read (mean FRES 47.9 ± 7.7 , range 25.3 – 63.8), this is considered comprehensible to less than one-third of native English-speaking adults. 1/72 (1.4%) PILs were classified as very difficult to read, 41 (56.9%) were difficult, 26 (36.1%) were fairly difficult and only 4 (5.5%) were considered to be plain English. None were considered easy to read (FRES >70).

Conclusion: Only a minority of CIRSE PILs are considered to be written in standard 'plain English', with the remainder being considerably more difficult to read. This may hinder their usefulness to both healthcare professionals and patients as an adjunct in informed consent, particularly as they may require translation into multiple languages. Further emphasis should be placed on improving readability of PILs.

P-655**Outcomes from a single tertiary referral centre of catheter directed thrombolysis (CDT) for acute pulmonary embolism (PE)**

A.K. Gupta¹, J. Jackson¹, N. Thulasidasan², A. Diamantopoulos³, K.A. Breen⁴, A. West⁵, N. Karunanithy⁶

¹Interventional Radiology, Guy's and St. Thomas' Hospitals NHS

Foundation Trust, London, UK, ²Interventional Radiology, Guy's and St.

Thomas' Hospital, London, UK, ³Interventional Radiology, Guy's and

St. Thomas' NHS Foundation Trust, King's Health Partners, London, UK,

⁴Haematology, Guy's and St. Thomas' Hospitals NHS Foundation Trust,

London, UK, ⁵Respiratory Medicine, Guy's and St. Thomas' Hospitals NHS

Foundation Trust, London, UK, ⁶Department of Interventional Radiology,

Guy's and St. Thomas Hospitals NHS Foundation Trust, London, UK

Purpose: Patients with acute PE stratified as high risk (massive) but with a contraindication to systemic thrombolysis, and those stratified as intermediate-high risk but failed to respond to initial anti-coagulation treatment were considered for CDT. We present our 6 year experience of PE CDT.

Material and methods: All patients who received CDT at our tertiary referral centre were reviewed. Primary outcome was reduction in right heart strain (measured as RV:LV ratio). Secondary outcomes were complications and symptoms at follow up.

Results: 30 patients underwent CDT between April 2012 – November 2018. Mean age 53.9 years (17-86), median PESI class 3 (2-5), mean CDT duration 13.6 hrs (2-24). The mean follow up 23.6 months (3-82). The mean RV:LV pre CDT 1.47 (0.85-2.0) and post CDT 1.19 (0.89-1.54). The mean RV:LV reduction was 19%. There were no reports of bleeding events and no other complication attributable to CDT.

In the intermediate-high risk group (20/30) symptomatic improvement was seen in 80% and return to normal right heart function on echocardiogram at 3 months. In the high risk group (9/30) symptomatic improvement was seen in 66% at 3 months follow up. CDT was performed in an

intermediate-low risk patient resulted in rapid symptomatic improvement but the patient died from their underlying malignancy at 6 weeks.

Conclusion: CDT for PE in a patient cohort including those considered high risk for systemic thrombolysis is effective with early reduction in right heart strain, mid term symptomatic improvement and low risk profile.

P-656

Lymphatic embolization of patients with lymphatic anomalies and pulmonary symptoms

M. Itkin¹, G.J. Nadolski², D. Rabinowitz³

¹Department of Radiology, University of Pennsylvania Medical Center, Philadelphia, PA, US, ²Radiology, Hospital of the University of Pennsylvania, Philadelphia, PA, US, ³Radiology, Nemours Hospital, Wilmington, DE, US

Purpose: Lymphatic anomalies (LA) are characterized by lymphatic tissue proliferation. Patients with this condition often develop pleural effusions and interstitial lung disease, which is a frequent cause of morbidity and mortality. Novel lymphatic imaging and interventional methods now allow visualization and treatment of pulmonary LA. Thus, the goal of this study was to summarize our experience treating symptomatic patients with LA.

Material and methods: This is a retrospective study of 7 consecutive LA patients (mean age 9yr, F/M-3/4) with symptomatic pulmonary involvement. Three patients presented with Kaposiform Lymphangiomatosis (KLA), 2 with Generalized Lymphatic Anomaly (GLA), and 2 with Gorham-Stout disease (GSD). All underwent dynamic contrast enhanced MR lymphangiography (DCMRL) and lymphatic embolization of the abnormal pulmonary lymphatic flow.

Results: Two patients presented with pleural and/or pericardial effusions without pulmonary involvement. The other five patients presented with combinations of effusions and interstitial lung disease. Intranodal lymphangiography was performed in all patients. Embolization of the thoracic duct was performed in all patients. In two patients, interstitial embolization of LA from the retroperitoneum to the mediastinum were also embolized. In one patient, lung re-expansion surgery with pleurectomy was performed. In all patients, there was a cessation of chylothorax and improvement of pulmonary function and symptoms.

Conclusion: In this study we demonstrated that there is abnormal pulmonary lymphatic flow in patients with LA and pulmonary symptoms. Hence, embolization of these lymphatic pathways can improve their symptoms. Given that pulmonary involvement is the main cause of mortality in these patients, they may benefit from earlier preventive embolization of abnormal lymphatic flow.

P-657

Role of C-arm computed tomography assisted adrenal venous sampling in the assessment of adrenal hypersecretion syndromes

A. Pisano¹, M.A. Tipaldi², G. Orgera¹, F. Laurino², A. Laghi², M. Rossi³

¹Interventional Radiology, St. Andrea University Hospital - Sapienza Rome, Rome, IT, ²Radiology, S. Andrea University Hospital, Rome, IT, ³Radiology, Sant'Andrea Hospital, Rome, IT

Purpose: Adrenal Vein Sampling (AVS) is a gold standard procedure in the diagnostic work up of adrenal hypersecretion syndromes. However, it is burdened by high failure rates due to technical issues and in particular for the right vein catheterization. Therefore, we investigated the impact of C-arm Computed Tomography-Assisted AVS (C-AVS) in comparison to standard AVS.

Material and methods: From September 2010 to January 2018, a total of 40 procedures were retrospectively reviewed: 23 AVS (group A) and 17 C-AVS (group B). Overall, 36 patients (90%) had primary hyperaldosteronism clinical features, and 4(10%) suffered from ACTH-independent Cushing's Syndrome with bilateral macronodular hyperplasia. Patients of both groups were infused with 50 microL/h cosyntropin 30 minutes prior the procedure. After catheterization of the right and left

adrenal vein, C-arm-CT was performed in group B during CE selective injection, to confirm correct catheter position. Technical success was defined by adequate bilateral sampling, intended as a selectivity index (SI) >3.

Results: Technical success was obtained in 52,2% of group A (12pt), while in 47,8% of the cases sampling did not prove diagnostic. On the other hand, technical success was achieved in 82,4% of group B (14pt), whereas 11,7% of them did not meet SI criteria and 1 procedure was aborted due to contrast-media reaction.

Technical success was significantly higher in group B than in group A (82,4% vs. 52,2% p-value <0.05). There was no procedure-related complication.

Conclusion: Despite limited data, C-AVS improved the overall success rate of AVS, as it proves crucial for an optimal catheterization of adrenal veins.

P-658

MDCT-guided percutaneous needle biopsy of lung and mediastinal lesions: tips and tricks for no conventional approaches

U.G. Rossi¹, F. Petrocelli², A.M. Ierardi³, P. Rigamonti⁴, L.C. Pescatori⁵, M. Femia⁴, G. Carrafiello⁶, M. Cariati⁷

¹Diagnostic Imaging Department - Interventional Radiology Unit, E.O. Galliera Hospital, Genoa, IT, ²Radiology, San Martino, University Hospital, Genoa, IT, ³Radiology, University of Milan, San Paolo Hospital, Milan, IT, ⁴Radiology and Interventional Radiology, San Carlo Borromeo Hospital, Milan, IT, ⁵Postgraduation School in Radiodiagnostics, University of Milan, San Donato Milanese, IT, ⁶Diagnostic and Interventional Radiology, University of Milan, Milan, IT, ⁷Diagnostic Sciences, San Carlo Borromeo Hospital, Milan, IT

Learning objectives: To describe tips and tricks for no conventional approaches in MD-CT-guided percutaneous transthoracic needle biopsy for lung and mediastinal lesions.

Background: MD-CT-guided percutaneous needle biopsy allows access to lesions in virtually all lung and mediastinal locations. But, in upper posterolateral lung nodules and retrosternal or paravertebral small lesions is difficult or hazardous to reach with the conventional approach. In these particularly anatomic situations transscapular, trassternal and paravertebral approach is to be considered.

Clinical Findings/Procedure Details: The purpose of this poster is to illustrate tips and tricks of the transscapular, transsternal and paravertebral approach, with coaxial needle technique for MD-CT-guided percutaneous transthoracic needle biopsy in the upper posterolateral lung nodules, retrosternal and paravertebral small lesions.

Conclusion: A better knowledge with MD-CT lung and mediastinal anatomy facilitates planning of a safe and effective percutaneous access for needle biopsy. For upper posterolateral lung nodules, retrosternal and paravertebral small lesions the knowledge of transscapular, transsternal and paravertebral approach allows perform the biopsy with technical success and reducing the possible risk of complications.

P-659

Respiratory failure for interventional radiologists: the basics and how to manage in the IR suite

S. Warhadpande¹, K. Kansagra², R. Ahuja³, K.J. Cooper⁴

¹Interventional Radiology, UPMC, Pittsburgh, PA, US, ²Interventional Radiology, Kaiser Permanente LAMC, Los Angeles, CA, US, ³Interventional Radiology, Einstein Healthcare Medical Center, Philadelphia, PA, US, ⁴Radiology, Loma Linda University, Loma Linda, CA, US

Learning objectives:

1. Know and understand the major types of respiratory failure and how to diagnose them using subjective and objective data.
2. Recognize the myriad of ways to diagnose impending respiratory failure within the interventional suite.
3. Develop an algorithm for managing the commonly encountered causes of respiratory failure in the IR suite.

Background: Interventional radiologists (IR) are involved with the treatment of patients across a broad spectrum of illnesses. Many of these patients are at risk for developing respiratory failure, and the risk increases during procedural sedation. Having a sound understanding of respiratory failure is critical for any IR in order to provide safe care.

Clinical Findings/Procedure Details: Being able to successfully diagnose and manage respiratory failure requires a strong foundational knowledge of the underlying pathophysiological processes. This exhibit aims to outline the major types of respiratory failure, hypoxemic and hypercapnic, and their common causes, especially etiologies that may be related to an IR procedure. Additionally, respiratory failure will be defined using subjective and objective data to facilitate how it can be promptly diagnosed. Lastly, uniting all this foundational knowledge will be a practical algorithm that an IR can implement to detect and mitigate impending respiratory failure in the procedural suite, incorporating concepts such as pharmacology and noninvasive ventilation.

Conclusion: Respiratory failure is a severe process that can have catastrophic consequences. Early detection of signs of this condition and implementation of basic interventions can prevent escalation of care and poor outcomes.

P-660

Percutaneous retrieval, repositioning, unknotting, and stripping of intracardiac catheters and foreign bodies

J. Tisnado¹, M. Leyva Vásquez Caicedo²

¹Radiology/Vascular and Interventional, MCV Hospitals/VCU Medical Center, Richmond, VA, US, ²Radiology/Vascular and Interventional Radiology, Hospital Universitario Clínico San Carlos, Madrid, ES

Learning objectives:

1. To review problems associated with the presence of iatrogenic or traumatic foreign bodies eventually lodged in the heart and great vessels.
2. To review some of the methods used by the interventional radiology team to manage these problems.
3. To prevent these potentially lethal mishaps.

Background: Intracardiac embolization of catheter fragments and other foreign bodies, intracardiac formation of knots in catheters, malpositioning and misplacement of intracardiac catheters, thrombi and fibrin deposition in intracardiac catheters are serious complications of catheterization techniques and placement of central catheters and ports.

Clinical Findings/Procedure Details: A mortality rate as high as 71 % has been reported in the literature due to complications of embolized catheters and other foreign objects, if they are not removed. However, if these are solved, full recovery of the patient is expected.

In the past, the only way to remove embolized catheters or intravascular foreign bodies or unknot knotted catheters was surgically. The endovascular management of these complications is a safe and successful minimally-invasive method. Therefore, it should be considered as a first-line option to manage these cases.

Conclusion: The interventional radiologist should be familiar with the different techniques for retrieval of intracardiac foreign bodies, and for the unknotting of intracardiac catheter knots, repositioning of misplaced intracardiac catheters and stripping of intracardiac fibrin deposits and sheaths in catheters.

These procedures are safe and effective to manage potentially serious complications of percutaneous and surgical placement of central and peripheral catheters, ports and other devices.

A complete and varied supply of retrieval devices, baskets, loop snares, wires, different loops, etc. must be available.

P-661

Endovascular methods in treatment of visceral artery aneurysms

M. Szymgin¹, K. Pyra¹, M. Sojka¹, T. Jargiełło²

¹Department of Interventional Radiology and Neuroradiology, Medical University of Lublin, Lublin, PL, ²Department of Interventional Radiology, University School of Medicine, Lublin, PL

Learning objectives: The purpose of this study is the evaluation of the efficacy and safety of treatment of visceral artery aneurysms with percutaneous endovascular methods based on the assessment of long-term results.

Background: 60 patients with visceral artery aneurysms were treated percutaneously. Various techniques were used: coiling (23), covered stents (15), thrombin (7) and other mixed techniques.

Clinical Findings/Procedure Details: The procedure was performed in 57 of 60 patients. In 56 of 57 patients aneurysms were effectively excluded. The success rate was 93.3% (56 of 60 enrolled patients). Technical success after the first surgery was 82.4%, after second 98.2%. Embolizations with covered stents were characterized by highest efficiency. Serious complications occurred in 1.8% of cases.

Conclusion: The survey results allow us to conclude that minimally invasive endovascular treatment of visceral aneurysms is characterized by high efficacy and safety. Good treatment results depend on proper assessment of the aneurysm's morphology as well as on selection of the appropriate vascular approach and endovascular technique.

P-662

Case-based review and comparison of peripheral AVM classifications

S. Dyer Hartnett¹, F.C.M. Bouwman², B.H. Verhoeven³, W. Klein¹, H. Daniels¹, D. Lobeek¹, L.J. Schultze Kool¹

¹Radiology, Radboud University Nijmegen Medical Centre, Nijmegen, NL, ²Radiology and Nuclear Medicine, Radboud University Medical Center, Nijmegen, NL, ³Pediatric Surgery, Radboud University Medical Center, Nijmegen, NL

Learning objectives:

1. Case-based review of Cho-Do and Yakes' peripheral AVM classifications and therapeutic guidelines;
2. Compare the diagnostic and therapeutic aspects of each system

Background: Cho-Do and Yakes are the main peripheral AVM classification systems. They share certain diagnostic and therapeutic similarities, although Cho bases his classification on angiographic features and Yakes on angioarchitecture. Literature shows other approaches and recommendations like authors Houdart or J.Jackson that we shall review, albeit in lesser depth. This literature reflects the fact that the selection of a classification system is mostly based on personal preference.

Clinical Findings/Procedure Details: As Yakes pointed out, Cho I and II are similar to Yakes IIIA/B, as is Cho IIIA/B with Yakes II, if considering angioarchitecture. These patients, independent of the classification used, would receive a similar treatment, since the therapeutic guidelines for Yakes IIIA/B are similar to Cho I/II, as are Cho IIIA/B with Yakes II.

The important difference between classifications is Yakes type I and IV, which aren't described by Cho and, although less frequent, have different treatment recommendations and therefore are important to take into consideration.

Conclusion: One may argue against the need to generalize the use of one or another system, since the majority of AVM patients would receive similar treatment, but there is a need for uniformity so as to compare data and obtain a more standardized therapeutic guideline to improve patient safety and outcomes. We believe Yakes is more appropriate, being based on the structure of the lesion, as well as including a wider range of patients.

P-663

Interventional management of chyle leaks – various approaches

N.S. Shetty, S.S. Kulkarni, S. Mohd, K.B. Gala, A. Narang
Interventional Radiology, Tata Memorial Hospital, Mumbai, IN

Learning objectives: Interventional management of chyle leaks – various approaches.

Background: Chyle leaks can present as chylothorax, chylous ascites, chylous pericardial effusion and neck collections. Chyle leak may be classified as traumatic or nontraumatic. Low-output chylous leaks are usually managed conservatively. High-output chylous leaks require surgical or interventional treatment. Surgical management is difficult due to the high incidence of variant anatomy and associated morbidities. Percutaneous therapies provide a high success rate coupled with low morbidity and mortality. Here are 7 patients with chyle leaks (4 chylothorax, 1 chylous ascites, 1 neck collection, 1 chylothorax and chylous pericardial effusion) managed with interventional techniques.

Clinical Findings/Procedure Details: These patients underwent bipedal lymphangiography (using lipiodol and contrast) and postprocedure CT imaging to visualize site of leak. This was followed by conservative management for 72 hours with monitoring of drain output. 3 out of 7 patients had reducing drain output and the leak resolved with bipedal lymphangiography. For 3 patients the thoracic duct was cannulated after taking left brachial venous access and embolized. One patient had persistent chyle leak after embolization of thoracic duct, hence percutaneous transabdominal puncture was taken and rest of the thoracic duct was also embolized. For one patient thoracic duct could not be cannulated, surgical neck dissection was performed by surgical team, thoracic duct was cannulated and embolized. No major complications were seen in any of the above cases. Six patients had complete resolution of leak.

Conclusion: Percutaneous therapies for chyle leaks provide safe, minimally invasive and effective treatment with low morbidity and mortality.

P-664

Sclerotherapy treatment of orbital low flow malformations

A.K. Emira¹, S. Katsari¹, A. Elsharkawy¹, A.M. Barnacle², L. Mailli¹, L. Ratnam¹

¹Department of Radiology, St. George's Hospital, London, UK, ²Radiology, Great Ormond St Hospital for Children, London, UK

Learning objectives:

1. Diagnosis and classification of orbital malformations.
2. Treatment by percutaneous sclerotherapy with bleomycin.
3. Review specific protocols required for bleomycin use.

Background: Low flow orbital malformations are rare and consist of a mixture of lymphatic and venous malformations. Surgical treatment carries risks of haemorrhage, recurrence/residual lesion or non-targeted injury. Percutaneous sclerotherapy offers a safe and effective alternative to surgery. A range of sclerosants are available, however, for these lesions, bleomycin is preferred.

Clinical Findings/Procedure Details: Diagnosis is made with a combination of clinical history, MRI and ultrasound imaging. Clinical presentation and symptoms guide requirements for treatment. The procedure is usually performed under general anaesthesia with ultrasound guidance utilised for needle positioning. Intraleisional contrast instillation is performed under digital subtraction venography to exclude any intracranial vascular communication prior to injection of sclerosant. Potential complications include haemorrhage where an increase in retroorbital pressure can result in visual loss if urgent decompression is not carried out. Close working with oculoplastic surgeons is therefore mandatory.

Bleomycin is a cytotoxic drug that is used for its inflammatory properties as well as its ability to cause cell breakdown. It is used specifically for these lesions as it is usually less painful and causes minimal post-operative swelling when compared to other agents, as well as resulting

in reduction in the malformations size. Specific risks with bleomycin use include pneumonitis, pulmonary fibrosis, alopecia and skin discolouration.

Conclusion: Percutaneous sclerotherapy is a safe and effective alternative to surgery in the treatment of orbital low flow vascular malformations provided appropriate precautions are adhered to.

P-665

Orbital venous malformations endovascular treatment: state of the art

M. Pecorilla¹, R. Di Meo¹, M. Fusco¹, G. Buccimazza¹, A. Arrichiello¹, M. Petrillo², C. Floridi³, G. Carrafiello⁴

¹Scuola di specializzazione in radiodiagnostica, Università degli studi di Milano, Milan, IT, ²Diagnostic and Interventional Radiology, San Paolo Hospital, Milan, IT, ³Radiology, San Paolo Hospital, Milan, IT, ⁴Diagnostic and Interventional Radiology, University of Milan, Milan, IT

Learning objectives: The purpose of this educational poster is to illustrate orbital venous malformations (OVM) complex classification applied to the different treatment described in literature.

Background: OVM is the most common congenital orbital vascular disease. According to International Society for the Study of Vascular Anomalies (ISSVA) and Mulliken and Glowaki's classification, the classification of OVM is based on different angiogenesis, hemodynamics and locations. Complementary imaging examination is indispensable for the differential diagnosis and treatment of OVMs. Computed tomography (CT) and magnetic resonance imaging (MRI) are the most important imaging techniques.

Clinical Findings/Procedure Details: Most OVMs can be managed conservatively by observation. Indications for treatment include high orbital pressure with functional defect, severe pain and cosmetic disfigurement. Management of OVM is challenging and complicated. Treatment approaches include sclerotherapy, laser therapy, embolization, surgical resection and radiotherapy. A sequential multi-modality treatment strategy, which uses two or three forms of treatment in a stepwise manner, has been proposed through the increased understanding of the pathophysiology and hemodynamics of OVMs and development of new techniques. A satisfactory outcome can be achieved only by selecting the appropriate treatment according to lesion characteristics.

Conclusion: OVM is a rare complex disease. Correct diagnosis and multidisciplinary approach is necessary for an optimal treatment choice and clinical outcome. The endovascular is the first choice treatment.

P-666

Microballoon-occluded intervention (MB-intervention) using a dedicated microballoon catheter in various kinds of clinical application

M. Inoue¹, S. Nakatsuka¹, M. Hase¹, H. Torikai², N. Ito¹, M. Tamura¹, H. Yashiro³, M. Jinzaki¹

¹Diagnostic Radiology, Keio University School of Medicine, Tokyo, JP, ²Diagnostic Radiology, Keio University Hospital, Tokyo, JP, ³Diagnostic Radiology, Hiratsuka City Hospital, Hiratsuka-city, JP

Learning objectives: MB catheter can be used for various clinical situations other than balloon-occluded transarterial chemoembolization (TACE). The purpose is to learn wide variety of clinical application of balloon-occluded intervention (MB-intervention) in the field of interventional radiology.

Background: MB catheters was launched to the market in 2011. MB catheter can be advanced into smaller, and tortuous vessels compared to 5-French balloon catheter. At first, MB catheters was used for balloon-occluded TACE; however, nowadays, MB catheter can be widely available for various clinical situations. MB catheter has three advantages: flow control, pressure injection, stability of the system. Herein, we introduce several clinical applications of MB catheter by utilizing these advantages.

Clinical Findings/Procedure Details: MB-intervention includes three categories: MB-glue, MB-coiling, and MB-ablation.

MB-glue: glue injection under inflation of MB catheter is like a wedge injection and can demonstrate better control of the embolus range with less fragmentation and reflux of glue. We can utilize this technique not only for hemostasis but also for occlusion of biliary tract to stop bile leakage and for occlusion of the nidus of arteriovenous malformation.

MB-coiling: Stabilization of the system is important for tight coil packing. After inflation of MB, system becomes stable and tight packing of coils becomes possible. B-coiling using double microballoon catheters is also useful for short segment embolization.

MB-ablation: Under balloon inflation, we can achieve pressure injection of alcohol to eradicate tissue. We utilize MB-ablation for tumor ablation for angiomyolipoma of kidney, bile leakage from isolated bile duct occurred after surgery, leakage from isolated bile duct occurred after surgery.

Conclusion: MB-intervention is feasible and useful for various kinds of situations.

P-667

Iatrogenic complications management by interventional radiology: a case series

A.A. Gursale¹, V.K. Ukride²

¹Vascular and Interventional Radiology, LTMMGH, Sion Hospital, Mumbai, Mumbai, IN, ²Interventional Radiology, Lokmanya Tilak Municipal General Hospital, Mumbai, IN

Learning objectives: Evaluation of various techniques used by Interventional Radiology department in management of various iatrogenic complications occurred during patient treatment

Background: High risk patients already face challenges of risk of general anaesthesia and open surgery, interventional technique can offer a good rescue procedure. This will further reduce morbidity and mortality associated with treatment and also reduce hospital stay significantly along with the pre-existing co-morbidities.

The common referrals to our department in Vascular and Interventional radiology were from Surgery, Gastro medicine, cardiology, Urology and gynaecology which comprised more than 75 % of the total 50 cases referred in the interval.

Clinical Findings/Procedure Details: It is a cross sectional as well as retrospective study

Of the total referrals 58 % were females and 42 % were males of which maximum 16 cases were from the age group 46 to 60 yrs.

Common referrals were from the department of gastro-medicine and surgery (38%), which were of post-operative bile leak, followed by post-operative renal injury (23%), cardiology (13%) [pseudo aneurysm repair], foreign body removal (4%), post-operative bleeder (13% : coiling & 4% glue embolisation).

None of the patients needed any additional surgical intervention post procedure.

Conclusion: Vascular and interventional radiology is a recent upcoming branch which due to advances in physics and technology has provide a vast spectrum of possibilities in therapy of patients through minimal access.

Awareness and proper utilization of resources would be helpful in further diversifying this field of radiology with the help of multidisciplinary approach.

P-668

A systematic review to identify and assess operational research frameworks used to optimise delivery of oncological clinical trials that use interventional radiology, nuclear medicine and radiology in a healthcare setting

G. Delanerolle¹, L. Gelling²

¹FHEMS, Anglia Ruskin University, Aylesbury, UK, ²School of Medicine, Anglia Ruskin University, Cambridge, UK

Learning objectives: To systematically summarise methodological literature that have reported empirical evidence of research delivery systems is used to effectively deliver research activities within oncology, IR and nuclear medicine.

Background: The importance of delivering high quality oncological care is dependent not only on advancements in research but also the ability to efficiently deliver the intervention through specialties such as IR and nuclear medicine in a healthcare setting that patients are able to access. Timely access to novel interventions is an issue. Therefore, a primary systematic research review was conducted using a mixed methods approach to explore the current level of practice knowledge published to assess research delivery framework systems available to oncology and support specialties such as IR and nuclear medicine.

Clinical Findings/Procedure Details: Methods: Medline/OvidSP, Science Direct, PROSPERO, PRISMA, PubMed, PubMed Health, SciELO, ProQuest, Academic search complete, Ageline, Google Scholar, Cochrane and BIOSIS search engines were used. Key words used include operational science, research framework, research delivery systems, research culture, and efficient research framework. The inclusion criteria was created using PRISMA and published as a protocol in PROSPERO (crd42019124020). All studies and material published between January 1980 to January 2019 in all languages and participants.

Results: There were no publications indicating an operational research framework used at an institution and specialty level.

Conclusion: It is evident, due to the current knowledge gap, operational level research would be required to establish a fit for purpose framework system that would enable research studies to be delivered more effectively and efficiently within oncology, IR and nuclear medicine.

P-669

Use of cone-beam CT to confirm right adrenal vein cannulation in adrenal vein sampling for primary hyperaldosteronism

E. Soo¹, K. Chow², M. Kolhe², M.H. Hui², M. Razman³, N. Thulasidasan³

¹School of Medicine, Kings College London, London, UK, ²Faculty

of Life Sciences and Medicine, King's College London, London, UK,

³Interventional Radiology, Guy's and St Thomas' NHS Foundation Trust, London, UK

Learning objectives:

1. Understand the anatomic features of the right and left adrenal veins.
2. Assess correct catheter choice for adrenal vein cannulation.
3. Appreciate the role cone-beam computed tomography (CT) can play in confirming successful right adrenal vein cannulation.

Background: Hypertension secondary to primary hyperaldosteronism is often treatable by adrenalectomy, if a unilateral hypersecreting adrenal gland can be identified. Adrenal venous sampling (AVS) remains the gold standard for identifying a hypersecreting adrenal gland. AVS is a technically demanding procedure, primarily due to difficulty in cannulating the right adrenal vein.

Clinical Findings/Procedure Details: Right adrenal vein cannulation in AVS can be technically challenging, both due to the size discrepancy between the inferior vena cava and the right adrenal vein, and the highly variable position, angulation and venographic appearance of the right adrenal vein itself. With experience, high volume operators are able to achieve successful cannulation rates exceeding 80-90%, however the

learning curve is steep and in lower volume centres may be difficult to achieve. Image fusion techniques can be used to guide right adrenal vein cannulation, and cone-beam CT can be used to confirm successful cannulation. This may be of utility to less experienced operators who may benefit from the increased confidence 3D imaging confers over planar imaging.

Conclusion: Adrenal venous sampling is technically demanding procedure due to difficulties identifying and cannulating the right adrenal vein. Novel technologies such as CT-fluoroscopy fusion and cone-beam CT can be used to guide and then confirm RAV cannulation, and may shorten the learning curve for less experienced operators.

P-670

Emerging technologies in vascular and interventional radiology: 3D printing

G. Salahia¹, K. Moore¹, S.E. Junaid¹, A. Saeed¹, R.D. White²

¹Radiology, Cardiff and Vale UHB, Cardiff, UK, ²Department of Clinical Radiology, University Hospital of Wales, Cardiff, UK

Learning objectives:

1. Appreciate the roles of 3D printing in contemporary vascular and interventional radiology
2. Understand how to create 3D printed models relevant to the field

Background: 3D printing technologies have evolved significantly in the last decade and they are rapidly developing a key role in medicine, such as for procedural planning, teaching and training, educating patients and facilitating consent. We provide an overview of the 3D printing process and highlight key areas pertinent to vascular and non-vascular interventional radiology where 3D modelling can be of significant benefit.

Clinical Findings/Procedure Details: Workflow from cross-sectional scans to 3D printed models includes image acquisition, segmentation, design, production, post-processing and application.

Conclusion: 3D printing has the potential to revolutionise vascular and interventional radiology, not least in terms of improving procedural planning, education and consent. Review of this exhibit should provide an understanding of the printing process and of the many utilities of 3D models relevant to our specialty.

P-671

Innovative mini-invasive non-thermal endovascular treatment of chronic venous disease: ablation with cyanoacrylate. A comparison with traditional endovascular thermal ablative techniques

G. Dedone¹, G. Turtulici²

¹DISSAL, University of Study of Genoa, Genoa, IT, ²Radiologia, Ospedale Evangelico Internazionale, Genoa, IT

Learning objectives: To describe the newest us-guided non-thermal vein ablation technique with cyanoacrylate glue in treatment of chronic venous disease and to compare this procedure with traditional endovenous laser or radiofrequency ablation.

Background: Today, in the treatment of varicose veins traditional endovenous thermal ablation techniques, such as radiofrequency and laser, are effective and widely in use. However, these techniques necessitate infiltration of tumescent anesthesia, which can cause severe discomfort for the patient. Bruising along the saphenous vein following thermal ablation, arteriovenous fistula, pseudoaneurysm formation, and neurological complications causing paresthesia are other potential side effects. A recent non-thermal, non-tumescent methods is cyanoacrylate ablation: this technique don't use thermal energy, obviating tumescent anesthesia and, as a result it is better tolerated by patients. Also the potential for nerve damage is minimal.

Clinical Findings/Procedure Details: Upon intravascular injection, cyanoacrylate rapidly solidifies via a polymerization reaction and produces an inflammatory vein wall reaction. Granulomatous foreign body reaction occurs 30 days after treatment and fibroblasts can be seen invading the

contents of the tunica intima and tunica media at 60 days. In this study we describe step by step and assess safety and efficacy of the novel cyanoacrylate ablation us-guided of great saphenous vein, paying attention to the efficacy in the obliteration of the vein, to the procedural pain, the possible side effects and complications.

Conclusion: Cyanoacrylate ablation is a safe, simple method which can be recommended as an effective endovenous ablation technique. We can affirm that cyanoacrylate ablation for the treatment of incompetent great saphenous veins has an important future role.

P-672

Scleroembolization of varicocele in children and adolescents: state of art

S. Seminatore¹, M.C. Calcagno¹, E.F. Santonocito¹, D.G. Castiglione², A. Conti¹, P.M. Coppolino¹, C. Mosconi³, S. Palmucci¹, A. Musumeci¹, A. Semeraro⁴, C. Defilippi⁴, A. Basile¹

¹Radiology Unit I - Department of Medical and Surgical Sciences and Advanced Technologies - University of Catania, Azienda Ospedaliero Universitaria Policlinico Vittorio Emanuele, Catania, IT, ²Section of Radiological Science, Di.Bi.Med, University of Palermo, AOUP Policlinico Giaccone, Leonforte, IT, ³Department of Digestive Disease and Internal Medicine, Policlinico Sant'Orsola Malpighi, Bologna, IT, ⁴Radiology, AOU Meyer, Florence, IT

Learning objectives: To describe scleroembolization (S) of varicocele in paediatric patients (pp): indications, technique and clinical success.

Background: Varicocele is the most commonly identified and correctable cause of male factor infertility (prevalence rates 25.4%-81%). Indications depend on clinical aspects: a persistent asymmetry between left and right testes size of more than 20% over a period of 12 months and pain (sperminogram anomalies cannot be considered in pp). Color duplex scrotal ultrasound is accepted to assess the pathologic venous reflux. Treatment aims to preserve future fertility, but there is not universally agreed management. Endovascular treatment (ET) and microsurgery showed the same results, but the latter is not widespread in pp. Compliance and ability to collaborate of pp is an important aspect for eligibility to ET: S is an option.

Clinical Findings/Procedure Details: After local anesthesia, catheterization is performed with transfemoral or transbasilic venous access and advanced into the left renal vein. The spermatic vein is catheterized and after a flebography showing the presence of a varicocele, S is achieved with the injection of sclerosant through an occluding balloon (that prevents symptoms related to reflux) performed using atosissclerol 3%. A post-treatment phlebography during a Valsalva manoeuvre shows technical success. Remission of pain and dimensional difference between testes shows clinical success. Radiation exposure must be as low as possible for radioprotection aspects.

Conclusion: S is safe and effective in symptomatic patients. Low radiation dose is mandatory; an advantage is a short recovery time (with a fast back to school). Further studies about the outcome on fertility are necessary.

P-673

Endovascular management of inadvertent arterial catheter insertion during central venous catheter placement

B. Shaygi, R. Alchanan

Interventional Radiology, King's College Hospital, London, UK

Learning objectives:

1. Intra-procedural recognition of arterial entry during central venous catheter (CVC) placement
2. Relevant regional anatomy
3. Pictorial review of the arterial placement
4. Therapeutic management options and endovascular solutions, literature review

Background: The CVCs are increasingly used for the treatment of critically ill patients for parenteral nutrition, medication administration, hemodynamic monitoring and hemodialysis.

Arterial injuries comprise an uncommon but serious complication of CVC placement in these already critically ill patients. This can lead to a wide spectrum of presentations from localized hemorrhage and hematoma to fistulization, dissection, pseudoaneurysm formation, thrombosis and neurological deficit and stroke.

Clinical Findings/Procedure Details: We describe factors (both pictorial and clinical) to assist in immediate recognition of inadvertent arterial entry during CVC placement.

We then discuss the treatment options to deal with the immediate and late complications of this entity and describe 5 cases treated in our institution (4 endovascular and 1 openly treated cases) and represent the current evidence in the literature.

Conclusion: Immediate recognition of the inadvertent arterial entry during CVC placement is crucial in order to treat the potential disastrous subsequent complications.

Endovascular repair of the site of arterial entry is an effective and efficient method, which can be considered as the first therapeutic option in the majority cases.

P-674

Pearls and pitfalls of adrenal vein (AV) sampling – how to do it – learning points from our experience

R. Sundareyan¹, W.R. Thomas², S. Walker³, C. Aleman³, Q. Jehanzeb⁴

¹Interventional Radiology, Queen Elizabeth Hospital, University Hospitals Birmingham, Birmingham, UK, ²Radiology, University of Wales Hospital Cardiff, Cardiff, UK, ³Interventional Radiology, University Hospital Birmingham, Birmingham, UK, ⁴Radiology, Russells Hall Hospital, Dudley Group of Hospitals NHS Trust, Dudley, UK

Learning objectives:

1. To review technique of adrenal vein sampling
2. To review pre procedural preparations for a hassle free and successful procedural outcome
3. To review the literature about the current status and indications

Background: Primary aldosteronism causes 15%–25% of cases of drug-resistant hypertension. Since unilateral adrenal lesions may be surgically resected or percutaneously ablated, identifying the sources by venous sampling is critical. In this study we review technical aspects of the procedure, with emphasis on strategies to avoid common difficulties during AVS. Having a written institutional protocol and defined person responsibilities are crucial.

Cannulating the right AV is difficult and potential limiting factor since it originates directly from the IVC.

Common trunk draining both AV and inferior phrenic vein is a common variation and the sample can be taken either from the trunk through the mother catheter or selectively from the adrenal vein with a microcatheter. We follow sequential sampling of the veins. Though simultaneous sampling has some theoretical advantages, doing this makes the procedure complex.

In this study we review our institutional cohort of patients.

Clinical Findings/Procedure Details: Retrospective analysis of institutional cohorts who underwent adrenal vein sampling. Highlighting the technical difficulties and how to overcome them through specific cases. Review of current literature.

Conclusion: Our experience proved proper patient selection and following a written protocol helps to do a hassle free adrenal vein sampling. We describe the learning points and highlight the potential limitations and their solutions with our selected cases.

P-675

Acute pulmonary artery pseudoaneurysm secondary to severely displaced rib fractures in blunt chest trauma

D. Hynes¹, H. Jalaeian², B. Janne d'Othee²

¹Department of Radiology, University of Massachusetts Medical School Baystate Medical Center, Springfield, MA, US, ²Division of Interventional Radiology, University of Massachusetts Medical School Baystate Medical Center, Springfield, MA, US

Clinical History/Pre-treatment Imaging: Following a traumatic motorcycle collision, a 57 year old male presented hemodynamically stable without dyspnea or hemoptysis. Trauma chest CT demonstrated an acute pseudoaneurysm of a subsegmental branch of the left lower lobe pulmonary artery in the setting of multilevel left sided rib fractures of ribs 3-8 and a clinical flail chest.

Treatment Options/Results: Emergent angiographic confirmation of the pseudoaneurysm in the laterobasal segmental branch of the left lower lobe pulmonary artery was made, with slow flow and delayed opacification of the sac noted. Subsequent successful microcoil embolization of the parent vessel was performed. Following day the patient underwent bronchoscopy followed by thoracotomy and surgical rib stabilization for left sided flail chest of ribs 5-7. The patient was extubated on post op day 0, transferred out of Surgical Intensive Care Unit POD 2 and discharged on POD6. The patient was asymptomatic at 6 month follow-up.

Discussion: Pulmonary artery pseudoaneurysms (PAP) are rare and most frequently present with hemoptysis. Etiologies include trauma, vasculitis, necrotizing pneumonia, septic emboli, cavitating lung carcinoma and tuberculosis. Prompt management is pertinent as rupture of PAP can be catastrophic with massive hemoptysis and mortality approaching 50%. Transcatheter intrasaccular embolization of the PAP can successfully exclude the pseudoaneurysm, with preservation of distal pulmonary artery.

Take-home points: Therapeutic decisions for pulmonary artery pseudoaneurysms in the polytrauma patient are challenging. The therapeutic debate encompasses the necessity to exclude the pulmonary artery pseudoaneurysm due to the risk of rupture, hemodynamic stabilisation of the patient and surgical stabilisation of a flail chest, the instigating insult of this PAP.

P-676

Iatrogenic foreign body retrieval in a neonate - grasp from inside technique

M.K. Yadav¹, M. Unni², R. Pillai³

¹Interventional Radiology, Kerala Institute of Medical Sciences, Trivandrum, IN, ²Radiology, Kerala Institute of Medical Sciences, Trivandrum, IN, ³Cardiology, Kerala Institute of Medical Sciences, Trivandrum, IN

Clinical History/Pre-treatment Imaging: 34 weeks preterm newborn underwent 6F umbilical catheter placement. During catheter removal, catheter tip got inadvertently cut and catheter was inaccessible for simple removal. Mini cutdown of umbilical vein was attempted as the catheter was still palpable just cranial to the umbilicus. During surgical manipulation the catheter migrated further cranially.

Treatment Options/Results: Treatment options were, percutaneous approach through the umbilical vein or surgical exploration through laprotomy/ Thoracotomy.

Fluoroscopy showed lower end of catheter at the lower edge of liver and catheter passing through Ductus venosus, IVC, right atrium, patent foramen ovale, left atrium and the tip into the right superior pulmonary vein. Umbilical vein was catheterised under direct vision using a 025" guidewire, which was navigated into the lumen of the displaced umbilical catheter. Over this guidewire a 6 French TR sheath was placed into the umbilical vein with tip of the sheath in close contact with lower end of umbilical catheter. A.014" guidewire was passed along side the previous

guidewire into the umbilical catheter. The 0.025" guidewire was removed and a 1.5mm Balloon was introduced over the 0.014" guidewire into the catheter lumen. After confirming good grip over the catheter by the inflated balloon, the whole assembly was retrieved.

Discussion: Foreign body Retrieval in pediatric population is challenging due to radiation concerns and small vessel size. Here the small vessel proved advantageous by canulating the catheter from inside, followed by its successful retrieval.

Take-home points: Gripping a foreign body from inside is a valuable technique especially in small calibre or collapsed vessels.

P-677

Endovascular treatment of traumatic suprahepatic IVC rupture

H.-O. Kim¹, B.C. Lee², N.Y. Yim³, Y.J. Kang², J.K. Kim¹, S.G. Song⁴

¹Radiology, Chonnam National University Hospital, Gwangju, KR,

²Diagnostic Radiology, Chonnam National University Hwasun Hospital,

Jeollanam-do, KR, ³Diagnostic Radiology, Chonnam National University

Hospital, Gwangju, KR, ⁴Radiology, Gwangju Veterans Hospital,

Gwangju, KR

Clinical History/Pre-treatment Imaging: A 33-year-old female presented with unstable hemodynamics following blunt trauma. The patient's initial systolic blood pressure was 60 mmHg. Pre-treatment CTA showed suprahepatic IVC rupture and descending thoracic aorta injury.

Treatment Options/Results: The trauma surgeons at our hospital determined that immediate surgical management of suprahepatic IVC rupture was difficult because of the anatomical complexity of suprahepatic IVC and the patient's unstable hemodynamics. Therefore, we tried emergent endovascular treatment of suprahepatic IVC rupture and descending thoracic aorta injury. Right internal jugular vein access was obtained and a conventional stent-graft was inserted for management of suprahepatic IVC rupture. Thereafter, TEVAR was performed for descending thoracic aorta injury. After endovascular treatment, the patient's vital signs were stable. The patient underwent corrective surgery for traumatic liver and spleen injury 1 day and 3 days after the endovascular treatment. No extravasation of contrast media was seen around the suprahepatic IVC on a post-treatment CTA one-week post-endovascular treatment. The patient was discharged 3 months after the endovascular treatment.

Discussion: Injury of the IVC following blunt trauma is rare condition, occurring in less than 1% of trauma victims. Unfortunately, operative treatment of suprahepatic IVC injury is challenging and very limited due to anatomical complexity. We would like to present successful endovascular management with conventional stent-graft for suprahepatic IVC rupture in a young patient showing unstable hemodynamics.

Take-home points: Endovascular management using conventional stent-graft in patients with suprahepatic IVC rupture can be a way to save patients' lives if surgical treatment is difficult to apply.

P-678

Coil retrieval using endobronchial forceps during a bronchial artery embolization

D. Barillà¹, D. Spinelli², G. Derone², N. Pipitò², F. Benedetto²

¹Cardiothoracic Surgery, Policlinico Universitario G. Martino of Messina,

Messina, IT, ²Vascular Surgery, Policlinico Universitario G. Martino, Messina, IT

Clinical History/Pre-treatment Imaging: We describe a case of a 62yr old woman with haemoptysis, secondary to a hypertrophied tortuous bronchial artery with an ectopic origin.

Treatment Options/Results: We planned a Bronchial Artery Embolization (BAE). The intervention was performed under local anaesthesia by a right femoral artery percutaneous approach. The hypertrophied bronchial artery was identified and catheterized (Fig. 1). A pushable coil was delivered but, due to high flow conditions and vessel tortuosity, it migrated to the left femoral artery bifurcation. Angiography demonstrated no

evidence of thrombosis or vascular injuries. An endovascular approach was planned to retrieve the coil. A 7Fx65cm long sheath was advanced up to the contralateral left femoral artery bifurcation. The endobronchial forceps were inserted through the 7F sheath and the coil was successfully grasped and removed (Fig. 2). Then the BAE was correctly performed. Thirty days postoperative CT Angiography demonstrated correct position of the coil and the complete occlusion of the bronchial artery.

Discussion: One of the complications after BAE includes coil dislodgment with subsequent emboli or thrombotic vessel occlusion and serious ischemic events. Retrieval of the displaced coils is of great importance in preventing severe complications. Current coil retrieval techniques include the use of pigtail- or J-shaped microwires, snare, alligator and stent retrieval devices, and microsurgery.

Take-home points: The use of endobronchial forceps in some cases, is a safe bailout device and it guarantees the complete retrieval of the dislocated coil without injuries or damages to the vessels.

P-679

An unusual case of traumatic foreign body pulmonary embolism with endovascular retrieval

M. Desai¹, R. Rudolph², L. Lam³, J. Crozier⁴, V. Malka⁵, M. Jarmin⁵

¹Radiology, Prince of Wales Hospital, Sydney, NSW, AU, ²Interventional

Radiology, Liverpool Hospital, Sydney, NSW, AU, ³Diagnostic Radiology,

Liverpool Hospital, Sydney, NSW, AU, ⁴Vascular Surgery, Liverpool

Hospital, Sydney, NSW, AU, ⁵Trauma Surgery, Liverpool Hospital, Sydney, NSW, AU

Clinical History/Pre-treatment Imaging: A 22 year old male presented after crashing through a pane of glass whilst riding a quad bike. On arrival the patient was exsanguinating from a laceration to Zone 1 of the right neck and was taken to theatre for immediate repair of the right internal jugular vein (IJV). The CT pan-scan revealed a 23 x 6mm linear hyperdense foreign body in the pulmonary artery of the left lower lobe, which had presumably embolised from the neck laceration.

Treatment Options/Results: Utilising a 24Fr triaxial sheath system in the right common femoral vein (CFV), a 6F Amplatz Goose Neck snare was used to retrieve the foreign body from the pulmonary vasculature. Three 8 x 40mm balloons were used to centre the foreign body within the orifice of the sheath. A 23 x 8mm irregular shard of transparent glass was removed together with the sheath. The right CFV was preclosed with Proglide closure device.

The patient developed a post-operative non-occlusive right CFV thrombus and anticoagulation was commenced. There were no other perioperative complications.

Discussion: Whilst endovascular retrieval is a well described technique, it was used to retrieve an unusual foreign body from the pulmonary vasculature following intravascular embolisation of a glass shard from a penetrating neck injury to the right IJV.

Take-home points: We present an unusual case of intravascular embolization of a glass shard to the pulmonary vasculature following a penetrating injury of the right IJV.

This is the first described case of endovascular retrieval of a glass shard following traumatic embolisation.

P-680

Percutaneous pancreatic duct drainage for pancreaticojejunal leak after pancreaticoduodenectomy

M. Kamo¹, R. Miyazawa², T. Nishiyama², J. Yamamura¹, K. Yagihashi³

¹Department of Diagnostic and Interventional Radiology, University

Medical Center Hamburg-Eppendorf (UKE), Hamburg, DE, ²Department

of Radiology, St. Luke's International Hospital, Tokyo, JP, ³Radiology, St.

Marianna University School of Medicine, Kawasaki, Kanagawa, JP

Clinical History/Pre-treatment Imaging: A 64-year-old man status post pancreaticoduodenectomy for pancreatic adenocarcinoma had

the gastroduodenal artery stump bleeding on post-operative day 17, successfully treated by placing a covered stent into the hepatic artery. A fluid collection in the surgical bed developed, presumably due to pancreaticojejunal anastomotic leakage; percutaneous transgastric drainage of the main pancreatic duct was planned after multidisciplinary discussion.

Treatment Options/Results: After fixing the stomach to the abdominal wall, a 21-gauge needle was punctured fluoroscopically to access the non-dilated main pancreatic duct, targeting the surgically-placed pancreaticojejunal drainage catheter. A guidewire was successfully advanced into the main pancreatic duct. A drainage catheter was placed, the tip of which was advanced to the anastomosed jejunum. The leak was well treated using the catheter and the fluid collection in the area disappeared. The patient remained symptom and re-bleeding free.

Discussion: Percutaneous interventional approach to the pancreatic duct has been sporadically reported, although the procedure was applied so far mainly to patients with the pancreatic duct obstruction accompanying dilated pancreatic ducts, and not to patients with pancreatic leakage after pancreatic operations. In this case, targeting a previously placed pancreaticojejunal internal drainage catheter made it possible to puncture with safety the main pancreatic duct fluoroscopically. By fixing the stomach to the abdominal wall, risks of injuring surrounding structures were presumably reduced. Transgastric approach would also have an advantage of creating internal fistula to the stomach, enabling removing the catheter thereafter.

Take-home points: Percutaneous transgastric pancreatic duct drainage might be an useful and a feasible option to resolve the pancreaticojejunal anastomotic leakage.

P-681

Leiomyoma initially misdiagnosed as pelvic arteriovenous malformation

H.N. Lee¹, D. Hyun², Y.-S. Do², K.B. Park², S.H. Bae³

¹Radiology, Soonchunhyang University Cheonan Hospital, Cheonan-si, KR, ²Radiology, Samsung Medical Center, Seoul, KR, ³Radiology, Inje University College of Medicine, Ilsan Paik Hospital, Goyang, KR

Clinical History/Pre-treatment Imaging: A 46-year-old female patient was admitted for persistent copious vaginal bleeding requiring transfusion. Abdomen CT revealed a huge vascular tangles in the rectovaginal pouch displacing the adjacent organs. MRI demonstrated serpentine vascular structures, which appears as large flow voids on spin echo sequences suggesting high-flow AVM without definite enhancing soft tissue. The initial diagnosis was pelvic AVM and sclerotherapy was planned.

Treatment Options/Results: Pelvic angiogram showed typical features of AVM: enlarged feeding arteries, AVM nidus, and early opacification of draining veins (Fig. 1). With coil embolization of the draining veins, 8 sessions of ethanol sclerotherapy was performed at the feeding arteries over the 14 months. However, a 2-year follow-up CT after sclerotherapy depicted 11.4-cm new soft tissue mass arising from anterior aspect of AVM that had been treated (Fig. 2). Multiple pulmonary nodules (up to 1.8 cm) were found on enhanced chest CT, which were considered metastases. After surgical resection, leiomyoma was pathologically confirmed.

Discussion: The mainstay of AVM treatment is currently endovascular management because surgical removal has a high risk of bleeding uncorrectable. Highly vascular soft tissue tumors can exhibit features alike AVM and lead to misdiagnosis and delay in appropriate treatment.

Take-home points: Even if a small amount of soft tissue present, a high index of suspicion should call for histologic confirmation. Periodic imaging follow-up during the multisession sclerotherapy is important to help reduce delay of accurate diagnosis.

P-682

Treatment of inadvertent subclavian artery catheterisation

M. Abdelaziz¹, M. Salsano², S.S. Pillai³

¹Clinical Radiology, Aberdeen Royal Infirmary, Aberdeen, UK, ²Clinical Radiology, Raigmore Hospital, Inverness, UK, ³Clinical Radiology, Ninewells Hospital & Medical School, Dundee, UK

Clinical History/Pre-treatment Imaging: A 50 year old complex poly-trauma patient underwent central venous catheterisation, as part of his initial resuscitation. In addition to multiple visceral and skeletal injuries, CT demonstrated inadvertent right subclavian artery catheterisation.

Treatment Options/Results: The patient was referred to Interventional Radiology for further management. A decision was made to remove the indwelling catheter and to seal the puncture site using a percutaneous closure device. Via a right common femoral artery access, the right subclavian artery was selectively catheterised. A guidewire and a non-inflated balloon were kept across the right subclavian artery catheter entry point. This provided a safe bail out option in the event of closure device failure. The right subclavian artery catheter was exchanged for a 5F sheath and a 6F Angioseal™ closure device was used to close the subclavian puncture site. An angiogram confirmed a successful result with no evidence of extravasation.

Discussion: Inadvertent subclavian artery puncture is uncommon but potentially fatal. The artery is non-compressible and catheterisation or injury can lead to vessel occlusion, embolism, dissection, pseudoaneurysm and fatal haemorrhage. Endovascular treatment options include using a closure device and placing a covered stent across the puncture site. These can prevent the very invasive surgical option. Treatment decisions depend on various factors including patient age, patient co-morbidity and vessel integrity.

Take-home points: Inadvertent subclavian artery catheterisation can be successfully managed using a percutaneous vascular closure device. Placing a non-inflated balloon across the subclavian puncture site provides an extra layer of safety by providing a bail out option in case of closure device failure

P-683

Effectiveness of percutaneous ethanol injection therapy for symptomatic primary hyperparathyroidism

Y. Sugino

Radiology, Mie University School of Medicine, Tsu, Mie, JP

Clinical History/Pre-treatment Imaging: A 71 year old female with history of primary hyperparathyroidism whose parathyroid glands except left upper gland were resected. She received medical treatment to reduce intact PTH and serum Ca level, but they were maintained at a slightly higher value than normal range. She was pointed out pancreatic neuroendocrine cancer with liver metastasis and needed to be surgically resected. The control of serum calcium level before surgery was required.

Treatment Options/Results: Because of adhesion, it was impossible to remove the parathyroid gland surgically. It was decided to perform percutaneous ethanol injection therapy (PEIT). The left upper gland was confirmed by CT and it was possible to puncture with a 25G needle under real time CT guidance. The first PEIT was performed with 1.0 mL anhydrous ethanol mixed with a small amount of contrast agent and the serum Ca and intact PTH value were slightly decreased. One month after first PEIT, the second PEIT was performed with anhydrous ethanol 1.0 mL. In this time, a small amount of Lipiodol was mixed instead of a contrast agent in order to improve the visibility under CT fluoroscopy. Lipiodol deposition in postoperative CT was observed 3 days after the second PEIT. Serum Ca and intact PTH value were decreased and no adverse events were observed after injection.

Discussion: PEIT for the parathyroid gland could be performed safely. Under CT fluoroscopy, visibility is improved by using Lipiodol. It is possible lipiodol enhanced the PEIT effect.

Take-home points: The residual deposition of Lipiodol in CT after PEIT suggested that Lipiodol might enhance PEIT effect.

P-684

Successful thoracic duct embolization for treatment of an iatrogenic right chylothorax after esophageal surgery

C. Ballano Franco¹, A. Alvarez Luque², M. Echenagusia Boyra¹, M. González Leyte³, E. Calleja Cartón⁴

¹Radiology, Hospital General Universitario Gregorio Marañón, Madrid, ES, ²Vascular Interventional Radiology, University Hospital, Madrid, ES, ³Interventional Radiology, Hospital General Universitario Gregorio Marañón, Madrid, ES, ⁴Vascular and Interventional Radiology, Hospital General Universitario Gregorio Marañón, Madrid, ES

Clinical History/Pre-treatment Imaging: We report a case of a 55-year-old male with chylous pleural effusion after a distal esophageal resection. Conservative management was initially used with no effective results. Lymphatic embolization of the lymphatic duct leak was then proposed. **Treatment Options/Results:** Chylothorax has indication of treatment when losses are greater than 1000 ml/day during at least five days or there are metabolic or nutritional complications (immunosuppression and severe electrolyte loss).

If conservative management does not lead to clinical improvement, interventional management (lymphangiography (LAG), thoracic duct embolization (TDE) and thoracic duct disruption (TDR)) has shown to be an effective therapeutic tool with much more lesser morbidity rates than surgical treatment (pleurodesis and thoracic duct ligation). In our case, a TDE was performed after inguinal intranodal lymphangiogram. Cyanocilate - lipiodol was used to embolize the leak with clinical and radiology response.

Discussion: Percutaneous treatment of chylothorax has been proved to be a safety and effective technique.

In patients with low-output (<500 ml/day), LAG alone may achieve clinical success rates up to 70% of the cases. In those with higher output, TDE or TDR are needed.

Take-home points: In selected patients, percutaneous embolization of chylothorax is a safe technique with effective results.

P-685

Spontaneous bilateral hemothorax associated to type I neurofibromatosis treated by endovascular procedure

E.G. Ferreira Júnior¹, A. Filipe Neto², L.D.M. Silveira¹, F.G. Carvalho¹, P.F. Saad¹

¹Vascular Surgery, School of Medicine of Vale do São Francisco Federal University, Petrolina, BR, ²Medicine, Escola Superior de Ciências da Saúde, Brasília, BR

Clinical History/Pre-treatment Imaging: A 43-year-old man, with no relevant history of trauma, presented respiratory failure and reported difficult endotracheal intubation because of increase in cervical volume. Physical examination revealed dullness to percussion, decreased breath sounds bilaterally, cutaneous nodules, café-au-lait spots and Lisch nodules. Chest computed-tomography (CT) revealed large bilateral hemothorax. The patient had a family history of several first-degree relatives with similar skin lesions. Thus it was suggested the hypothesis of type I neurofibromatosis (NF1).

He was then submitted to an arteriography, which evidenced a right internal thoracic artery aneurysm, with no other abnormalities. (FIG 1)

Treatment Options/Results: Bilateral chest drainage was performed. The aneurysm was selectively catheterized and embolized, followed by a video-assisted thoracoscopy surgery (VATS) to drain the hemothorax, expand the lungs and review the pleural cavity. (FIG 2) Despite therapeutic success in the first 48h after intervention, because of the complications in prehospital healthcare, the patient developed cerebral edema and had brain death due to a hypoxic ischemic cerebral injury.

Discussion: Vascular lesions associated do NF1 include stenosis and aneurysm. In this case, the bleeding dissected to both pleural cavities, causing the bilateral hemothorax.

As the patient was stable, we performed an endovascular coil embolization of the aneurysm and then use VATS to drain the pleural cavities and expand the lungs. VATS showed retained and fibrous clot, suggesting chronic bleeding.

Take-home points: Surgeons should consider artery aneurysms in patients with NF1 as a cause of spontaneous hemothorax.

Although the high mortality of this complication, the endovascular treatment associated do VATS has shown the best results.

P-686

A case of chylothorax by central conducting lymphatic anomaly treated with CT guided lymphatic embolization

Y. Tanahashi¹, M. Ozeki², H. Kawada¹, S. Yasue², S. Endo², T. Ando¹, N. Kawai¹, S. Nagata¹, Y. Noda¹, S. Goshima¹, T. Fukao², M. Matsuo¹

¹Radiology, Gifu University Hospital, Gifu, JP, ²Pediatrics, Gifu University Hospital, Gifu, JP

Clinical History/Pre-treatment Imaging: A 3-year-old girl had experienced abdominal pain and nausea, diagnosed with acute pancreatitis accompanying pleural effusion. The pleural effusion had been increased despite the treatment. She was performed thoracentesis and diagnosed as chylothorax. MRI demonstrated dilated lymphatic vessels around vertebrae, indicating lymphatic anomaly. Since the chylothorax was uncontrollable with the conservative therapy and thoracoscopic surgery, she was transferred to our hospital.

Lymphoscintigraphy and lymphangiography were performed. Although Lymphoscintigraphy showed lymphatic leakage from left upper abdomen into right thoracic cavity, lymphangiography did not demonstrate neither the leak point nor thoracic duct.

Treatment Options/Results: The medication of sirolimus, lymphaticovenous anastomosis (LVA), lymphatic disruption/embolization, radiation therapy were offered as treatment options. Since the lymphatic leak point was not shown on lymphangiography, the medication of sirolimus was performed initially, but failed. After the failure of LVA performed 6months after the admission, lymphoscintigraphy was performed for re-evaluation and showed the lymphatic leakage into left thoracic cavity. The leakage from paraspinal lymphatic vessels was suspected. Thus, we performed direct puncture lymphatic embolization of paraspinal lymphatic vessels under CT guidance. After the embolization, the chylothorax was dramatically improved.

Discussion: Nontraumatic chylothorax is more difficult to treat than traumatic chylothorax because leak point may be less predictable. Although the efficacy of thoracic duct embolization for the nontraumatic chylothorax was previously reported, our patient did not have thoracic duct. Thus, we directly punctured and embolized paraspinal lymphatic vessels flowing into thoracic cavity.

Take-home points: The direct puncture lymphatic embolization can be treatment of option for nontraumatic chylothorax.

P-687

Embolisation of a mandibular metastasis from colorectal cancer to halt life-threatening haemorrhage

A.E. Stroiescu¹, J.B. Hennebry¹, M.P. Bolger¹, C.A. Byrne², L. Greene², A.G. Ryan³

¹Division of Interventional Radiology, University Hospital Waterford, Waterford, IE, ²Radiology, University Hospital Waterford, Waterford, IE,

³Division of Interventional Radiology, Department of Radiology, University Hospital Waterford, Waterford City, IE

Clinical History/Pre-treatment Imaging: A 57 year-old man with Stage 4 Colon cancer with metastases to lymph nodes, liver and bone developed a metastasis to the body of the mandible which eroded adjacent vessels

and the oral mucosa and caused repeated severe haemorrhage resulting in profound anaemia and haemodynamic compromise. Standard post-contrast CT and CT angiography demonstrated a very large, hypervascular mass centred on the body of the mandible in the territory of the inferior alveolar artery. Maxillofacial surgeons advised that they had nothing to add. IR consult sought by the Oncologist in charge.

Treatment Options/Results: Angiography and embolisation was offered and proceeded with catheterisation of the External Carotid, the Maxillary and Inferior Alveolar arteries in turn, the latter embolised with multiple micro-coils resulting in haemorrhage cessation, stabilisation and correction of his anaemia.

Discussion: The patient succumbed to his disease two months post-embolisation, but had no further episodes of oral haemorrhage, which he had described as 'terrifying'.

Take-home points: IR is frequently the 'port of last resort', but can often provide significant benefit and resolution of reversible conditions towards the end of cancer patients' lives, effecting palliation and allowing them time to put their affairs in order without distress.

P-688

Bronchial obstruction treated by a tooth extraction in the interventional radiology suite

Z. Chudacek

Department of Radiology and Toxicology, University of South Bohemia, Ceske Budejovice, CZ

Clinical History/Pre-treatment Imaging: An 18-year-old young man with accident polytrauma, in deep unconsciousness, was transferred from the provincial hospital for the purpose of serious jaw trauma treatment. The admission chest X-ray revealed the presence of an upper molar in the right principal bronchus. The attempts to grab the tooth with bronchoscopic forceps were unsuccessful. The patient was transported to our interventional radiology suite.

Treatment Options/Results: Through the tracheostomic canula, we catheterised the right principal bronchus ostium under fluoroscopic control. Then we succeeded in getting around the tooth with a hydrophilic guide-wire into the connective bronchus and after that to insert the guiding catheter of a Dormia basket over the wire. After the insertion of the basket in to the level of the tooth, we applied slight rotation in both directions and in such a way succeeded in catching the tooth into the basket and in grasping the basket with the guiding catheter (fig.1). The tooth was extracted together with the tracheostomic canula from the airways (fig.2). In the further course of the treatment, no respiratory complications occurred.

Discussion: Reports about using the fluoroscopy and radiointerventional extraction tool for the emergency treatment in respiratory tract are very rare in the literature. The author succeeded with such a technique to help the patient with completely occluded right principal bronchus by a traumatically released and aspirated tooth.

Take-home points: In very rare conditions the interventional radiologist can be more successful with the extraction of the foreign body from central bronchial tree than the bronchoscopist.

P-689

Massive bleeding due to bronchial-pulmonary artery fistula treated with combination of bare metal stent, metallic coil and n-butyl-2-cyanoacrylate

R. Woodhams¹, K. Fujii¹, M. Takigawa², T. Yamane¹

¹Department of Diagnostic Radiology, Kitasato University School of Medicine, Sagami-hara, JP, ²Department of Radiology, Sagami-hara National Hospital, Sagami-hara, JP

Clinical History/Pre-treatment Imaging: A 66-year-old male with bronchial necrosis due to surgery and chemoradiotherapy for esophageal cancer had massive bronchial bleeding during bronchoscopy. CT

demonstrated an extravasation from the right pulmonary artery (RPA) into the right lower bronchus through a fistula.

Treatment Options/Results: Endovascular treatment rather than pneumonectomy was selected in consideration of respiratory disorder due to atelectasis. After placing a microcatheter from RPA into the right bronchus through the fistula for subsequent embolization of the fistula, E-LUMINEXX (14mm/8cm) was placed over the fistula. Subsequently metallic coils followed by N-butyl-2-cyanoacrylate (NBCA) were filled in the fistula and the space out of the stent. NBCA spilled over into RPA was aspirated and displaced with balloon angioplasty and placement of another E-LUMINEXX. Final angiogram showed hemostasis and patency of RPA. On day 25, RPA was embolized because of rebleeding due to dislocation of coils. Although his general condition had been improving after second procedure, he died from pulmonary infection on day 72.

Discussion: Bronchial-pulmonary artery fistulae is a rare and life-threatening phenomenon. There was only one case report of successful hemostasis with stent-graft placement for the same condition. Although stent-graft placement was considered as a more secure hemostatic method for our patient, there was no suitable size of stent-graft available at that time due to the sharp caliber change at the landing zone, from 16mm to 10mm.

Take-home points: The placement of bare-metal stent followed by introduction of metallic coil and NBCA to occlude bronchial-pulmonary artery fistula can be one of the temporal hemostatic options before radical hemostatic measure.

P-690

The treatment of neck lymphorrhea after total thyroidectomy: thoracic duct embolization using N-butyl cyanoacrylate and microcoils

Y. Kwon, J.M. Lee, J. Kim, J.H. Won

Radiology, Ajou University Hospital, Suwon, KR

Clinical History/Pre-treatment Imaging: A 49-years-old female patient was referred for treatment of lymphatic leak after total thyroidectomy. The patient had undergone total thyroidectomy and left level IV lymph nodal dissection one week previously after which she developed swelling in the left neck. After failed surgical attempts, the patient was referred for lymphangiography.

Treatment Options/Results: A lymph node in the right groin was punctured using a fine needle under ultrasound guidance and lymphangiography was performed by injecting Lipiodol into the lymph node under fluoroscopy. Lymphangiography revealed disrupted lymphatics associated with a collection of extravasated Lipiodol at the site of the left neck level IV. Upon the decision to embolize the leaking duct using glue and microcoils, prepare to access cisterna chyli. Punctured using a 22-gauge needle, and a microcatheter was co-axially advanced into the thoracic duct. The thoracic duct was embolized with microcoils. This was then flushed with dextrose-5-water, after which N-butyl cyanoacrylate diluted in Lipiodol was injected via microcatheter. Two days later, a dry tap was confirmed from the surgical drain which was successfully removed.

Discussion: While thoracic duct embolization has been reported to be successful in treating lymphatic leaks occurring in the thoracic cage, reports on treatment of neck regions are scarce. With growing interest in embolization techniques for lymphatic leaks occurring after the surgery, this case demonstrates the application of embolization for the treatment of lymphatic leaks in the neck.

Take-home points: The technique of thoracic duct embolization is useful to treat lymphatic leaks occurring in locations not only abdomen or thorax, but also neck region.

P-691

Pre-operative transcatheter embolization of a mediastinal paraganglioma

F. Zandrino¹, I. Gallesio¹, M. Reale², S. Barbero¹

¹Radiology, Ospedale SS Antonio e Biagio e C. Arrigo, Alessandria, IT,

²Cardiology, Ospedale SS Antonio e Biagio e C. Arrigo, Alessandria, IT

Clinical History/Pre-treatment Imaging: A 41-years-old female presented to the ER with acute coronary syndrome. ST segment elevation was present. Serum troponin levels were elevated. Invasive coronary angiography was performed. No coronary artery stenosis was found, but a hypervascular mediastinal lesion was detected. The mass was vascularized from branches of the right and the circumflex coronary arteries. CT examination showed a 3.2 cm mass located between left atrium, descending aorta and right branch of the pulmonary artery. The mass was also fed from a large bronchial vessel. Urinary catecholamines were elevated.

Treatment Options/Results: Due to the risk of severe bleeding and of catecholamines release at the time of surgical excision, preoperative transcatheter embolization was performed. First, the feeding bronchial artery was embolized with detachable coils. Then, the feeding branch arising from the right coronary artery was embolized, also with detachable coils. The small branches from the left circumflex artery were non catheterized. No complication occurred during the procedures. The day after, surgery was performed, without bleeding or other complications. At histopathology a paraganglioma was diagnosed.

Discussion: Clinical onset of paraganglioma as acute coronary syndrome is rare. In this case symptoms may be determined by coronary spasm or myocardial toxicity induced by the high levels of catecholamines. Paragangliomas are highly vascularized masses, with multiple feeding branches and a high risk of bleeding or catecholamine release during surgical maneuvers. Therefore, in this case transcatheter embolization was decided.

Take-home points: Transcatheter embolization can be a useful and safe approach before surgical removal of paragangliomas, in particular when located in unfavorable sites.

P-692

Percutaneous embolization of a large pelvic lymphocele refractory to the multiple approaches

C.S.S. Menezes, T. Fabiano, D. Barbosa, H.S. Martin, H. Gouveia

Radiologia Intervencionista, Instituto Nacional do Cancer, Rio De Janeiro, BR

Clinical History/Pre-treatment Imaging: 50 year old female, who underwent surgical resection and pelvic lymphadenectomy due to ovarian cancer, developed two unresolved large lymphocells after 02 sessions of open surgical marsupialization, percutaneous drainage, and alcoholization.

Treatment Options/Results: The embolization was performed according to the technique described: lymphangiography performed by right and left inguinal lymph nodes (intranodal) with a 22G needle positioned at the cortical-medullary transition guided by USG, followed by injection of 5 ml of lipiodol, with extravasation in the canaliculi sectioned at the level of the external iliac chains bilaterally. We proceeded with injection of glue mixed with lipiodol (ratio of 1:3) until the extravasation stopped. The previously placed external drains were maintained for drainage of the remaining liquid, being withdrawn after maintenance of flow rate less than 10 ml / day for 3 days. Control CT after 01 month of drainage withdrawal and 03 months after embolization demonstrated complete lymph node resolution as well as contrast filling in inguinal lymph nodes that were punctured (red arrows - fig 1A, 1B and 2A) and sectioned lymph nodes, extravasation sites (green arrows - fig 1 A-C and fig 2A).

Discussion: Infra-cisternal lymphatic embolization is a relatively fast procedure, without major technical challenges, quite effective and low morbidity when compared to the surgical approach.

Take-home points: Infra-cisternal lymphatic embolization should always be considered as a non-invasive therapeutic option, especially in cases of refractory large lymphatic collections.

P-693

Thrombolysis and celiac artery stent placement for early transplant hepatic artery thrombosis

O. Bashir¹, M. Arabi²

¹Interventional Radiology, King Abdulaziz Medical City, Riyadh, SA,

²Medical Imaging, King Abdulaziz Medical City, Riyadh, SA

Clinical History/Pre-treatment Imaging: Acute transplant hepatic artery thrombosis was diagnosed on Doppler ultrasound and CT angiography on 3rd post-operative day. Significant celiac axis origin stenosis was also noted (overlooked in pre-op planning).

Treatment Options/Results: Using femoral artery access, the thrombosed hepatic artery was cannulated with a microcatheter and thrombus laced with 3mg tPA. A 5cm Cragg-McNamara infusion catheter was placed across the thrombus. tPA infusion was commenced at 0.5mg/hr and the patient monitored in the intensive care unit. Check angiography performed at 12 hours showed near complete resolution the thrombus. 7mm balloon-expandable stent (Valeo) was placed across the stenotic celiac artery origin following which significant improvement in transplant hepatic artery flow was noted. Transplant hepatic artery remained patent on follow-up imaging several months after the intervention.

Discussion: Transplant hepatic artery thrombosis is a serious complication, which can cause graft loss as well postoperative mortality. Treatment options include surgical or endovascular revascularization and if necessary re-transplantation. Endovascular revascularization with catheter directed thrombolysis is a minimally invasive option, though it carries a significant risk bleeding especially in the early post-operative period. We were able to successfully use endovascular-first approach with intensive patient monitoring and hence avoided a potentially morbid surgical procedure. Additionally, detection and treatment of the underlying celiac origin stenosis helped us obtain a durable result.

Take-home points: Percutaneous transplant hepatic artery thrombolysis, a minimally invasive option, is feasible even in the early post-operative with intensive monitoring of the patient. Treatment of any underlying parent artery stenosis is essential to avoid re-thrombosis.

P-694

Vascular plug placement for iatrogenic aortic injury in patient with massive TAAA (thoracoabdominal aortic aneurysm)

D.V. Meccia¹, A. Boccuzzi¹, L. Giorgi¹, R. Cervelli¹, O. Perrone²,

A. Cicorelli², R. Cioni²

¹Diagnostic and Interventional Radiology, University of Pisa, Pisa, IT,

²Diagnostic and Interventional Radiology, AOU PISA, Pisa, IT

Clinical History/Pre-treatment Imaging: Female patient, 84yr old, with type II respiratory insufficiency, massive thoracic aortic aneurysm inoperable for high risk surgery, bladder urothelial carcinoma treated by TURB and hypertension, accessed to emergency department for dyspnea and worsening left thorax pain. Several chest radiographs confirmed aneurysmatic dilatation of aorta and bilateral pleural effusion. Bedside thoracocentesis and thoracostomy was performed to improve respiratory function. Fluid drained had a bloody appearance. The drainage was immediately clamped. Patient symptoms got worse so it was performed a contrast-enhanced CT scan that reported the pig-tail drainage had penetrated the thoracic aortic wall. There was no evidence of extravasation of contrast medium. The patient hemodynamically stable was transferred to our Hospital.

Treatment Options/Results: After a multidisciplinary consult (vascular surgeon, anesthesiologist, interventional radiologist), because of the impossibility for intravascular or trans-thoracic aneurism prosthesis repair, we decided to place a vascular plug (Amplatzer™ Vascular Plug II) under general anesthesia using drainage as access to aortic lumen. Final aortogram confirmed well-positioned plug and no evidence of extravasation of contrast medium. Finally the patient was transferred to the ICU with tracheal intubation. During following days it was not possible to weaning her from ventilators. Five days later the patient hemodynamically instable died.

Discussion: The concomitant presence of massive TAAA and pleural effusion is an important risk factor for all thoracic interventional procedures.

Take-home points: Patient comorbidities complicated the outcome of a well-executed procedure without no more safe alternatives. Interventional radiology procedures, also in extreme cases, are a safe choice for treatment of life-threatening iatrogenic injuries of major blood vessels.

P-695

Selective arterial embolization for a high-flow priapism following minimal perineal trauma in a child

L.D.M. Silveira¹, A. Filipe Neto², E.G. Ferreira Júnior³, F.A. de Oliveira¹, K.R. Saad¹, P.F. Saad¹

¹Vascular Surgery, School of Medicine of Vale do São Francisco Federal University, Petrolina, BR, ²Medicine, Escola Superior de Ciências da Saúde, Brasília, BR, ³Vascular Surgery, School of Medicine of Vale do São Francisco Federal University, Petrolina, BR

Clinical History/Pre-treatment Imaging: A 6-year-old child, with high flow priapism after minimal trauma. We performed Duplex Scan with no localization of the vascular lesion. Therefore the patient was submitted to a selective catheterization of the left hypogastric artery and of the left pudendal artery were performed and the angiography that showed arteriocavernosal fistula (FIGURE 1).

Treatment Options/Results: It was opted for minimally invasive percutaneous treatment, by metal microcoil embolization, achieving immediate resolution of the arteriocavernosal fistula, with preservation of the organ's functionality, with no complications. (FIGURE 2)

Discussion: Generally the penis is not fully rigid, and the child do not complain of pain. In children this is a rare condition, usually due to a major perineal trauma. There is the possibility of doppler ultrasound guided compression. However, due the limitation of the pediatric patients, the selective embolization must be considered and have excellent results.

Take-home points: The minimal invasive treatment with selective embolization is safe, painless and effective. It must be considered even in the pediatric patients.

P-696

Management of massive pulmonary embolism in a patient status post trauma and intracranial malignancy

K. Dudley¹, R. Chen², D. Jin¹

¹Radiology, Loma Linda University Medical Center, Loma Linda, CA, US,

²Interventional Radiology, Loma Linda University Medical Center, Loma Linda, CA, US

Clinical History/Pre-treatment Imaging: 51 year old male with history of glioblastoma multiforme status post resection 1 year ago presented to the ED after cardiac arrest and fall. Return of spontaneous circulation was achieved. CT head revealed recurrent invasive tumor involving the bilateral frontal lobes. CT chest revealed extensive bilateral pulmonary emboli (PE) with right heart strain. CT abdomen revealed a splenic laceration with intraperitoneal hemorrhage. The patient was tachycardic (HR 150-160s), tachypneic (RR 33), and with positive cardiac markers. Interventional radiology was consulted for possible splenic embolization and management of massive PE.

Treatment Options/Results: In the angiographic suite, pigtail catheter was placed within the pulmonary trunk, with the pressure measuring 56/20 mmHg. Mechanical aspiration was performed within the right lower, right upper, and left lower lobar/segmental pulmonary arteries using an Indigo Cat-8™ mechanical aspiration device. Post-procedural pulmonary artery pressure measured 33/6 mmHg. Hemodynamic improvement was observed immediately after intervention, including marked improvement in tachycardia (HR 100s). The patient was extubated 2 days later, and underwent frontal craniotomy for resection 8 days later.

Discussion: Traditionally, systemic thrombolysis has been the standard of care of massive PE. In recent years, catheter directed therapies have emerged as adjunctive and/or alternative treatment for massive PE or in patients with lower risk profile. This case demonstrates safety and efficacy of mechanical thrombectomy alone in the setting of contraindication for thrombolysis.

Take-home points: Mechanical thrombectomy alone can be safe and effective in the treatment of massive PE when there is a contraindication to thrombolysis.

Peripheral vascular disease intervention

P-697

Dorsalis pedis or distal tibialis anterior as a primary single access in treatment of critical limb ischemia

D. Raskin¹, B. Khaitovich¹, S. Balan¹, D. Silverberg², M. Halak², U. Rimón¹

¹Diagnostic Imaging, Sheba Medical Center, Tel Hashomer, IL, ²Vascular Surgery, Sheba Medical Center, Tel Hashomer, IL

Purpose: To evaluate the Dorsalis Pedis (DPA) and distal Tibialis Anterior (TA) arteries approach as a single access site for revascularization in patients with critical limb ischemia (CLI) when the femoral approach is hostile or unavailable.

Material and methods: A retrospective review of patients who underwent iliac and femoropopliteal, ipsilateral revascularization via a single access site from the DPA or distal TA between January 2017 and December 2018. Twenty two limbs in 22 patients, 16 men and 6 women, with average age 72 years (range 49-96 years) were included. All patients were unfit for a surgical bypass graft. The treated occluded segments involved 3 iliac, 21 femoropopliteal, one bypass graft and three posterior tibial arteries. Technical success was defined as recanalization with residual stenosis less than 30%, and improvement in ABI after 24 hours. Patients were followed for up to 15 months. End points were freedom from reintervention and limb salvage, both for one year.

Results: Technical success was achieved in 21 of the 22 patients (95%). Stents were placed in 19 of 21 patients (90%). No immediate complications were encountered. The accessed artery was patent on post 24 hours Doppler. Average ABI increased from 0.46 to 0.84 post procedure. Median follow-up was 8.2 months (range 1-15). One patient was lost to follow-up. Reintervention was needed in 5 limbs, after an average of 4.5 months.

Conclusion: Using the DPA and distal TA as a single access could be a valuable approach when traditional access sites are unavailable for treating patients with CLI.

P-698

Rotarex mechanical atherothrombectomy in chronic arterial de novo lesions: single center experience with 671 patients

B. Freitas¹, S. Steiner¹, Y. Bausback¹, M. Üllrich¹, S. Bräunlich¹, A. Schmidt¹, D. Scheinert²

¹Interventional Angiology, University Hospital - University of Leipzig, Leipzig, DE, ²Angiology and Cardiology, University of Leipzig Heart Center, Leipzig, DE

Purpose: To report our preliminary experience with mechanical rotational atherothrombectomy in chronic lower limb PAD patients using Rotarex®.

Material and methods: Consecutive patients undergoing PMAT of native lower limb chronically occluded arteries were included.

Results: 671 consecutive patients were available for analysis with a mean age of 70.1±11.5 years. 748 lesions were treated in this group, with approximately two thirds (n=461; 68.7%) of men. The majority of occlusions were de novo lesions (n=539; 72.1%) and 209 had at least one previous balloon angioplasty (27.9%). Patients presented mostly in Rutherford-Becker category (RBC) 4 (51.4%) and 3 (20.5%) at admission. Mean lesion length was 167mm (range 20-293mm), with moderate and severe calcification in 263 (41.2%) of the analyzable lesions. Solely PMT was performed in 116 (17.3%), PMT+balloon angioplasty in 354 (52.8%), provisional stenting in 201 (29.9%), mainly through spot-stenting implantation (n=136 (20.3%). Procedural technical success rate was 96.9%, with improvement in RBC persisting in 76.4% of patients after 12±2.4 months mean time follow-up. Overall 30-days Major Adverse Events (MAE) was 7.2% with a 30-days mortality rate of 1.3% (n=9). No death was directly related to the device. After 12-months, a promising overall Target Lesion Revascularisation (TLR) (12.7%), non-TLR (6.9%) and major amputation rates (2.6%) were found. One-year mortality was 7.3%.

Conclusion: Treatment with PMAT resulted in clinic and hemodynamic improvement in the majority of patients, thereby unmasking the guilty lesion and reducing the need of stent implantations and/or metal load in a significant proportion of patients. Prospective studies in this issue are recommended.

P-699

Is activated clotting time necessary to guide sheath removal in heparinised patients undergoing endovascular intervention for peripheral vascular disease?

M.C. Tan¹, K. Duff², L. Roberts³, V. Ramachandran¹

¹Department of Medical Imaging, Eastern Health, Box Hill, VIC, AU,

²Medical Imaging / Angiography, Box Hill Hospital, Box Hill, VIC, AU,

³Department of Cardiology, Eastern Health, Melbourne, VIC, AU

Purpose: To evaluate the best practice for arterial sheath management in heparinised patients undergoing endovascular intervention for peripheral vascular disease (PVD) at Eastern Health.

Material and methods: Patients undergoing endovascular intervention for PVD at Eastern Health between January 2016 and February 2018 were studied. Those who fulfilled the inclusion criteria were randomly assigned to five interventional radiologists and Category A (sheath removed upon return to recovery and without activated clotting time (ACT)), Category B (ACT check 1 hour post heparin and sheath was removed without knowing the ACT) or Category C (ACT check 1 hour post heparin and sheath removed once ACT<160; our hospital's current protocol). Nurses removing sheaths independently have >3 years of experience. Data were collected on baseline clinical characteristics, dose of heparin administered, sheath size and direction, time from heparin administration to sheath removal, time to hemostasis, blood pressure at time of sheath removal and complications.

Results: 152 patients were included. They were predominantly older males. There was no significant difference in baseline characteristics influencing complications and other contributing factors. The only significant finding was that Category C experienced the longest mean time

to sheath removal (143.4±52.1 minutes) while Category A experienced the shortest mean time (62.2±27.1 minutes, p= 0.0001). There was no significant difference in outcomes.

Conclusion: Considering the factors influencing complications were comparable among the three categories and yet there was no significant difference in the outcomes, it warrants further investigation as to whether ACT is necessary to guide sheath removal.

P-700

Preoperative MRI for predicting thromboembolic complications during endovascular treatment for iliac artery occlusion

K. Maruyama¹, R. Kawasaki¹, M. Kinoshita¹, S. Seike¹, T. Okada², M. Yamaguchi², K. Sugimoto², T. Murakami²

¹Radiology, Hyogo Brain and Heart Center at Himeji, Himeji, JP,

²Department of Diagnostic and Interventional Radiology, Kobe University Hospital, Kobe, JP

Purpose: To assess the relation between the incidence of thromboembolic complications during endovascular treatment (EVT) for iliac artery occlusion and the signal intensity of the occlusion on MRI.

Material and methods: This single-institution study included 54 iliac artery atherosclerotic lesions in 53 patients (mean age, 70.8 years; range 54–88 years) who underwent preoperative MRI using an inversion-recovery prepared steady-state free precession technique following successful EVT between January 2010 and March 2018. We defined thromboembolic complications as distal embolization, in-stent thrombotic occlusion, and in-stent protrusion >25% of the stent cross-sectional area confirmed by angiogram and intravascular ultrasound, regardless of symptoms. The highest signal intensity of the iliac artery occlusion divided by the signal intensity of the nearby iliopsoas muscle (i.e., the target-to-muscle ratio [TMR]) was measured on MRI images. A multivariate analysis was performed to clarify predictors of thromboembolic complications during EVT, including TMR, patient characteristics, and other imaging findings.

Results: Thromboembolic complications were observed in 12 vessels (22.2%) from 12 patients: distal embolization (n=3), in-stent thrombotic occlusion (n=2), and in-stent protrusion (n=7). A cut-off value >2.57 of the TMR had 91.7% sensitivity, 78.0% specificity, a positive predictive value of 55.0%, and a negative predictive value of 97.1% for detecting thromboembolic complications during EVT. On multivariate analysis, a TMR >2.57 was the only independent factor associated with thromboembolic complications (odds ratio 35.90, 95% confidence interval 3.20–404.00, p=0.004).

Conclusion: High signal intensity of the occlusion on preoperative MRI is useful for predicting thromboembolic complications during EVT for iliac artery occlusion.

P-701

A single-centre, retrospective, cohort study on the influence of demographic and technical factors on the complication rates of the MynxGrip™ vascular closure device when used for femoral arteriotomy closure in lower limb angioplasty

S.M. Amis, D.V. Thomas

Dept of Radiology, Northampton General Hospital, Northampton, UK

Purpose: There appears to be a paucity of evidence in the literature regarding complication rates associated with using the MynxGrip™ vascular closure device to achieve haemostasis following lower-limb angioplasty. We sought to determine the risk of bleeding complication at the arteriotomy site on a «real world» cohort of patients and determine which technical and demographic factors increase this risk.

Material and methods: All patients undergoing lower limb angioplasty at a single institution between January 2018 and January 2019 were enrolled retrospectively (n=110). Data was collected on patient demographics, clotting status, intraoperative technical factors and post-operative complications.

Results: Out of 118 MynxGrip™ deployments the rate of bleeding complication at the arteriotomy site was 7.63% (only one of which resulted in a haemodynamically significant bleed). Device failure rate was 0.85%. There was no difference in clotting status, mean age or gender composition between the patients who suffered a bleeding complication and those unaffected. Univariate analysis showed that sheath size >5Fr (OR 1.88, p-value 0.370), retrograde access (OR 2.21, p-value 0.283) and SFA access (OR 2.26, p value 0.346) all increased the rate of bleeding complication. **Conclusion:** The MynxGrip™ appears to be a safe and reliable means of achieving haemostasis in lower-limb angioplasty. Further data will be collected over the next twelve months to confirm the observed association between specific technical factors and an increased risk of bleeding complications. This may facilitate risk stratification of patients in the future and so identify those that require additional manual pressure to reduce the rate of bleeding complication further.

P-702

The long-term results of endovascular therapy in patients with popliteal artery steno-occlusive disease

D.T. Nguyen¹, M. Vértés¹, P. Bayerle¹, A. Berczi¹, E. Dósa²

¹Heart and Vascular Center, Semmelweis University, Budapest, HU,

²Vascular Surgery, Semmelweis University, Budapest, HU

Purpose: The first line therapy of symptomatic popliteal artery (PA) steno-occlusive disease is percutaneous transluminal angioplasty (PTA) in itself or combined with stenting. Only smaller studies are available about the long-term patency of PA interventions. The purpose of this study was to analyze the rate and predictive factors of PA restenoses.

Material and methods: Our single-center retrospective study included 124 symptomatic patients [70 male, median age: 67.4 (60.5-74.4) years; Fontaine stage IV: n=61], whose atherosclerotic PA stenoses/occlusions were treated endovascularly between 2008 and 2015. Atherosclerotic risk factors, lesion characteristics, balloon/stent parameters, and the degree of residual stenosis were analyzed.

Results: Out of 124 patients, 50 had PTA, while 74 underwent selective or primary stenting (self-expandable: n=73, balloon-expandable: n=1). The median follow-up time in the PTA group was 41.1 (9.5-62.5) months, while it was 32.5 (18.3-62.7) months in the stent group. Primary patency rates were 88% and 92% at 6 months, 71% and 86% at 1 year, 71% and 70% at 2 years in the PTA and in the stent group, respectively. There was no significant difference between the two groups regarding the primary patency rates (p=0.715). Restenosis occurred in 32% of the cases in both groups. Predictive factors of restenosis were residual stenosis in the PTA group (p=0.028) and the presence of preprocedural occlusion in the stent group (p=0.017).

Conclusion: PTA and stenting both have similar efficacies in the therapy of PA steno-occlusive disease. In patients with a minimum residual stenosis of 20% or preprocedural occlusion, more careful follow-up might be required.

P-703

FemoSeal vascular closure device for antegrade common femoral artery access: safety and technical notes

F.B. Tagliaferro¹, M. Rossi¹, M.A. Tipaldi¹, G. Orgera², L. Mascagni¹, F. Laurino¹

¹Radiology, St. Andrea University Hospital, Rome, IT, ²Interventional Radiology, St. Andrea University Hospital, Rome, IT

Purpose: To retrospectively assess the efficacy and safety of FemoSeal® Vascular Closure Device (VCD) to achieve hemostasis following antegrade common femoral artery (CFA) puncture after lower limb revascularization using vascular sheaths from 5F to 8F.

Material and methods: We reviewed the hemostatic outcome achieved with FemoSeal® in 103 consecutive patients (mean age 69±8, 71 males) that undergone to 111 antegrade CFA accesses for lower limb percutaneous

revascularization using 5F to 8F vascular sheaths. The primary outcome was the technical success, meant as achieving complete hemostasis without immediate complications.

Results: Hemostasis was achieved in all 111 puncture sites (100% technical success). We observed eight (7%) puncture site minor complications (hematomas). There weren't statistically significant differences between the variables potentially related to the occurrence of complications in patients with and without complications. Complications group mean BMI was 26.4 ± 2.8 kg/m² vs non-complications group 26.6 ± 4.4 kg/m², p=0.92. Mean INR and PTT ratio were respectively 1.05 ± 0.01 and 1.05 ± 0.14 vs 1.13 ± 0.2 (p=0.39) and 1.12 ± 0.23 (p=0.53). CFAs calcification grade was the same (mean 1, p=1). PLT count was 202x10³/ml ± 66.7 vs 226x10³/ml ± 91.2, p=0.55. Mean age was 72.3 ± 10 vs 72.8 ± 8, p=0.86.

Conclusion: the low rate (7%) and grading of the adverse events, combined with the high technical success rate (100%), in an unselected group of patients treated in daily routine, suggest high safety and efficacy of FemoSeal® VCD in antegrade CFA puncture site hemostasis when using vascular sheaths ranging from 5F to 8F.

P-704

Efficacy and safety of the "off-label" use of the Angio-Seal vascular closure device

A.H. Mahnken¹, R.P. Thomas², S. Vinio³, N. Hallal⁴

¹Department of Diagnostic and Interventional Radiology, University Hospital Marburg, Philipps University of Marburg, Marburg, DE,

²Diagnostic and Interventional Radiology, Uniklinikum Marburg, Marburg, DE,

³Dept. Of Diagnostic and Interventional Radiology, Marburg University Hospital UKGM, Marburg, DE, ⁴Dept. of Diagnostic and Interventional Radiology, Marburg University Hospital UKGM, Marburg, DE

Purpose: Closure devices are increasingly used in interventional radiology. In complex situations such as coagulation disorders or repeated arterial punctures they are particularly helpful, but its use will be "off-label". This retrospective study analyzed the safety and efficacy of the "off-label" use of the Angio-Seal closure device.

Material and methods: The use of 6F and 8F Angio-Seal devices in 471 consecutive patients was analyzed. Indications, puncture technique and patient characteristics including coagulation state were recorded. Outcome was monitored using data from the institutional complication management system and patient records. Results were statistically analyzed.

Results: In 94 patients the Angio-Seal closure device was used in one or more off-label indications, including oversize puncture (n=31), thrombolysis for more than 24h (n=44), recurrent arterial punctures within 90 days (n=7), superficial femoral artery puncture (n=7) and coagulation disorders (n=13). The off-label group included significantly more male patients (p=0.008), smokers (p=0.004), diabetics (p=0.026) and patients with previous vascular surgery at the access site (p<0.001). Devices were successfully applied in 466 patients; all technical failures occurred in the "on-label" group. There were 3.6% minor complications and 1.3% major complications, with a significantly higher complication rate in the "off-label" group (p=0.012). Outcome was not different when comparing antegrade and retrograde puncture techniques (p=0.527).

Conclusion: The use of the Angio-Seal vascular closure device in "off-label" indications has a high technical success rate. Although complication rates are higher in case of "off-label" use, they are well within the ranges reported in the literature.

P-705

A single center study on the risk of mortality in patients treated with paclitaxel-coated devices for femoropopliteal disease

V. Linehan¹, M. Doyle¹, H.M. Coffey², M. Earle³, B. Barrett¹, R. Gullipalli²

¹Faculty of Medicine, Memorial University of Newfoundland, St. John's, NL, CA, ²Radiology, Memorial University of Newfoundland, St. John's, NL, CA, ³Radiology, University of Toronto, Toronto, ON, CA

Purpose: Randomized controlled trials have shown that paclitaxel-coated balloons and stents significantly reduce restenosis in femoropopliteal lesions. A recent meta-analysis suggested these devices increase mortality at 2- and 5-years post-intervention. However, since this meta-analysis only assessed all-cause mortality, it remains unknown whether paclitaxel has causal role in patient mortality. Therefore, the purpose of our study is to use local patient-level data to address this question.

Material and methods: We completed a retrospective study of femoropopliteal interventions at a single center from December 2009 to 2015. Currently, we are expanding this pilot study to include patients up to December 2018. In total, an estimated 300 patients treated with paclitaxel-coated balloons and stents will be compared to 300 patients treated with bare metal stents and plain balloon angioplasty. Mortality up to 5 years follow-up and patient characteristics including risk factors, lesion characteristics, and target lesion revascularization will be assessed.

Results: Our study showed no difference in mortality at 2-years post-intervention, with 28 deaths of 200 patients in the paclitaxel group compared to 29 deaths of 201 patients in the control group. Data collection is ongoing to increase sample size and the duration of follow up.

Conclusion: Our preliminary data do not support an increased risk of mortality following endovascular treatment with paclitaxel-coated devices. The strengths of our study include using patient-level data in a homogenous population, combined with real-world clinical decision making, which can provide a stronger context for patient outcomes when using paclitaxel-coated devices.

P-706

Safety and efficacy of covered endovascular reconstruction of the aortic bifurcation (CERAB) technique for complex aortoiliac occlusive disease: a single center experience

S. Varello¹, M.A. Ruffino², M. Fronda¹, E. Soncin¹, A. Discalzi², A. Mancini², P. Muratore², D. Rossato², D. Righi², P. Fonio¹

¹Department of Surgical Sciences, Università degli Studi di Torino, Turin, IT, ²Vascular Radiology, AOU Città della Salute e della Scienza - San Giovanni Battista Hospital, Turin, IT

Purpose: Endovascular intervention with kissing stenting (KS) is the first-line treatment for complex aortoiliac occlusive disease (AIOD) and it is related to less morbidity and a shorter hospital stay compared with open surgery. Unfortunately, recent study reported a primary patency of KS at 2-year follow-up of 79%. To achieve better long-term patency in 2013, a new technique named the covered endovascular reconstruction of the aortic bifurcation (CERAB) technique was introduced. The results at 1-year and 3-years FU reported a primary and secondary patency rates of 87% and 95% and 82% and 97% respectively. We report our single center experience with CERAB for the treatment of extensive AIOD.

Material and methods: Between February 2018 and September 2018, 12 patients (1 female) were diagnosed with intermittent claudication (8) and critical limb ischemia (4) and treated with CERAB technique. Lesion morphology was evaluated by CT angiography. All lesions were 10 TASC D and 2 TASC C lesions. Follow-up consisted of clinical assessment and duplex ultrasound at one, three, and six months follow up. Patency rates and clinically driven target lesion revascularization were calculated.

Results: Technical success was obtained in all the procedures (100%). Primary patency at 1, 3 and 6 months was 100%. No complications were reported. There was no 30-day mortality. Median hospital stay was 1 days.

Conclusion: The CERAB technique appears to be a safe and feasible alternative to open surgical reconstruction of the aortic bifurcation in complex occlusive disease. Our results are in line with what reported by latest studies in literature.

P-707

Fusion imaging reduces radiation and contrast medium exposure during endovascular revascularization of iliac steno-occlusive disease

E. Stahlberg¹, M. Sieren¹, S. Anton¹, F. Jacob¹, M. Planert², J. Barkhausen², J.P. Goltz²

¹Department of Radiology and Nuclear Medicine, University Hospital Lübeck, Lübeck, DE, ²Department of Radiology and Nuclear Medicine, University Hospital Schleswig-Holstein, Campus Lübeck, Lübeck, DE

Purpose: To evaluate feasibility, safety and efficacy of fusion imaging (FI) in order to guide endovascular revascularization of iliac steno-occlusive disease.

Material and methods: Retrospectively we identified twenty-seven patients (21 male, mean age 62±8y; Rutherford II-V) who underwent revascularization of a chronic total occlusion (n=6, 22%) or severe stenosis (n=21, 78%) of the common and/or external iliac artery. Median lesion length was 30 mm (IQR: 20-60). In one group of patients (NEW, n=12) FI with 2-D/3-D registration was used to guide revascularization. No baseline digital subtraction angiography (DSA) had been acquired in these patients. In another group of patients (OLD, n=15) no FI had been utilized and at least one DSA run had been performed to guide the procedure. In both groups final DSA of the treated lesions was performed. Number of DSA runs, radiation- and contrast-medium-exposure, technical success (residual stenosis <30%) and complications were analyzed.

Results: Median DSA runs needed in OLD for guidance were n=2 (IQR: 2-3) and in NEW n=0 (IQR: 0-0) (p=0.001). Compared to OLD median dose area product (DAP) was reduced by 17118mGy*cm² (IQR: 10407-23614) (p=0.02) if FI guidance had been used (NEW). Based on the median DAP of the final angiogram in NEW median DAP reduction was 5999mGy*cm² (IQR: 3635-14048) (p=0.07). Median total contrast medium volume injected in NEW was 45ml (IQR: 30-89) and in OLD 120ml (IQR: 100-140) (p=0.001). Technical success was 100% for both groups. In 1/27 patients (3.7%) a minor complication (embolism) occurred.

Conclusion: Fusion imaging proved to be feasible as well as safe and significantly reduces radiation- and contrast-medium-exposure during endovascular revascularization of iliac steno-occlusive disease.

P-708

Recurrent hemarthrosis of elbow joint in hemophilic patients: endovascular embolization

L. Martinetti¹, A.F. Nicolini¹, J.G.P. Acquati Lozej², S.M. Siboni³, L.P. Solimeno², E. Santagostino³

¹Interventional Radiology Unit, Fondazione IRCCS Ca' Granda Ospedale Maggiore Policlinico, Milan, IT, ²Ortopedia e Traumatologia, Fondazione IRCCS Ca' Granda Ospedale Maggiore Policlinico, Milan, IT, ³Dipartimento di Medicina - Emostasi e Trombosi, Fondazione IRCCS Ca' Granda Ospedale Maggiore Policlinico, Milan, IT

Purpose: Hemophilic patients develop a specific arthropathy related to repeated intra-articular hemorrhages starting from the hyperemic and hypertrophic synovia. We report our experience resulted from the embolization of synovial vessels through microspheres.

Material and methods: From 2015 to 2018 we have treated with embolization 4 patients (average age 31 years old, range 19-53 years) affected by severe hemophilia A, with recurrent haemarthroses of the elbows with frequency higher than 3 episodes in 6 months. The angiography showed intense hypervascularization of the synovial tissue and accelerated venous return. The embolization was performed with a 2F microcatheter (Asahi Intecc - Japan) and slow injection of microspheres of 250 and 500

micron (Embozene – Boston Scientific- Ireland) after proceeding with a hyper-selective catheterization of at least 4 vessels (range 3-5), until arresting the flow.

Results: In all cases it prevailed an important reduction of the hyper-vascularization of the synovia and a reduction of the venous return. During the follow up we appreciated a reduction of the coagulation factor assumption, a decrease of the haemarthroses number (frequency less than 3 episodes in 6 months). Two patients remained free of bleeding until today. No complications occurred.

Conclusion: The hyper-selective embolization of the articular vessels of the elbow that irrigate the hypertrophic synovia was safe and effective in reducing the frequency of haemarthroses, medication consumption (coagulation factor) and it improves quality of life for these patients. Further studies will be needed to evaluate the impact of the embolization after a long term follow-up and to understand the correct timing of intervention.

P-709

Retrospective analysis of initial results of an atherectomy and thrombectomy device in patients with acute, subacute and chronic lower limb artery occlusion

C. Wissgott

Institut für Diagnostische und Interventionelle Radiologie, Westküstenklinikum Heide, Heide, DE

Purpose: To evaluate the safety and effectiveness of the Rotarex® S atherothrombectomy device for the treatment of acute, subacute and chronic femoropopliteal artery occlusions.

Material and methods: In total 273 patients with acute (n=87), subacute (n=121) and chronic (n=65) occlusions were treated by mechanical debulking with the Rotarex® S-catheter between 2013 and 2018. All patients had occlusions of the femoropopliteal arteries. The ankle-brachial index (ABI) was determined prior to and after the intervention. An additional follow-up to establish patency at 1 month was performed using color-coded duplex sonography.

Results: The mean age of the patients was 71.2 ± 8.5 years (49-91). The mean lesion length was 15.9 ± 5.3 cm (range 4-31 cm). The technical success rate was 98.1% (268/273). In 242 patients (88.6%), adjunctive balloon dilation of the underlying lesion was performed using drug coated balloons, and 55 (20.1%) patients required additional stent implantation. Clinically, there was an increase in the ankle-brachial index from 0.49 ± 0.21 to 0.87 ± 0.14 post-intervention. No distal embolizations were observed and there was no need of additional lysis. In 3 patients (1%) a perforation occurred which could be treated by prolonged balloon inflation. There were no amputations or deaths up to 30 days post intervention

Conclusion: Atherothrombectomy of lesions in femoropopliteal arteries using the Rotarex® S - is safe and effective. The low rate of peri-interventional stenting and low rate of complications recommended Rotarex® S as a first-line treatment for debulking and vessel preparation.

P-710

Aspiration thrombectomy for acute limb ischemia: a single center experience

M. Fronda¹, M.A. Ruffino², E. Soncin¹, S. Varello¹, A. Discalzi², A. Mancini², P. Muratore², D. Rossato², D. Righi², P. Fonio¹

¹Radiology Unit, Department of Surgical Sciences, University of Turin, Turin, IT, ²Vascular Radiology, Department of Diagnostic Imaging and Radiotherapy, A.O.U. Città della Salute e della Scienza di Torino, Turin, IT

Purpose: Acute lower-extremity ischemia (ALI) is associated with high in-hospital amputation rates and 1-year mortality rates. Although catheter-directed thrombolysis (CDT) is associated with a lower morbidity rate and is as effective as surgery for stage I and IIa ALI, it takes substantial time to be effective. The Indigo system (Penumbra, Inc) is designed for aspiration thrombo-embolectomy available from 3 F to 8 F in size. The

size-matched "separator" allows the catheter to be cleared of occlusive material without catheter removal from the area of thrombus. It has a pump-driven vacuum for consistent aspiration.

We want to report our single center experience with percutaneous aspiration thrombectomy (PAT) as a first-line treatment for acute lower limb ischemia (ALI).

Material and methods: Twenty-three patients who underwent PAT for ALI from March 2017 to June 2018 were included. Primary end-point was complete thrombus aspiration with patency of the target vessel. Additional treatment for underlying stenosis or occlusion was not considered indicating technical failure, while the use of supplementary treatment for thrombus removal was considered as a technical failure.

Results: The technical success was obtained in 20/23 patients (87%); in 2 cases was required additional treatment for thrombus removal and in 1 case the PAT failed to restore patency and the patient underwent open surgical treatment. No complications related to PAD were reported.

Conclusion: PAT is a safe and effective procedure in the treatment of ALI, reducing the need for open surgical embolectomy and catheter-direct thrombolysis. Our results are in line with previous studies in literature.

P-711

Efficacy of embolization with ethylene vinyl alcohol copolymer (Onyx®) for peripheral acute hemorrhage

I. Pierre-Yves¹, F. Tradi², J.-F. Hak¹, A. Jacquier³, J.-M. Bartoli³, V. Vidal¹

¹Service de Radiologie, Hôpital Timone Adultes, Marseille, FR, ²Bouches du Rhône, Hôpital de la Timone, Marseille, FR, ³Radiologie Adulte, APHM CHU La Timone, Marseille, FR

Purpose: The goal of this study is to report the feasibility and safety of embolization with Onyx® for peripheral acute hemorrhage embolization.

Material and methods: Retrospective study of all consecutive patients who underwent visceral or peripheral embolization using Onyx® for acute bleeding in our department between January 2014 and January 2018. Demographic data, clinical presentation, etiology, target vessel, endovascular procedure, pain during embolization, outcomes and follow-up data were collected.

Results: Sixty-five patients (sex-ratio: 2.4; mean age: 59.7 ± 18.5 years) were included. Hemostatic embolization procedure was done for iatrogenic arterial lesion (n=26; 40%), arterial aneurysm rupture (n=14; 21.5%), post-traumatic hemorrhage (n=8; 12.3%), gastrointestinal bleeding (n=7; 10.8%), vascular neoplastic erosion (n=5, 7.7%) or other indications (n=5; 7.7%). Onyx-18 was used in 50 (77%) patients, Onyx-34 in 13 (20%) patients and a mixture of both in 2 (3%) patients. Onyx was used alone in 57 (88%) patients or associated with other agents in 8 (12%) patients. Mean number of Onyx® vials used was 1,6 (range, 1-4). The immediate technical success rate was 100% and primary clinical success was achieved in all patients. No recurrent bleeding, no major complications or side effects were noticed during the 1-month follow-up.

Conclusion: Embolization with Onyx® is feasible, safe and economic in peripheral acute hemorrhage regardless of the anatomic site.

P-712

Can thromboaspiration be a viable alternative to Fogarty catheter in acute lower limb ischemia?

M. Scarabello¹, P. Rigamonti², S. Gitto¹, G. Damiani², M. Femia¹, S. Squarza³, M. Tramarin⁴, U.G. Rossi⁵, M. Cariati⁶

¹Postgraduation School in Radiodiagnostics, Università degli Studi di Milano, Milan, IT, ²Radiology and Interventional Radiology, San Carlo Borromeo Hospital, Milan, IT, ³Radiologia, ASST Santi Paolo e Carlo, Milan, IT, ⁴Diagnostic-Therapeutic Advanced Technology Department – Diagnostic and Interventional Radiology Unit, ASST Santi Paolo e Carlo - San Carlo Borromeo Hospital, Milan, IT, ⁵Diagnostic Imaging Department - Interventional Radiology Unit, E.O. Galliera Hospital, Genoa, IT, ⁶Diagnostic Sciences, San Carlo Borromeo Hospital, Milan, IT

Purpose: Acute arterial thromboembolism is a potentially fatal condition, since vascular obstruction hinders tissue perfusion. Acute ischemia was traditionally treated with pharmacological therapy or surgery, yet mechanical thrombectomy with Fogarty catheter has two limitations: it is invasive and it is not able to address the cause of the thrombosis. In the last decades many attempts have been made to devise new mechanical thrombectomy techniques. The greater challenge in the development process is the need to remove an adequate amount of thrombotic material keeping the device adequately small, flexible and easy to use. The majority of the devices failed to be effective enough and suffered from unacceptable complication rates.

Material and methods: From September 2017 to December 2018 we treated 48 patients with the Penumbra Indigo System as a first-line treatment. The location of the obstruction was as follows: for 17 patients (35.4%) in the deep femoral artery, for 16 patients (33.3%) in the popliteal artery, for 9 patients (18.7%) below the level of the popliteal artery, and for 6 patients (12.5%) in the iliac axis.

Results: At the end of the procedure complete or near-complete revascularization was achieved in 41 patients (85.4%). Complete restoration of vascular flow was obtained in 34 patients (70.8%). One patient subsequently underwent surgical bypass. No complications related to the device were observed.

Conclusion: The Penumbra Indigo System is effective in revascularization of acute and subacute peripheral arterial occlusion, as a first-line therapeutic strategy or after other treatments have been attempted.

P-713

The treatment of post-PTA dissections of below-the-knee arteries using Tacks

S. Loeschner¹, F. Scheer¹, R. Andresen¹, C. Wissgott²

¹Institute of Diagnostic and Interventional Radiology/Neuroradiology, Westküstenklinikum Heide, Academic Teaching Hospital of the Universities of Kiel, Lübeck and Hamburg, Heide, DE, ²Institut für Diagnostische und Interventionelle Radiologie, Westküstenklinikum Heide, Heide, DE

Purpose: In the treatment of angioplasty dissections and the resulting re-stenosis/-occlusions are a major problem. This prospective study's goal was to evaluate the effectiveness and safety of Tack Endovascular Systems® following PTA.

Material and methods: 17 patients ageing 74 ± 9.2 years (52-85) were included. Dissections of below-the-knee arteries following PTA were treated using Tack implants. The Tack Endovascular System® consists of 4 Nitinol implants measuring 6 mm in length and is designed to adapt to different vessel sizes while maintaining a constant radial force to selectively re-attach dissective membranes. Pre-procedure the Rutherford Score showed an average of 4.13 ± 0.80 while the Ankle-Brachial-Index came to an average of 0.7 ± 0.19 (0.43-1.2). The mean length of the treated lesions was 133.8 ± 94.8 mm (10-300 mm). Clinical follow-ups 1 and 6 months post-procedure included duplex sonography and a re-assessment of the ABI.

Results: The mean degree of stenosis was $89.1 \pm 11.9\%$ with 41.2% occlusions. The immediate post-procedural success rate was 100%. Each patient

had at least one dissection with relevant impediment of hemodynamics post Balloon-PTA. The total being 18 dissections. These were successfully treated with Tacks (2.9 ± 1.5 ; 1-8). The ABI improved measuring 1.1 ± 0.11 after 1 month and 1.0 ± 0.1 after 6 months. The Rutherford scores were reduced to 0.75 ± 1.7 and 0.1 ± 0.1 . During the 6 months of observation there was no case of amputation or re-occlusion resulting in a re-intervention rate of 0%. There were two cardiovascular fatalities.

Conclusion: The treatment of dissections of below-the-knee arteries post Balloon-PTA using Tacks is a safe and effective procedure with good clinical outcome after 6 months.

P-714

Nontraumatic intra-luminal recanalization of difficult below the knee total occlusions using combination of laser ablation and wire back-end wire support in a crossing catheter

K.K. Zhang

Radiology, Thomas Jefferson Medical College, New York, NY, US

Purpose: To evaluate safety and effectiveness of an innovative technique of combining laser ablation and usage of wire-back-end support of a crossing catheter to treat below the knee total occlusion

Material and methods: Twelve patients underwent conventional antegrade crossing techniques for below the knee tibial artery CTO using weighted tip wires and crossing catheters (Abbott). All had failed. The proximal calcium cap was ablated using laser atherectomy (Ra Medical Systems). An.014" crossing catheter was then placed against the CTO with the support of wire-back-end 1mm inside and short of the crossing catheter tip. The catheter was pushed forward with firm pressure down to the ankle. Contrast was injected through the catheter to confirm intraluminal location. An.014" glide tip wire was used to complete the recanalization to the foot. This was followed by additional atherectomy and angioplasty.

Results: Twelve patients had average age of 69 (range 62-89), 5 smokers, 5 with left leg lesions; 11 are diabetic. Each patient underwent conventional contralateral access antegrade crossing techniques using weighted tip wires (Abbott) and crossing catheters (Philips); and novel techniques using laser atherectomy (Ra Medical Systems) and wire back-end approach. 11 patients were technically successful with patent target tibial vessel at the end of the procedure. 8 patients had 6 months patency based on ultrasound, 4 had reocclusion. 3 patients had extravasation during the novel technique. 0 patients had post-procedural bleeding or hematoma in the calf.

Conclusion: Combining laser ablation and wire back-end support in a crossing catheter is a safe and effective novel approach to recanalize difficult tibial CTO.

P-715

Vessel calcification as a risk factor for in-stent restenosis in complex femoropopliteal artery lesions after Zilver PTX paclitaxel-coated stenting

S. Ichihashi¹, T. Shibata², N. Fujimura³, S. Nagatomi¹, H. Yamamoto⁴, R. Kyuragi⁵, A. Adachi⁶, S. Iwakoshi¹, K. Kichikawa¹

¹Radiology, Nara Medical University, Kashihara, JP, ²Cardiovascular Surgery, Hakodate Municipal Hospital, Hakodate, JP, ³Vascular Surgery, Saiseikai Central Hospital, Minatoku, JP, ⁴IVR Center, Sumitomo Hospital, Osaka City, JP, ⁵Vascular Surgery, National Hospital Organization Kyushu Medical Center, Fukuoka, JP, ⁶Radiology, Tottori University, Faculty of Medicine, Yonago, JP

Purpose: Vessel calcification is known as a factor undermining the performance of drug coated balloons in femoropopliteal (FP) lesions. The purpose of this study was to evaluate the effect of vessel calcification on in-stent restenosis (ISR) after drug coated stent (DCS) placement.

Material and methods: Consecutive symptomatic patients with FP lesions treated using Zilver PTX DCS in six hospitals between June 2012 to March 2018 were included in this retrospective multi-center study.

Patients without duplex ultrasound (DUS) evaluation after endovascular procedures were excluded from the analysis. The primary patency was evaluated by DUS. To evaluate the vessel wall calcification, peripheral arterial calcium scoring system (PACSS) was applied. Lesions were divided either to PACSS 0/1/2 (non or unilateral wall calcification) or PACSS 3/4 (bilateral wall calcification).

Results: A total of 220 patients with 230 limbs were enrolled. The lesion characteristics included average lesion length of 16.4 ± 9.7 cm, 45.2% of total occlusions, 29.6% of ISR lesions. Bilateral vessel wall calcification (PACSS 3/4) was observed in 36.8% of the limbs. The 1,2 and 5-year primary patency were 75.9%, 63.6%, and 45.0%. In multivariable analysis, PACSS 3/4 calcification (adjusted hazard ratio, 1.718, $P = 0.036$) was significantly correlated with the occurrence of ISR, along with lesion length and cilostazol administration.

Conclusion: Our study suggested that PACSS 3/4 calcification was an independent risk factor for ISR in complex FP artery lesions after Zilver PTX DCS placement, along with lesion length and non-cilostazol administration. The role of lesion modification prior to DCS placement should be evaluated in a future.

P-716

Ultrasound-guided retrograde tibial access through chronically occluded tibial arteries

S. Yilmaz¹, N. Dincer¹, S. Deniz², L. Oguzkurt²

¹School of Medicine, Koç University, Istanbul, TR, ²Interventional Radiology, Koc University Hospital, Istanbul, TR

Purpose: Ultrasonography-guided retrograde tibiopedal access through completely occluded tibial arteries is not reported before. The aim of this study is to demonstrate feasibility of ultrasound-guided retrograde tibial access through chronically occluded tibial arteries as a bail-out endovascular recanalization procedure in patients with critical limb ischemia.

Material and methods: Fifty-one patients with critical limb ischemia failed conventional antegrade tibiopedal recanalization required retrograde tibiopedal access at the same session. In all of these patients, the target tibial artery was chronically occluded at the puncture site. Access attempts were made under real-time ultrasound by a single operator experienced in image-guided vascular access procedures. Fluoroscopy was used only as an adjunct during advancement of a 0.018 inch guide wire. If access to the artery was successful by retrograde route, the occluded artery was usually predilated with a 2 mm balloon and the standard endovascular treatment was mostly performed through antegrade route.

Results: Patients had atherosclerosis ($n=35$) or Buerger disease ($n=32$) and presented with Rutherford category IV to category V. Successful placement of a guide wire in the occluded artery lumen was achieved in 81% of patients; whereas, treatment success, i.e. angiographic demonstration of in-line flow at the end of procedure, was achieved in 49%. No significant procedure-related complications were observed. Of 33 limbs with initially successful endovascular treatment, 6 required minor and 1 required major amputation during follow-up.

Conclusion: Ultrasound-guided retrograde access through completely occluded tibial arteries is difficult but feasible. Half of the tibial arteries that could not be recanalized otherwise were converted to successful recanalization by this method.

P-717

Does duration of angioplasty balloon inflation impact result?

A. Nath¹, C. Stove¹, M. Hennessy¹, A.I. Christie²

¹Interventional Radiology, Queen Elizabeth University Hospital, Glasgow, UK, ²Radiology, Gartnavel Hospital, Glasgow, UK

Purpose: To assess if there is an impact on procedural success and longevity from duration of angioplasty balloon inflation. There is little published evidence to guide practitioners and there anecdotally appears to be wide variation in practice.

Material and methods: Initial e-mail survey of all 9 IR consultants and 1 senior trainee in a single health board. Interrogation of the CRIS database from 1st January 2018 to 30th June 2018 for index procedure. We then searched for repeat procedures, amputation and bypass on clinical record and TASC grade calculated. The IFU for the balloons were also reviewed.

Results: 100% response from the survey. Median duration is 1 min 45s (IQR 1-3). 213 procedures were identified. There were 49 repeat procedures. Of those, 3 patients had more than 2 (total = 52). Median age 68 (66-76); M:F - 2.3:1. 170 above knee and 43 below knee procedures (with 31 and 18 repeat procedures respectively). There is a significantly increased rate of repeat procedure for longer duration PTA (3 mins) ($p=0.04$ Chi²) in above knee procedures with no significant difference in lesion severity (TASC).

Conclusion: Little published evidence to guide practice. We found that duration of balloon inflation appears to influence results in terms of repeat procedures. There is heterogeneity in the data sample and surrogate markers were used. A prospective trial with patient and lesion matching may be of benefit.

P-718

Hybrid endarterectomy in common femoral artery with endovascular femoropopliteal revascularization in TASC C and D patients

J.Y. Park¹, K.M. Park², Y.S. Jeon¹, S.G. Cho¹, K.C. Hong²

¹Department of Radiology, Inha University Medical School, Incheon, KR,

²Department of Surgery, Inha University Medical School, Jung-Gu, Incheon, KR

Purpose: Hybrid common femoral artery (CFA) endarterectomy with femoropopliteal (FP) revascularization have the advantages such as avoiding mortality and morbidity. However hybrid surgery showed lower patency rates than open FP bypass. The purpose of our study was to compare the postoperative complication and clinical results between hybrid CFA endarterectomy with endovascular FP revascularization and FP bypass.

Material and methods: A total of 65 patients with FP occlusive disease involving CFA were included in this study at our hospital from January 2013 to December 2017 and retrospectively analyzed. Of these, 37 had hybrid surgery (CFA endarterectomy and FP revascularization) and 28 had open FP bypass. We examined patient's characteristics, procedural detail and follow up data. We compared to primary and secondary patency rate between hybrid and bypass group.

Results: We underwent 37 hybrid surgeries (CFA endarterectomy with PTA ($n=28$) or stent ($n=9$)) and 28 FP bypass surgeries with saphenous vein graft ($n=18$) and PTFE graft ($n=10$). There is statistically no difference in patient characteristics between two groups including popliteal involvement (Hybrid group ($n=14$) vs. bypass group ($n=11$) $p=0.55$). There was 1 technical failure in postoperative immediate occlusion in hybrid groups. Operative time of hybrid group (mean $\pm$ sd, 113 $\pm$ 24 mins) is shorter than of bypass group (mean $\pm$ sd, 166 $\pm$ 32) ($p<0.01$). The primary patency rates were 70% and 76% (Log rank = 0.742) and the secondary patency rates were 80% and 82% ($P = 0.813$) at 3 years for hybrid and surgery group, respectively.

Conclusion: Hybrid treatment provide feasible and effective management of selected patients with FP occlusive disease involving CFA.

P-719

Educating patients – improving the management of peripheral arterial disease

S. Keelan, N. Foley, D. Healy, P. Naughton, S. McHugh, D. Moneley
Vascular Surgery, Beaumont Hospital, Dublin, IE

Purpose: Supervised exercise programmes are effective as first line treatment for claudicants, however, access can be difficult for geographically remote patients and compliance is often poor. Studies have utilized smartphones to support home-based exercise (HEP) programmes. The

primary aim of this study was to assess smartphone usage in a cohort of patients as well as their understanding and basic knowledge of PAD.

Material and methods: Patients with PAD attending the vascular clinic over a 4 week period were invited to complete a validated questionnaire assessing knowledge of PAD, its risk factors, and familiarity with common technologies. Data was collated in an excel spreadsheet and exported to SPSS (v20) for statistical analysis.

Results: 50 patients (M=32, F=18) partook, with an average age of 66 years. 96% were either current or ex-smokers. Women were statistically more likely to have attained third level education ($p=0.001$). Despite attending a vascular clinic, 48% were not familiar with PAD. Most accepted cigarette smoking's correlation with PAD, though 12% did not. 60% owned a smartphone. 52% used the internet, with a female preponderance ($p=0.03$). Only 36% stated they would use an exercise app.

Conclusion: These results highlight room for improvement in patient awareness of PAD, particularly given that 1 in 10 are not aware of the correlation of PAD with smoking. Future advances in the global management of PAD patients should involve raising patient awareness e.g. through a national campaign. Additionally, better incorporation of IT training will strengthen HEP and is prudent.

P-720

Single center long-term results of endovascular treatment for critical limb ischemia: a retrospective study

D. Vrzel, J. Lučev, A. Slanič, M. Zerdin, S. Breznik
Radiology, UKC Maribor, Maribor, SI

Purpose: To evaluate the long-term treatment outcome in endovascularly treated patients for CLI at our institution

Material and methods: A retrospective analysis of 320 consecutive patients who were endovascularly treated for CLI was performed. Patients were included between the 1st of January 2013 and the 31st of March 2016. The last follow-up was on the 31st of December 2018. Possible treatment outcomes were patient death, lower limb amputation and limb preservation. Rutherford category, patient demographics and risk factors were observed. The T-test, Mann-Whitney U test, the Chi-square test, Fischer's exact test, Spearman rho test, Kaplan-Meier survival curves and log-rank test were used for statistical analysis. The statistical significance was set at 0.05.

Results: 180 lower limbs of 154 female patients and 194 lower limbs of 166 male patients were included in the study. The mean age was 78.6 years and 71.6 years for females and males, respectively ($p<0.05$). Longest observation period was 2181 days, mean 1012 days. 78 (20.8%) lower limbs had a major amputation event, 5 (1.3%) required a surgical bypass, and 291 (77.8%) were salvaged. The median survival time of limbs was 1437 days (0-2181). Altogether, 471 endovascular procedures were done. 298 (79.6%) limbs underwent only one procedure, 54 (14.4%) two procedures, and 22 (5%) three or four procedures. The survival curves showed a statistically insignificant difference ($p=0.119$) in patient mortality based on the presence of a major amputation event.

Conclusion: A high percentage of lower limbs in patients presenting with CLI can be successfully salvaged with endovascular treatment.

P-721

Endovascular treatment of critical hand ischemia: a single-center experience

D. Morosetti¹, A. D'Onofrio², S. Merolla², A. Di Martino², A. Raso², R. Gandini¹

¹Department of Diagnostic Imaging, Molecular Imaging, Interventional Radiology and Radiation Therapy, University Hospital Policlinico Tor Vergata, Rome, IT, ²Department of Diagnostic Imaging, Molecular Imaging, Interventional Radiology and Radiation Therapy, University Hospital Policlinico Tor Vergata, Rome, IT

Purpose: To clarify the role of endovascular treatment in patients with Critical Hand Ischemia of the distal upper extremities.

Material and methods: From January 2012 to January 2017, 18 dialyzed patients presented chronic critical hand ischemia; 6 patients had a chronic occlusion of the ulnar artery and radial artery stenosis, 5 patients had a chronic occlusion of the radial artery and ulnar artery stenosis, 4 patients presented multiple stenosis of the ulnar, radial and interosseous arteries, 2 patients had only ulnar artery occlusion while one patient presented only radial artery occlusion. All patients underwent duplex ultrasound and a subsequent brachial angiography, in order to evaluate the distal run-off circulation. Revascularization was achieved via antegrade brachial puncture in all patients, with retrograde approach in 4 patients, with distal retrograde puncture in 3 patients and in one patient with loop technique.

Results: No complications were observed during the periprocedural follow-up. One patient was not successfully revascularized (technical success rate: 94.4 %). The patient had no direct flow after ulnar artery angioplasty. The procedure was clinically effective in 15 patients (clinical success rate: 83.3%). Clinical evaluation and Duplex-US were performed in the follow up period. $TcpO_2$ evaluated in the perilesional skin surface increased from 20.2 ± 6.5 mmHg to 53.8 ± 13.1 mmHg in the follow up period ($P<0.01$). We observed an improvement of pain, ulcers and infection healing in all treated remaining patients during the postoperative period.

Conclusion: Percutaneous intervention prevents hand loss and functional impairment in patients with Critical Hand Ischemia and multiple comorbidities.

P-722

Day case lower limb angioplasty – how safe is it?

B. Almazedi, D. West, A. Bowker
Radiology, York Teaching Hospital NHS Foundation Trust, York, UK

Purpose: To assess the feasibility and safety of same day discharge following elective lower limb angioplasty, and to quantify their success and complication rates.

Material and methods: Retrospective analysis of medical records of elective patients treated with lower limb angioplasty at a medium-sized teaching hospital between 01/07/2016 and 30/06/2017. Our institution's standard post angioplasty care is discharge in 3 hours following puncture site haemostasis without the routine use of closure devices. The rate of successful same day discharge, in addition to, procedure success and complication rates were calculated.

Results: Cohort included 88 women and 213 men ($n = 301$) undergoing elective angioplasty with or without stenting, using access sheath size ranging from 4 to 7 French. 294 (97.7%) were successfully discharged the same day, and 7 (2.3%) were admitted overnight from complications. 11/294 (3.7%) of the same-day discharge group were re-admitted within 30 days due to procedure related complications or clinical failure. Technical success rate was 92% (556 of 606 angioplasties), 4% residual stenosis and 4% failure. Five of 301 patients (1.7%) underwent further unplanned procedure during angioplasty and 14 (4.7%) had procedural complications. No significant difference in complication rate between 4 French and larger sheath sizes (OR 1.86 [95% CI: 0.23 – 14.95], $p=0.558$). No procedure related deaths within 30 days.

Conclusion: Elective lower limb angioplasty as day case procedure is generally safe, successful and associated with low complication rate. It could significantly increase patient throughput and alleviate pressure on hospital inpatient resources as patients can be safely discharged on the day of the procedure.

P-723

Percutaneous mechanical thrombectomy in acute and subacute critical lower limb ischemia: a single center retrospective study

F. Salimei¹, D. Morosetti¹, A. Di Martino¹, A. Bozzi¹, A. Raso¹, J. Scaggiante¹, R. Gandini²

¹Department of Diagnostic Imaging, Molecular Imaging, Interventional Radiology and Radiation Therapy, University Hospital Policlinico Tor Vergata, Rome, IT, ²Diagnostic and Interventional Radiology, Policlinico Tor Vergata, Rome, IT

Purpose: The aim of this study was to evaluate technical feasibility, results and complications relative to aspiration thrombectomy for treatment of acute and subacute thrombosis of the lower limb.

Material and methods: This retrospective analysis assessed the results from procedure of percutaneous mechanical thrombectomy (PMT) in a cohort of 35 patients (aged 45-81, median 68), between March 2017 and January 2018.

Success was defined on the basis of angiographic procedure result, as complete revascularization of the embolized vessel, and clinical improvement of limb perfusion as absence of amputation surgery in the next 45 days. We then performed a 1-year follow-up evaluation of vessel patency through clinical examination and Doppler ultrasound of the lower limb.

Results: In 28 patients, we performed aspiration with a AXS Catalyst 5 catheter, in 6 patients with a 3MAX, and in only one case we opted for Vacuum Assisted Thrombectomy with the Indigo system.

Technical success was obtained in 32 patients (91%), and clinical improvement and avoidance of limb amputation was assured in all but two patients (94%).

We observed no complications during interventional procedures.

Overall vessel patency 12 months after intervention was seen in 30 patients (85%), with one needing a new hospitalization 5 months after discharge and eventual amputation. One patient died during that span, from causes unrelated to the procedure.

Conclusion: Mechanical thrombectomy constitutes a fast, safe and short-term efficient procedure in the setting of critical lower limb ischemia, resulting in lower rates of limb amputation and sensible clinical conditions improvement.

P-724

Prognostic factors of spontaneously ruptured hepatocellular carcinoma treated with transcatheter arterial chemoembolization

A. Suzuki¹, M. Tsurusaki¹, I. Numoto¹, T. Oda², Y. Yagyu¹, T. Kadoba³, N. Kashiwagi¹, K. Ishii¹

¹Radiology, Kindai University, Faculty of Medicine, Osakasayama, JP, ²Radiology, Kindai Hospital, Osakasayama, JP, ³Radiology, Tenri Yorodu Soudansho Hospital, Tenri-city, JP

Purpose: To investigate the factors that influence survival of spontaneously ruptured hepatocellular carcinoma (HCC) patients following transcatheter arterial chemoembolization (TACE).

Material and methods: We retrospectively reviewed 27 patients (21 males, 6 females, age ranged 50-97 years old) with ruptured HCC from January 2008 to December 2017 in our hospital. Survival rate was calculated using the Kaplan-Meier curves. To categorize the factor contributing to 6-month survival, we examined the age, gender, presence or absence of hepatitis C, tumor size, presence or absence of multiple lesions, presence or absence of distant metastases, presence or absence of vascular invasion, Alb (g / dl), Bil (mg / dl), PT (%), platelet count and

AFP (ng / ml). Prognostic factors were determined by multivariate Cox regression analysis.

Results: The median overall survival was 2 months (1 day -47 months) and the 6 month survival rate was 26%. In multivariate analysis AFP values (<500 vs $\geq$ 500; $p = 0.0183$, median survival: 6.5 vs 0.34 months), PT% values ($\geq$ 60% vs <60; $p = 0.018$, median survival: 6.5 vs 0.20 months) was a factor contributing to 6 months survival.

Conclusion: TACE is feasible and potentially efficacious in ruptured HCC patients, and identifies factors that may predict the prognosis of these patients.

P-725

Use of Tigris vascular stent in femoropopliteal peripheral arterial disease: long term follow-up

A. Peker¹, M.E. Krokidis², N. Shaida², N. Hilliard², A. Winterbottom³, B. Koo², T.C. See²

¹Radiology, Cambridge University Hospitals NHS Foundation Trust, Cambridge, UK, ²Department of Radiology, Addenbrooke's Hospital, Cambridge, UK, ³Radiology, Cambridge University Hospitals, Cambridge, UK

Purpose: To evaluate the efficacy and safety of the Tigris vascular stent (Gore, Flagstaff, Arizona) with emphasis on the factors that may potentially affect the patency rates at superficial femoral and popliteal arterial lesions.

Material and methods: This retrospective study included 29 patients (mean age = 72.2 ± 10.9 years) treated with Tigris stent between October 2015 and January 2016. Patients' charts were reviewed for lesion localization, length, type of revascularization, smoking status and the presence of diabetes. Patients were followed-up with clinical assessment, if necessary, Doppler ultrasonography and catheter angiography. Primary patency, assisted primary patency and secondary patency rates of the stents and factors associated with re-occlusion were evaluated with Kaplan-Meier analysis and Cox multivariable logistic regression analysis.

Results: All procedures were technically successful. The follow-up period was a median of 48 months (range: 7-70). Twelve patients were treated subintimally and 17 patients were treated intraluminally. Lesions were located in the superficial femoral ($n = 19$), popliteal ($n=3$) and femoropopliteal ($n=7$) arteries. Mean lesion length was 13.9 ± 7.6 cm. Primary patency rates at 6, 12, 18, 24 and 36 months were 96.6%, 85.7%, 81.9%, 78.2% and 74.3% respectively. Secondary patency rates at 12, 24 and 36 months were 100%, 96.3% and 92.4%; assisted primary patency rates at 12, 24 and 36 months were 100%, 92.3% and 88.3% respectively. No stent fracture was observed and any none of the variables were associated with stent re-occlusion.

Conclusion: This study demonstrated that use of Tigris vascular stent for femoropopliteal arterial disease appears to be safe and effective with good long-term follow-up results.

P-726

Japanese Interventional Radiology of femoropopliteal in-stent restenosis with Eluvia drug-eluting stent: Japanese IR ELUVIA ISR study

K. Takayama¹, S. Ichihashi², T. Sato³, H. Yamamoto⁴, K. Sugimoto⁵, T. Hasebe⁶, M. Inoue⁷, A. Adachi⁸, R. Kawasaki⁹, T. Mine¹⁰, K. Kichikawa¹¹

¹Radiology and Interventional Neuroradiology, Ishinkai Yao General Hospital, Yao, JP, ²Radiology and IVR Center, Nara Medical University, Kashihara City, JP, ³Radiology, Tsuchiya General Hospital, Hiroshima, JP, ⁴IVR Center, Sumitomo Hospital, Osaka City, JP, ⁵Radiology and Center for Endovascular Therapy, Kobe University Hospital, Kobe, JP, ⁶Department of Radiology, Tokai University Hachioji Hospital/Tokai University School of Medicine, Hachioji, Tokyo, JP, ⁷Diagnostic Radiology, Keio University School of Medicine, Tokyo, JP, ⁸Radiology, Tottori University, Faculty of Medicine, Yonago, JP, ⁹Radiology, Hyogo Brain and Heart Center at Himeji, Himeji, JP, ¹⁰Radiology, Nippon Medical School Chiba Hokusoh Hospital, Chiba, JP, ¹¹Radiology, Nara Medical University, Kashihara, JP

Purpose: In-Stent Restenosis (ISR) after femoropopliteal (FP) interventions is an increasing problem.

Although there were several reports that drug eluting stent (ZILVER-PTX) was useful for FP ISR, it has been recently reported that new Drug-Eluting Stent (Eluvia stent) was better than ZILVER-PTX for FP disease.

In February 2019, Eluvia stent became available in Japan. Therefore no published studies have examined Eluvia Drug-Eluting Stent in the treatment of FP ISR.

This study will seek to evaluate the outcomes of Eluvia stent treatment for femoropopliteal ISR.

Material and methods: Japanese IR ELUVIA ISR study is prospective multicenter study that will be enrolled 100 patients in 12 Japanese centers between March 2019 and December 2019 treated with Eluvia Drug-Eluting Stent in FP ISR.

The primary efficacy end point is primary patency at 6, 12 and 24 months, defined as freedom from clinically driven target lesion revascularization and restenosis as determined by a duplex ultrasonography-derived peak systolic velocity ratio of ≤ 2.4

Results: The preliminary result of Japanese IR ELUVIA ISR study will be shown in CIRSE 2019.

Conclusion: The preliminary result of Japanese IR ELUVIA ISR study will be shown in CIRSE 2019.

P-727

Innovative percutaneous treatment of femoral arterial pseudoaneurysms (FAP): a series of 6 patients

F.L. Gatti¹, A. Mazzaro¹, A. Contro², G. Mansueto¹

¹Radiology, Policlinico Universitario G.B. Rossi, Verona, IT, ²Institute of Radiology, Vascular and Interventional Radiology Unit, University Hospital G.B. Rossi, A.O.U.I-Verona, Verona, IT

Purpose: To investigate the efficacy of an innovative percutaneous approach in the treatment of iatrogenic Femoral Arterial Pseudoaneurysm (FAP) refractory to targeted compression and thrombin injection.

Material and methods: 6 Patients who developed pseudoaneurysm of the common femoral artery as a complication of repeated access sites for invasive cardio-vascular procedures, were included. All Patients underwent primarily to an attempt to repair with Ultrasound-guided compression and subsequently to percutaneous thrombin injection, both failed. A mini-invasive endovascular approach was chosen to prevent open surgical repair. First a contralateral percutaneous access was performed to ensure a way to control possible bleeding. Under US-guidance the FAP was punctured with a 18G needle. A 0.035-inch angled hydrophilic wire was passed through the lesion into the artery lumen, followed by a 10-cm-long Angiographic Introducer. The Vascular Closure Device was positioned across the FAP and the breach repaired. The subsequent

angiography, performed by the contralateral access, demonstrated success or failure of the procedure.

Results: In 6/6 Patients the procedure had been performed without major complications (haemorrhage or thrombosis). In 1/6 case the treatment failed due to the excessive calcific arterial disease of the injured arterial wall. In 5/6 Patients the treatment had been successful and the 2-weeks US Follow-up demonstrated complete exclusion of the FAP.

Conclusion: Percutaneous treatment of FAP with Vascular Closure Device is safe and effective and should be considered as alternative to open surgery in case of failure of targeted compression and thrombin injection.

P-728

Zilver PTX global data analysis from five studies and nearly 2400 patients highlights DES benefits in challenging patient populations

M.D. Dake

Falk Cardiovascular Research Center, Stanford University School of Medicine, Stanford, CA, US

Purpose: A pooled analysis combined all available data from five global studies of the Zilver PTX drug-eluting stent (DES). Patient and lesion factors impacting freedom from target lesion revascularization (TLR) were evaluated.

Material and methods: Kaplan-Meier analyses were performed with all available data through 5 years. A Classification Tree analysis was used to rank patient and lesion factors for their impact on TLR. Factors were then evaluated using a Cox Proportional Hazards Ratio model. Clinically driven TLR was defined in all studies as reintervention performed for $\geq 50\%$ diameter stenosis after recurrent clinical symptoms.

Results: Nearly 2400 patients were included in the analysis. There was a high incidence of diabetes (49%), average lesion length was 11.1 ± 8.7 cm, 36% of lesions were totally occluded, and 13% of lesions were treated for in-stent restenosis (ISR). From this pooled analysis, the DES had a 1-year rate of freedom from TLR of 91%. The Classification Tree analysis revealed that ISR, long (>15 cm) lesions, reference vessel diameter (RVD), and total occlusions were the factors with the most impact on TLR. The Cox model revealed that ISR ($p < 0.001$) and total occlusions ($p < 0.001$) were significant factors impacting freedom from TLR through 1 year. Furthermore, sex, calcification, and diabetes had no significant impact on TLR.

Conclusion: This global analysis of the Zilver PTX DES is the largest dataset reporting 5-year results for endovascular intervention of the superficial femoral artery. The impact of these patient and lesion factors on outcomes can help inform optimal patient selection and treatment algorithms.

P-729

Distal radial artery access using slender technique for superficial femoral artery intervention

Z. Ruzsa¹, B. Nemes², E.M. Végh³, V.I. Óriás², K. Hutt¹

¹Cardiac and Vascular Center, Semmelweis University, Budapest, HU,

²Heart and Vascular Center, Semmelweis University, Budapest, HU,

³Vascular Surgery, Semmelweis University, Budapest, HU

Purpose: The purpose of this pilot study was to evaluate the acute success and complication rate of the distal radial artery access for femoral artery intervention.

Material and methods: The clinical and angiographic data of 195 consecutive cases with symptomatic superficial femoral stenosis, treated via distal radial (DR) or proximal radial (PR) access using 6F sheathless guiding between 2014 and 2018, were evaluated in a pilot study. Secondary access was achieved through the pedal artery.

Results: Overall technical success was achieved in 186 patients (95.4%) with 25/26 (96.1%) success in DR and 161/169 (95.2%) success in PR group (ns). The cross over rate to femoral access site was 3.8 % in DR and 4.7 % in PR group (ns), while dual (transradial and transpedal) access was used in 9/26 (34.6%) patients in DR and 39/169 (23%) patients in PR

group ($p < 0.05$). The mean contrast consumption, fluoroscopy time and procedure time was in the DR and PR group was: 93.4 [78-108]ml vs 120 [108-131]ml, 662 [501-822]vs 769 [671-866]min, and 33.4 [27-39]vs 36.5 [32-40]min (ns), respectively. The rate of access site complications in the DR and PR group was 0% and 4.7% (0% major, 4.7% minor) ($p < 0.001$), respectively. The cumulative incidence of MAE at 3 months in the DR and PR group was 3.8 % vs 10.6%. ($p < 0.05$)

Conclusion: Femoral artery intervention can be safely and effectively performed using proximal and distal radial access with an acceptable morbidity and a high technical success rate, but the distal radial access is associated with very low vascular complication rate.

P-730

First-in-man efficacy and safety study to evaluate Ranger drug-eluting balloon for treatment of below the knee lesions in patients with critical limb ischemia: 12 months outcomes of the Ranger BTK registry

C. Del Giudice¹, C. Tiercelin², A. Galloula³, E. Messas⁴, C. Déan¹, E. Larger²

¹Vascular and Oncological Interventional Radiology, Hôpital Européen Georges Pompidou, Université Paris Descartes, Paris, FR, ²Diabetic Foot Care Unit, Hôpital Cochin, APHP, INSERM U1016, Université Paris Descartes, Paris, FR, ³Vascular Medicine, Hôpital Européen Georges Pompidou, Université Paris Descartes, Paris, FR, ⁴Cardiology, Hôpital Européen Georges-Pompidou, Paris, FR

Purpose: To evaluate the safety and efficacy of Ranger BTK (Boston Scientific) drug eluting balloon (DEB) to treat below the knee (BTK) lesions in patients with critical limb ischemia (CLI).

Material and methods: November 2016 and November 2017, 30 consecutive patients (mean 68.8±12.7 years, 6 female) with BTK lesions and CLI were included in this single center, prospective non randomized study. The primary safety endpoint was a composite of all-cause mortality and major amputation at 6 months follow-up (6mFU). The primary efficacy endpoint was the primary angiographic patency at 6 months follow-up assessed by an independent corelab. Immediate technical success, Late lumen loss (LLL), target lesion revascularization (TLR) and ulcer healing rates at 12mFU were also evaluated.

Results: Immediate technical success was 96.7% (29/30): 1 patient had an acute thrombosis at the end of index procedure. Primary safety outcome was 93.3% (28/30): 2 patient underwent major amputation and 2 patient died of others comorbidities at 2 months FU. Angiographic FU was done in 20 patients. Primary angiographic patency was 57.1% (12/21) and LLL was 0.99±0.68 at 6mFU. TLR was 7.1% (2/28) at 12mFU. The rate of ulcer healing was 75% (22/26).

Conclusion: Ranger BTK balloon was demonstrated to be safe and effective to treat BTK lesions in CLI.

P-731

A new method and devices to cross peripheral chronic total occlusions

R. Gandini¹, C. Del Giudice²

¹Diagnostic and Interventional Radiology, Policlinico Tor Vergata, Rome, IT, ²Vascular and Oncological Interventional Radiology, Hôpital Européen Georges Pompidou, Université Paris Descartes, Paris, FR

Purpose: The purpose of this study was to evaluate safety and efficacy of a new balloon catheter with two guidewire lumens to recanalize peripheral CTO.

Material and methods: After unsuccessful CTO luminal and subintimal re-entry crossing using conventional methods, a guidewire was placed subintimal and distal to the CTO (first guidewire). A balloon catheter was introduced over the first guidewire and positioned in subintimal space over the distal CTO cap. The balloon catheter was then inflated and deflated to create a transient fenestration between subintimal space

and the true lumen. A second guidewire was introduced into the second guidewire lumen within the balloon catheter and navigated through the fenestration to re-enter into the distal true lumen. Then, the balloon catheter and the first guidewire were removed and intervention was continued using the second guidewire positioned in the true lumen.

Results: Between May 2018 and December 2018, we used the balloon catheter with two guidewire lumens in 12 patients (Mean age 75.5 ± 5.7). All patients had critical limb ischemia and Rutherford scale scores from 4 to 6. Five patients had infrainguinal CTO and seven patients had CTO below the knee. The mean infrainguinal CTO length was 157 mm ± 53mm and mean CTO length below the knee was 121 mm ± 32mm. No vessel perforation or dissection were observed. Technical success was achieved in all 12 patients.

Conclusion: Subintimal calcific CTO recanalization using a balloon catheter with two guidewire lumens for re-entry in the true lumen has proven to significantly decrease procedure time, is safe and efficient.

P-732

Drug-eluting stents vs interwoven nitinol stents in the femoro-popliteal segment: 2 year propensity matched analysis based on plaque characteristics

B. Corbo¹, A.K. Gupta¹, A. Saratzis², N. Rudarakanchana², G. Gradinariu², K.N. Katsanos³, H. Zayed², A. Diamantopoulos¹

¹Interventional Radiology, Guy's and St. Thomas' Hospitals NHS Foundation Trust, London, UK, ²Vascular Surgery, Guy's and St. Thomas' Hospitals NHS Foundation Trust, London, UK, ³Interventional Radiology, Patras University Hospital, Patras, GR

Purpose: Biomimetic nitinol stents (Supera Peripheral Stent – SPS) and Drug Eluting Stents (DES) were introduced to improve the patency of Femoro-Popliteal segment (F-P) endovascular treatment. We present a comparative performance study of the above while taking atherosclerotic plaque-characteristics into consideration.

Material and methods: From a prospectively database, we identified 296 consecutive patients (mean age: 73 years, SD: 11 years, 65% male, 68% with critical limb ischaemia) that were treated using either SPS or DES during a 5-year period. Patient demographics and plaque characteristics, including plaque characterisation were collected. From these 121 case-matched pairs were produced using a propensity score which was based on patient and plaque data.

Results: Median follow-up was 24-months. Target Lesion Restenosis (TLR) >50% was noted in 28% of the cohort (32% SPS vs. 24% DES, $p = 0.07$). Amongst the 121 case-matched patients, there was not significantly trend to develop TLR >50% for those with SPS vs. DES (31% vs. 27%, $p = 0.34$), have a major amputation (10% vs. 6%, $p = 0.16$), require reintervention (14% vs. 9%, $p = 0.12$), or die (7% vs. 4%, $p = 0.31$). Plaque calcification did not predict restenosis or occlusion in either stent group. Multivariate analysis adjusted for patient and plaque characteristics revealed that the main predictors of restenosis >50% at 2 years were: previous F-P occlusion (OR: 1.35, $p = 0.04$), hypertension (OR: 2.10, $p = 0.04$) and female sex [Odds Ratio (OR): 2.05, $p = 0.01$].

Conclusion: Medium term results following F-P endovascular treatment with either SPS or DES are comparable, regardless of plaque calcification.

P-733

EFFPAC-RCT: effectiveness of luminor DCB versus POBA in the SFA. 24-month outcomes presented for the first time.

U. Teichgräber¹, M. Enrich²

¹Radiology, University Hospital Jena, Jena, DE, ²Marketing, IVASCULAR, SLU, Sant Vicenç Dels Horts, ES

Purpose: The multicenter randomized-controlled EffPac trial evaluates the safety and efficacy of the Luminor Paclitaxel-coated drug-eluting balloon (DEB) catheter produced by iVascular, S.L.U., Barcelona, Spain

compared to several uncoated plain old angioplasty balloon (POBA) catheters in inhibiting restenosis and in ensuring long-term patency.

Material and methods: All analyses of primary and secondary endpoints followed the intention-to-treat (ITT) principle and were performed for all participants based on the group to which they were randomly allocated. The primary endpoint was analysed by a linear mixed model with fixed effect of the treatment and random center effects. Kaplan Meier curves estimated the secondary endpoints mortality, minor and major amputations. The survival curves of the treatment groups are compared by the log-rank test.

Results: The late lumen loss showed in the POBA-group a recurrence of stenosis of 1.06 and in the Luminor-group 0.14 [CI: -0.38; 0.67]. This results in a difference of -0.92 with a p-value <0.001. At 12 months, the patency rate showed in the POBA-group 65.3 (47/72) and in the Luminor-group 90.3 (65/72) leading to a relative risk of 1.38 and a number to treat of 4. The 24-month outcomes are going to be presented for the first time at CIRSE 2019.

Conclusion: In summary, the Luminor Paclitaxel-coated balloon catheter demonstrates to be clinical highly effective and safe in inhibiting restenosis compared to POBA. The innovative coating technique matters and is shown not only in the patency, LLL and TLR data, but also in an improvement of the Rutherford stage.

P-734

Guidewire perforation and compartment syndrome after lower extremity angioplasty

K. Ganesan¹, P. Kumar², J.S.H. Tan², J.M.E. Chua², S. Chandramohan², E.T.C. Choke³, J.C.C. Wang³, K.-H. Tay²

¹Medical School, University of Sheffield, Sheffield, UK, ²Vascular and Interventional Radiology, Singapore General Hospital, Singapore, SG,

³Vascular Surgery, Singapore General Hospital, Singapore, SG

Learning objectives: Iatrogenic acute compartment syndrome from guidewire perforations are being increasingly observed due to the greater complexity of below-the-knee revascularisation procedures. Early recognition and management are crucial to prevent further ischaemic insult to hypoxaemic tissues.

Background: Chronic total occlusion remains one of the most challenging lesions to treat despite continuing developments in medical devices and increasing operator experience. Guidewire perforation complications are observed with increasing frequency. The 'endovascular-first' approach towards treating patients with critical limb ischaemia and availability of newer technologies have allowed operators to push the boundaries to achieve technical success in revascularisation procedures. In patients with critical limb ischaemia, a more aggressive approach towards treating chronic total occlusions may be justified. However, with more aggressive approaches comes risks of complications such as acute compartment syndrome secondary to perforations.

Clinical Findings/Procedure Details: We present three cases of this potentially limb-threatening complication of endovascular revascularisation. All three cases presented with symptoms of acute compartment syndrome soon after attempted endovascular recanalization of chronic total occlusions and required urgent fasciotomy. An overview of acute compartment syndrome, specifically in relation to contrast extravasation, is presented.

Conclusion: As the complexity of below-the-knee recanalization techniques evolve, it is important for less experienced operators to be cognizant of the potential devastating complications of guidewire perforation. Early recognition and rapid institution of appropriate treatment strategies are essential to prevent potentially catastrophic sequelae.

P-735

Vascular inflammation as a global burden - what the interventionalist needs to know

M.C. Gissler

Faculty of Medicine, University of Freiburg, Freiburg Im Breisgau, DE

Learning objectives:

1. To review the pathophysiology of atherosclerosis, the underlying cause for peripheral artery disease, ischemic stroke and myocardial infarction.
2. To provide insights into recent experimental and clinical studies with possible implications for the interventionalists daily practice.
3. To discuss global health perspectives and promising strategies for the future.

Background: Atherosclerosis is the underlying chronic inflammatory disease responsible for the majority of cardiovascular conditions worldwide and the leading cause for admissions to endovascular procedures by interventional radiologists/neuroradiologists, vascular surgeons, and interventional cardiologists/cardiologists. Thus, a basic understanding of the modern concept of vascular inflammation is highly appreciable for any individual involved in the treatment of its complications.

Clinical Findings/Procedure Details: This exhibits aims to provide concise biological insights that may be useful for understanding and shaping future therapeutic approaches in vascular inflammation. In this context, current literature, further research opportunities as well as possible applications for anti-inflammatory and/or anti-hypertensive agents that may allow to locally modulate atherogenic processes and outcomes of endovascular therapy are reviewed and reflected upon. Finally, the topic is addressed from a global health perspective with respect to the expected rise of cardiovascular disease in large numbers of the global population, underlining the importance of constantly refining cardiovascular interventional treatment modalities.

Conclusion: Identification and adequate treatment of complications arising from vascular inflammation is crucial to reduce global morbidity and mortality. Recent advances in understanding the underlying pathology bear promising opportunities for the future development of successful therapeutic strategies.

P-736

Clinical aspects of persistent sciatic artery: report of a case and a review of the literature

M.R. Umutlu¹, Y. Onal², E. Canipek¹, B. Acunas¹

¹Radiology, Istanbul Medical Faculty, Istanbul, TR, ²Radiology, FSM Teaching and Research Hospital, Istanbul, TR

Learning objectives:

1. To provide a comprehensive review of the persistent sciatic artery.
2. To describe incidence of complications including aneurysm formation and ischemia that may lead to amputation.

Background: Persistent sciatic artery is rare vascular anomaly representing the persistence of the sciatic artery in adult life that is responsible for the major blood supply to the lower limb in early embryologic development. Such persistence may be bilateral and can remain asymptomatic. However, aneurysmal degeneration which may cause critical limb ischemia resulting from thrombosis or embolization can be seen.

Clinical Findings/Procedure Details: We present a case of a rare presentation of bilateral persistent sciatic artery (PSA) who sustained a car accident with a favorable outcome.

Conclusion: PSA is a rare congenital vascular anomaly that represents with various clinical features. Management strategies can be planned according to symptoms, aneurysmal changes and anatomical features of the PSA.

P-737**Successful endovascular treatment of acute blunt brachial artery injury secondary to humeral fracture - a case report****H. Muranishi, Y. Komura***Cardiovascular and Interventional Radiology, Taijukai General Hospital Kaisei Hospital, Sakaide-City, Kagawa, JP*

Clinical History/Pre-treatment Imaging: A previously healthy 27-year-old man was transferred to our hospital after a fall accident during his work. On examination, he had a left compound distal humeral fracture with severe swelling and decreased radial pulse. An urgent orthopaedic surgery, including release of the entrapped artery, was performed, after which the vascular team was alerted because of sustained pain and paraesthesia in his palm. CT angiogram and colour Doppler ultrasonography revealed no flow in the left distal brachial artery and a filling of radial and ulnar artery via collaterals.

Treatment Options/Results: Traditional surgical repair was considered to have higher risks of infection in this case because of the compound fracture with severe swelling. Therefore, balloon angioplasty with prolonged pressure inflation after transcatheter thrombectomy, and the application of a distal protection filter device were successfully performed. This procedure and the post-operative anticoagulant therapy improved his symptoms gradually to nearly normal. He had an excellent clinical outcome and a normal duplex examination at 1-year follow-up.

Discussion: The gold standard approach to acute blunt brachial artery injury has been traditional surgical management. However, recent studies suggest that endovascular treatment of trauma-related injuries to peripheral arteries might be effective and reasonable. To our knowledge, there is limited literature regarding the endovascular management of acute blunt brachial artery injury. The findings of our case suggest the efficacy and safety of endovascular treatment of acute blunt brachial artery injury.

Take-home points: Percutaneous endovascular treatment of acute blunt brachial artery injury could be a less-invasive alternative to surgical repair.

P-738**Huge pelvic arteriovenous malformation successfully treated by retrograde transvenous embolization****A. Ugajin, H. Nakamura, Y. Koyashiki, N. Kunitomo, Y. Kawahara, T. Sasaki, S. Kijima, H. Sugimoto***Department of Radiology, Jichi Medical University Hospital, Shimotuke-shi, Tochigi, JP*

Clinical History/Pre-treatment Imaging: A 59-year-old woman presented with gross hematuria. She had been diagnosed with pelvic arteriovenous malformation (AVM) and she had undergone transarterial embolization 5 years before. Contrast-enhanced computed tomography showed a huge hypervascular lesion in the left retroperitoneum and the pelvis surrounding the urinary bladder, suggesting residual AVM. Diagnostic angiography showed the lesion with numerous meandering feeding arteries arising from the bilateral internal and external iliac arteries and the inferior mesenteric artery. The feeding arteries were draining into the dilated left ovarian vein and the dilated left internal iliac vein through a large single venous pouch.

Treatment Options/Results: Treatment was performed by retrograde transvenous embolization with coils, vascular plug, and n-butyl-2-cyanoacrylate for the drainage veins and the venous pouch under outflow occlusion using balloon catheters. Subsequent angiography confirmed complete disappearance of early venous drainage. There were no further episodes of hematuria, and no significant complications were observed.

Discussion: The management of pelvic AVMs has been a difficult problem especially for huge lesions with high volume flow. There is no consensus on a standardized strategy for endovascular treatment of these lesions. Relatively high clinical and radiological recurrences have been observed after transarterial embolization alone using various embolic materials.

Therefore, multiple embolization procedures are often required for the treatment of patients with pelvic AVMs.

Take-home points: For embolization of huge pelvic AVMs with multiple feeding arteries and a single venous pouch, retrograde transvenous embolization with coils, vascular plug, and n-butyl-2-cyanoacrylate for the drainage veins and the venous pouch under outflow occlusion using balloon catheters may be a useful option.

P-739**Endovascular treatment of concomitant popliteal arterial pseudoaneurysm and occlusion in Behcet's disease****J.S. Shin***Radiology, Hallym University Dongtan Sacred Heart Hospital, Seoul, KR*

Clinical History/Pre-treatment Imaging: A 50-year-old man complained of a palpable left popliteal mass from 1 month previously, and intermittent claudication in right leg from 18 months ago. Physical examination revealed a painful, pulsatile mass on the left popliteal fossa.

He was diagnosed with Behcet's disease (BD) 3 years ago. Computed tomography (CT) angiography demonstrated a 6.5x5.0cm sized left popliteal pseudoaneurysm with partial thrombus and about 13cm long occlusion of right popliteal artery.

Treatment Options/Results: Angiography of left lower extremity showed a large pseudoaneurysm arising from the posterolateral aspect of proximal popliteal artery. The stent-graft (6x100mm; Viabahn) was deployed, and post balloon dilatation for fixation was performed. Then blood clot within aneurysm sac was aspirated using 18G needle under ultrasound-guidance. Angiography of right lower extremity showed about 13cm long total occlusion of popliteal artery. The wire was intraluminally across the lesion. The recanalized popliteal artery was dilated with a 5x120mm sized balloon catheter and the stent-graft (5x150mm; Viabahn) was deployed. 24 months follow-up CT angiography showed that each stent remained patent with no significant stenosis or recurrent aneurysm.

Discussion: BD with arterial pseudoaneurysm and occlusion is not common, but may lead to fatal rupture or infarction and weakness of extremities. Although graft-stent placement across the knee joint would present with a higher risk of breakage and subsequent occlusion, bilateral arterial lesions in our patient were successfully treated and have shown good results in the 24 months follow up.

Take-home points: Our case suggests that endovascular stent-grafts for both arterial occlusion and pseudoaneurysm of popliteal artery are also feasible in the setting of BD.

P-740**Percutaneous treatment of a subclavian artery pseudo-aneurysm****A. Andreone, U. Russo, G. Capurri, E. Epifani, I. Paladini, C. Marcato, P. Piazza***Radiologia Interventistica, Azienda Ospedaliero-Universitaria di Parma, Parma, IT*

Clinical History/Pre-treatment Imaging: 47 y.o. male patient with i.v. drug abuse history, HIV+ and HCV+, presented at E.R. for intense right upper limb pain and swelling, with neurological deficit (paresis). Angio-CT revealed a subclavian artery pseudo-aneurysm due to accidental arterial puncture.

Treatment Options/Results: Brachiocephalic trunk catheterisation was performed from bilateral groin access (12F on the right, 5F on the left) and subsequent DSA showed a large subclavian artery lesion (6 x 5 cm) immediately after vertebral artery origin.

Options were:

- covered stent;
- pseudoaneurysm coil embolization ("sandwich technique");
- surgical approach.

Through right introducer sheath we gained axillary artery lumen with an hydrophilic guidewire, then exchanged with a rigid PTFE covered 260

cm long guidewire (Rosen, Cook Medical); subsequently a 11 x 100 mm stent-graft (Viabahn, Gore) was positioned across the vascular lesion and released, preserving vertebral artery (RVA) from stenting. Final angiogram showed correct pseudo-aneurysm exclusion with preserved axillary artery vascularization.

Discussion: Subclavian artery damages are rare and challenging lesions for surgery, due to difficult surgical approach and high morbidity and mortality.

Endovascular treatment is a valid and less invasive alternative to surgical repair in these injuries.

Take-home points: Self-expandable covered stents represent gold standard endovascular therapy, due to complete vessel lumen restoration. When stenting is not possible or feasible, coiling of the vessel distal and proximal to the lesion stops the bleeding and leads to a less emergent surgery.

P-741

Successful endovascular management of acute isolated external iliac artery dissection secondary to blunt pelvic trauma - a case report

H. Muranishi, Y. Komura

Cardiovascular and Interventional Radiology, Taijukai General Hospital Kaisei Hospital, Sakaide-City, Kagawa, JP

Clinical History/Pre-treatment Imaging: A 49-year-old man was transferred after being crushed by a concrete platform while he was working. He showed hemodynamic stability, ecchymosis, and swelling on his right groin and negative results for focused assessment with sonography for trauma examination. Findings of contrast-enhanced computed tomography revealed a pelvic fracture, a small pelvic hematoma without active extravasation, no flow on the right external iliac artery (EIA) with reconstitution at the common femoral artery, and non-flow limiting dissection on the left EIA.

Treatment Options/Results: Treatment options include conservative management, open surgical revascularization, and endovascular treatment. In this case, the left EIA was treated conservatively, and the right EIA was successfully treated by endovascular repair with placement of a self-expanding stent after the use of an intravascular ultrasound, which showed flow-limiting dissection. He had an uneventful postoperative course and has been free of clinical symptoms at his 3-year clinical follow-up.

Discussion: Isolated EIA dissection associated with pelvic fracture is extremely rare. Therefore, the therapeutic approach still remains controversial. Open surgical revascularization, which has been the established treatment, has several potential risks. On the other hand, endovascular repair might provide a less-invasive alternative treatment option in appropriate cases. To our knowledge, there is limited literature regarding endovascular management in this setting. The findings of our case suggested the long-term efficacy and safety of endovascular treatment for acute isolated EIA dissection in the setting of blunt pelvic trauma.

Take-home points: Endovascular repair of acute isolated EIA dissection secondary to blunt pelvic trauma would be a safe and viable treatment option.

P-742

Endovascular treatment of peroneal artery aneurysm

M. Zertalis, N. Mustaq, K. Randhawa

Radiology, Russells Hall Hospital, Dudley, UK

Clinical History/Pre-treatment Imaging: A 71 year old patient presented acutely with a swollen left ankle. Past medical history included anti-synthase antibody syndrome and pulmonary emboli. Ultrasonography demonstrated a below knee DVT. Incidentally, a 1.7 cm aneurysm of the peroneal artery measuring 3 cm in length was identified confirmed with subsequent CT Angiography.

Treatment Options/Results: An endovascular approach was considered given her multiple co-morbidities and high risk for general anaesthetic. Two 3.0 x 26 mm Biotronic PK Papyrus coronary covered stents were deployed over a 0.018 wire with subsequent 3 mm balloon angioplasty (Figure1, 2). There was a good result with slow filling of the aneurysmal sac likely arising from the bridging segments. There were no complications and the patient was discharged the next day. Factor Xa inhibitor and clopidogrel on a long-term basis was prescribed. Follow-up at 9 months demonstrated a patent stent and resolution of the small endoleak.

Discussion: There is no consensus for the indications of peroneal artery aneurysm management, neither enough evidence to suggest a preference of surgical over endovascular approach. Endovascular treatment offers a quicker recovery time and negates the need for general anaesthesia. Where bridging stents are used, the distal stent should be deployed first to minimise the risk of endoleak. Due to the rare nature of these cases it is important that treatment is discussed within a multi-disciplinary setting.

Take-home points: Endovascular peroneal artery aneurysm repair should be considered in high risk patients.

Where bridging stents are used, distal stent should be deployed first to reduce the risk of endoleak.

P-743

Flow diverter stent in visceral aneurysm

S. Tollot, R.A. Pozzi Mucelli, F. Pozzi-Mucelli, G. Soppelsa, J. De Groodt, M.A. Cova

SC (UCO) Radiologia Diagnostica ed Interventistica, ASUITs, Azienda Ospedaliero-Universitaria Ospedali di Trieste, Trieste, IT

Clinical History/Pre-treatment Imaging: Case 1: 75 yo male performed CT screening of pulmonary hypertension. The slices acquired on the abdomen showed a multi-lobulated formation of the common hepatic artery. Therefore the exam was completed with a CT-angiography of the abdomen. The scan demonstrated the presence of a fusiform aneurysm, with transverse diameters of 44 x 93 mm, with eccentric thrombotic deposit. Case 2: 62 yo female arrived at the Emergency department with abdominal pain. Ultrasound showed a round anechoic formation with Color-Doppler signal, which CT-angiography confirmed to be an aneurysm of the pancreaticoduodenal arcade of 3 cm of maximum diameter.

Treatment Options/Results: Both lesions were treated with an endovascular approach, with the positioning of flow-diverter stents (FDS, Surpass Streamline-Stryker); for Case 1 three FDS were deployed, while one FDS for Case 2; CT follow-up after one month showed complete exclusion of the aneurysm with regular patency of the FDS.

Discussion: FDS was developed for the treatment of intracranial aneurysms. For visceral aneurysms it is still an off-label application, however FDS could represent an option for their treatment when the necessity to maintain distal flow occurs or when the extreme tortuosity of aneurysmatic arteries does not allow the deployment of conventional stent-grafts. Considering the high costs and the off-label use of FDS in extra-cranial vessels, an accurate selection of these cases is mandatory.

Take-home points: FDS for treatment of visceral aneurysms is indicated: -when patency of distal arteries must be maintained -in cases with extreme visceral arteries tortuosity

P-744

The case of successful hybrid revascularization in patient with the critical limb ischemia after multiply aortobifemoral bypass thrombosis and the absence of outflow

A. Kharazov¹, V. Luchkin², N. Basirova³, S. Lisin², O. Osmanov², V. Kulbak¹, A. Kaliaev⁴, A. Maslov¹

¹Vascular Surgery, National Medical Research Center of surgery named after A.V. Vishnevsky, Moscow, RU, ²Vascular Center, Doldoprudny Central State Hospital, Doldoprudny, RU, ³Faculty of Vascular Surgery, Russian Academy of Postgraduation Education, Moscow, RU, ⁴Department of Radiology, Boston Medical Center, Boston, MA, US

Clinical History/Pre-treatment Imaging: We present the case of successful treatment of a 63 years old patient with CLI, who had history of aortobifemoral bypass (ABF) branch thrombosis with the absence of distal arterial outflow - totally occluded superficial and profunda femoris arteries with only patient anterior tibial artery.

Treatment Options/Results: We performed the mechanical retrograde recanalization and balloon angioplasty of the left anterior tibial artery, popliteal artery and superficial femoral arteries. The superficial femoral artery was recanalized subintimally. After successful thrombectomy from the occluded ABF branch the PTFE graft was anastomosed with the subintimal lumen of the left superficial femoral artery with fixation of detached intima to the walls of the anastomosis and blood flow to the affected limb was restored

Discussion: Patients with thrombosis of the aorta-femoral bypasses are special population, because often the reason of the thrombosis of the graft branch is the poor runoff due to arteries occlusion (most often the deep femoral artery). We have not found data published in existing literature regarding similar procedures been performed as compared to those we have done. The most interesting aspect is the concept of restoring blood flow in the extremity in virtue of recanalization of the superficial femoral artery with occlusion of the deep femoral artery and the formation of the distal anastomosis of the branch of the aortobifemoral graft with subintimal lumen of the superficial femoral artery.

Take-home points: The conception of retrograde limb arteries recanalization and formation of ABF distal anastomosis to recanalized artery expands the possibilities of limb redo surgery in the absence of outflow.

P-745

Covered endovascular reconstruction of aortic bifurcation (CERAB-technique) in a case of a blister of the infrarenal abdominal aorta

E. Soncin¹, M.A. Ruffino², S. Varello¹, M. Fronda¹, L. Gibello³, G. Varetto³, D. Righi², P. Fonio¹

¹Radiology Unit, Department of Surgical Sciences, University of Turin, Turin, IT, ²Vascular Radiology, Department of Diagnostic Imaging and Radiotherapy, A.O.U. Città della Salute e della Scienza di Torino, Turin, IT, ³Vascular Surgery Unit, Department of Surgical Sciences, A.O.U. Città della Salute e della Scienza di Torino, Turin, IT

Clinical History/Pre-treatment Imaging: We report a case of covered endovascular reconstruction of aortic bifurcation (CERAB) to exclude a blister if the infrarenal abdominal aorta (AA) in a patient with small native arteries.

A 61-year-old female patient referred to our hospital after an incidental duplex ultrasound (US) finding of a blister of the infrarenal AA. Computed tomography angiography (CTA) confirmed the lesion, located at 7mm above the aortic carrefour. The aortic diameter was 14.2mm, right common iliac artery 11.4mm, and contralateral common iliac artery 11.6mm.

Treatment Options/Results: Due to anatomical characteristics, since in our Hospital the smallest available device for abdominal aortic aneurysm is 20 mm, with consequent high risk of device infolding, we performed an endovascular repair of the lesion with CERAB-technique.

Access: RCFA 12-F sheath, LCFA 7-F sheath. A 16mmX38mm BeGraft Aortic stentgraft (Bentley) above the aortic bifurcation, a 12mmX49mm as right iliac limb and a 10mmX57mm BeGraft Peripheral as a left limb were positioned.

Angiography confirmed the exclusion of the lesion.

1-month CTA evidenced stentgrafts patency without endoleaks and complete exclusion of the lesion.

Discussion: CERAB is safe and feasible in extensive aortoiliac occlusive disease.

It might represent a reliable endovascular technique to exclude aneurysmatic aortic lesion in elective procedure when no other devices can be implanted, as for patients with small aortic diameter.

Take-home points: CERAB technology offers promising results in obstructive aorto-iliac disease.

In selected cases of aortic aneurysms, the CERAB-technique represents a reliable "custom-made" alternative to the other dedicated devices on the market.

P-746

Percutaneous trans-gluteal embolization of an internal iliac aneurysm in a case of occlude iliac branched endoprosthesis (IBE)

M. Fronda¹, M.A. Ruffino², S. Varello¹, E. Soncin¹, A. Discalzi², D. Righi², P. Fonio¹

¹Department of Surgical Sciences, Università degli Studi di Torino, Turin, IT, ²Vascular Radiology, AOU Città della Salute e della Scienza - San Giovanni Battista Hospital, Turin, IT

Clinical History/Pre-treatment Imaging: A 79-year-old male, asymptomatic, with occluded left IBE and right-to-left crossover femoral-to-femoral bypass, came to our attention for a left IIA aneurysm (66 x 72 mm). The aneurysmal sac was perfused by the superior gluteal artery (SGA), recanalized by contralateral gluteal branches.

Treatment Options/Results: Embolization of the lesion was decided considering its diameter. Since the iliac axis was occluded, both retrograde and antegrade approaches were technically unfeasible. Therefore, we performed the embolization through a direct puncture of the left SGA. Under local anesthesia, in a hybrid room, with patient in prone decubitus position, an ultrasound-guided direct puncture of the left SGA was performed. A 4F micro-puncture sheath was inserted on a 0.018inches guidewire into the vessel. The aneurysm sac was catheterized and embolized with pushable 0.035" coils. The final angiography showed complete exclusion of the aneurysm. After 15 minutes of manual compression, the patient was placed supine to facilitate the hemostasis.

24-hours CTA scan confirmed the exclusion of the aneurysm; the patient was discharged without complications in the second postoperative day.

Discussion: In case of an occluded IBE occlusion and crossover femoral to femoral bypass, percutaneous trans-gluteal approach could be the only endovascular approach available to treat an IIA aneurysm. The procedure is safe and effective and can avoid open surgery.

Take-home points: In suitable anatomy, a complete full percutaneous endovascular approach to superior gluteal artery under DUS guidance can be safely performed.

In case of unfavorable anatomy, however, accurate preoperative planning and CT scan guidance are mandatory to avoid technical failure and systemic complications.

P-747

Polyarteritis nodosa-induced pancreaticoduodenal artery aneurysmal rupture

K. Murakami, K. Kamada, Y. Oonuma

Diagnostic Radiology, Hakodate Goryoukaku Hospital, Hakodate, JP

Clinical History/Pre-treatment Imaging: A 73-year-old man presented with a 3-week history of fever and abnormal liver function. He had a past history of hepatitis B infection. Computed tomography (CT) demonstrated

multiple aneurysms (celiac artery branch, superior mesenteric artery (SMA) branches renal artery, etc), compatible with polyarteritis nodosa. Antibiotic therapy was administered, and the symptoms improved. One week later, he presented with abdominal pain and a bloody bowel discharge. His hemoglobin decreased to 6.0 mg/dl. The second CT scan showed that all multiple aneurysms were enlarged. The pancreaticoduodenal artery aneurysm showed the largest increase, and it was thought to be ruptured. Angiography showed hundreds of microaneurysms at branches of the celiac and superior mesenteric arteries. The pancreaticoduodenal aneurysm had a diameter of 26 mm.

Treatment Options/Results: Embolization was performed using detachable coils, and the bloody bowel discharge and anemia stopped. Six months later, a follow-up CT showed that all multiple aneurysm were smaller.

Discussion: Visceral aneurysms associated with polyarteritis are rare and can be lethal. Involvement of the pancreaticoduodenal arteries is extremely rare and requires a high index of suspicion in patients presenting in extremis secondary to a ruptured visceral artery aneurysm.

Take-home points: This case represents a rare arterial complication of polyarteritis nodosa. If microaneurysms rupture, endovascular treatment is an effective procedure.

P-748

BTK (below the knee) kissing stenting with SFA and popliteal stents in addition

B.B.B. Shafi

Radiology, Thomas Jefferson University Hospital, Philadelphia, PA, US

Clinical History/Pre-treatment Imaging: A 74-year-old lady presents with left 2nd toe gangrene and severe ischemic rest pain. Previous SFA, popliteal artery, anterior tibial and peroneal artery angioplasty.

Pre-treatment Imaging: Severe SFA and popliteal artery stenosis. Anterior tibial artery, proximal peroneal artery and posterior tibial artery occlusion.

Treatment Options/Results: SFA and popliteal artery stenosis treated with 5 mm Supera stent. Complete Anterior tibial artery occlusion crossed and treated with 2.5 mm PTA. Proximal peroneal artery occlusion crossed and treated with 2.5 mm PTA. Persistent stenosis in TP trunk and proximal Anterior tibial artery treated with kissing 3 mm drug eluting balloon expandable stents with good result. Amputation and symptom free at 1 month, 6 months and 12 months follow up.

Discussion: SFA and popliteal artery stenotic disease with concurrent long segment BTK occlusive disease can be treated with drug eluting PTA or self expanding stents in setting of critical limb ischemia. In this case, the SFA and popliteal artery stenosis was initially treated with drug eluting PTA and BTK long segment occlusive disease was treated with POBA with good result but recurrent disease at 6 months. Subsequent treatment with self expanding stents in SFA and popliteal artery and kissing drug eluting stents in TP trunk and proximal anterior tibial resulted in better patency.

Take-home points: 1. Balloon-expandable kissing stents offer a good option to treat recurrent TP trunk and anterior tibial artery occlusion. 2. SFA and popliteal artery stenting resulted in better patency and symptom free limb survival when compared with drug eluting balloon PTA.

P-749

The first experience of percutaneous mechanical thrombectomy with Casper CAS system in a patient with acute upper limb ischemia

A.D. Kiselew¹, G.A. Sobolev², A.N. Ivanenko², V.A. Pyatkov¹, I.S. Semin¹, I.L. Bakhtin¹

¹Interventional Radiology, Arkhangelsk Regional Clinical Hospital, Arkhangelsk, RU, ²Endovascular Surgery, Arkhangelsk Regional Clinical Hospital, Arkhangelsk, RU

Clinical History/Pre-treatment Imaging: A 78 year-old patient, previously treated for unstable angina (3-days before the patient had a coronary

angioplasty with a brachial approach) showed a clinic of acute upper limb ischemia-II a category Rutherford classification.

Doppler US data were confirmed by preoperative arteriography, which revealed thrombotic occlusion of the right brachial artery, elbow and wrist arteries contrasted with collaterals.

Since there were contraindications to CDT and presence of severe heart failure (relative contraindication to traditional surgery) we made a decision to perform percutaneous mechanical thrombectomy with stent Casper (Microvention Inc).

Treatment Options/Results: The first step was- catheterization of the right brachial artery with destination Terumo Sheath under local anesthesia, then recanalization of thrombotic occlusion with 0.014" guidewire, after it stent placement in the zone of thrombosis and expanding 75% of stent and traction. We performed 5 tractions.

As a result we revealed the restoration of antegrade blood flow in the brachial artery and arteries of the forearm and wrist. The absence of contrast defects.

Discussion: Along with traditional surgery and CDT, percutaneous mechanical thrombectomy with Casper CAS System has shown high efficacy in this clinical case.

Take-home points: The percutaneous mechanical thrombectomy with Casper CAS System is less traumatic compared with traditional surgery, does not have absolute contraindications and can be used in patients with severe concomitant pathology.

P-750

Endovascular treatment of an iatrogenic common iliac artery bifurcation to iliac vein arteriovenous fistula with iliac branched stent-graft

E.T. Ilgit¹, K. Akkan¹, A. Özer², B. Önal¹, H.N. Şendur¹, E. Iriz², D. Erer²

¹Radiology, Gazi University, Ankara, TR, ²CVS, Gazi University, Ankara, TR

Clinical History/Pre-treatment Imaging: A 42 year-old male patient referred to the IR with complaints of left leg swelling and claudication. His medical history included lumbar disectomy 10 years ago.

Ultrasound revealed aneurysmal dilatation of the left iliac vein with arterialized, turbulent flow typical for arteriovenous fistula (AVF). CT/A showed early filling and aneurysmal dilatation of the iliac veins, suggesting common iliac artery bifurcation as the fistula site. Angiographic evaluation confirmed the diagnosis of high-flow distal common iliac artery to vein fistula close to the iliac bifurcation.

Treatment Options/Results: Endovascular treatment with preservation of the left internal iliac artery (IIA) was considered and GORE® EXCLUDER® Iliac Branch Endoprosthesis which was designed to treat iliac aneurysms was chosen.

Surgical treatment with open exposure is challenging in such chronic cases with delayed diagnosis as a result of elevated venous pressure. Both common femoral arterial access was obtained through direct surgical exposure. Iliac branched device (23x12mmx10cm) was introduced retrogradely from the left side through a 16F sheath. Left IIA was catheterized through the side branch from a 12F sheath on the right side and a self-expandable stent-graft (16x10mmx7cm) was deployed and dilated simultaneously with balloon catheters, respectively. Follow-up at six months revealed resolution of all symptoms related to venous hypertension and patency of IIA.

Discussion: Endovascular treatments are the method of choice for many vascular injuries. Iliac branched stent-grafts can also be used successfully for nonaneurysmal disease with preservation of the IIA.

Take-home points: Iliac branched stent-grafts can be used for the treatment of iliac AVF with preservation of the IIA.

P-751

Systolic pulsation of heavily calcified aorta can cause collapse of a balloon expandable stent

S. Ichihashi¹, S. Nagatomi¹, H. Taguchi¹, Y. Yoshiyama², T. Nakai¹, H. Kishida¹, S. Iwakoshi², K. Kichikawa²

¹Radiology, Nara Medical University, Kashihara, JP, ²Radiology and IVR center, Nara Medical University, Kashihara, JP

Clinical History/Pre-treatment Imaging: A 70's female was referred to our vascular center due to severe claudication. Contrast enhanced CT revealed a focal 5cm aortic occlusion with massive calcification occupying the aortic lumen. Endovascular treatment was performed for the calcified aortic lesion. After successful passage of the 0.014 inch guidewire intraluminally, a balloon-expandable EXPRESS-LD stent (8x57mm) was implanted to cover the occlusive lesion (Figure 1). After the procedure, her symptom completely disappeared. One year later, the symptom recurred. CT demonstrated a complete collapse of the stent inside the calcified plaque (Figure 2).

Treatment Options/Results: In order to revascularize the lesion, 0.014 inch guidewire was managed to pass through the collapsed balloon expandable stent under IVUS guidance. Placement of self-expanding nitinol stent (S.M.A.R.T. CONTROL, 7x60mm, Cordis, Hialeah, FL, USA) in a stent in stent fashion restored the arterial flow. Another year later, the both, self-expanding and balloon-expandable stents collapsed again. The aortic lesion was revascularized after the 3rd stent (S.M.A.R.T. CONTROL) was deployed inside the two layered collapsed stents.

Discussion: Causes of fractures in balloon expandable stents include external compression, and extensive daily stretching, and calisthenics. The cause of the stent collapse in this case remains unclear. The aortic wall surrounding the deployed stent was heavily calcified, and repeated systolic pulsations of the calcified wall could have caused metal fatigue.

Take-home points: Balloon expandable stents are vulnerable against mechanical compression. Implantation of balloon expandable stents inside the pulsatile calcified aorta can be a subject to external compression, leading to stent collapse.

P-752

Endovascular treatment of splenic aneurysm with neurovascular device

M. Femia¹, M. Scarabello¹, S. Gitto², M. Tramarin³, G. Damiani³, P. Rigamonti³, U.G. Rossi⁴, S. Criscuolo¹, M. Cariati³, S. Squarza³

¹Postgraduation School in Radiodiagnostics, Università degli Studi di Milano, Milan, IT, ²Radiology, Università degli Studi di Milano, Milan, IT, ³Diagnostic-Therapeutic Advanced Technology Department – Diagnostic and Interventional Radiology Unit, ASST Santi Paolo e Carlo - San Carlo Borromeo Hospital, Milan, IT, ⁴Diagnostic Imaging Department - Interventional Radiology Unit, E.O. Galliera Hospital, Genoa, IT

Clinical History/Pre-treatment Imaging: A distal splenic artery aneurysm with maximum diameter of 42 mm was incidentally found in an 81-year-old woman during an abdominal ultrasound examination. Contrast-enhanced computed tomography showed that the vessel was tortuous proximal to the aneurysm and had a kinking distal to it, thus making endovascular treatment challenging.

Treatment Options/Results: We treated the aneurysm using a 6x100 Viabahn endoprosthesis delivered through a Neuron MAX 088 introducer. Neuron MAX is a flexible device used for neurovascular procedures. Its distal shaft has a hydrophilic coating with an optimal trackability. We introduced Neuron MAX using a coaxial and buddy-wire technique with two Thruway guides 0.018 " and advanced it to the splenic hilum branches. Thus, the endoprosthesis was released to treat the aneurysm.

Discussion: The endovascular treatment of splenic aneurysms is the strategy of choice, but vessel tortuosity may make it challenging. The use of neurovascular devices that enable the access to small and tortuous arteries is an option to be considered.

Take-home points: A vascular device used for cerebral procedures could be successfully adapted to safely perform endovascular treatment of splenic artery aneurysm, despite the tortuosity of the vessel and the distal location of the aneurysm.

P-753

Endovascular embolisation and exclusion of a true axillary artery aneurysm in a renal transplant patient with previous aneurysmectomy and vein graft bypass

S. Scardicchio¹, G. Lucente¹, M. Ruggiero², F. Calcagni¹, T. Dabbicco², A. Oliva², G. Maritati²

¹Interventional Radiology Unit, ASL Brindisi, Brindisi, IT, ²Vascular Surgery Unit, ASL Brindisi, Brindisi, IT

Clinical History/Pre-treatment Imaging: Case of 25-year-old male with a painful, pulsatile mass on his right arm. He had an occluded AVF on his right elbow joint and previous surgery for aneurysmal degeneration of the right brachial artery. The first surgical intervention was performed in Oct 2016 with a 6mm PTFE conduit after aneurysmectomy. The second one was a right subclavian-ular autologous saphenous vein bypass (Feb 2018). He received a kidney transplant in 2017 since then he has been administrated with immunosuppressive drugs and corticosteroids. In September 2018 the patient was admitted to our department and performed duplex ultrasound and angio-CT with evidence of great true aneurysm of the right axillary artery, with parietal thrombosis, distal occlusion of the brachial artery and the patency of two side branch arteries feeding the aneurysmal sac previously excluded by surgical ligation.

Treatment Options/Results: A selective coils embolization of the right subscapular and posterior circumflex humeral arteries was performed. At 4-month follow-up the patient did not present neurologic or ischemic symptoms and duplex scan showed the complete aneurysmal sac thrombosis.

Discussion: Arterial dilatation after longstanding arteriovenous fistula (AVF) is a common finding as the artery adapts to the increased flow rate. Aneurysmal degeneration of the donor brachial arteries with the development of true aneurysms is rare and may be associated with a history of renal transplantation and immunosuppressive treatment.

Take-home points: Endovascular treatment of donor artery aneurysm can be a valid treatment option in selected cases and when previous surgical procedures make a further "redo-surgery" uncomfortable.

P-754

Endovascular treatment of bronchopulmonary sequestration

D.S. Kurtasov¹, A.G. Koledinskii², T. Yarakhmedov²

¹Endovascular Surgery, Sergiev Posad Hospital, Sergiev Posad, RU, ²Endovascular Surgery, SM Clinic, Moscow, RU

Clinical History/Pre-treatment Imaging: A 26-year-old man shortly before admission to the clinic noted the appearance of subfebrile temperature to 37.2 C, recurrent cough with a hemoptysis, pain in the calf muscles. Hospitalized with suspected pulmonary embolism. CT angiography of the pulmonary arteries and aorta was performed and revealed additional arterial branch from the celiac trunk to the right lung's lower lobe, as well as a prominent pulmonary veins normally draining into the left atrium.

Treatment Options/Results: Additional branch of the celiac trunk was selectively catheterized. Embolization of the celiac trunk's additional branch was performed through catheter by using 2 embolization spirals Terumo Azur35 8mm 14cm and 5mm 10cm consistently. Anomalous systemic arterial supply to lung was stopped. In the postoperative period antibiotic therapy was carried out, episodes of hemoptysis regressed. Patient was discharged from the clinic after 9 days of stay.

Discussion: Pulmonary sequestration accounts for 0.15–6 % of lung malformations. Anomalous systemic arterial supply to the lungs with normal bronchial branching and pulmonary arterial supply is an unusual variant of the sequestration spectrum called pulmonary pseudosequestration.

Pseudosequestration is referred as the combination of systemic arterial supply to lung with normal bronchial connection. It is characterized by a long latent period due to the absence of specific clinical symptoms. It is detected radiographically during screening or manifests itself in adulthood by hemoptysis, often occurring when infection and pneumonia are attached to abnormal and/or adjacent normal parts of the lung.

Take-home points: Clinical symptoms of pulmonary sequestration can be successfully treated by endovascular embolization

P-755

Venous embolization in the management of a post-angioplasty infra-popliteal arteriovenous fistula (AVF) in the setting of critical limb ischemia (CLI)

V. Danda¹, T.W.I. Clark², H. Paik², A.Z. Vance²

¹Sidney Kimmel Medical College, Thomas Jefferson University, Philadelphia, PA, US, ²Department of Interventional Radiology, Penn Presbyterian Medical Center, Philadelphia, PA, US

Clinical History/Pre-treatment Imaging: A 79-year-old female presented with Rutherford category 5 CLI. Posterior tibial artery (PTA) angioplasty was complicated by development of an AVF resistant to prolonged angioplasty. A bare-metal drug-eluting coronary stent was deployed with mild improvement. New skin changes developed adjacent to the fistula related to steal phenomena distal to the AVF. She returned for venous embolization of the fistula with restoration of antegrade arterial flow.

Treatment Options/Results: Arteriography via antegrade common femoral access confirmed persistence of the posterior tibial AVF (Figure 1a). One of the paired posterior tibial veins (PTV) was accessed at the ankle (Figure 1b) through which a 3 mm angioplasty balloon was inflated across the AVF. Repeat angiogram demonstrated provisional resolution of the fistula (Figure 2a). Deployment of an MVP-7Q (Medtronic, Dublin, Ireland) microvascular plugs followed by coil embolization of single involved PTV resulted in full resolution of the AVF (Figure 2b-c). Antegrade distal runoff was re-established through the posterior tibial artery with subsequent improvement of the patient's wounds.

Discussion: Post-angioplasty complications including dissection, rupture, or arteriovenous fistula formation are typically managed by prolonged angioplasty. If prolonged angioplasty fails, the area can be managed with a stent-graft or arterial embolization. Unfortunately, there is a paucity of stent-grafts and other devices in sizes small enough for the infra-popliteal vasculature. Arterial embolization has been described for infra-popliteal post-angioplasty rupture, however this was avoided given the patient's underlying CLI.

Take-home points: Venous embolization is a safe and effective approach in the management of infra-popliteal AVFs to salvage arterial vasculature, particularly in the setting of CLI.

P-756

Percutaneous recanalization of the occluded radial artery after transradial coronary intervention

K. Akkan, H.N. Şendur, E. Cindil, M.N. Cerit, B. Önal, E.T. Ilgit
Radiology, Gazi University, Ankara, TR

Clinical History/Pre-treatment Imaging: A 56 year-old man presented with severe persistent forearm pain and loss of strength within one week after the transradial coronary intervention and referred to IR.

Doppler ultrasound revealed the occluded radial artery from the brachial artery bifurcation to the palmar arch. Angiographic evaluation with antegrade distal brachial artery access confirmed the diagnosis and showed patency of the ulnar artery, palmar arch and digital arteries. There was no reversed flow in the distal radial artery through the palmar arch.

Treatment Options/Results: After antegrade brachial arterial insertion of a 7F sheath, occluded radial artery can be crossed easily with a 0.035 hydrophilic guide-wire and aspiration thrombectomy with a 7F catheter was performed. Patency of the artery with persistent focal

residual stenoses proximally and distally probably at the puncture site was achieved. Dilatation with 5 mm and 3 mm balloons in diameter, respectively relieved the stenoses. The next day ultrasound revealed patency of the radial artery, and the patient was asymptomatic.

Discussion: The incidence of radial artery occlusion has been reported as 1-10% of all transradial interventions. Endothelial injury and decrease in blood flow after sheath and catheter insertion may contribute to thrombus formation. Up to 50% of patients have spontaneous recanalization of the artery within 1-3 months. The majority of patients are asymptomatic due to dual blood supply of the hand and rich collateral network between radial and ulnar arteries.

Take-home points: In symptomatic patients with hand ischemia, forearm pain and loss of strength percutaneous recanalization is a safe and effective treatment alternative.

Radiation safety

P-757

Using radiation dose metrics to identify individual and team outliers during EVAR and TEVAR aortic interventions

N. Keefe¹, N. Moore², K. McLean³, Z.J. Haskal⁴

¹Dept of Interventional Radiology, University of Virginia, Charlottesville, VA, US, ²Interventional Radiology, Virginia Commonwealth University, Richmond, VA, US, ³Interventional Radiology, University of Oklahoma, Oklahoma City, OK, US, ⁴Vascular & Interventional Radiology, University of Virginia, Charlottesville, VA, US

Purpose: To evaluate radiation dose and time as individual and team-based quality metrics for aortic endograft procedures.

Material and methods: Retrospective review of 314 primary EVAR and 366 TEVAR cases from 2012-2018 was performed. Patient dose, fluoro time, cumulative provider case volumes and years after fellowship were recorded for 7 IR attendings and 6 VS attendings. Data was analyzed by IR only, VS only and team procedures (average VS experience summed with the designated IR primary operator). Experience ranged from 1-38 years, median 9.5 years; case volume ranges from 4-23. TEVAR patients were stratified for complexity by number of implanted stentgraft components; EVAR by presence of fenestration. Both were also categorized by endoleak intervention, additional stenting, or branch vessel embolization.

Results: For "simple" EVAR and TEVAR, median air kerma was 1.56 and 1.49 respectively in the individual and 2.25 and 1.70 in the joint setting. Median fluoro time was 24.47 and 16.95 respectively in the individual and 24.17 and 13.40 in the joint setting. Analyses demonstrated variance in both the individual and team settings which did not correlate with operator experience. Outliers included 1 low-dose individual and 1 high-dose team for TEVAR and 2 high-dose individuals and 2 teams for EVAR. Higher doses for EVAR outliers were associated with less case experience.

Conclusion: User experience and number of cases does not necessarily yield lower patient dose. Review of these quality metrics might be used to guide cross-team education and quality improvement initiatives. This metric may highlight individual skills and team based dynamics for quality metrics.

P-758

Real-time radiation dose display during CT-fluoroscopy guided procedures and its impact on radiation safety

D. Raissi

Radiology, University of Kentucky, Lexington, KY, US

Purpose: To Investigate the effect of use of real-time radiation dosimeter during CT-fluoroscopy guided procedures on scatter radiation dose

Material and methods: A RaySafe i2 solid state real-time dosimeter system was used. Multiple wireless digital solid state detectors were placed at different body or phantom positions to transmit radiation dose data

for display on screen component of the system. A phantom study using multiple detectors at different body levels was conducted to determine badge positioning and the possible effects on scatter radiation doses at three angles relative to the CT gantry. A retrospective study was also conducted to compare scatter radiation and patient radiation doses during live CT-fluoroscopy guided procedures performed by two experienced interventional radiologists.

Results: In the phantom study, the scattered dose-rates varied from 1.56-6.76 mSv/h for parallel position, 6.63-11.12 mSv/h for 45° position, and 7.05-11.11 mSv/h for 90° position. The mean dose-rates at shoulder and waist were not significantly different with 0.16 ± 0.15 mSv/h and 0.17 ± 0.15 mSv/h for physician L, and 0.57 ± 1.54 mSv/h and 0.89 ± 1.90 mSv/h for physician S. There was no difference in patient dose with mean total DLP of 538 ± 251.09 mGy*cm prior to and total DLP of 563.26 ± 184.60 mGy*cm with real-time dose monitoring.

Conclusion: Use of real-time dose monitoring system provides immediate feedback during CT-fluoroscopy procedures allowing timely behavior modification. The measured scatter radiation dose strongly depends on operator's orientation relative to the CT gantry with perpendicular position offering the most accurate measurement. There was no significant difference in patient dose exposure

P-759

Radiation exposure to pediatric patients and staff during retrograde wedge portography

R. Gerasia, L. Maruzzelli, R. Miraglia

Diagnostic and Therapeutic Services, Mediterranean Institute for Transplantation and Advanced Specialized Therapies (IsMeTT), Palermo, IT

Purpose: Retrograde Wedge Portography (RWP) is performed in patients with portal vein cavernoma, when the Rex Recessus of the left portal vein is not well delineated with other non-invasive imaging techniques, in order to plan a possible Meso-Rex shunt surgical procedure. Aim of this study was to prospectively evaluate radiation exposure to pediatric patients undergoing RWP and effective dose (E) of each operator performing them in a single center using a flat-panel detector based system (FPDS).

Material and methods: Between September 2016 and December 2018, 19 consecutive RWP were performed on 19 children (mean age 7 ± 5 years, 3rd quartile 11.5 years). Two radiologists, six radiographers and six anesthesia nurses were involved in this study.

A pediatric fluoroscopy protocol optimized to produce high contrast images using 50% as threshold dose with modified parameters was routinely employed. Electronic personal dosimeters were used to measure radiation doses to radiologist, anesthesia nurse and radiographer. E was determined using a modified Niklason algorithm ($E=0.03 \cdot Hp(10)$). Patients' radiation exposure was measured with Dose Area Product (DAP) and fluoroscopy time (FT).

Results: Patients: mean DAP was 11.2 ± 12.9 Gy*cm² (3rd quartile 11.9 Gy*cm²); mean FT was 357 ± 181 sec (3rd quartile 420 sec).

Staff: mean E for the radiologist was 0.50 ± 0.46 μ Sv (3rd quartile 0.75 μ Sv); for the radiographer 0.12 ± 0.11 μ Sv (3rd quartile 0.18 μ Sv); for the anesthesia nurse 0.08 ± 0.17 μ Sv (3rd quartile 0.03 μ Sv).

Conclusion: The use of FPDS with additional modifications of preset fluoroscopic parameters allows for a reasonably low radiation exposure to pediatric patients and medical staff during RWP.

P-760

Target-based CBCT reconstruction for interventional radiology

S. Hatamikia¹, A. Biguri², G. Kronreif³, J. Kettenbach⁴, W. Birkfellner⁵

¹Austrian Center for Medical Innovation and Technology, Austrian Center for Medical Innovation and Technology, Vienna, AT, ²Institute of Sound and Vibration Research, University of Southampton, Southampton, UK, ³Austrian Center for Medical Innovation and Technology, Austrian Center for Medical Innovation and Technology, Wiener Neustadt, AT, ⁴Institute of Diagnostic Radiology, Intervention and Nuclear Medicine, Landeskrankenhaus Wiener Neustadt, Wiener Neustadt, AT, ⁵Center for Medical Physics and Biomedical Engineering, Medical University of Vienna, Vienna, AT

Purpose: Nowadays, cone beam CT (CBCT) image guidance has turned into a widespread clinical routine imaging modality for image-guided interventions. In clinical systems, an x-ray source is mounted opposite to a flat panel detector, typically on a C-arm system, in which source and detector rotate around the patient to acquire projections in a circular trajectory. However, a high number of projections is needed for adequate 3D reconstruction which causes a significant amount of radiation dose to the patient. In particular for the repetitive use of CBCT needed for an image guided procedure, the accumulated radiation dose has become a concern. In this study, we investigate to optimize source-detector trajectories with an optimal arbitrary orientation and minimal number of projections, which could therefore lead to a dose reduction.

Material and methods: We investigate some source-detector trajectories in the way to maximize performance of the reconstructed image at a particular region of interest. For this aim, we use an Alderson head phantom and consider a particular region of interest as a target inside that. We use the Mutual Information (MI) as a measure to evaluate the performance of the reconstructed image at the target region.

Results: Our experimental results show that our proposed optimized trajectories can localize the target almost as good as a standard trajectory while using just 1/3 number of projections.

Conclusion: The proposed trajectory optimization technique may then minimize radiation dose and has a potential for low dose CBCT-based interventions.

P-761

Effective dose management by changing FD (flat detector) size for fluoroscopy

S. Kim¹, I. Ko², K. Yeon¹

¹Radiology, Samsung Medical Center, Seoul, KR, ²Interventional Radiology, Samsung Medical Center, Seoul, KR

Purpose: Flat detector (FD) size is reduced to provide a convenient view during image magnification, but there is a disadvantage of increasing the output dose. However, reduction in FD size is effective for decreasing the dose received by the operator and patient.

Material and methods: The device model used was 'Allular X-per FD-20,' with the table height set at 85 cm, SID 100 cm. The glass dosimeter was attached at 2 points: surface of the phantom for patient dose and the location of the operator for neighboring dose 3 cm away from the end of the radiation field at FD 48. Auto exposure control (AEC) was used at 15 fps and FD was changed to 48, 31, and 15 for 60 seconds. Patient dose was calculated by applying area conversion factor (ACF).

Results: On an average, the neighboring dose were 668.77 ± 22.29 , 392.21 ± 14.74 , and 215.27 ± 19.13 μ Gy at FD 48, 31 and 15, respectively. The surface doses applied using ACF at FD 48, 31 and 15, were found to be 3435111, 2077144 and 1039683 μ Gycm², respectively.

Conclusion: The neighboring doses at FD 31 and 15 were reduced to 41.35% and 67.81%, respectively, as compared with the doses at FD 48. Surface doses, concentrating on the output increase for image correction for magnification, but when comparing the total dose applying ACF, reduced FD 31, 15 at 39.53, 69.73% based on FD 48. Therefore, the

reduction in FD size helps reduce operator and patient doses as well as makes the procedure more convenient to perform.

P-762

Dose mapping during an interventional cardiology procedure using a DACS

S. Carpentier¹, F. Leroy¹, S. Battini², L. Guerin², A. Al Masri², T. Julien², **F. Maaloul**²

¹Cardiology, Hôpital Privé La Louvière, Lille, FR, ²R&D, BIOMEDIQA, Villeneuve d'Ascq, FR

Purpose: During an interventional radiology procedure, the patient's skin-dose can become strong enough. In order to avoid the skin deterministic effects to occur, an accurate estimation of the skin-dose mapping is highly needed. The aim was to develop a model to calculate and localize the radiation dose to integrate it into our Dose Archiving and Communication System (DACS) called DOSITRACE.

Material and methods: DOSITRACE uses a mathematical model to reconstruct a two-dimensional skin-dose mapping that reflects the magnitude, shape, and localization of irradiation fields. The reconstruction is based on geometrical and dosimetric information contained within the stored acquisition DICOM files.

The theoretical model was validated by comparison with clinical tests performed on phantoms. Gafchromic films were placed on the phantom's back and so were exposed identically to the skin. Four experimentations have been performed including 34 field projections simulating simple and very complex acquisition cases.

Results: Comparison between simulated and measured skin dose on phantoms showed a difference less than 15 %. Moreover, the simulation of DOSITRACE produces results with a very good level of geometrical accuracy: simulated and measured fields have the same shape, size, and localization. Very small field displacement were reported for very few ones and are due to machine's uncertainty on the tube angle (measured to be +/- 1 to 2°).

Conclusion: This study shows that our software is a reliable tool to warn physicians when a high radiation dose is reached and then deterministic effects can be avoided. Thirty chronic total occlusion procedures will be performed soon during real patient procedures.

P-763

Validation of a bio-dosimeter in interventional radiology: preliminary study

J. Guersen¹, Y. Rizzi¹, L. Cassagnes², E. Gouzou¹, M. Lanaret¹, J. Bensimon-Etzo^{1,3}, C. Bettencourt³, P. Chabrot¹, **L. Boyer**²

¹Radiology, University Hospital, Clermont Ferrand Cedex, FR, ²Service de Radiologie B, CHU Clermont Ferrand, Clermont-Ferrand, FR, ³Technology, ACUBENS, Paris, FR

Purpose: In the case of external irradiation, knowledge of the exposition doses is essential to make a diagnosis and define the therapeutic strategy. We performed a preliminary validation study of a bio-dosimeter quantifying external irradiation.

Material and methods: 58 patients with intracranial aneurysms treated by embolization were included. Per procedural comparative measurements were performed: thermoluminescent dosimeter (to obtain the absorbed dose to the scalp), VS bio-dosimeter to obtain the level of DNA repair proteins (γH2AX) in hair bulbs after irradiation.

Results: There was a significant induction of γH2AX protein level after irradiation in 74% of patients who have received a > 200mGy dose, and a correlation trend between increase in γH2AX level and cutaneous doses > 500mGy.

Conclusion: These preliminary results suggest a validation of the bio-dosimeter, leading to carry on this study in order to include patients irradiated with larger doses, and precisely determine the threshold of sensitivity of the bio-dosimeter.

P-764

Estimating radiation dose to the fetus during prophylactic internal iliac occlusion in patients with abnormal inherent or inserted placenta

M. Černá¹, M. Köcher¹, K. Huml², V. Prášil¹, M. Homola³, T. Vávra¹

¹Department of Radiology, University Hospital Olomouc, Olomouc, CZ,

²Department of Gynecology and Obstetrics, University Hospital Olomouc, Olomouc, CZ, ³Department of Medical Physics and Radiation Protection, University Hospital Olomouc, Olomouc, CZ

Purpose: The risk of fetal effects, including childhood cancer induction, are thought to be negligible at doses < 50 mGy. The aim of our study is to estimate fetal radiation dose associated with prophylactic internal iliac occlusion during section Caesarean in patients with abnormal placenta.

Material and methods: From November 2015 to December 2018 we performed a prophylactic occlusion of the internal iliac arteries in 33 pregnant patients, average age 35 years (23-48 years). The combined procedures were indicated in 17 patients with prenatally diagnosed placenta previa, in 1 patient with placenta praevia and adherens, in 11 patients with placenta praevia and placenta accreta, in 4 patients with placenta praevia and percreta. Fogarty embolectomy catheters were used for occlusion of internal iliac arteries inserted by cross-over technique. All procedures were performed in the hybrid operating room with X-ray system Philips Allura Xper FD 20.

Results: The insertion of Fogarty catheters was technically successful in all patients. We use low dose x-ray fluoroscopy (7.5 frames per second, more noise). Fluoroscopy times required for the insertion of Fogarty catheters were 1.1-4.2 minutes, average time was 2.2 minutes. The average estimated radiation dose to the fetus was 12.05 mGy, the median was 12.875 mGy (4.18-34.85 mGy). Complications related to the interventional radiology procedure were found in one patient (thrombosis of common femoral artery).

Conclusion: A prophylactic occlusion of internal iliac arteries is a simple and safe procedure with very low estimated radiation dose to the fetus.

P-765

Prophylactic balloon occlusion of internal iliac arteries in women with placenta previa: analysis of the radiation dose to the foetus

A. Vizzuso, F. Ermili, M. Graziano, Z. Ferrante, S. Dall'Ara, E. Salviato, R. Galeotti

Morphology, Surgery and Experimental Medicine, University of Ferrara - Saint'Hanna Hospital, Cona (Fe), IT

Purpose: To evaluate the foetal radiation exposure during the prophylactic balloon occlusion of the internal iliac arteries (PBOIIA) for the prevention of intrapartum hemorrhage. Moreover, we analyzed the safety and efficacy of this procedure.

Material and methods: We evaluated six consecutive pregnant women with placenta previa which underwent PBOIIA in conjunction with cesarean section. Three procedures were performed in the obstetric operating room fitted with a moveable angiographic C-arm system and three in the angiographic room with a fixed C-arm system. Fluoroscopic times, dose area products and foetal radiation doses were recorded. We also compared PBOIIA group with no endovascular intervention group (two cases) in terms of pre- and post-delivery hemoglobin, blood transfusion and the postoperative hospitalization time.

Results: The total mean dose area product (mGycm²), mean foetal radiation dose (mGy) and mean fluoroscopic time (min) were 20978, 9.03 and 3.63, respectively. The mean foetal radiation dose and mean fluoroscopic time were 6.63 and 4.97 for the procedures performed in the obstetric operating room, but 11.43 and 2.29 when considering procedures in the angiographic room. Technical success was achieved in all six cases. One case needed blood transfusion (post-delivery hemoglobin from 8.5 to 7.4 g/dL). The mean postoperative hospitalization time was 3.33 days.

In the no endovascular intervention group all patients needed transfusion and one had hysterectomy. The length of hospital stay was 4 days.
Conclusion: PBOIIA was associated with an acceptable foetal radiation dose, which is below the specific threshold level for deterministic effect. It was safe and effective with the blood loss volume effectively controlled.

P-766

Effective dose management using digital subtraction fluoroscopy save (DSFS) technique for extremity angiography

S. Kim¹, I. Ko¹, K. Yeon²

¹Interventional Radiology, Samsung Medical Center, Seoul, KR,

²Radiology, Samsung Medical Center, Seoul, KR

Purpose: Proper use of the "fluoroscopy save," option allows for the DSFS (digital subtraction fluoroscopy save) to be substituted for cases requiring hand injection DSA (digital subtraction angiography) images.
Material and methods: To best replicate a real clinical situation where a dye is injected into the patient, Phantom and vessel models were used. A polyvinyl chloride tube was curved to represent the vessel, which was placed inside an acrylic box (3mm) with an entry and an exit site for the dye. The Phantom was placed above the box to commence the experiment. The device model used was 'Allular X-per FD-20,' with the table height set at 85cm, SID 100, and FD size 48. The glass dosimeter was attached at 2 points: surface of the phantom for surface dose and the location of the operator for neighboring dose, with the detector 1cm away. An auto-injector was used to administer 20mL of the dye at 1mL/sec, with the image acquired through both DSA and DSFS.

Results: On average, 79.19% of the surface dose was reduced from 4122.67µGy to 857µGy, the neighboring dose from 117µGy to 23.67µGy at 79.75%. Independent t-test was completed through SPSS (version 18; PASW statistics), with the analysis showing significant difference ($p < 0.001$).

Conclusion: Compared to the DSA, DSFS allows image acquisition with 79% reduced radiation dose, and a higher frame rate useful for capturing branching of the vessels. Furthermore, DSA road map can be used in conjunction with DSFS, further reduction in radiation would be possible without compromise of patients' health.

P-767

Percutaneous embolization of recurrent varicocele in pediatric population: patient dose exposure analysis

M. Graziano, F. Siviero, A. Vizzuso, F. Ermili, S. Dall'ara, Z. Ferrante, E. Salviato, R. Galeotti

Morphology, Surgery and Experimental Medicine, University of Ferrara - Saint'Hanna Hospital, Cona, IT

Purpose: Spermatic vein embolization represent an effective and minimally invasive option for varicocele. In pediatric population it is currently reserved for surgical relapse. Aim of this work is to prove that the varicocele endovascular treatment in pediatric patients entails low rate of complications and recurrences with a low ionizing radiation exposure.

Material and methods: A consecutive retrospective series of 47 adolescent patients treated with endovascular retrograde embolization after post-surgical recurrence was collected. Images were acquired according to a strict protocol of low dose radioscopy. Dose area product (DAP) was recorded for each procedure. We estimated with Monte-Carlo Simulator by our Health Physics Unit the Effective dose (E) and malignancy risk.

Results: Results were as follows: therapeutic success in 46/47 patients (98%) with complete resolution in 41/46 (89%) and degree reduction in 5/46 (11%). No significant complications occurred. Average DAP was equal to 18881 mGyxc²; average DAP was equal to 13208 mGyxc² after the introduction of flat panel (2013). Average E equal to 1,6 mSv and a risk of malignancy equal to $8,7 \times 10^{-5}$.

Conclusion: Percutaneous embolization of varicocele appears to be effective as surgical correction. Pediatric patients undergoing this treatment have very low values of ionizing radiation exposure with an equally low

risk of malignancy. New technological devices combined with a greater experience of the operators can further reduce the dose administered to these young patient.

P-768

Phantom study of real-time eye lens dose rate monitoring with a scintillator with optical fiber dosimeter

Y. Sakuhara¹, T. Takata², M. Ishikawa³, J. Kotoku², H. Kondo⁴

¹Diagnostic and Interventional Radiology, Tonan Hospital, Sapporo, JP,

²Graduate School of Medical Care and Technology, Teikyo University,

Itabashi-ku, JP, ³Graduate School of Health Sciences, Hokkaido

University, Sapporo, JP, ⁴Radiology, Teikyo University School of Medicine, Tokyo, JP

Purpose: To evaluate real-time monitoring of the eye lens dose rate during fluoroscopy measured with a scintillator with optical fiber (SOF) dosimeter.

Material and methods: Posteroanterior (PA), right anterior oblique 30 (RAO30) and left anterior oblique 30 (LAO30) fluoroscopies (10 seconds exposure, 2.5 f/s) were performed at the phantom patient's chest and upper abdomen with a physician phantom positioned at the right thigh. Physician's left eye lens dose rate (µGy/s) was recorded with a SOF dosimeter (MIDSOF, Acrobio Co., Japan) with and without a suspended transparent leaded shield (2 mm lead equivalent) and leaded table skirt (0.5 mm lead equivalent). The median dose rate and interquartile range (IQR) of 10 times fluoroscopies in each condition were analyzed. Reduction factors of the dose rate were compared with the unshielded condition.

Results: The medians of eye lens dose rate without protection implements were 27.8 (IQR: 24.9-36.1), 32.4 (24.7-39.0) and 33.6 (29.8-43.6) µGy/s in PA, RAO30 and LAO30, respectively. The medians with a suspended shield were 19.6 (17.3-24.4), 23.5 (19.2-28.9) and 21.5 (19.1-27.7) µGy/s, respectively. The medians with a skirt were 17.6 (16.0-22.3), 19.8 (17.8-26.2) and 19.7 (13.0-27.3) µGy/s, respectively. The medians with both protection implements were 12.2 (10.7-15.7), 12.8 (10.6-15.9) and 12.0 (10.1-15.2) µGy/s, respectively. Use of a suspended shield or skirt alone significantly reduced the lens dose rate ($p < 0.001$). Use of both implements together was more protective than either used alone ($p < 0.001$).

Conclusion: Use of a suspended transparent leaded shield or/and leaded table skirt significantly decreases physician's eye lens dose rate.

P-769

Radiation exposure in 250 patients in a single high-volume center for prostatic artery embolization (PAE)

M. Zeile¹, R.M. Wentz¹, P. Steffen¹, D. Rothfuchs¹, C.R. Habermann²

¹Institute of Diagnostic and Interventional Radiology, Kath.

Marienkrankehaus, Hamburg, DE, ²Diagnostic and Interventional Radiology, Kath. Marienkrankehaus GmbH, Hamburg, DE

Purpose: In published studies, radiation exposure (RE) in PAE to the patient may reach critical levels as in the study of Andrade (JVIR 2017) with mean dose are products (DAP) of 45.070 cGycm² and a maximum exposure of 79.173 cGycm² in a single patient. The aim of this study was to assess the impact of experience on RE in this demanding procedure in a high-volume center (HVC).

Material and methods: Between January 2017 and September 2018, 250 consecutive patients with lower urinary tract symptoms (LUTS) secondary to benign prostate hyperplasia (BPH) were treated by intended bilateral PAE. For each patient, age, body mass index (BMI), Dose area product (DAP), fluoroscopy time (FT) were recorded. Examinations performed in 2017 (N = 121, Group A) were compared to the ones of 2018 (N = 129; Group B). A comparison to the literature was amended.

Results: All patients were male, mean age was 70.9 ± 8.6 years. Mean BMI measured 26.8 ± 3.6. Regarding patient related parameters, there were no differences between Groups A and B ($p > 0.05$). Looking at procedure parameters, mean FT of all patients was 52.1 ± 23.8 mins. Mean DAP amounted for 10.515 ± 4.970 cGycm². There was no difference observed

for FT for patients in group A and B ($p > 0.05$) whereas DAP was significantly lower in Group A with 11.696 cGycm² than in Group B with 9.219 cGycm² ($p < 0.0001$).

Conclusion: With increased experience, RE exposure in PAE will reduce significantly. Additionally, PAE performed at our institution showed significant lower DAP compared to published studies.

P-770

Computed tomography angiography of the pelvis prior to prostatic artery embolization (PAE) does not increase technical success rate nor decreases radiation dose

P. Steffen¹, R.M. Wentz¹, C.R. Habermann², M. Zeile¹

¹Institute of Diagnostic and Interventional Radiology, Kath. Marienkrankenhaus, Hamburg, DE, ²Diagnostic and Interventional Radiology, Kath. Marienkrankenhaus GmbH, Hamburg, DE

Purpose: PAE is becoming an increasing popular treatment option for patients with severe lower urinary tract symptoms due to benign prostatic hyperplasia (BPH). One of the mayor challenges is the variable anatomy and anastomosis to adjacent organs. This trial explores whether a CT-Agiography (CT-A) of the pelvis is a beneficial preprocedural planning tool.

Material and methods: IRB-approved retrospective study of 173 consecutive patients who underwent PAE under DSA-guidance in a single-center from August 2017 to July 2018. 44 of these patients received a CT-A of their pelvis taken prior to PAE (Group-A). In the remaining 129 patients, PAE was performed without prior CT-A (Group-B). Mean BMI, age, technical success rate, mean radiation dose and fluoroscopy time were recorded for both groups.

Results: Bilateral PAE was technically successful in 105 of all patients (61.9%), unilateral PAE was performed in 60 patients (35.7%). Bilateral PAE was technically successful in 63.6% in Group-A and in 59.7% in Group-B. Unilateral PAE was achieved in 31,2% of patients in Group-A vs. 35,7% in Group-B. In 8 patients (4.6%) neither side could be embolized; 2 (4.5 %) in Group-A and 6 (4.7%) in Group-B which was recorded as a technical failure. No significant differences were found regarding age, BMI, fluoroscopy time (48.6 mins, Group-A vs. 50.5 mins, Group-B), and The mean DAP (10,305 cGycm² $\pm$ 4,150 cGycm², Group-A vs. 9,281 cGycm² $\pm$ 4,209 cGycm², Group-B).

Conclusion: Our data suggest that a preprocedural CT-Angiography of the pelvis before PAE does not improve the technical success rate significantly nor decreases the mean radiation dose.

P-771

Incremental radiation dose from cone beam CT during prostatic embolization

A.Z. Vance, K.M. Kratz, T.W.I. Clark

Department of Interventional Radiology, Penn Presbyterian Medical Center, University of Pennsylvania, Philadelphia, PA, US

Purpose: Cone-beam CT is widely utilized during prostate embolization to confirm prostatic artery supply and exclude penile, cystic and rectal perfusion prior to target vessel embolization. We sought to characterize the incremental radiation dose produced by the addition of cone-beam CT to a prostate embolization protocol.

Material and methods: Dosimetry data from an opportunity cohort of 22 consecutive prostate embolization procedures for benign prostatic hyperplasia were retrospectively compiled. Patient age, prostate volume, and procedural dosimetry data were recorded. All embolization procedures were performed using the same flat-panel angiographic system (Axiom Artis, Siemens Healthineers, Erlangen, Germany) using a dedicated cone-beam CT protocol configured for prostate embolization.

Results: Mean age of the patient cohort was 68 years and mean prostate volume was 96 gms. Mean fluoroscopy time was 41 $\pm$ 13 minutes (range, 21-79 minutes). Median number of digital subtraction acquisitions was

6 (range 3-13). Mean dose area product and absorbed dose for each embolization procedure was 35,450 μ Gy/m² and 2178 mGy, respectively. Of this, cone beam CT acquisitions (mean acquisitions/ procedure = 1.8) accounted for 18.6% and 10.0% of cumulative dose area product and absorbed dose. Conversely, fluoroscopy accounted for 33.3% and 69.9% of cumulative dose area product and absorbed dose, respectively.

Conclusion: The addition of cone beam CT to prostate embolization protocols did not produce substantial incremental radiation to the cumulative radiation dose of each procedure. Cone beam CT to confirm target vessel supply remains a valuable adjunct to optimize safety and precision of prostate embolization.

P-772

The pregnant patient undergoing interventional radiology procedures: special considerations, reducing radiation dose, selecting appropriate medications

S. Aziz¹, A.K. Pillai²

¹Diagnostic and Interventional Imaging, UTHealth McGovern Medical School, Houston, TX, US, ²Interventional Radiology, The University of Texas Mc Govern Medical School, Houston, TX, US

Learning objectives:

1. Highlight considerations unique to the pregnant patient undergoing an interventional radiology procedure;
2. Discuss strategies to minimize radiation dose;
3. Discuss concepts regarding analgesia and sedation specific to the pregnant patient;
4. Discuss medications appropriate to use during pregnancy.

Background: Interventional radiology procedures involving the pregnant patient are unique as the operator must consider the welfare of both the sick mother and the developing fetus. This affects the procedure in many ways, including timing, approach, imaging and medications used.

Clinical Findings/Procedure Details: The interventional radiologist may need to have interdisciplinary discussions with the ordering clinician and the obstetric and anesthesiology services, stratify the urgency of the procedure and decide the appropriate timing.

Considerations during the procedure include safe positioning of the gravid patient, appropriate fetal monitoring and providing adequate analgesia and sedation.

Radiation dose to the pregnant patient can be minimized by carefully planning the procedure to minimize fluoroscopy time, utilizing alternative imaging modalities, preparing the IR suite and equipment and using techniques to minimize radiation exposure while maintaining diagnostic quality such as limiting magnification, tight collimation, optimal positioning of the X-ray tube and image intensifier, reducing tube current and increasing the pitch.

It is also important to be aware of medications safe to use in pregnancy to provide adequate analgesia, sedation, and antibiotic prophylaxis.

Conclusion: Interventional radiology procedures can be safely performed on pregnant patients with knowledge of their special needs, utilizing strategies to minimize radiation dose, providing adequate analgesia and sedation, and using appropriate medications.

P-773

Guide to radiation dose reduction

R. Gaggini¹, A. Koukourou²

¹Medical Imaging, Flinders Medical Centre, Adelaide, SA, AU, ²Medical Imaging, Flinders Medical Centre, Bedford Park, SA, AU

Learning objectives: The basics of Radiation Dose Reduction in the Interventional Suite are widely understood.

Variables including Shielding, Collimation, Fluoro Time, Pulse Radiography are some of the many factors that contribute to dose reduction.

The team at the Flinders Medical Centre, South Australia have adopted methods above and beyond standard practice which has resulted in significantly higher dose reductions.

What are the key strategies and protocols that has enabled this? Can these techniques be widely used?

Background: The electronic poster "Radiation Dose Reduction Angiography and Interventional Radiology" was presented at CIRSE 2012. This described 90 percent dose reduction over all Interventional procedures at the Flinders Medical Centre.

This poster will present the "How to" guide in order to be able to implement them in practice.

Clinical Findings/Procedure Details: Testing of multiple variables showed that changes to digital acquisition dose protocol allowed significant radiation dose savings for minimal image quality loss.

Analysis of imaging requirements for most procedures showed that "low dose" acquisition parameters could be introduced depending on the stage of the intervention.

Innovative audits and real time dose monitoring creates an enhanced awareness and creates a "visualisation" of x-rays.

A wide variety of complex Interventional Procedures including TIPS, Biliary Interventions and EVAR are completed at Flinders Medical Centre, at the lower end of x-ray procedure radiation dose levels.

Conclusion: This poster presents the key points to significant radiation dose savings that go beyond what is commonly understood and practised. This is required information for all interventional suites.

P-774

Mixed reality for interventional radiology: an intuitive real-time radiation visualization system

T. Takata¹, H. Kondo², M. Yamamoto², S. Furui², T. Kobayashi¹, K. Shiraishi², H. Oba², J. Kotoku¹

¹Graduate School of Medical Care and Technology, Teikyo University, Itabashi-ku, JP, ²Radiology, Teikyo University School of Medicine, Tokyo, JP

Learning objectives: This study proofs a concept and feasibility of a wholly new radiation visualization system for interventional radiology (IR) using the Mixed Reality (MR) hologram. We developed a world's first application for holographic visualization of the exposure dose in real-time for elucidating the dose intuitively.

Background: Understanding the exposure dose which varies considerably in IR is crucially essential to reduce the risk posed by radiation dermatitis to patients and physicians. We developed a Monte-Carlo-based fast dose estimation system for IR (FDEIR) [Takata et al. 2018]. FDEIR estimates the patient's skin dose distribution and the physician eye dose in real-time. This study applied FDEIR with the wearable MR device, Microsoft HoloLens, for 3D dose visualization.

Clinical Findings/Procedure Details: The MR system projects holograms which show the patient's 3D skin dose and the physician's eye dose in real-time. The system was assessed by 20 radiologists and radiological technologists using the NASA Task Load Index for workload assessment. The median workload score (33.50) was lower than the scores for medical tasks (50.60) and computer activities (54.00) observed in the literature [Grier. 2015]. This result suggests that this MR system can reduce the workload of the medical staff.

Conclusion: This study demonstrates that the groundbreaking MR application, a 3D dose visualization tool for IR, would have a high value on radiation dose management. Eighteen subjects (90%) provided positive feedback for the understandability of MR doses. This MR system can be expected to lead to reduction of patient and physician exposure dose by expressing invisible radiation exposure in real space.

Renal and visceral artery intervention

P-775

Thrombectomy devices in the treatment of acute mesenteric ischemia: initial single-center experience

B. Freitas¹, Y. Bausback¹, J. Schuster¹, M. Üllrich¹, S. Bräunlich¹, A. Schmidt¹, D. Scheinert²

¹Interventional Angiology, University Hospital - University of Leipzig, Leipzig, DE, ²Angiology and Cardiology, University of Leipzig Heart Center, Leipzig, DE

Purpose: To report our preliminary experience with endovascular treatment of patients with acute mesenteric ischemia (AMI), using Rotarex.

Material and methods: Retrospective analysis of patients admitted to due to AMI with concomitant or exclusive endovascular treatment. Procedure was performed through left brachial artery access, selective catheterization and thrombectomy with 6F/8F Rotarex. Demographic, clinical/periprocedural, postoperative, complication, and adjunct intervention data were reviewed.

Results: 20 patients (69.8±11.3y) were operated for AMI using Rotarex. Abdominal pain (65%), ileus (35%), sepsis (25%), and myocardial infarction were the main clinical presentation at admission. 15 patients (75%) had suggestive Angio-CT signs of AMI. Procedural success rate was 100%, with a mean procedural time of 28±17min. Superior mesenteric artery was the main vessel involved in 75%, mainly periosteal occlusions (30%) or at middle colic artery's offspring (35%). Primary thrombectomy was performed in all patients, associated with balloon angioplasty (7/20; 50%), stent deployment (5/20; 25%), intraoperative selective thrombolysis (4/20; 20%) and catheter-assisted aspiration in 10% (2/20) of patients. Average time between admission and angio-CT was 1.5±0.5h, between admission and angiography was 2.5±1h, and between admission and surgery was 9±5h. Following recanalization, 14 patients (70%) underwent open surgery. Laparotomy with intestinal resection (enterectomy, colectomy) and transit deviation was the most common procedure. Complications directly related to the endovascular procedure occurred in 2 patients, represented by self-limited small perforations. Overall 30-day mortality was 40% (n=8). During the period of this study, no patient died as a result of complications related to the use of rotational thrombectomy.

Conclusion: Treatment of AMI with Rotarex proved to be feasible and reasonably fast procedure. Further studies are necessary to confirm these findings.

P-776

Embolization of adrenal glands hemorrhages in acute setting

F. Giurazza¹, F. Corvino¹, M. Silvestre¹, G. de Magistris², E. Cavaglià², R. Niola²

¹Interventional Radiology, Cardarelli Hospital, Naples, IT, ²Vascular and Interventional Radiology, Cardarelli Hospital, Naples, IT

Purpose: Acute adrenal bleedings are a rare event compared to other abdominal visceral injuries because of the anatomic localization of the adrenal glands; main causes are trauma and ruptured neoplasms.

Here we report on a single center experience of transarterial embolizations of adrenal hemorrhages in emergency setting.

Material and methods: This is a retrospective analysis from 2010 to 2018; 17 patients (12 men and 5 women, mean age: 59.8 years) presenting with adrenal bleedings were treated by endovascular embolization. Etiology was traumatic in 7, ruptured neoplasm in 8 and spontaneous in 2 patients assuming oral anticoagulant therapy. After thin slice contrast enhanced CT, a superselective embolization was conducted with different embolizing agents according to the type of vessel lesion and operator preference.

Results: Technical success rate, considered as interruption of adrenal bleeding detectable at angiography, was 94.1%. Clinical success rate, considered as hemodynamic stability restoration within 24 hours from the

procedure, was 82.3%. Vessels involved were the superior adrenal artery in 5, the middle adrenal artery in 8, the inferior adrenal artery in one patient and more than one adrenal artery in 3 patients. No procedure-related major complications occurred and no patients had infarctions, necrosis, abscess formation, or required long-term steroid supplementation.

Conclusion: Acute adrenal hemorrhages can be safely and effectively managed by catheter directed embolizations; the source of bleeding has to be carefully investigated at CT and angiography because adrenal glands present with a wide and complex vascular arterial network.

P-777

Usefulness of transarterial infusion of iodized oil and gelatin particles for marking before CT-guided percutaneous cryoablation of renal cell carcinoma

K. Kajiwara¹, R. Yoshimatsu², M. Nishimori³, T. Yamanishi⁴, H. Minamiguchi³, T. Karashima⁵, K. Inoue⁵, K. Awai⁶, T. Yamagami³
¹Radiology, Medical School, Kochi University, Kochi, JP, ²Radiology, Kochi University, Nankoku, JP, ³Radiology, Medical School, Kochi University, Nankoku, JP, ⁴Radiology, Kochi Medical School, Kochi, JP, ⁵Urology, Medical School, Kochi University, Nankoku, JP, ⁶Radiology, Hiroshima University Hospital, Hiroshima, JP

Purpose: To evaluate the usefulness of the transarterial infusion of iodized oil and gelatin particles for marking before CT-guided percutaneous cryoablation (PCA) in patients with renal cell carcinoma (RCC).

Material and methods: This study included 10 patients (7 men, 3 women; mean age 53 years, range 23-83 years) with 13 RCCs. Between July 2016 and September 2017, they underwent transarterial infusion of iodized oil and gelatin particles, followed by CT-guided PCA. The mean diameter of the ablated tumors was 19.1 ± 7.0 mm (range 10 - 35 mm). Preoperative marking was performed 2 - 7 days before PCA; it was considered successful when iodized oil accumulated in the marked area on CT scans. Two diagnostic radiologists assigned scores to the visualization of the tumors. PCA was recorded as successful when the cryoablation ice ball covered the entire tumor on post-ablation CT scans.

Results: Preoperative marking was successful in all 13 tumors; the median visualization score was 5 (excellent) post-lipiodol marking and 4 (good) at the time of PCA. The mean CT value was 597 ± 371 Hounsfield units (HU) just after marking and 437 ± 234 HU at the time of PCA. All 13 CT-guided PCA procedures were successful. There were no significant procedure-related complications. During follow-up (median 11.5 ± 7.0 months) there were no local recurrences.

Conclusion: As the transarterial infusion of iodized oil and gelatin particles improved RCC visualization on unenhanced CT scans, its delivery before CT-guided PCA may improve its safety and success rate in patients with RCC.

P-778

Factors associated with conservative management failure in symptomatic isolated mesenteric artery dissection

Z. Jia

Department of Interventional and Vascular Surgery, The Affiliated Changzhou No. 2 People's Hospital of Nanjing Medical University, Changzhou, CN

Purpose: To assess factors associated with the failure of conservative management in patients with symptomatic isolated mesenteric artery dissection.

Material and methods: Patients with symptomatic isolated mesenteric artery dissection who underwent conservative therapy as first-line treatment between February 2010 and May 2018 were included in this retrospective study. Failure of conservative management was defined as the persistence or aggravation of symptoms and signs, increasing size of aneurysmal dilation, or new appearance of a dissecting aneurysm after

conservative management. Univariate and multivariate analyses were performed to identify risk factors for failure of conservative management.

Results: A total of 123 patients (115 men, 8 women, mean age, 53.7 ± 6.1 y) were included in this study. Conservative management was successful in 89 (72.4%) patients but failed in the remaining 34 (27.6%) patients. Of the 89 patients in whom conservative management was successful, all of the symptoms were eliminated ($n = 81$) or relieved ($n = 8$) within 3.8 ± 0.7 days after conservative management. All of the 34 patients in whom conservative management failed underwent successful endovascular stenting. Failure of conservative management was associated with type II IMADs as defined by the Sakamoto classification system (odds ratio: 33.76; 95% confidence interval: 8.65-131.85; $P < 0.001$) and with degree of luminal stenosis $\geq 90\%$ (odds ratio: 40.70; 95% confidence interval: 3.76-440.07; $P < 0.01$).

Conclusion: Conservative management can be used successfully in most patients with symptomatic isolated mesenteric artery dissection. Risk factors for failed conservative treatment were type II IMADs and degree of luminal stenosis $\geq 90\%$.

P-779

Endovascular treatment of splenic artery steal related to hepatic artery stenosis in living donor liver transplant recipients

U.R. Kang¹, Y.H. Kim²

¹Radiology, Daegu Catholic University Medical Center, Daegu, KR, ²Radiology, Daegu Catholic University Hospital, Daegu, KR

Purpose: To evaluate the efficacy of endovascular treatment of splenic artery steal related to hepatic artery stenosis in living donor liver transplant (LDLT) recipients.

Material and methods: From July 2008 to March 2018, nine patients with splenic artery steal related to hepatic artery stenosis after LDLT were enrolled in our study among 517 LDLT recipients. We performed Laboratory Exam, Doppler USG and CT scan for diagnosis of hepatic artery stenosis. All nine patients underwent splenic artery embolization alone for treatment of hepatic ischemia by improvement of hepatic arterial blood flow. Follow-up Laboratory exam, Doppler USG and CT scan were retrospectively reviewed to evaluate the efficacy of transcatheter embolization of splenic artery.

Results: Technical success was achieved in all patients. Hepatic enzymes were significantly decreased, and Doppler USG findings showed increased PSV, EDV and RI after procedure in all patients. CT findings of hepatic parenchyma were normalized after procedure. The diameter of pre-stenotic, post-stenotic RHA and CHA/SA ratio were increased on follow-up CT scan in spite of persistent hepatic artery stenosis in all patients. The mean follow-up duration was 43.3 months (2-118 months). During the follow-up period, two patients died of sepsis (1month, 3months), one patient underwent PTBD for treatment of biliary stricture (2months). Other patients still alive without any further intervention.

Conclusion: Transcatheter embolization of splenic artery alone without any intervention for hepatic artery stenosis is enough to assure sufficient blood supply of the graft in patients with splenic artery steal related to hepatic artery stenosis after LDLT.

P-780

Endovascular thromboaspiration in acute renal artery thromboembolic occlusion

M. Femia¹, U.G. Rossi², P. Rigamonti³, M. Tramarin³, G. Damiani³, M. Cariati³

¹Postgraduation School in Radiodiagnostics, Università degli Studi di Milano, Milan, IT, ²Diagnostic Imaging Department - Interventional Radiology Unit, E.O. Galliera Hospital, Genoa, IT, ³Diagnostic-Therapeutic Advanced Technology Department - Diagnostic and Interventional Radiology Unit, ASST Santi Paolo e Carlo - San Carlo Borromeo Hospital, Milan, IT

Purpose: To describe our experience in the management of acute renal artery thromboembolic occlusion through endovascular thromboaspiration.

Material and methods: Between January 2014 and December 2017, we treated 11 patients with MD-CT diagnosis of acute renal artery thromboembolic occlusion and initial signs of renal ischemia. All patients underwent endovascular thromboaspiration within 8 hours from the acute event. The procedure was performed through right femoral access with co-axial technique (6-8 Fr sheath, 5 Fr guiding catheter, 0.035 hydrophilic guide-wire). 3/11 patients (27%) underwent thromboaspiration of the main trunk of the renal artery and subsequent transcatheter (5 Fr) selective thrombolytic therapy for the treatment of small distal branches residual thrombus. Patients underwent US-color doppler and serum creatinine at 24 hours, 1-6-12 months.

Results: Complete technical success was achieved in 10/11 patients (91%). One patient (9%) showed post-procedural patency of the main trunk of the renal artery with still occlusion of some main intraparenchymal branches. The remaining 10 patients showed regular patency of both the main renal artery and interlobar branches at US-color doppler and no alterations of serum creatinine during the follow up.

Conclusion: Acute renal artery thromboembolic occlusion is a vascular emergency that requires early diagnosis and prompt restoration of kidney blood flow. Percutaneous transcatheter revascularization techniques are a valuable alternative to surgical thrombectomy, as a first line therapy.

P-781

Assessment of the efficacy of endovascular techniques in transplanted renal artery stenosis: PTA alone and stenting

M. Macchini¹, O. Meyrignac², H. Rousseau², F. Salvatori³, M. Rosati¹, M. Torresi¹, E. Paci¹, R. Candelari¹

¹SOD Radiologia Interventistica, Az Osp-Univ OORR Torrette, Ancona, IT, ²Radiology, CHU Rangueil, Toulouse, FR, ³Scuola di specializzazione in Radiodiagnostica - Università Politecnica delle Marche, Az Osp-Univ OORR Torrette, Ancona, IT

Purpose: The purpose of this study was to assess the efficacy of endovascular techniques for the treatment of transplanted renal artery stenosis (TRAS) by analyzing technical and clinical success and to compare percutaneous transluminal angioplasty (PTA) alone versus stenting.

Material and methods: A retrospective analysis was conducted on patients who underwent endovascular treatment for TRAS between January 2012 and December 2017. The following clinical parameters were recorded before and after treatment: serum creatinine levels, glomerular filtration rate (GFR), arterial blood pressure values, antihypertensive medication. Technical success was assessed for each procedure. Clinical success was defined as a 15% reduction in serum creatinine levels, a decrease of over 15% in mean blood pressure values or a decrease of over 10% in mean blood pressure values with a reduction in the number of antihypertensive medicinal products.

Results: Thirty-one patients (23 males; 8 females; median age of 65, range 24 – 81) underwent endovascular treatment for TRAS with 31/31 (100%) of technical success and 27/31(87%) of clinical success. Four patients (4/31;13%) underwent reintervention. Ten patients (10/31; 32%) were

treated with PTA alone and 21/31 (68%) with stenting. Serum creatinine levels and mean arterial blood pressure values were significantly lower after treatment compared to before treatment ($P < 0.05$) in the stent group but not in the group treated with PTA alone.

Conclusion: The endovascular approach is safe and effective in the management of TRAS and stenting, depending on the morphology of the stenosis, should be the treatment of choice where possible.

P-782

Embolization in splenic artery syndrome after liver transplantation: experience of a center

C. Terra Rodrigues¹, D. Diogo², L. Domingues², M. Cruz¹, N. Campos¹, A. Aguiar Ferreira¹, M.A. Portilha¹, P. Donato¹

¹Medical Image Service of the Hospital and University Center of Coimbra, Centro Hospitalar e Universitário de Coimbra, Coimbra, PT, ²Unit of Liver and Pediatric Transplantation of the Hospital and University Center of Coimbra, CHUC, Coimbra, PT

Purpose: Splenic artery syndrome (SAS) is described as a decrease in hepatic artery flow associated with increased flow in the splenic artery (SA) or gastroduodenal artery resulting in hepatic hypoperfusion. The present study aim was to access efficacy of embolization in splenic artery syndrome after liver transplantation and to describe the main complications after embolization in a series of patients.

Material and methods: Between March 2010 and August of 2016, 70 orthotopic liver transplants on patients over 18 years of age were performed. Of these patients, 27 developed SAS and were submitted to embolization of the SA corresponding to the case group, with the 43 patients that didn't develop SAS to the control group. Data were collected from echo-Doppler examinations in the post-transplantation and postembolization periods. Splenic artery embolization was performed via percutaneous femoral artery approach under local anesthesia.

Results: The difference between pre-embolization and postembolization resistive index (RI) was 0,2 which demonstrates a significant improvement after embolization of the SA ($p < 0.001$, CI 95% 0.11-0.25). The RI of the HA postembolization in the case group is equal to the RI of the HA in the control group, indicating therapeutic success. As major complications after embolization, 1 patient had hepatic artery thrombosis, which necessitated surgical repair. None developed complete splenic infarction or severe hepatic insufficiency.

Conclusion: Splenic artery embolization is a safe and effective minimally invasive method for treating splenic artery syndrome in orthotopic liver transplant recipients and an alternative to open splenectomy or to splenic artery banding during transplantation.

P-783

Emergency endovascular treatment of 16 peripheral artery injuries with viabahn stent-graft: mid-term results

T. Ueda¹, F. Sugihara¹, D. Yasui¹, H. Saito¹, I. Tanaka¹, S. Shirai¹, E. Kodani¹, S. Murata², H. Tajima³, S.-I. Kumita¹

¹Radiology, Nippon Medical School, Tokyo, JP, ²Radiology/Interventional Radiology Center, Teikyo University Chiba Medical Center, Chiba, JP, ³Center for Minimally Invasive Treatment, Nippon Medical School Musashi-Kosugi Hospital, Kawasaki, Kanagawa, JP

Purpose: To report a single-center experience with emergency endovascular treatment (EVT) of fifteen patients and sixteen peripheral artery injuries (PAIs) including extravasations and pseudo-aneurysms using Viabahn stent-graft (SG), focusing on technical aspects, clinical outcome and mid-term results.

Material and methods: Consecutive patients affected by PAIs from January 2017 to December 2018 and received to emergency EVT using selfexpandable Viabahn SG were retrospectively reviewed. Technical success, 30-day clinical success, peri-procedural complications, 30-day

mortality, procedure time, endoleak (EL), and follow-up period (SG patency, ischemic complications) were analyzed.

Results: Emergency SG implantation was performed in 15 patients (mean age 70.5 years, 11 males, 4 females) by 16 PAIs via trans-femoral in 11 cases (trans-brachial in 4 cases). The location of the injured arteries were 10 visceral arteries in 9 patients, 3 upper limb arteries in 3 patients, and 3 lower limb arteries in 3 patients. The overall technical and clinical success rates were both 100%. Peri-procedural complications and overall 30-day mortality was both 0%. Mean procedure time was 42 minutes. One case showed type 1a EL, and the EL was treated with additional balloon angioplasty. The other case had abscess surrounding SG on the 56th day after the treatment, and SG removal was performed. Stent-graft thrombosis occurred in two patients (one in one week, and the other in one year) respectively without ischemic complications. Stent-graft patency were confirmed at 1, 3, 6 and 12 months in 93.3%(11/12), 88.9%(8/9), 83.3%(5/6), 60%(3/5), respectively.

Conclusion: Emergency EVT using Viabahn SG was safe and effective with low rate of complications and mortality.

P-784

Endovascular angioplasty and stenting for hepatic artery stenosis: a retrospective study of 18 patients

I. Khati¹, F. Tradi², V. Vidal³, A. Jacquier⁴, J.-M. Bartoli⁴, J. Hardwigen², E. gregoire², P.-A. Barral⁵

¹Marseille, CHU Timone, Marseille, FR, ²Bouches du Rhône, Hôpital de la Timone, Marseille, FR, ³Service de Radiologie, Hôpital Timone Adultes, Marseille, FR, ⁴Radiologie Adulte, APHM CHU La Timone, Marseille, FR, ⁵Service de Radiologie, Hôpital de la Timone, Marseille, FR

Purpose: To evaluate the efficiency of angioplasty and stenting in hepatic artery stenosis.

Material and methods: A retrospective review of all endovascular interventions for hepatic artery stenosis (HAS) after liver transplantation between June 2013 and November 2018 was performed in a single institution. Angioplasty or stenting were performed at the discretion of the radiologist. We analysed short-term (technical success, arterial tortuosity, complications) and long-term outcomes (liver function, arterial patency at 12 months (AP), graft survival at 12 months (GS12), and re-intervention) and we aimed to compare percutaneous balloon angioplasty (PBA) with stent placement. A total of 18 stenosis were suspected by routine surveillance duplex ultrasound imaging, all of them were confirmed by angio CT and 17 by angiography.

Results: Seventeen patients were included (14 male; mean age, 57 years and 3 female; mean age, 58 years). Interventions were performed in 17 cases (95%) with percutaneous transluminal angioplasty alone (5 of 17), stent only (5 of 17) or both (4 of 17). In 4 cases no treatment was possible. Immediate technical success was 76%. Major complication occurred in one of 17 cases (5.8%), consisting of target vessel dissection. Follow-up was 1 month to 4 years (median 15 months). The analysis of the three groups PBA only, stent only or the both shows: same procedural success (100%), GS12 (100%) and normal liver function after procedure but different rate of complications (2% vs. 0% vs. 0%), AP (60% vs. 80% vs. 100%), early stenosis (40% vs. 80% vs. 0%) or late stenosis (60% vs. 20% vs. 100%) and requirement for re-intervention (40% vs. 20% vs. 0%) ($p=0.04$).

Conclusion: PBA alone and stent alone have the same results in the treatment of HAS but our study suggests that ATP+stent in the same procedure would give better results considering AP. Moreover, our study does not show any significant difference in prognosis between early and late stenosis.

P-785

Endovascular treatment of vascular renal injuries

F. Salvatori¹, M. Macchini², M. Rosati², E. Paci², M. Fichetti², P. Boscarato², C. Mincarelli², M. Torresi², R. Candelari²

¹Scuola di specializzazione in Radiodiagnostica - Università Politecnica delle Marche, Az Osp-Univ OORR Torrette, Ancona, IT, ²SOD Radiologia Interventistica, Az Osp-Univ OORR Torrette, Ancona, IT

Purpose: We aimed to evaluate the efficacy of endovascular treatment (ET) for vascular renal injuries (VRIs) like bleeding, pseudoaneurysm and artero-venous fistula (AVF) and to compare patients with trauma (T-VRIs) and those with iatrogenic damage (I-VRIs).

Material and methods: We retrospectively assessed 49 renal artery embolizations performed to treat T-VRIs (26.5%) and I-VRIs (73.5%). Different embolic materials were used based on the type of lesion. Technical success was defined as the complete occlusion of target arteries with no more visualization of VRIs. Clinical success was defined if no recurrence was present and if renal function (difference between creatinine after and before treatment < 0.5 mg/dl) was preserved after one month.

Results: Angiography showed bleeding in 27 patients, pseudoaneurysm in 29 and an AVF in 6. Embolic agents used were coils in 39 procedures, coils with sponge in 4 and others in 6. Technical success was 100% while clinical success was 85.7% due to 7 patients with recurrence. The group I-VRIs showed a higher rate of clinical success than the group T-VRIs (94.4% vs 61.5%; $P<0.05$). Moreover, the group I-VRIs had a higher incidence of pseudoaneurysms and AVFs compared with the group T-VRIs (69.4% vs 30.8% and 16.7% vs 0%; $P<0.05$).

Conclusion: ET for VRIs showed satisfactory results (technical success of 100%, clinical success of 85.7%). No patient had a worsening of renal function because ET was always selective. I-VRIs had better clinical success and more frequently appeared as pseudoaneurysms compared to T-VRIs: probably iatrogenic injury is localized and pseudoaneurysm is easily identifiable and treatable with ET.

P-786

Renal angioplasty in stenosis documented by duplex ultrasound in patients suffering from renal insufficiency: A French monocentric study

M. Darras, S. Greciano

Interventional Cardiology, Colmar Hospital, Colmar, FR

Purpose: Evaluate the severity of renal artery stenosis and viability of renal parenchyma using duplex ultrasound measurement of intrarenal resistance index (RI) by studying the evolution of renal function after transluminal angioplasty.

Material and methods: Forty-eight patients were included between 2010 and 2018. The patients were classified into a stable chronic kidney disease (CKD) ($n=26$) group and an acute renal failure (ARF) on CKD ($n=22$) group. RAS were first screened by DU measurement of RI (threshold <0.8) and confirmed by selective renal angiography. Data regarding changes in serum creatinine (Cr), glomerular filtration rate (GFR) and systolic blood pressure (SBP) were analyzed.

Results: General population Cr and GFR significantly improved from $177,62 \pm 105,74 \mu\text{mol.L}^{-1}$ to $117,02 \pm 41,80 \mu\text{mol.L}^{-1}$ ($p<0,001$) and $40,16 \pm 21,29 \text{mL.min}^{-1.1,73\text{m}^2}$ to $45,53 \pm 19,36 \text{mL.min}^{-1.1,73\text{m}^2}$ ($p=0,01$) 30,76 months after angioplasty. In the ARF group Cr and GFR significantly improved from $253,09 \pm 112,72 \mu\text{mol.L}^{-1}$ to $173,36 \pm 106,22 \mu\text{mol.L}^{-1}$ ($p<0,001$) and $25,13 \pm 12,66 \text{mL.min}^{-1.1,73\text{m}^2}$ to $39,90 \pm 19,33 \text{mL.min}^{-1.1,73\text{m}^2}$ ($p<0,001$) 25,38 months after angioplasty and dialysis withdrawal was achieved in all patients ($n=3$). Cr and GFR of patients in the CKD group was stabilized but didn't significantly improve. The mean SBP significantly decreased from $164 \pm 33 \text{mmHg}$ at baseline to $135 \pm 17 \text{mmHg}$ ($p<0,001$).

The mean RI of stenotic arteries was $0,67 \pm 0,16$ versus $0,75 \pm 0,13$ for non-stenotic arteries ($p=1,848 \times 10^{-6}$). It significantly increased after angioplasty

to 0.74 ± 0.11 ($p=0.005$) for stenotic arteries but not for non-stenotic arteries. Mean RAS was $91.2 \pm 7.2\%$.

Conclusion: Renal function was significantly improved in the ARF group allowing dialysis withdrawal in all patients while it was stabilized in the CKD group. SBP was significantly decreased in all groups. Measurement of RI was an excellent tool for detection of RAS.

P-787

Clinical outcome of an extravascular coil after transcatheter arterial embolization for gastrointestinal bleeding

J.J. Shim¹, J.M. Lee¹, J.H. Shin², H.H. Chu²

¹Radiology, Soonchunhyang University Bucheon Hospital, Bucheon, KR,

²Radiology, Asan Medical Center, Seoul, KR

Purpose: This study was designed to evaluate the clinical outcome of an extravascular coil after transcatheter arterial embolization (TAE) for gastrointestinal bleeding.

Material and methods: We retrospectively reviewed the medical records of 1415 patients who underwent TAE for gastrointestinal bleeding between 2001 and 2017. Among these 1415 patients, 70 underwent TAE using coils and consecutive follow-up endoscopy. Finally, 11 patients with an extravascular coil seen on follow-up endoscopic examination were included in this study. We evaluated the underlying cause of the gastrointestinal bleeding, the technical and clinical success rates, the type of extravascular coil after TAE, and the clinical outcomes of the extravascular coil seen on follow-up endoscopic examination.

Results: Of the 11 patients, the most common underlying cause of gastrointestinal bleeding was a duodenal ulcer ($n=7$). On angiography, the bleeding artery was most commonly found in the gastroduodenal artery ($n=6$). The technical success and clinical success rates of TAE were 100% and 90.9%, respectively. The type of extravascular coil found on endoscopic examination was classified by submucosal migration ($n=6$) and protrusion ($n=5$). On second-look endoscopic evaluation, 10 of 11 (90.9%) patients showed healing ulceration. On the final-look endoscopic evaluation, healing ulceration without further bleeding were seen in one (9.1%) patient and scar formation was seen in ten (90.9%) patients.

Conclusion: Extravascular coil after TAE for gastrointestinal bleeding is rare and the most common underlying cause is duodenal ulcer bleeding. The extravascular coil eventually shows a healing process with adequate treatment of underlying bowel pathologies.

P-788

Single centre evaluation of transplant renal artery stenosis (TRAS) by percutaneous transluminal angioplasty and/or stenting

S.U. Mahmood¹, J. Pancholi¹, D. Kotecha¹, S.A.R. Mustafa², A. Saeed¹

¹Radiology, University Hospitals Leicester, Leicester, UK, ²Radiology, Leicester Royal Infirmary, Leicester, UK

Purpose: Retrospective evaluation of technical procedures, clinical success, and complication rates of endovascular treatments in allograft renal transplant patients with transplant renal artery stenosis (TRAS).

Material and methods: Retrospective single centre study of all 41 patients, who received endovascular treatment for TRAS between 2008–2017. Information for analysis was gathered with the use of RIS/PACS and ICE. Parameters included technical success, reintervention, complication and mortality rates. The creatinine level before and 30 days after the intervention and locations of the stenosis were collated. Only a small number of procedures had pressure measurements documented, these were insufficient for statistical analysis.

Results: Total of 53 renal artery catheter angiograms were performed on 41 patients during a 9-year period. 75% had percutaneous angioplasty and/or stenting. The rate of reintervention was 20%. Technical success was 100%. 23% of the angioplasties were performed with stenting predominantly for stenotic recurrences. Complications included groin haematoma (4%), access site pseudoaneurysm (2%), arterial dissection

treated with stenting (2%) and transplant kidney arteriovenous fistula (4%). 30-day mortality was 0%. The mean pre-procedural creatinine level was 224 ± 48 $\mu\text{mol/l}$, the 30-day post procedural mean creatinine was decreased to 210 ± 34 $\mu\text{mol/l}$. The most common stenotic site was at the level of proximal anastomosis.

Conclusion: TRAS is detected to be significant through the use of Doppler ultrasound or Magnetic Resonance Angiography. Revascularization is recommended to improve graft function as measured by improvement in serum creatinine. Stenting is advised for patients with restenosis or after a lack of response to angioplasty.

P-789

Direct percutaneous puncture and embolization of visceral pseudoaneurysms (PSA): safety and clinical efficacy

J. Reddy, J. Singh

Interventional Radiology, Asian Institute of Gastroenterology, Hyderabad, IN

Purpose: To assess the safety and clinical efficacy of direct percutaneous puncture and embolization in the treatment of visceral pseudoaneurysms.

Material and methods: Retrospective analysis of all patients who underwent direct percutaneous puncture of PSA & embolization between January 2012 to February 2018 was done. Study included 38 patients (29 male & 9 female) with mean age of 33 years (10–71 years). Indications for direct percutaneous embolization were noted. Patients demography, details of endovascular procedure, complications & clinical outcomes were evaluated. Patients were followed up for recurrence of PSA & symptoms (mean follow up: 1–24 months).

Results: Etiology of PSA was pancreatitis ($n=30$), trauma ($n=4$) postoperative ($n=2$) and incidentally detected in 2 cases. 17 patients had difficult catheterization, 12 patients had prior embolization of feeding artery, in 8 patients feeding artery was not identifiable on angiography and 1 patient had common hepatic artery dissection. NBCA (N-butyl cyanoacrylate) with lipiodol was used in 28 (73.7%) patients, coils were used in 1 (2.6%) patient and both coils & NBCA were used in 9 (23.7%) patients. Embolization of PSA was successful in all cases except in one case. Recurrent PSA noted in one case. Nontarget site recurrence was seen in 3 cases. Self-limiting splenic infarct was seen in 6 patients. Mild abdominal pain was noted in patients embolized with NBCA. 1 patient each developed splenic and liver abscess requiring percutaneous drainage.

Conclusion: Direct percutaneous puncture and embolization is a safe & effective treatment of visceral PSAs and can be considered as an alternative treatment in patients with a failed endovascular approach.

P-790

Hepatic pseudoaneurysm formation after blunt and penetrating traumatic liver injury: a level 1 trauma centre experience

N.R. Patel¹, D. Mallon², A. Sandhu², A. Mehdi², E. Dick², N. Batrick³, E. Kashef¹

¹Interventional Radiology, Imperial College Healthcare NHS Trust, London, UK, ²Radiology, Imperial College Healthcare NHS Trust, London, UK, ³Major Trauma Centre, Imperial College Healthcare NHS Trust, London, UK

Purpose: Hepatic pseudoaneurysm (HPA) is a potentially life-threatening sequela of liver trauma. At our institution, we have developed a follow-up CT imaging protocol for solid organ injuries at 48–72 hours to assess HPAs and other vascular abnormalities.

The aim was to determine the incidence and factors associated with the development of HPAs following liver trauma using CT angiography.

Material and methods: A retrospective analysis was performed in a cohort of patients admitted to St Mary's Hospital following liver trauma between 2014–2018. From the Trauma Audit and Research Network data and RIS/PACS, information on patient demographics, mechanism

of injury, severity of injury (ISS and AAST), CT findings and interventional procedures were collected.

Results: During the study period, 149 major trauma patients were admitted with liver injuries (mean age 35.6 years). Mean time to follow-up CT was 46.1 hours. Follow-up CT identified 8 (5.4%) HPAs and 1 (0.7%) arteriovenous malformation. 6 (66.7%) were following blunt injury and 3 (33.3%) following penetrating injury. 6 (66.7%) of these patients were treated with embolisation. In a multivariable logistic regression analysis, neither ISS nor AAST were associated with HPA formation. Both ISS (OR 1.06 [1.02, 1.09; $p=0.002$]) and AAST (OR 2.24, [1.31, 3.83; $p=0.003$]) however, were associated with the requirement for HPA embolisation.

Conclusion: Follow-up CT angiography is important for the diagnosis of HPA given the high rate of intervention. The requirement for endovascular treatment of HPA was associated with ISS and AAST, and therefore these scores may help in the early identification of patients who are likely to require intervention.

P-791

The minimally invasive management of pancreaticoduodenal artery aneurysm and bleeding associated with median arcuate ligament syndrome

T. Oda¹, M. Tsurusaki², M. Wakana², A. Suzuki², I. Numoto², T. Kadoba³, Y. Yagyu², N. Kashiwagi², K. Ishii²

¹Radiology, Kindai Hospital, Osakasayama, JP, ²Radiology, Kindai University, Faculty of Medicine, Osakasayama, JP, ³Radiology, Tenri Yorodu Soudansho Hospital, Tenri-city, JP

Purpose: Median arcuate ligament syndrome (MALS) can be associated with development of pancreaticoduodenal artery aneurysm and bleeding. However, there are few reports mentioning aneurysm management. The aim of this study is to retrospectively assess the management of MALS-related aneurysm and bleeding.

Material and methods: Fifteen patients who had aneurysms or showed bleeding associated with MALS between 2014 and 2018. We divided into two groups; non-treatment group (group N, that was included in the patients with small aneurysm or the unknown bleeding portion; $n=6$) and treatment group (group T, that was included in the patients with large aneurysm or pseudoaneurysm formation; $n=9$). The large or small aneurysm was distinguished by diameter of aneurysm-parent-vessel ratio as more or less than 3. We examined its validity as to whether or not treatment is necessary between two groups. During follow-up period, the bleeding control rate and the cumulative survival rate were calculated between two groups.

Results: The median follow-up periods were 655.3 days for the group T and 527.5 days for the group N. During follow-up period, there was no significantly difference both of bleeding control and survival rates between group N and T (100/100%, 100/100%), respectively. None of the patients developed adverse events requiring therapeutic intervention. In the group T, transcatheter arterial embolization (TAE) was performed in all patients.

Conclusion: We experienced that 15 patients with aneurysm or retroperitoneal bleeding associated with MALS. Our indication of treatment may be reasonable, and TAE was effective, minimally invasive control of active retroperitoneal bleeding or prevention of bleeding from MALS related aneurysms.

P-792

Role of immediate endovascular treatment in early artery complications after pediatric liver transplantation

M. Gonzalo Carballes¹, M.A. Rios-Vives¹, I. Díez Miranda², C. Gonzalez-Junyent², J.C. Correa Zapata², D. Barnés², J. Quintero Bernabeu³, R. Charco Torra³, M. Pérez Lafuente²

¹Radiology, Hospital Universitari de la Vall d'Hebrón, Barcelona, ES,

²Interventional Radiology, Hospital Universitari de la Vall d'Hebrón,

Barcelona, ES, ³Pediatric Liver Transplant Unit, Hospital Universitari de la Vall d'Hebrón, Barcelona, ES

Purpose: Early hepatic artery complications (EHAC) after liver transplantation (LT) are the most severe complications. The mainstay of therapy was urgent surgery. Recently, endovascular therapies have shown encouraging results. The aim of this study was to assess the effectiveness and safeness of immediate endovascular treatment.

Material and methods: From 2003 to 2017, 152 pediatric LT were recorded at our institution. Retrospective study of 10 patients (6.5%) with EHAC (in the first 15 days) and endovascular treatment as primary therapy including: intra-arterial fibrinolysis and/or vasodilators, angioplasty and stent placement. We analyzed the endovascular complications during the procedure, graft and patient survival and biliary complications during follow-up.

Results: Mean age: 4.5 years. Time from LT to endovascular treatment was: ≤ 1 hour (straight from the theater) ($n=6$), first 24 hours ($n=2$), first 48 hours ($n=1$) and at 14 days ($n=1$). Type of vascular complication: thrombosis ($n=8$), stenosis ($n=1$) and spasm ($n=1$). Technical success in 7 patients (70%) with arterial patency after one procedure, three of them developed biliary complications. Three patients (30%) needed more than one procedure, two of these developed biliary complications. No intraprocedure complications were recorded in 9 patients (90%). One patient had intraprocedure self-limited contrast leakage. The mean follow-up period was 44.6 months (2months–15years). Survival rate of 90%. Only one patient died during follow-up. No retransplantations recorded.

Conclusion: Although classic treatment for EHAC after pediatric LT was surgical, our statistics suggest that immediate endovascular treatment using intraarterial fibrinolysis and PTA is effective and safe. Despite our results, further studies should be done.

P-793

Percutaneous glue embolization as salvage therapy for pseudoaneurysmal hemorrhage

R.B. Robinson, M. Hsu, S. Berkowitz, S. Mehta
Vascular and Interventional Radiology, Beth Israel Deaconess Medical Center/Harvard Medical School, Boston, MA, US

Learning objectives:

1. Transarterial embolization for pseudoaneurysmal hemorrhage can be challenging when feeding vessel tortuosity is present or there is persistent flow post coil embolization.
2. Percutaneous glue embolization can be used as a salvage technique.
3. Ultrasound or Cone-Beam CT needle guidance may be used for direct percutaneous access.

Background: In the setting of visceral pseudoaneurysms, factors such as severe vessel tortuosity and persistent filling or recanalization after transcatheter embolization may necessitate prolonged selective angiography and repeat procedures. Percutaneous access and embolization with N-butyl cyanoacrylate as an embolic agent can provide permanent embolization and expedite procedure time.

Clinical Findings/Procedure Details: We present 3 patients with pseudoaneurysms who were successfully treated with percutaneous glue embolization. In one case, extreme tortuosity of the gastropiploic artery resulted in a more favorable approach via ultrasound-guided direct needle access followed by glue embolization. In another case of a right

hepatic artery pseudoaneurysm, a previous attempt at direct access with thrombin injection had resulted in recanalization. In the third case, percutaneous needle access was obtained within a mycotic pseudoaneurysm of a left upper lobe pulmonary arterial branch due to continued filling after coil embolization. Cone-beam CT and 3D (cone-beam) fluoroscopic needle guidance were used to guide needle placement. In each case, glue embolization with dilutions ranging from 2:1 to 5:1 (lipiodol:glue) resulted in definitive treatment.

Conclusion: Ultrasound and fluoroscopic-guided percutaneous glue embolization is a viable alternative to transarterial embolization in difficult cases complicated by vessel tortuosity or persistent pseudoaneurysmal filling after embolization. In appropriate patients, this technique can provide definitive treatment while shortening the procedural time.

P-794

Image-guided interventions in renal transplants

T.J. Cavenagh¹, J.-Y. Chun¹, U. Patel²

¹Radiology, St. George's Hospital, London, UK, ²Department of Radiology, St. George's Hospital and Medical School, London, UK

Learning objectives:

1. Review common vascular and non-vascular complications of renal transplantation and indications for treatment
2. Consider the timeline of common complications and the diagnostic process
3. Discuss image-guided treatment options including their outcomes and limitations
4. Summarise our experience of interventional radiology procedures related to common graft complications. Common pitfalls will be discussed and how to avoid them.

Background: Renal transplantation is the treatment of choice for patients with end-stage renal failure. It is associated with dramatic improvement in quality of life and survival rates in comparison to long-term dialysis. Despite many advances in surgical technique and immunotherapy, renal transplants are at risk of developing post-operative complications which may result in graft dysfunction. Diagnostic imaging and image-guided interventions play a pivotal role in early diagnosis and management of both vascular and non-vascular complications. In many cases, surgery can be avoided resulting in reduced morbidity while achieving long-term improvement in graft function and patient survival.

Clinical Findings/Procedure Details: The following graft-related complications, diagnosis and associated interventional radiology treatment options will be discussed:

1. Vascular – transplant artery stenosis, iatrogenic renal arteriovenous fistula or pseudoaneurysm, acute haemorrhage and Page kidney
2. Non-vascular – transplant ureteral obstruction, anastomotic leak, peri-graft fluid collections

Conclusion: This educational exhibit provides a comprehensive review of common and clinically relevant renal transplant complications and their successful management by minimally-invasive image-guided techniques.

P-795

Advanced interventions of the transplanted kidney

O. Sarioglu, A.E. Capar, U. Belet

Interventional Radiology, Tepecik Training and Research Hospital, Izmir, TR

Learning objectives:

1. To review the complications of renal transplant,
2. To demonstrate the vascular and non-vascular interventional radiology techniques that can be performed on transplanted kidneys,
3. To manage with renal transplant complications.

Background: Renal transplantation is the favorite option in patients with end-stage renal disease. Nonvascular complications (ureteral obstruction,

leak, fluid collections) appear in 4-8% of patients, and vascular complications (renal artery stenosis, arteriovenous fistula, pseudoaneurysm, renal vein thrombosis) occur in 1-2%. These complications affect morbidity and mortality significantly. Advancements in interventional techniques have made the transplant complications manageable without surgical procedures. In this poster, we illustrated a variety of advanced interventions to treat renal transplant complications.

Clinical Findings/Procedure Details: We used a case-based approach to demonstrate advanced interventional techniques for the management of renal transplant complications. Percutaneous nephrostomy was performed in a patient with urinary obstruction. Percutaneous nephrostomy, ureteral stent placement, and balloon ureteroplasty were performed in a renal transplant recipient with ureteral stricture occurred after inguinal hernia repair. Renal artery stenosis and an arteriovenous fistula after biopsy were treated with stent placement and embolisation, respectively. Also, renal artery embolisation by means of coils and absolute ethanol was performed in a patient with graft intolerance syndrome.

Conclusion: Improvements in surgical techniques and immunosuppressive treatments have brought better long-term outcomes in renal transplant recipients. However, urologic and vascular complications do not occur rarely. Interventional radiology has an essential role in both evaluation and management of these complications.

P-796

Pictorial essay on the indications, angiographic appearances and the technique of renal artery embolization

N.W. Nicholas, J. Barber, S. Shaikh

Department of Radiology, Bradford Royal Infirmary, Bradford, UK

Learning objectives:

1. To learn about the indications, angiographic appearances and the technique of renal artery embolisation (RAE).
2. To have an understanding of the different embolisation agents used in RAE

Background: RAE is a procedure performed to control either active haemorrhage from the kidney in conditions such as trauma, iatrogenic injury, bleeding from tumours and post-nephron-sparing surgery but also as prophylaxis in certain renal masses. While the technique of RAE is relatively standard, the angiographic appearances and the choice of embolisation agents vary with the aetiology. This exhibit will illustrate the common and uncommon causes of RAE encountered in day-to-day practice and the techniques applied in each case.

Clinical Findings/Procedure Details: We conducted a retrospective audit and analysed all the RAE procedures performed at our institution in the last nine years. Thirty-eight patients underwent renal angiograms of which 36 embolisation procedures were carried out. The mean age of the population was 57.5 with a male-to-female ratio of 1.2:1. The overall technical success was 97.2%. The most common indications were post-renal biopsy (9/38), haematuria resulting from renal tumours (6/38), post-Urosurgery (4/38) amongst others. Most common embolisation agents were coils (25/38) followed by a combination of coils and particles (5/38).

Conclusion: Although the technique of RAE is relatively standard between different interventionists, the knowledge and the understanding of different indications, angiographic appearances and the application of the different type of embolisation agents are essential for an endovascular specialist to perform this procedure with confidence. This pictorial essay will provide a one-stop review of performing a successful RAE procedure.

P-797**Pictorial review: vascular complications of renal transplantation****C. Hazar, E. Palkhi, S.J. Ong, S. Puppala***Radiology Department, The Leeds Teaching Hospitals, Leeds, UK***Learning objectives:**

1. Review common vascular complications following renal transplantation.
2. Review imaging pathways of renal transplants.
3. List important imaging findings of vascular complications.
4. Discuss treatment options of vascular complications of renal transplantation

Background: Vascular complications after renal transplantation is not uncommon and can be the cause for graft loss. UK wide five year graft survival rate is 86%. Vascular complication can be successfully treated with endovascular techniques by interventional radiologists.

Clinical Findings/Procedure Details: Vascular complications can be classified into two main groups as arterial and venous. Arterial complications also include proximal stenoses due to aortoiliac disease. Previously main transplant renal artery complications reported between 3-25%. Venous complications are less well described in the literature. Arterial complications include stenosis, thrombosis, kinks, dissections, pseudoaneurysms and artery to vein fistulas. Main complications of the transplant renal vein includes thrombosis. This pictorial review will explain these complications with relevant imaging findings and treatment options.

Conclusion: Early recognition and treatment of vascular complications of renal transplantation can be graft and/or life saving.

P-798**The use of interventional radiology in treating post-operative complications in pediatric kidney transplant patients****M. Elango, P.A. Kotta***School of Clinical Medicine, University of Cambridge, Cambridge, UK***Learning objectives:**

1. Review the vascular and non-vascular interventional methods used on complications post pediatric kidney transplant
2. Review the relative indications for intervention radiology over surgical treatment in these patients

Background: Approximately 1375 children (aged <21) develop end stage renal failure each year in the US and there were 861 pediatric kidney transplants performed in 2016. Vascular complications are common with arterial stenosis being the most common issue post-transplant and thrombosis being the third most common cause of graft failure. Complications can also occur in the renal pelvis and ureters and are seen in up to 13% of patients. These complications have both surgical and interventional radiology treatment options with the latter becoming more widely used.

Clinical Findings/Procedure Details: Percutaneous transluminal angioplasty is the most common first line treatment of renal artery stenosis but there is some evidence for the use of cutting-balloon angioplasty in certain cases. Thrombosis of the renal vessels can be treated with catheter-direct thrombolysis or surgical thrombectomy. Nephrostomies and ureteroplasty can be used to treat some non-vascular complications post-transplant. The indications, treatment outcomes and potential complications for the interventional radiology treatment options will be reviewed and cases from the literature will be presented.

Conclusion: Pediatric kidney transplant present a different set of complications than adults and it is vital to understand the interventional radiological treatment options in these patients. Increasing graft survival is crucial as these patients will outlive their graft and promptly delivered IR treatment will improve patient outcome.

P-799**Median arcuate ligament syndrome: what does the radiologist need to know?****E.Y.A. Palkhi, C. Hazar, N.W. Nicholas, J. Barber***Department of Radiology, Bradford Royal Infirmary, Bradford, UK***Learning objectives:**

1. Anatomical basis of MALS
2. Role of imaging including CT angiography, ultrasound, MRA and mesenteric angiography in diagnosis and assessment
3. Evaluation of secondary effects of MALS; including collateral vessels, preferential flow, detection of visceral aneurysms and acute bleeding
4. Individualised stepwise treatment pathways to consider based on symptoms and presentation; including surgery, endovascular stenting and embolization of aneurysms.

Background: Median arcuate ligament syndrome (MALS) is caused by extrinsic compression of the coeliac trunk by the MAL. Patients often present with the classical triad of chronic postprandial abdominal pain, weight loss/epigastric bruit and radiological confirmation of coeliac axis compression (>50%).

Clinical Findings/Procedure Details: The diagnosis and complications of MALS employs a combination of mesenteric angiography, CT angiography, MRA or, in selected patients, spectral doppler ultrasound. Complications include formation of collateral pathways, visceral aneurysms and acute bleeding due to aneurysmal rupture.

The treatment pathway of MAL and aneurysms is a controversial subject and often is tailored to the patients presentation and imaging. The primary treatment involves surgical transection of the MAL and stent-angioplasty of the coeliac artery, however in-patient's who present with complications for instance a ruptured aneurysm of the collateral pathways, the treatment pathway may be reversed.

Conclusion: Vascular imaging and intervention plays a central role in the diagnosis, complications and treatment planning.

P-800**Endovascular treatment of acute adrenal bleeding****G. Rafart Martínez, J. Sampere Moragues, G.A. Tovar Felice, V. Benito Santamaria, P. Puyalto De Pablo, A. García Gamez***Radiology, Germans Trias i Pujol, Badalona, ES***Learning objectives:**

1. To review the normal vascular anatomy of the adrenal gland and its most common variants.
2. To describe the imaging findings of acute adrenal bleeding (AAB) using CT and conventional angiography.
3. To report our experience in the endovascular treatment of AAB in 3 patients.

Background: AAB is a rare entity, secondary to an adrenal mass spontaneous hemorrhage or to abdominal trauma, representing 1-2% of the total of visceral traumatic bleeding.

The adrenal gland is irrigated by three arteries: superior, middle and inferior adrenal arteries, branching from the inferior phrenic artery, abdominal aorta and renal artery, respectively. The venous drainage consists, mainly, of a single vein, where right drains in the inferior vena cava and left in the renal vein. These small caliber arteries are recognized by conventional angiography in 57-92% of the cases

Using CT, AAB can be identified as an well-defined, heterogeneous, non enhancing adrenal gland mass secondary to hematoma, which can be associated to retroperitoneal fat trabeculation and active contrast extravasation.

Clinical Findings/Procedure Details: AAB can be identified as contrast extravasation after adrenal arteries selective catheterization. Once the bleeding vessel is identified, different materials, such as microcoils, microparticles or N-butyl-cyanoacrylate (NBCC), can be used for embolization.

Three patients with AAB, using these three different embolization materials, are reported.

Conclusion: Adrenal vascularization normal anatomy knowledge and pre-treatment imaging assessment by CT, are essential to plan and select the best embolization material in order to achieve a safest percutaneous procedure with further better vessel occlusion results, in patients with AAB.

P-801

Gas formation after renal ischaemia

J. Salvador¹, E. Lonjedo², E. Casula¹, J. Gomez¹, A. Ruiz¹

¹Radiology, University Hospital Dr Peset, Valencia, ES, ²Sección de Radiología Vascular e Intervencionista, Servicio de Radiología, Hospital Universitario Dr. Peset, Valencia, ES

Learning objectives: To illustrate the appearance of gas in renal tissue after therapeutic embolization or spontaneous thrombosis.

Background: The presence of gas in the kidney is described in cases of ureteropyeloenteric fistulas, emphysematous pyelonephritis, and in serious infections with abscess formations in the renal parenchyma. The "post-infarction syndrome" of pain, fever, nausea, and leukocytosis has also been well documented. The formation of gas in the infarcted tissues without clinical evidence of abscess may appear as part of the syndrome.

Clinical Findings/Procedure Details: Various patterns of gas are seen after therapeutic embolization or spontaneous thrombosis. A branching serpiginous linear distribution of gas may be seen in renal vessels after acute ischaemia without associated clinical signs to suggest infection. Gas that fills the potential spaces occurs as a result of tissue infarction quite similar to post chemoembolization or ethanol ablation therapy for hepatocellular carcinoma. This appearance should be well differentiated from localized collection of gas in a necrotic-infarcted that appears as globular foci on CT with clinical signs of underlying infection.

Conclusion: The presence of gas within the renal parenchyma after renal ischaemia is not uncommon. The infarcts can explain the presence of postembolization fever and thereby decrease concern for an additional source of infection. However, the presence of an air/fluid level should raise concern for the presence of renal abscess.

P-802

Endovascular management of hepatic arterial complications after orthotopic liver transplant (OLT) – review

R. Sundareyan¹, W.R. Thomas², S. Walker³, C. Aleman³, H. Mehrzad⁴

¹Interventional Radiology, Queen Elizabeth Hospital, University Hospitals Birmingham, Birmingham, UK, ²Radiology, University of Wales Hospital Cardiff, Cardiff, UK, ³Interventional Radiology, University Hospital Birmingham, Birmingham, UK, ⁴Interventional Radiology, QEHB Hospital, Birmingham, UK

Learning objectives:

1. To review the clinical and imaging features of early and late hepatic arterial complications post OLT
2. To compare the clinical course and outcomes between patients treated with Interventional Radiology and surgery
3. To review the recent trend and current status of IR in the management of post transplant hepatic arterial complications

Background: Liver transplantation has become standard therapy for end-stage liver disease with the improvements in surgical technique and immunosuppressive treatment. Hepatic arterial complications mainly thrombosis is still one of the leading cause of graft dysfunction and failure. Acute and hyperacute hepatic arterial complications are traditionally treated surgically and IR options are preferred for late complications. With recent improvements, evolving literature suggests increased role of interventional radiology even in acute hepatic arterial thrombosis.

Various IR options like intra arterial thrombolysis, balloon angioplasty, stenting and colining of aneurysm are used in treating the hepatic arterial complications.

This study reviews the current trend and status of both IR and surgery in this regard.

Clinical Findings/Procedure Details: Retrospective analysis of our institutional cohort cases who had hepatic arterial complications after orthotopic liver transplant.

To review related current literature.

Conclusion: There is increasing use of IR options in treating hepatic arterial complications after liver transplant hepatic arterial complications. Understand the values of both surgical and endovascular treatment of hepatic arterial complications following liver transplant, such as hepatic artery thrombosis, hepatic artery stenosis, hepatic artery pseudoaneurysm, and so on. We will highlight various IR techniques, their limitations and potential complications with selected cases.

P-803

Endovascular treatment of renal artery aneurysms: where do we stand?

M. Cruz, C. Ferreira, P.G. Oliveira, E. Pinto, A. Gil-Agostinho, P. Donato
Serviço de Imagem Médica, Centro Hospitalar e Universitário de Coimbra, Coimbra, PT

Learning objectives: The purpose of this article is to discuss the current endovascular therapeutic options for renal artery aneurysms, illustrated by clinical cases from our institution.

Background: Renal artery aneurysms (RAAs) are an uncommon pathology, with an angiographic prevalence of 0.3-0.7%. Their clinical manifestations include abdominal pain, hematuria, renovascular hypertension, decreased renal function and acute hemodynamic collapse secondary to rupture.

True RAAs are usually associated with fibromuscular dysplasia and atherosclerosis. False RAAs have shown increasing incidence due to the advent of minimally invasive kidney procedures such as biopsy, nephrostomy and percutaneous stone removal.

Clinical Findings/Procedure Details: Currently most RAAs are treated via an endovascular approach due to its minimal invasiveness and reduced morbidity.

The indications for treating RAAs include symptomatic aneurysms, large (> 2 cm) or enlarging aneurysms, aneurysms in pregnant women or antecipating pregnancy, false aneurysms and aneurysms associated with rupture, dissection or arteriovenous fistulas.

In our experience, endovascular therapeutic options consist of:

- N-butyl cyanoacrylate, ethylene vinyl copolymer, gelfoam and coils (false aneurysms)
- Coils (small-necked aneurysms)
- Stent/balloon-assisted coiling and stent grafts (wide-necked aneurysms)
- Flow diverting stents (complex aneurysms that involve the bifurcation points of the main or segmental arteries, allowing preservation of flow to the side branches).

Selecting the appropriate technique is key to provide optimal treatment.

Conclusion: Endovascular therapy represents the first-line treatment of RAAs at our institution, with current data supporting its efficacy and safety. Recent advances in stent technology allow a wider use of endovascular treatment.

P-804

Getting to know SAM

B. Dhillon¹, A. Belkhir², M. Crawford³, M. Lewis³, K.K.Y. Tan³, T. Ali³

¹Radiology, Norfolk & Norwich University Hospital, Norwich, UK, ²Clinical Radiology, Norfolk and Norwich University Hospital, Norwich, UK,

³Norwich Radiology Academy, Norfolk & Norwich University Hospital NHS Trust, Norwich, UK

Learning objectives:

1. To identify the imaging findings in segmental arterial mediolysis (SAM).
2. To acknowledge problems in diagnosis and differentiation from related types of vasculitides.

Background: SAM is an uncommon medium vessel arteriopathy first described in 1976. It has a predilection for mesenteric arteries in the older population but has also been reported in the carotid / coronary arteries in younger patients.

Gold standard of diagnosis is from histopathology, which is invasive. Radiological appearances on CTA are growingly considered pathognomonic and in combination with negative serum vasculitis screens are becoming accepted as the diagnostic criteria.

Clinical Findings/Procedure Details: We present a cohort of 4 patients who presented with acute haemorrhage, and were found to have imaging features of SAM.

Patient 1: 72 year old woman presented with sudden abdominal pain and anaemia. CTA demonstrated multiple aneurysms and stenosis of the marginal artery of Drummond causing transverse colon haematoma.

Patient 2: 66 year old woman presented with vomiting, abdominal pain and anaemia. CTA demonstrated duodenal haematoma with aneurysmal IPDA and GDA.

Patient 3: 85 year old woman presented with abdominal pain. CTA showed multiple aneurysms of GDA and splenic artery.

Patient 4: 58 year old woman presented with abdominal pain. CTA showed subcapsular liver haematoma with pseudoaneurysms of right hepatic artery.

All patients required embolization. 3 patients had negative vasculitis screening. One patient died before testing could be performed.

Conclusion: SAM is a rare but important condition that is becoming more recognised by Interventional Radiologists. Raising awareness of the imaging findings can aid to formulate effective treatment strategies.

P-805

A recurrent celiac trunk aneurysm

A. Borzelli¹, A. Paladini², F. Pane³, F. Amodio⁴, G. de Magistris⁴, E. Cavaglià⁴, R. Niola⁴

¹U.O.C. Radiologia Vascolare ed Interventistica, AORN "A. Cardarelli", Naples, IT, ²SCDU Radiologia Diagnostica ed Interventistica,

AOU "Maggiore della Carità"- Novara, Novara, IT, ³Advanced Biomedical Sciences, AOU Federico II Napoli, Naples, IT, ⁴Vascular and Interventional Radiology, Cardarelli Hospital, Naples, IT

Clinical History/Pre-treatment Imaging: 57-year-old man with recurrent severe abdominal pain. CT-angiography of the abdomen showed a big aneurysm of the celiac trunk measuring 60x57 mm, with most of its sac filled with thrombus. Its visceral artery branches were occluded at their origin but revascularized by collaterals coming from the pancreaticoduodenal artery

Treatment Options/Results: Endovascular exclusion of the aneurysm was performed by transcatheter embolization employing metallic coils (10 to 18mm). The patient was asymptomatic after the procedure and discharged 3 days after embolization. Ten months later, the patient came back to hospital for new episodes of abdominal pain because of the recur of the aneurysm of the celiac trunk, measuring 44x46 mm, with an opacified lumen measuring 27x26 mm, due to the deployment of the metallic coils ahead into the fund of the sac. A second embolization was

performed releasing multiple metallic coils (14 to 16mm) and, to completely embolize the in-flow of the aneurysm and completely exclude it from arterial flow, by releasing a 16 mm Amplatzer-plug. After 2 years from the embolization, the patient is still asymptomatic.

Discussion: In the first embolization, the only employment of metallic coils has not proven to be effective, as they have been pushed ahead into the fund of the sac of the aneurysm by the high pressure of aortic blood flow. The employment of Amplatzer-plug, instead, allowed to definitively seal the celiac trunk and the in-flow of the aneurysm

Take-home points: Transcatheter endovascular embolization is an effective and minimally invasive technique in the treatment of visceral aneurysms. An effective embolization requires not only the filling of the sac but the exclusion of in-flow and out-flow tracts of the aneurysms to avoid late revascularization

P-806

Successful endovascular embolization of an unusual spontaneous bleeding: accessory spleen

F. Pane¹, E. Cavaglià², F. Corvino³, M. Silvestre⁴, M. Coppola¹, A. Borzelli⁵, A. Paladini⁶, F. Amodio², G. de Magistris², G. Cangiano², F. Giurazza⁷, R. Niola²

¹Advanced Biomedical Sciences, AOU Federico II Napoli, Naples, IT,

²Vascular and Interventional Radiology, Cardarelli Hospital, Naples, IT,

³Department of Advanced Biomedical Sciences, Diagnostic Imaging

Section, Federico II University, Naples, IT, ⁴Diagnostica per Immagini e Radioterapia, AOU Federico II, Naples, IT, ⁵U.O.C. Neuroradiologia,

AORN, Naples, IT, ⁶SCDU Interventional Radiology, "Maggiore della Carità" Hospital, Novara, IT, ⁷Interventional Radiology, Ospedale Antonio Cardarelli di Napoli, Naples, IT

Clinical History/Pre-treatment Imaging: A 42-years-old woman with no recent trauma, was admitted to emergency department. She was affected by left upper abdominal pain, sweatiness and anemia. She underwent two surgeries 20 years before (splenectomy and abdominal adhesions). US showed an accessory spleen with ipoechoic area inside and surrounded by iso-ipoechoic fluid spill. CECT detected a little active bleeding inside accessory spleen and confirmed perisplenic liquid fluid spill

Treatment Options/Results: Due to previous surgeries in the splenic loggia, the surgeon preferred an endovascular treatment. A Celiac Trunk angiography performed with a Cobra catheter demonstrated normal branching pattern and two hypertrophic artery branches arising from the residual portion of the splenic artery that feed the accessory spleen hilus. We performed coaxial ultrasensitive catheterization of hilar branches and no active bleeding was detected. We embolized both vessels using pushable and detachable microcoils.

After embolization neither arterial supply nor further symptoms occurred. CECT at 2-day follow-up demonstrated spleen hypoperfusion and reduction of fluid spill.

Patient was resigned after one week with normal Hb level and US at 1-month follow-up detected heterogeneous ipoechoic accessory spleen with no blood sign

Discussion: Spontaneous bleeding from accessory spleen is rare and 20 cases have been reported in literature, most of them treated with surgery. A minimally invasive endovascular embolization was permitted by previous surgery in the splenic loggia. Endovascular approach compared to "Open Surgery" caused less complications, determined lower period of hospitalization and a reduction of health cost

Take-home points: Endovascular Embolization is a valuable tool in non-operative management of patients affected by accessory spleen haemorrhage.

P-807

A coil embolization using micro-balloon assistance combined with the double-catheter technique for a large entry and re-entry false lumen of the spontaneous isolated superior mesenteric artery dissection

H. Yamaguchi¹, S. Murata², T. Ueda³, T. Mine⁴, S. Onozawa⁵, S.-I. Kumita³

¹Radiology, Nippon Medical School Tama Nagayama Hospital, Tokyo, JP, ²Radiology/Interventional Radiology Center, Teikyo University Chiba Medical Center, Chiba, JP, ³Radiology, Nippon Medical School, Tokyo, JP, ⁴Radiology, Nippon Medical School Chiba Hokusoh Hospital, Chiba, JP, ⁵Radiology, Teikyo University Mizonokuchi Hospital, Kawasaki, Kanagawa, JP

Clinical History/Pre-treatment Imaging: Spontaneous isolated visceral artery dissection (SIVAD) is rarely encountered and resulting in an incidence rate of 0.68% among all abdominal contrast-enhanced computed-tomography (CE-CT) scans taken for acute abdominal symptoms. We describe an 80-year-old man with an acute abdominal pain who presented with the spontaneous isolated superior mesenteric artery (SMA) dissection measuring 35.0x6.6 mm diameters in CE-CT scan. After admission, an abdominal pain was progressive, and CE-CT scan revealed a progress of the dissection.

Treatment Options/Results: For the coil embolization, detachable coils were placed in the false lumen of the SMA under the micro-balloon occlusion at the point of re-entry and entry through the true lumen to prevent coil migration via the bilateral femoral approach. Technical and clinical success was obtained without any serious adverse events.

Discussion: Treatment for SIVAD has evolved from open surgery to endovascular intervention. The diameter of entry and re-entry was large; we speculated that it is difficult to reduce the blood flow in the false lumen even if the bare-stent is implanted. Covered stent placement for the dissection is unsuitable in a strongly curved vessel and peripheral vessel, and long-term patency is poor. Furthermore, a covered stent placement will occlude the unnecessary branch vessels.

Take-home points: A coil embolization using micro-balloon assistance combined with the double-catheter technique involving a large entry and re-entry false lumen of SIVAD was useful and feasible. This technique can be applied to every vessel dissection in which using a covered stent placement is hesitated.

P-808

Successful transcatheter arterial embolization for traumatic right gastric artery pseudoaneurysm using the balloon assist technique

Y. Murata¹, R. Nakama¹, K. Kato², K. Matsumura³, D. Kaito¹, D. Kujirai¹, Y. Izawa¹, K. Kase¹

¹Department of Emergency Medicine, Saiseikai Utsunomiya Hospital, Utsunomiya, JP, ²Department of Radiology, Saiseikai Utsunomiya Hospital, Utsunomiya-shi, JP, ³Department of Emergency and Critical Care Medicine, Keio University School of Medicine, Tokyo, JP

Clinical History/Pre-treatment Imaging: A 70-year-old male met with a motor vehicle accident and was transferred to our hospital. Contrast-enhanced computed tomography (CT) showed a traumatic mesenteric injury and right gastric artery pseudoaneurysm. Conservative management was selected instead of transcatheter arterial embolization (TAE) as the patient had severe cognitive disease. However, since follow-up CT at day 4 and day 14 showed continuous enlargement of the pseudoaneurysm, we decided to perform TAE.

Treatment Options/Results: We selected a 5 Fr sheath for the right femoral artery and a shepherd hook catheter was used to select the celiac artery. We succeeded in detecting the right gastric artery pseudoaneurysm, although we could not isolate it due to tortuosity of the vessel. Using the micro-balloon catheter via the left femoral artery, we successfully

deployed the micro-guidewire into the right gastric artery. We embolized the proximal, sac, and distal sites of the pseudoaneurysm with micro-coils and the pseudoaneurysm resolved.

Discussion: To the best of our knowledge, this is the first report of TAE for traumatic right gastric artery pseudoaneurysm using a balloon catheter. Compared to the other branches of the celiac artery, such as the left gastric artery, the right gastric artery is small; planning the strategy prior to catheterization is difficult, since it is often indistinguishable on CT. In several case reports, the balloon catheter technique has been shown to be useful for TAE in these small artery branches originating from a major artery that is known to be technically challenging.

Take-home points: In blunt trauma cases, traumatic right gastric artery pseudoaneurysms are rarely encountered. Due to its anatomical characteristics, the balloon catheter technique can be useful to perform TAE.

P-809

Retrograde access using the pancreaticoduodenal arcade to embolise aneurysms in Sutton Kadir syndrome

R. Chidambaram, J. Soares

Radiology, Sir Charles Gairdner Hospital, Nedlands, WA, AU

Clinical History/Pre-treatment Imaging: Sutton and Lawton first described the association between stenosis of the coeliac axis and aneurysm formation in the collateral supply of the coeliac axis territory in 1973. We present four emergency cases treating aneurysms of the pancreaticoduodenal artery (PDA) and gastroduodenal artery (GDA) that are secondary to coeliac axis stenosis.

Treatment Options/Results: In all four cases, the aneurysms were treated via a retrograde approach through the superior mesenteric artery (SMA). Various embolics; Histoacryl-Lipiodol and microcoils were used for embolisation depending on the morphology of the aneurysm. Technical success was achieved in all cases.

Discussion: It is more challenging when embossing the 'front' and 'back' door through retrograde access, which is the only means of treating this disease in Sutton Kadir syndrome.

Take-home points: Endovascular embolization is a minimally invasive alternative to treating visceral aneurysms in emergency scenarios.

P-810

Successful endovascular treatment of acute mesenteric ischemia concomitant with active bleeding from middle colic artery

Y. Usami

Radiology, Sapporo Teishinkai Hospital, Sapporo, JP

Clinical History/Pre-treatment Imaging: A 70-year old man whose chief complaint was a sudden upper abdominal pain, which occurred early in the morning. In the afternoon, he developed back pain and shock status. He was immediately transferred to our hospital. A CT scan showed hemorrhagic ascites and a hematoma around the pancreas, which contained abnormally dilated vessels. Additionally, the SMA was completely occluded with thrombus from proximal area, but the distal side was slightly visible via the developed pancreatic arcade. The celiac artery was narrow and there was no intestinal necrosis.

Treatment Options/Results: A Laparotomy seemed to be high risk, so an emergency transarterial embolization and an angioplasty was planned. After the PTA, a VIABAHN (5mm6cm) was placed in the SMA. Any evidence of bleeding areas was not evident after a selective angiography. Since a pseudoaneurysm was observed from MCA on CT on POD1, a selective embolization procedure was planned on POD3. Although the microcatheter was attained just before a pseudoaneurysm of MCA, it was unreachable to the distal end of pseudoaneurysm. Therefore, an approach from the IMA side was added and the coil embolization (isolation) was successful. Intestinal necrosis was not observed. He was discharged from POD127.

Discussion: Developed pancreatic arcade enable endovascular treatment to avoid intestinal necrosis. MCA aneurysm was thought to be originally present relating to a celiac axis narrowing, and hemodynamic change caused by SMA occlusion might lead to MCA aneurysm rupture.

Take-home points: In cases that thrombolytic therapy is contraindication, PTA and stenting in SMA might be useful.

P-811

Left omental artery bleeding due to segmental arterial mediolysis successfully treated with coil embolization using triple coaxial system through celiac axis stenosis

T. Nishiyama¹, D. Yamada¹, M. Yabuta¹, K. Yagihashi²

¹Department of Radiology, St. Luke's International Hospital, Tokyo, JP,

²Department of Radiology, St. Marianna University School of Medicine, Kawasaki, Kanagawa, JP

Clinical History/Pre-treatment Imaging: A healthy 54-year-old man presented with hemorrhagic shock and abdominal pain. On contrast-enhanced CT, distal portion of the left omental artery, which branched from splenic artery and did not directly communicate with gastroepiploic artery, developed aneurysmal dilation with hemoperitoneum. Diagnosis of segmental arterial mediolysis (SAM) was made.

Treatment Options/Results: Transarterial embolization (TAE) was planned. Celiac and splenic artery angiography revealed a pseudoaneurysm formation of the distal left omental artery with aneurysmal dilatation. Due to its smallness and tortuosity, triple coaxial system (4.2 Fr catheter, 2.9/2.85 Fr microcatheter and 2.0 Fr microcatheter) was selected to easily approach the bleeding point. TAE was successfully performed using coils. He discharged on fifth hospital day without rebleeding and newly SAM lesions.

Discussion: Few cases of omental artery embolization have been reported; partly because the number of such cases is rare, partly because surgical partial omentectomy is not difficult for surgeons and partly because it may be difficult to cannulate such small and tortuous omental artery. Previous cases similar to the presented case unfortunately underwent proximal coil embolization or NBCA injection. Herein, triple coaxial system made it possible to cannulate the deeply distal side of left omental artery and to accomplish hemostasis by isolation technique.

Take-home points: SAM can rarely affect omental artery and TAE can be a treatment of choice. Using triple coaxial catheter system may be effective in embolization of deeply distal portion of a small and tortuous vessel such as the left omental artery in the presented case here.

P-812

Embolization of large, wide-neck bifurcation aneurysms of the renal artery

C. Scheurig-Muenkler¹, H. Ruhnke², T.J. Kroencke³

¹Radiology, Universitätsklinikum Augsburg, Augsburg, DE, ²Radiology, Klinikum Augsburg, Augsburg, DE, ³Department of Diagnostic and Interventional Radiology and Neuroradiology, Klinikum Augsburg, Augsburg, DE

Clinical History/Pre-treatment Imaging: We present two cases of incidental wide-neck aneurysms located at the first major bifurcation of the renal artery with a diameter of more than two centimeter. Magnetic resonance angiography was acquired for case planning.

Treatment Options/Results: In the first patient (see images) with two equally large parent vessels of the bifurcation aneurysm we used the Y-configuration double-stenting technique by deploying one Medtronic SolitaireAB stent (6x30mm) in each parent vessel. Then a Penumbra PXslim microcatheter was advanced through the meshes into the aneurysm and embolization was achieved by using ten Penumbra Ruby coils. The second patient presented a larger and a smaller parent vessel, the latter with an unfavourable angulation for stent placement. Both branches were probed and temporarily occluded with suitable balloons (Boston Scientific

Sterling 6x40mm, Medtronic Hyperform 4x7mm) after placing a Penumbra PXslim microcatheter into the aneurysm. Embolization was performed using seven Penumbra Ruby coils. Hereafter an Optimed sinus superflex stent (7x40) was placed into the larger branch to prevent displacement of the coil package. Follow-up imaging one year after treatment showed complete obliteration of the aneurysms, patent parent vessels and no parenchymal infarction.

Discussion: True aneurysms of the renal arteries are a rare entity and may be anatomically challenging. In addition, embolization in such cases is subject to similar assumptions as embolization of cerebral aneurysm. All parent vessels should be kept open and perfusion of the renal parenchyma be preserved.

Take-home points: The adaptation of well-proven neurovascular embolization techniques helps to successfully treat challenging bifurcation aneurysms of the renal arteries.

P-813

Hepatic artery injury caused by biliary stent position change after concurrent chemoradiotherapy

H.N. Lee¹, J.H. Seo¹, W.-H. Lee¹, S.H. Bae², S. Ko³

¹Radiology, Soonchunhyang University Cheonan Hospital,

Cheonan-si, KR, ²Radiology, Inje University College of Medicine, Ilsan

Paik Hospital, Goyang, KR, ³Radiology, Samsung Medical Center,

Sungkyunkwan University School of Medicine, Seoul, KR

Clinical History/Pre-treatment Imaging: A 55-year-old man with locally advanced pancreatic cancer (LAPC) was evaluated as stable disease after neoadjuvant CCRT. Biliary decompression was achieved with 10mm x 6cm Self-Expanding Metal Stents (SEMS) and palliative chemotherapy was administered. After #9 cycle of chemotherapy, the patient presented with abrupt onset anemia and hematochezia. Abdomen CT revealed acute angulation of right hepatic artery compressed by biliary stent. Retrospective analysis of serial follow-up CT during 4 to 12 months after CCRT demonstrated that stent was getting closer to hepatic artery, eventually causing abrupt kinking of artery (Fig. 1).

Treatment Options/Results: Emergent common hepatic angiography revealed contrast extravasation at proximal right hepatic artery, which corresponds to kinking segment on CT (Fig. 2). Because it was unable to negotiate guidewire to distal circulation through kinking segment, limited embolization was performed with 2 microcoils at proximal segment. Follow-up CT after 3 days showed no evidence of hepatic infarction or pseudoaneurysm formation. He was discharged in stable condition.

Discussion: Although neoadjuvant CCRT is increasingly applied in patients with LAPC, there have been only a few reports concerned about the safety of SEMS placement after CCRT. In previous studies, interfractional anatomical change was analyzed focusing on the localization of tumor bed during radiotherapy. This case highlights the careful consideration of anatomic change after CCRT as a potential cause of major bleeding complication.

Take-home points: The possibility of biliary stent position change should be considered after CCRT. Careful scrutiny of anatomical change on follow-up imaging is recommended to prevent unexpected bleeding complication.

P-814

A case of type III congenital renal arteriovenous malformation successfully treated by selective transarterial embolization with triple coaxial system

S. Kasuya¹, T. Uchi¹, H. Kikuchi², J. Toda¹, S. Kato¹, H. Masuda¹, R. Ishikawa¹, T. Nakatsuka¹, N. Kitamura¹, T. Inaoka¹, N. Kamiya³, H. Suzuki³, H. Terada¹

¹Radiology, Toho University Sakura Medical Center, Sakura, JP,

²Gastroenterology, Toho University Sakura Medical Center, Sakura, JP,

³Urology, Toho University Sakura Medical Center, Sakura, JP

Clinical History/Pre-treatment Imaging: A 54-year-old male presented with massive hematuria. He had post-renal renal failure caused by coagula tamponade in the urinary bladder. CT showed a large amount of hematoma from the left renal pelvis to the urinary bladder. Since several dilated vascular structures at the left renal pelvis were seen, AVM of the left kidney was suspected.

Treatment Options/Results: Abdominal angiography showed Houdart type III AVM with multiple arterial feeders, nidus and numerous venous drainers at the left renal hilum. The feeding arteries were superselected by using a microcatheter, and transarterial embolization with N-butyl cyanoacrylate (NBCA) was performed. A microballoon catheter was simultaneously used to prevent a backflow of NBCA in the left renal arteries proximal to the feeding arteries. In angiography after the embolization, the findings of a nidus and early venous shunting were completely disappeared. Hematuria was disappeared just after the embolization as well. The area of renal infarction was small and post-embolization symptoms were mild.

Discussion: In the treatment of AVMs, complete and safe embolization of a nidus is very important. Although NBCA is useful for the treatment of AVMs as a permanent embolic agent among numerous embolic agents, it is very concerned that even healthy arteries may be damaged from an overflow of a permanent embolic agent of NBCA. The triple coaxial system can prevent a drop-off of NBCA adhered to the tip of selective microcatheter when the microcatheter is withdrawn and can provide a safer embolization of AVMs.

Take-home points: Triple coaxial system can provide a safer embolization of renal AVMs.

P-815

Three days of kidney ischemia: what can happen after renal artery endovascular mechanical aspiration thrombectomy?

F. Petrocelli¹, G. Bovio², A. Utili³, N. Camisassi², U.G. Rossi⁴

¹Radiology, San Martino, University Hospital, Genoa, IT, ²Interventional Radiology, San Martino University Hospital, Genoa, IT, ³Radiology and Interventional Radiology, IRCCS San Martino, University Hospital, Genoa, IT, ⁴Diagnostic Imaging Department - Interventional Radiology Unit, E.O. Galliera Hospital, Genoa, IT

Clinical History/Pre-treatment Imaging: A 53-year old woman with stage III renal cell carcinoma and normal renal function underwent left nephrectomy. From the first day after surgery an abrupt decline in renal function was registered with creatinine worsening and anuria. Doppler ultrasound revealed regular parenchymal morphology without hydronephrosis and normal patency of the main renal artery. For persisted anuria and overload volume signs, Renal Replacement Therapy (RRT) was started. On the third day after surgery a Doppler ultrasound and subsequent Multi-Detector Computed Tomography (MD-CT) scan showed the distal occlusion of the right main renal artery and lack of kidney intraparenchymal vascularization. The patient was underwent a renal Digital Subtraction Angiography (DSA) that confirmed the distal occlusion of the main renal artery.

Treatment Options/Results: Continuous vacuum pump assisted aspiration endovascular mechanical thrombectomy was performed with the Indigo CAT6. The procedure was terminated when selective right

renal artery DSA demonstrated good patency of most of renal intraparenchymal arteries. On the sixth day after treatment and diuretic stimulation, urinary output slightly recovered and constantly increased until the eleventh day follow. The patient was discharged dialysis-free, in conservative medical therapy.

Discussion: Although general consensus that early diagnosis and treatment reduce the ischemic injury, controversy exists about the timing of treatment. Nowadays no recommendation exists about the timing of treatment.

Take-home points: The revascularization of an ischemic kidney must always be attempted, even if it is over the first 24 hours. The presence of the collateral supply, as described, often protects the vitality of the kidney, while not allowing the excretory activity.

P-816

Splenic artery aneurysm embolisation; when things go wrong

A. Alsherbini¹, M.J.H. Elhissi², A. Barah³, A. Omar⁴

¹Radiology, Hamad General Hospital, Doha, QA, ²Radiology Department, Hamad Medical Corporation, Doha, QA, ³Clinical Imaging, Hamad Medical Corporation, Doha, QA, ⁴Clinical Imaging, Hamad General Hospital (HGH), Hamad Medical Corporation, Doha, QA

Clinical History/Pre-treatment Imaging: 71-year-old gentleman presented to the ER after suffering a traumatic injury due to fall from stairs. Pan CECT demonstrated an incidental finding of splenic saccular aneurysm measuring 28 mm in diameter.

Treatment Options/Results: The treatment options for splenic artery aneurysm is either coiling or stenting. In this case, a 5 mm V12-Balloon-Expandable covered stent was our choice of treatment. The purpose of using a covered stent was to deploy it across the neck of the aneurysm to occlude the aneurysm sac while preserving flow to the spleen, however after marking the site of stent's deployment and right before deploying the stent the supporting guidewire (super-stiff 0.035 in) disfigured the shape of the splenic artery. Nevertheless, the Stent was deployed and showed satisfactory positioning. Once the wire got removed, the artery returned to its original shape causing dislodgment of the catheter into the aneurysm sac. Multiple coils were then used to embolize the aneurysm sac and the graft.

Discussion: Splenic artery aneurysm is a rare entity however it is the most common among visceral artery aneurysms. It is usually discovered incidentally and only treated in certain condition such as being larger than 20 mm of diameter. The Exclusive options of treatment is Coil-embolization or Stenting. Coil-Embolization remains the favorable option to be used specially when dealing with tortuous vessel.

Take-home points: Coil embolization shall be considered first in treating splenic artery aneurysm.

Stent graft shall not be used for tortuous vessels.

Adjustment of treatment plane should be considered any time during the procedure if needed.

P-817

Retrograde revascularization of a left renal artery proximal occlusion via the left spermatic artery

E.M. Fumarola¹, R. Vercelli², A. Alfonsi³, C. Migliorisi⁴, F. Di Bartolomeo⁵, P.M. Brambilla⁵, D. Volterra¹, F. Barbosa², A.G. Rampoldi²

¹Postgraduation School in Radiodiagnostic, Università degli Studi di Milano, Milan, IT, ²Interventional Radiology, Ospedale Niguarda, Milan, IT, ³Radiology, Campus Biomedico University of Rome, Rome, IT, ⁴Interventional Radiology, ASST Grande Ospedale Metropolitano Niguarda, Milan, IT, ⁵Radiologia, Università degli studi di Milano, Milano, IT

Clinical History/Pre-treatment Imaging: A 45 year old male, with history of hypertension and dyslipidemia presented with signs and symptoms of an hypertensive crisis (BP: 220/130mmHg, headache and chest pain).

An abdominal CT scan demonstrated an occlusive stenosis of the origin of the left renal artery (LRA).

An angiogram was subsequently performed but after multiple attempts to cross the occlusion, a LRA dissection was documented and the procedure was suspended. The patient was dismissed with indications of repeating a CT 8 weeks later with the aim to verify the resolution of the dissection flap.

Treatment Options/Results: Via a right transfemoral approach an aortoiliac angiography was performed which documented the LRA occlusion with revascularization of the kidney from a hypertrophic left spermatic artery (LSA). With ultrasound guidance, a LSA access was made at the level of the spermatic cord and a 4F sheath was positioned. Via a retrograde approach, the LRA occlusion was crossed and the 0.035 guidewire was entrapped in the aorta with a "GooseNeck" snare. Finally, via antegrade, a 6x18mm stent was deployed, and a final angiogram demonstrating the reestablished patency of the LRA.

Discussion: RA stenosis/occlusion can cause progressive renal insufficiency and cardiovascular complications. RA endovascular stenting is a safe and effective procedure with primary patency exceeding 80% at 5 years but may be technically challenging.

The retrograde approach via the LSA may be a valid option in selected cases when the traditional antegrade method is infeasible.

Take-home points: The LSA approach is a feasible option in case of proximal LRA occlusion and can lead to successful revascularization.

P-818

Acute portomesenteric thrombosis treated with pharmacomechanical thrombectomy (PMT) assisted with superior mesenteric arterial (SMA) fibrinolysis

E. Calleja Cartón, A. Alvarez Luque, M. González Leyte, M. Echenagusia Boyra, C. Ballano Franco
Vascular and Interventional Radiology, Hospital General Universitario Gregorio Marañón, Madrid, ES

Clinical History/Pre-treatment Imaging: 58-year-old male with mixed-cryoglobulinemia and hepatitis-C-virus cirrhosis with partial portal vein(PV)thrombosis.Liver transplant(LT)with initial splenectomy performed in 2016and splenic vein (SV)remnant thrombosis.

He came to the Emergency Department in January2019 with a7-days history of abdominal pain,post-prandial fullness and limitation of intake. CT Findings:Chronic thrombosis of the SVwith collateral circulation. Acute thrombosis of the left portal vein(LPV),portomesenteric axis and the superior mesenteric vein(SMV)with its tributaries.Stenosis of the portal anastomosis was also present.

Treatment Options/Results:Venography through right portal vein(RPV) showed complete occlusion ofSMV andLPV as well as severe stenosis in portal anastomosis bypassed through a large collateral.A12 mmHg gradient was measured out.

PMTwas performed using a6-FAngioJet Solvent Omni catheter(Medrad International).

Post-procedural venography showed significant reduction in thrombus burden although complete venous flow was not still restored.Portal anastomosis angioplasty(14mm balloon) and indirect thrombolysis(UK 60.000u/h/24h)via (SMA)was carried out.The24h venography control showed almost complete flow restoration in the portal system added to a complete relief of the patient's symptoms.

Discussion: Post-LT PVTcan significantly reduce both graft and patient survival afterLT and can cause loss of future options for re-LT.The recurrence rate of PVT has reduced from 36% in the early experience to2%-3% in recent years.Once post-LT PVToccurs, treatment is more challenging because alternative portal inflow can be difficult to establish.If PVTappears despite anticoagulation,treatment has to be started as soon as the diagnosis is made,and minimally invasive techniques should be considered. Surgical treatment is considered to be the last therapeutic option.

Take-home points: In post-LTpatients with PVT,Catheter-directed percutaneous PMTassisted with indirect(SMA) infusion of thrombolytic agents may be a safe and effective treatment option.

P-819

Effective catheter-directed thrombolysis in acute superior mesenteric artery thromboembolism

A. Rescigno¹, V. Sica¹, R. Cantarella¹, S. Capece¹, **U. Russo²**

¹Unit of Vascular and Interventional Radiology, Azienda Ospedaliero-Universitaria di Salerno "San Giovanni di Dio e Ruggi d'Aragona", Salerno, IT, ²Department of Medicine and Surgery - Unit of Radiologic Science, Azienda Ospedaliero-Universitaria di Parma, Parma, IT

Clinical History/Pre-treatment Imaging: A 76-year-old woman acceded to our emergency department with acute post-prandial abdominal pain. Clinical history was unremarkable. On admission she presented with tender but soft abdomen, mild hypertension (155/85 mmHg) and sinus rhythm (56 BPM). EKG was normal.

CT scan showed occlusion of the superior mesenteric artery 3 cm after its origin.

The diagnosis of superior mesenteric artery thromboembolism was confirmed on subsequent angiography.

Treatment Options/Results: In case of acute mesenteric ischemia occurring after superior mesenteric artery thromboembolism the possible treatments include:

- Open embolectomy
- Endovascular aspiration thrombectomy
- Catheter-directed thrombolysis

We decided to perform catheter-directed thrombolysis with endoarterial infusion of Urokinase (2,000,000 IU over 24h).

Control angiography at 24 h demonstrated extensive reperfusion of the superior mesenteric artery with complete resolution of the abdominal symptoms.

Discussion: Acute superior mesenteric artery thromboembolism is a rare but potentially fatal condition. Contrast enhanced CT scan is the diagnostic modality of choice in such cases. Unstable patients need urgent surgical approach, however endovascular management can be reserved for the less severe cases. Endovascular thrombectomy has been well-established as a valid treatment in arterial reperfusion, nonetheless it carries the risk of distal embolization. Endovascular thrombolysis is widely used both as a stand-alone treatment or in adjunction to mechanical aspiration to prevent distal embolization, it is effective in restoring the blood flow but unfortunately it can not be used in life-threatening situations since it takes several hours for achieving an efficient revascularization.

Take-home points: Catheter-directed thrombolysis represents an effective alternative in superior mesenteric artery thromboembolism.

P-820

Imaging and embolization of a pulmonary artery pseudoaneurysm complicating chronic cavitary tuberculosis

B. Dharmarajah, A. Alsafi, J.E. Jackson

Imaging, Hammersmith Hospital - Imperial College Healthcare NHS Trust, London, UK

Clinical History/Pre-treatment Imaging: A 34-year-old male with a history of treated multi-drug resistant pulmonary tuberculosis, subsequently complicated by an aspergilloma, presented with several episodes of massive haemoptysis. A chest radiograph demonstrated right upper zone volume loss and cavitary disease. A thoracic CT study performed during the aortic phase of contrast medium enhancement demonstrated a focal area of nodular enhancement in the diseased right upper lobe consistent with a pulmonary artery pseudoaneurysm (Figure 1). There was minor prominence of right superior intercostal arteries.

Treatment Options/Results: The patient was transferred for emergency angiography and embolization. Via a right femoral artery approach a

right superior intercostal artery arising from the proximal thoracic aorta was selectively catheterised. Arteriography demonstrated numerous tiny transpleural vessels arising from the intercostal arteries with retrograde filling of a right upper lobe pulmonary artery from which the pulmonary artery pseudoaneurysm originated (Figure 2a). Via a right femoral vein approach this pulmonary artery branch was selectively catheterised and embolized across the neck of the pseudoaneurysm with platinum microcoils. A post-embolization intercostal arteriogram confirmed exclusion of the pseudoaneurysm from the circulation (Figure 2b).

Discussion: Pulmonary artery pseudoaneurysms complicating chronic inflammatory lung disease occur in as many as 10% of patients presenting with massive haemoptysis and are important to recognise.

Take-home points:

- Pulmonary artery pseudoaneurysms complicating chronic inflammatory lung disease are only visualised on CT studies performed during the arterial phase of contrast medium enhancement
- Their embolization requires systemic and pulmonary artery approaches.

P-821

Selective transcatheter arterial embolization for the isolated calyx after the partial nephrectomy

K. Shimizu, K. Enoki, T. Higuchi, K. Motohashi, S. Sadaoka
Radiology, Jikei University, Kashiwa Hospital, Chiba, JP

Clinical History/Pre-treatment Imaging: A 37-year-old woman who underwent laparoscopic partial nephrectomy for right renal cell carcinoma had urine leakage to the retroperitoneal space. CT images revealed that the communication between the calyx of lower portion of right kidney and the renal pelvis was lost due to the stenosis of infundibulum. The patient was diagnosed the isolated calyx. It was resistant to the percutaneous drainage, ureteral catheter placement and sclerotherapy. Therefore selective transcatheter arterial embolization (TAE) of lower portion of right kidney was planned.

Treatment Options/Results: Percutaneous drainage, temporal catheter or stent placement for the recanalization of stenotic infundibulum, sclerotherapy using absolute ethanol, OK432 e.t.c., and radical nephrectomy were the other treatment options.

The renal arteries supplying the lower portion of right kidney were selectively embolized using the coils. Urine leakage from drain decreased and retroperitoneal fluid collection was disappeared promptly.

Discussion: The most common cause of isolated calyx is nephron sparing surgery. The first treatment of this complication is temporal catheter or stent placement for the recanalization of stenotic infundibulum. There is only a few case report performing TAE. TAE is one of treatment option to solve the problem quickly and to reduce risk of recurrence.

Take-home points: The isolated calyx is one of complication after nephron sparing surgery. The incidence of such complication will be increased by development of the nephron sparing surgery. Interventional radiologists should have better knowledge about urological surgery, its complication and treatment.

P-822

Endovascular revascularization of a very early occluded aorto-hepatic jump graft following living donor liver transplant (LDLT)

D. Volterra¹, E.M. Fumarola¹, F. Barbosa², C. Migliorisi², R. Vercelli², A.G. Rampoldi², A. Alfonsi³, F. Di Bartolomeo⁴

¹Postgraduation School in Radiodiagnostic, University of Milan,

Milan, IT, ²Interventional Radiology, Ospedale Niguarda, Milan, IT,

³Radiology, Campus Biomedico University of Rome, Rome, IT, ⁴Radiology, University of Milan, Milano, IT

Clinical History/Pre-treatment Imaging: A 35 year-old female, with HBV/HDV cirrhosis (MELD 21 Child-Pugh score C12) underwent LDLT with a jump bypass between the infrarenal aorta and the HA. On the same

day patient was evaluated with a Doppler ultrasound and a CT scan that showed no flow in the HA.

Treatment Options/Results: A preliminary diagnostic angiography (DA) showed thrombosis of the jump. A 6 CAT catheter was advanced and withdrawn under constant aspiration until clots were partially removed (Indigo System), and the DA showed recanalization of the aortic jump, with very poor flow into the liver due to a stenotic anastomosis with the HA. We therefore performed stenting of the anastomosis with Graft Master 4,80x26mm. At the end of the procedure, DA revealed the restoration of intraparenchymal flow. After the procedure 2 CT scans (1 and 4 days later) showed good flow in the HA. Doppler ultrasound performed 16 days after the procedure confirmed good flow restoration with normal resistance.

Discussion: Revascularization of occluded jump graft immediately after a LDLT is usually performed with open surgery. In selected cases, endovascular approach can be a valid and less invasive option with optimal results.

Take-home points: The indigo System appears to be a safe and manageable technique for endovascular management of HA and aortic jump graft thrombosis after LDLT. Stenting of the anastomosis, is a safe procedure that can lead to significant increasing of blood inflow into the liver and may avoid surgery.

P-823

Treatment of ruptured inferior pancreaticoduodenal pseudoaneurysm in patient with coeliac axis occlusion using covered stent graft to preserve visceral perfusion

G. Lee¹, H.J. Nagar¹, A.H. Shah²

¹Interventional Radiology, Queen's Medical Centre, Nottingham

University Hospitals NHS Trust, Nottingham, UK, ²Department of Vascular and Interventional Radiology, Nottingham University Hospitals NHS Trust, Nottingham, UK

Clinical History/Pre-treatment Imaging: 70 year old male presented acutely after abdominal trauma with flank pain. CT angiography demonstrated large peripancreatic haematoma from ruptured visceral pseudoaneurysm.

Treatment Options/Results: Preferred treatment for ruptured visceral artery pseudoaneurysms is endovascular. Options include stentgraft placement or sandwich embolisation.

Discussion: Visceral artery pseudoaneurysms may be inflammatory or traumatic. True aneurysms may be suitable for imaging followup, pseudoaneurysms usually grow rapidly necessitating treatment to prevent early rupture. Chronic coeliac insufficiency can cause compensatory hypertrophy of the pancreaticoduodenal artery (PDA) increasing the risk of pseudoaneurysm formation.

Antegrade embolisation of the ruptured pseudoaneurysm using coeliac approach was unsuccessful because of stenosis. Right 5Fr common femoral artery puncture was performed under ultrasound guidance and the superior mesenteric artery (SMA) selectively cannulated. Catheter angiography demonstrated retrograde supply to the pseudoaneurysm and coeliac axis territory via the inferior PDA, superior PDA and GDA. Coeliac stenosis had caused hypervascular retrograde flow with hypertrophy of the PDA. Embolisation of the inferior PDA pseudoaneurysm with glue or coils was not appropriate because of the need to maintain retrograde perfusion of the coeliac end organs. It was decided to treat with a stentgraft. After access sheath upsizing, a 7FR sheath was advanced to the SMA and a 7mm x 25mm covered stentgraft deployed across the pseudoaneurysm origin, treating the haemorrhage and maintaining coeliac territory perfusion via the PDA.

Post procedure and late followup imaging demonstrated excluded pseudoaneurysm sac and retrograde coeliac perfusion.

Take-home points: Premorbid coeliac insufficiency complicated treatment of this ruptured pancreaticoduodenal pseudoaneurysm.

Covered stentgraft placement treated the lesion maintaining end organ perfusion.

P-824

The forgotten fistulizing filter

N. Kafity¹, M.M. Shnayder², J.W. Albright¹, J.J. Mahn³, D.M. Williams³, M. Khaja¹, X. Marko²

¹Interventional Radiology, University of Michigan, Ann Arbor, MI, US,

²Vascular and Interventional Radiology, University of Michigan, Ann

Arbor, MI, US, ³Radiology, University of Michigan, Ann Arbor, MI, US

Clinical History/Pre-treatment Imaging: This is a 91-year-old female with history of IVC filter placement 10 years prior following an MVC with pelvic fractures. She had migration of a broken strut into her right common femoral vein causing her groin pain. The strut and the filter were retrieved without complication. She presented to the ED 3 months later with right flank pain, hematuria, and new onset CHF (EF of 30-35%). CTA demonstrated a right perinephric fluid collection with diffuse hypoperfusion of the kidney and right renal artery to renal vein fistula resulting in renal vein thrombosis.

Treatment Options/Results: Vascular surgery, urology, and IR were consulted for nephrectomy vs surgical AVF ligation vs endovascular treatment. She was a poor surgical candidate due to age and new onset CHF. A MAG3 renal study showed only 2% of renal function arising from her right kidney. She underwent placement of a 6mm Amplatzer plug in the right renal artery. She was recovering well 3 days post procedure with decreased SOB and hematuria. Follow up CTA and ECHO are scheduled for 1-month post.

Discussion: This case highlights the damage high flow AVFs can cause. The low-pressure venous system diverted enough flow to cause right sided renal failure and CHF.

Take-home points: Long standing IVC filter retrieval procedures carry higher complication rates. IVC filter registries need to be kept ensuring timely removal. Endovascular embolization is a non-invasive alternative for AVF treatment in select patients.

P-825

Endovascular exclusion combined with ultrasound guided percutaneous thrombin injection of renal artery anastomotic pseudoaneurysm after kidney transplant

F. Di Bartolomeo¹, S. Bongiovanni², R. Vercelli³, E.M. Fumarola¹, A. Alfonsi⁴, F. Barbosa³, A.G. Rampoldi³

¹Postgraduation School in Radiodiagnostic, Università degli Studi di Milano, Milan, IT, ²Radiology, Ospedale Santa Croce e Carle, Cuneo, IT,

³Interventional Radiology, Ospedale Niguarda, Milan, IT, ⁴Radiology, Campus Biomedico University of Rome, Rome, IT

Clinical History/Pre-treatment Imaging: A 45-year-old female with end-stage renal disease secondary to IgA-nephropathy received renal transplant. After 6-weeks, abdominal CT-scan, revealed a transplanted renal artery pseudoaneurysm, measuring 5.2cm. The surgical revision was considered at high risk of graft loss, therefore endovascular approach was decided.

Treatment Options/Results: Using bilateral femoral access, a 7-French sheath was placed antegrade over the aortic bifurcation. On the right, a 8-French sheath was placed retrograde to the proximal right external iliac artery.

First, a 7mm Amplatzer plug IV was placed in the right proximal internal iliac artery in order to avoid backflow.

The sheaths were then used to position an autoexpandable covered stent in a kissing fashion within the tract including proximal right external artery and distal right common iliac artery, with an autoexpandable covered stent in the autotransplant renal artery. Post-stents deployment angiogram revealed persistent flow into the aneurysm sac.

Next day, ultrasound guided percutaneous thrombin injections was performed, solving the leakage.

Follow-up ultrasound at two-months post-procedure revealed satisfactory renal perfusion with no flow within the pseudoaneurysm.

Discussion: The mainstay of treatment, in case of pseudoaneurysm after kidney transplant, is open surgical revision; however, this technique itself may be associated with high morbidity and possible graft loss.

When surgical repair is not-indicated, endovascular treatment is a valid alternative.

Moreover, in this case, endovascular intervention combined with ultrasound guided percutaneous thrombin injection, may be effective than endovascular exclusion alone.

Take-home points: Endovascular exclusion combined with ultrasound guided percutaneous thrombin injection may be effective in selected patients with renal artery anastomotic pseudoaneurysm after Kidney Transplant.

P-826

Retrograde approach in superior mesenteric artery chronic total occlusion revascularization

A. Alfonsi¹, F. Morelli², F. Di Bartolomeo³, E.M. Fumarola³, D. Volterra³, C. Miglioni⁴, F. Barbosa⁴, A.G. Rampoldi⁴

¹Radiology, Campus Biomedico University of Rome, Rome, IT, ²Radiology, San Paolo Hospital, Milan, IT, ³Postgraduation School in Radiodiagnostic, University of Milan, Milan, IT, ⁴Interventional Radiology, Ospedale

Niguarda, Milan, IT

Clinical History/Pre-treatment Imaging: A 81-year-old female presented to the Hospital with a 18-month history of chronic postprandial abdominal pain, nausea, vomiting, and weight loss.

Abdominal CT scan demonstrated complete ostial occlusion of superior mesenteric artery (SMA) extended for 2 cm and distal revascularization through collaterals.

Treatment Options/Results: Aortogram confirmed the occlusion of the SMA, ostial stenosis of inferior mesenteric artery, hypertrophic collaterals with celiac trunk through superior and inferior pancreaticoduodenal arteries. Post-occlusion vascular tract of SMA was reached navigating through the hypertrophic pancreaticoduodenal arteries, and the occlusion was eventually crossed with a 0.014 guidewire. With a goose-neck catheter the guidewire was caught and pulled back to the femoral right access site, making possible the SMA direct stenting. Three balloon-expandable overlapped stents were deployed at the mesenteric obstruction level (6x15mm + 6x18mm + 7x24mm to the ostium). A final angiogram demonstrated the complete patency of the SMA. Dual anti-platelet therapy was prescribed for 6 months.

At 1-year follow-up the patient is still asymptomatic, she has regained weight, CT scan demonstrating the graft patency.

Discussion: In patients with severe AMS occlusion percutaneous antegrade revascularization can be technically challenging.

In selected cases retrograde approach may be the only valid option to cross the occlusion and therefore to restore an adequate bowel perfusion.

Take-home points: SMA occlusion is a potentially fatal condition. SMA revascularization is crucial to relieve symptoms, to restore small bowel function, and to prevent bowel infarction.

P-827

Restenosis after repeated percutaneous transluminal renal angioplasty for managing renal artery fibromuscular dysplasia treated with a drug-eluting stent: a case report

N. Miyamoto¹, S. Yamada², A. Fujita², A. Kajihara¹, F. Namba¹, S. Adachi¹, M. Tomita¹, K. Awano², K. Sugimoto³

¹Radiology, Kita-Harima Medical Center, Ono, JP, ²Cardiology, Kita-Harima Medical Center, Ono, JP, ³Department of Diagnostic and Interventional Radiology, Kobe University Hospital, Kobe, JP

Clinical History/Pre-treatment Imaging: A 15-year-old female presented with sudden-onset headaches and convulsions at our hospital. Physical examination revealed a blood pressure of 167/125 mmHg. The patient was diagnosed with posterior reversible encephalopathy syndrome related

to hypertension. She had no personal and family history of hypertension and did not take any medication. Ultrasonography and magnetic resonance MR angiography revealed severe stenosis in the left renal artery; based on the images, fibromuscular dysplasia was suspected. Aortography performed 3 months after the onset revealed an occlusion in the left renal artery. Intravascular ultrasonography showed adventitial hyperplasia, and adventitial-type fibromuscular dysplasia was suspected. Percutaneous transluminal renal angioplasty (PTRA) with 1.0mm×10mm, 2.0mm×20mm, and 3.0mm×20mm conventional balloon was performed, and revascularization was achieved.

Treatment Options/Results: Antihypertensive agents were decreased from two types to one after PTRA; the patient was discharged without any complication. Four months after PTRA, ultrasonography revealed restenosis in the left renal artery. A second PTRA was performed using 3.5mm×15mm cutting balloon and 3.5mm×26mm drug-coated balloon. Although revascularization was achieved, ultrasonography revealed restenosis 4 months after the second PTRA. Eventually, a third PTRA was performed using 2mm×20mm conventional balloon and 3.5mm×15mm cutting balloon, and a 3.5mm×30mm drug-eluting stent was deployed. No restenosis was observed after the third PTRA.

Discussion: Some studies have reported that adventitial-type fibromuscular dysplasia treated with PTRA is refractory because of residual stenosis and dissection. Thus, drug-eluting stents could be beneficial.

Take-home points: A drug-eluting stent might be beneficial for the treatment of adventitial-type fibromuscular dysplasia.

P-828

Late extravascular migration of blocked covered stents after visceral aneurysm and pseudoaneurysm treatment: an underestimated phenomenon

M.A. Tipaldi¹, A. Pisano¹, F. Laurino¹, M.E. Krokidis², G. Orgera³, M. Rossi⁴

¹Radiology, S. Andrea University Hospital, Rome, IT, ²Department of Radiology, Addenbrooke's University Hospital, Cambridge, UK, ³Interventional Radiology, St. Andrea University Hospital - Sapienza Rome, Rome, IT, ⁴Radiology, Sant' Andrea Hospital, Rome, IT

Clinical History/Pre-treatment Imaging: The endovascular treatment of visceral artery aneurysms and pseudoaneurysms may be performed with a wide range of devices. The use of covered stents offers the advantage of preserving the flow to the organ distally to the vascular lesion, even though stent graft occlusion may occur in the long term.

Treatment Options/Results: In this brief report we describe 3 cases of late and unexpected complication consisting in the extravascular migration of covered stents, previously placed to exclude splenic visceral aneurysms, observed at the long term follow-up. In all cases migration was detected after their occlusion: in two cases in the lesser omentum at the 12th and 48th month follow-up, while in one case inside the gastric antrum at the 36th month follow-up.

Discussion: There is currently very little data on long-term complications of covered stents and this case series may provide some food for thought on possible reasons that may lead to extravascular migration of intravascular devices. Loss of vessel wall integrity for locoregional tissue inflammatory status and ongoing chemotherapeutic scheme, device's characteristics, tortuosity and pulsation of the implant site may be highlighted as possible features that could favor such phenomenon. Another potential explanation may be the hypothesis of an ischemic damage of the vessel wall as the underlined cause that occurs when the stent graft gets blocked.

Take-home points: In conclusion it is not actually possible to predict stent migration. The knowledge of such potential complication underlines the importance of an adequate patient's evaluation and a long-term follow-up, even when stents are occluded.

P-829

Upper gastrointestinal bleeding secondary to aneurysms of the pancreaticoduodenal artery

E. Elmahdi¹, R.G. McWilliams²

¹Interventional Radiology, Royal Liverpool University Hospital, Liverpool, UK, ²Radiology, Royal Liverpool University Hospital, Liverpool, UK

Clinical History/Pre-treatment Imaging: A 53 year old woman was re-admitted to hospital with syncope following two recent endoscopic treatments of a duodenal ulcer with hemospray® and clips. The patient became haemodynamically unstable and dropped her haemoglobin to 7 g/dl requiring a transfusion. A triple phase CT scan demonstrated occlusion of the coeliac trunk with two secondary high flow pancreaticoduodenal arterial arcade aneurysms. The aneurysm of the anterior superior pancreaticoduodenal artery had eroded into D1 of the duodenum causing the ulceration visualised during endoscopy. An Arc of Buhler was also identified.

Treatment Options/Results: An angiogram confirmed occlusion of the celiac axis. Detachable embolisation coils were placed within the inflow and outflow vessels via the inferior pancreaticoduodenal artery. Unfortunately the initial coil within the gastroduodenal artery migrated into the common hepatic artery. Attempts at snaring resulted in embolisation into the distal splenic artery. The decision was made that the risks of retrieval outweighed the benefits and so it was abandoned. A completion angiogram demonstrated stasis with no flow within either aneurysm.

Discussion: Knowledge of the Arc of Buhler allowed embolisation of the pancreaticoduodenal arcade without fear of foregut ischaemia. If these are high flow aneurysms of the pancreaticoduodenal artery, then the flow through the Arc of Buhler is now higher than before. As there are case reports of aneurysms of the Arc of Buhler, this raises the question as to whether there should be surveillance for this in this patient.

Take-home points: An Arc of Buhler is an important anatomical variant with implications on intervention.

P-830

Bilateral renal arteriovenous malformation embolization

M.M. Shnayder, J.J. Mahn, N. Kafity, J.W. Albright, J.J. Gemmette
Vascular and Interventional Radiology, University of Michigan Health System, Ann Arbor, MI, US

Clinical History/Pre-treatment Imaging: This is a 65-year-old female with bilateral Yakes' type 1 congenital renal AVMs initially managed conservatively with imaging surveillance. She became symptomatic over several months, presenting with enlarging pulsatile abdominal masses and new-onset high-output heart failure. MRI was performed demonstrating bilateral high flow AVMs, measuring up to 14 cm on the right and 7 cm on the left. Patient was referred to IR for embolization and prevention of catastrophic hemorrhage.

Treatment Options/Results: Patient was offered staged embolization of her bilateral AVMs. First, the right AVM feeding artery was embolized completely. Weeks later, the left AVM was near completely embolized, with minimal persistent slow flow through an upper pole branch. Both procedures were completed without clinically relevant complications and the patient was discharged post-procedure day one.

Discussion: Patients with large or enlarging renal AVMs may be at risk of catastrophic hemorrhage and may develop systemic symptoms such as high-output heart failure. Surgical resection of AVMs is challenging, at high-risk of hemorrhage, or not possible depending on complexity. Due to neovascularization, recurrence is common. Embolization has been demonstrated to be a safe and effective treatment strategy for renal AVMs.

Take-home points: When congenital AVMs become symptomatic or pose a high-risk for rupture, interventional radiologists may offer embolization as either a preoperative or definitive intervention. Even in cases of severe bilateral pathology, step-wise planned interventions can be successfully performed without severe complications and with minimal hospitalization.

P-831

Renal artery stent salvage

J.W. Albright, N. Kafity, M.M. Shnayder, J.J. Mahn, J.J. Gemmete
Department of Interventional Radiology, University of Michigan, Ann Arbor, MI, US

Clinical History/Pre-treatment Imaging: This is a 59-year-old female with a history of renal artery fibromuscular dysplasia and right renal artery aneurysm measuring up to 2.6 cm, status post failed stent assisted coiling. **Treatment Options/Results:** Initial imaging demonstrated herniation of the previously placed stent into the aneurysm sack. Angiogram was performed demonstrating a "string of pearls" appearance of the artery compatible with known FMD. Several combinations of catheters and wires were used to cannulate the misplaced stent, where ultimately access across the stent was achieved with a double angle GT guidewire and microcatheter. The micro system was exchanged for an 0.35 system, over which a longer self-expanding stent was deployed within the existing stent, extending from the right renal artery ostium across the wide neck of the aneurysm approximating a longer segment of normal artery on either side of the aneurysm neck. Following this several coils were deployed into the excluded aneurysm sack.

Discussion: A potential complication of attempted stent-assisted coiling is stent herniation into the aneurysm sack, especially if the stent is undersized in length. Salvage therapy for this problem includes recannulation of the malpositioned stent followed by deploying a longer stent within it, which approximates a longer landing zone on either side of the aneurysm neck.

Take-home points: Pretreatment imaging should be thoroughly reviewed to judge the landing zone and guide stent selection. Herniation of stents into aneurysm sacks can be salvaged with recannulation of stents with guidewires and re-stenting.

P-832

Bilateral and simultaneous Wunderlich Syndrome secondary to renal metastases: transarterial catheter embolization with ethylene vinyl alcohol copolymer (EVOH, ONYX[®])

M. Langleib¹, J.P. Escobar², V. De Mora², L. Dibarboure²

¹Departamento Clinico de Imagenologia, Hospital de Clinicas Dr. Manuel Quintela. Universidad de la Republica UDELAR, Montevideo, UY,

²Departamento Clinico de Imagenologia. Prof. Dr. Luis Dibarboure, Hospital de Clinicas Dr. Manuel Quintela. Universidad de la Republica UDELAR, Montevideo, UY

Clinical History/Pre-treatment Imaging: We present a 24y male patient with testicular carcinoma, bilateral renal metastasis and concomitant pulmonary secondary lesions. During masturbation to obtain semen for cryopreservation, prior to chemotherapy, suddenly presents severe pain in both kidneys and hematuria. Imaging studies (ultrasonography and computer tomography) showed bilateral renal hypervascular tumors and bilateral perirenal haematomas with concomitant anemia and hemodynamic reperfusion.

Treatment Options/Results: Therapeutic options in Wunderlich syndrome are three: conservative treatment (medical), transcatheter arterial embolization and nephrectomy.

In our case the patient is young and candidate to be treated with cisplatin which contraindicates unilateral or bilateral nephrectomy.

Transcatheter arterial superselective embolization was performed with EVOH (ONYX[®]) in one session with good results.

Discussion: Wunderlich syndrome is defined as a clinical manifestation secondary to sudden spontaneous rupture of renal parenchyma in the absence of injury, resulting in hemoretroperitoneum. It may occur in patients with benign or malignant neoplasm of the kidney and other pathologies.

Wunderlich syndrome is very infrequent and bilateral presentation had been published in few cases.

Transcatheter arterial embolization is an option to treat hypervascular lesions and to prevent nephrectomy.

Embolization with EVOH is a good option in peripheral lesions with better visualization than others agents like microparticles and have good penetration into the tumoral lesions. Another advantage is that EVOH is like sealant in the rupture zone.

Take-home points: Wunderlich syndrome is infrequent and bilateral presentation was reported in few cases.

Transcatheter arterial embolization is better option than nephrectomy. Transcatheter embolization with ethylene vinyl alcohol copolymer is feasible and safe for bleeding tumoral lesions.

P-833

Stent-assisted coiling of the SMA

J.W. Albright, N. Kafity, M.M. Shnayder, J.J. Mahn, M. Khaja
Department of Interventional Radiology, University of Michigan, Ann Arbor, MI, US

Clinical History/Pre-treatment Imaging: A 63-year-old male with a history AAA status post emergent EVAR, bilateral iliac and femoral artery aneurysms. He presented as referral from vascular surgery at our institution for management of a 23mm SMA artery aneurysm discovered on surveillance CTA.

Treatment Options/Results: Through right CFA access, angiography showed the jejunal branch aneurysm measuring approximately 2 cm. Angiography distal to the aneurysm demonstrated a large region of perfused bowel. An adjacent jejunal branch was cannulated and demonstrated adjacent perfusion without definite overlap. Given these findings, the decision was made to perform a stent assisted coiling.

A sheath was placed in the origin of the SMA. Left CFA access was obtained, and a 5Fr short sheath was used to place a microcatheter alongside the SMA origin sheath into the aneurysmal SMA branch. Through the SMA origin sheath, a 6 x 40 mm stent was placed across the aneurysm. Through the microcatheter, multiple detachable Ruby coils were placed in the aneurysmal segment to an approximately 25% packing volume. Completion SMA run showed good distal perfusion with no flow into the aneurysm.

He was placed on aspirin, clopidogrel. Ongoing surveillance CTA showed open SMA branch stent, with measured packed aneurysm size 16mm.

Discussion: Stent assisted coiling is a useful and often necessary procedure routinely performed in neurovascular cases, but often needed in other applications were preservation of blood flow to territory beyond the area of treatment is vitally necessary.

Take-home points: In visceral embolization cases, stent assisted coiling can be used to avoid bowel ischemia in select cases.

P-834

Acute management of iatrogenic renal artery rupture

M.J. Van Wyk, J. Tibballs
Radiology, Sir Charles Gairdner Hospital, Nedlands, WA, AU

Clinical History/Pre-treatment Imaging: A 17-year old female was managed for resistant hypertension (BP 176/111).

CT angiogram revealed a focal stenosis at the right renal artery bifurcation suggesting intimal type fibromuscular dysplasia (FMD).

Treatment Options/Results: A 45cm 5F sheath was inserted via the right common femoral artery. Angiogram confirmed the stenosis. The artery was selected by means of a C2 catheter. Intra-arterial administration of 3000U of heparin and 200mcg GTN. A 0.014" SpartaCore wire was placed in the main branch and a V18 support wire in the lower pole artery. Angioplasty with a 5 x 20 mm Sterling balloon couldn't obliterate the waist. The sheath was upsized to 6F to allow a 5 x 20mm cutting balloon which successfully abolished the stenosis. The patient experienced excruciating back pain on check angiogram revealing renal artery rupture. The balloon was immediately reinflated. Contralateral 12F groin access

was obtained following Proglide placement. A Coda balloon was inflated in the upper abdominal aorta to allow balloon removal and successful deployment of a 5 x 22mm V12 Atrium stent-graft.

Discussion: Percutaneous balloon angioplasty is currently considered first-line treatment in FMD. Cutting balloon angioplasty is indicated for stenoses resistant to conventional angioplasty but may result in vessel rupture especially in intimal type FMD. The cutting balloon should therefore be undersized in relation to the vessel diameter.

Take-home points: Intimal type fibromuscular dysplasia may be prone to rupture during angioplasty.

A cutting balloon, smaller than the desired vessel diameter, should be used.

Equipment for dealing with vessel rupture should be readily available.

P-835

Tortuous BRTO for gastric varices

J.W. Albright, M.M. Shnayder, N. Kafity, J.J. Mahn, J.J. Gemmete
Department of Interventional Radiology, University of Michigan, Ann Arbor, MI, US

Clinical History/Pre-treatment Imaging: A 74-year-old woman with history of upper gastrointestinal bleeding from gastric varices in the setting of chronic splenic vein and artery occlusions presented for potential splenic artery embolization and/or obliteration of gastric varices. Angiography showed occlusion of the splenic artery, terminating in a tortuous network of collaterals supplying both the stomach and the majority of the spleen. Given this unfavorable anatomy, splenic embolization was initially deferred, and BRTO was considered for definitive therapy.

Treatment Options/Results: Retrograde cannulation of splenosystemic shunt was performed via the gonadal vein. Balloon occlusion venogram of the splenogonadal shunt demonstrated gastric varices and outflow into the splenorenal shunt. Retrograde cannulation of the splenorenal shunt via right common femoral vein was performed. Coil embolization of venous outflow from gastric varices into the hemiazygos vein was completed. Then, balloon occlusion venogram of the splenorenal shunt was performed, followed by sclerosis/embolization of gastric varices via injection from the splenogonadal. This was followed by sclerosis/embolization of gastric varices via injection from the splenorenal shunt. Finally, coil embolization of the splenogonadal and splenorenal shunts was performed with by completion dyna-CT of the abdomen to evaluate distribution of sclerosant.

Weeks later, patient was brought back for splenic arterial embolization via the left gastroepiploic artery using advanced triaxial microcatheter techniques.

Discussion: This case required advanced BRTO and splenic artery embolization via left gastroepiploics utilizing microcatheter techniques traditionally utilized in neuro interventions.

Take-home points: It is important for interventionalists to understand and apply techniques from various interventional subspecialties to navigate through unexpected anatomic challenges.

P-836

Transarterial embolization of a congenital renal arteriovenous malformation (AVM) in 1st trimester pregnancy

J.Y. Oh¹, S.H. Kwon², J.H. Oh², J. Yoon²

¹Radiology, Kyung Hee University Hospital at Gangdong, Seoul, KR,

²Radiology, Kyung Hee University Medical Center, Seoul, KR

Clinical History/Pre-treatment Imaging: We present a case of a congenital renal AVM in a 32-year-old woman in IUP 12 weeks. She presented right flank pain and hematuria 2 day ago. On US, right hydronephrosis were demonstrated. Cystoscopic guided D-J stent insertion and bladder irrigation for hematoma evacuation were performed. After 24 hours, hemoglobin level was dropped continuous and serum Cr level was increased from 1.0 mg/dl to 2.7 mg/dl. Finally she took CT scan. It

demonstrated tiny, tortuous vascular structure in lower pole of right kidney. Angiography revealed a cirroid renal AVM, fed by multiple arteries arising from branches of anterior segmental artery draining into a non-dilated segmental renal vein.

Treatment Options/Results: Due to the several small arterial feeders, superselective arterial embolization were required. As an embolization agents, NBCA : Lipiodol mixture were used. Embolization procedures were effective resulting in invisible renal AVM on follow up CT and no recurrence of hematuria. After 1 month, surgical abortion was done due to high risk of radiation hazard of CT and angiographic procedure.

Discussion: Despite being infrequent, congenital renal AVMs in pregnancy can be the cause of massive hematuria and acute renal insufficiency. Usually have partial or total nephrectomy, resulting in loss of early fetus and long term complication of single kidney. Endovascular embolization is efficient, but there's not a standardized treatment consensus on pregnancy.

Take-home points: Symptomatic congenital renal AVM in pregnancy are very complicated pathology to decide the treatment plan. Usually superselective embolization are effective. However, it was considered the risk of radiation hazard for fetus.

P-837

Multiples ileolumbar, obturator and epigastric artery aneurysms embolisation after end to end internal iliac artery anastomosis in kidney transplantation

I. Paladini¹, A. Andreone¹, C. Marcato², E. Epifani¹

¹Radiologia Interventistica, Azienda Ospedaliero-Universitaria di Parma, Parma, IT, ²Department of Radiology, University of Parma, Parma, IT

Clinical History/Pre-treatment Imaging: 55 years old male patient with end to end internal iliac artery anastomosis in kidney transplantation performed in 1995 showed initial formation of multiple centimetric pelvic visceral aneurysms on Doppler ultrasound scan in 2011.

AngioCt confirmed the presence of two ileolumbar and one obturator artery aneurysms respectively, the biggest of 37x36mm of diameter.

Follow up ct scan in 2014 showed progressive aneurysms enlargement, the biggest of 75x51mm; consecutive embolisation was performed in 2015 using multiple detachable coils (from 7 to 11 mm) to exclude the aneurysms and their ileolumbar and obturator afferences and efferences. A 2018 Ct scan showed the main aneurysm enlargement (83x62mm) confirmed by a consecutive angiogram highlighting a new epigastric afference.

Treatment Options/Results: A following embolisation was then performed and multiple detachable coils (from 2 to 6 mm) were placed in the main afference with complete exclusion of the aneurism vascularisation, confirmed at 3 months follow-up ct scan.

Discussion: End to end internal iliac artery anastomosis in renal transplantation consist in ipsilateral pelvic collateral arteries ligation. This situation may lead to an inversion of the pelvic internal iliac flow to the ligated collateral arteries with a possible redistribution and increase of their blood pressure. In preexisting arteriopathy the risk of ligated vessel aneurism formation may be significative.

Progressive increase of aneurysm volume should be embolized to avoid sac rupture and transplanted renal compression.

Take-home points: Embolization should be considered as main treatment in ligated collateral artery aneurysms in arteriopathic, immunosuppressed, kidney transplanted patients.

P-838**Renal aneurysm embolization in setting of angiomyolipoma**

V. Gioioso, Z. Hu, S.J. Brest

Interventional Radiology, New York Presbyterian Hospital - Columbia University Irving Medical Center, New York, NY, US

Clinical History/Pre-treatment Imaging: Patient is a 53 year old female with history of tuberous sclerosis and bilateral angiomyolipomas who has previously undergone coil embolization for bleeding. Patient presented with 2 liters of gross hematuria and a hemoglobin of 7.1 (baseline 8.1 two months prior) and was transfused 2 units of PRBCs. The patient underwent triple-phase CT angiogram and was found to have a left intrarenal aneurysm measuring 1.9 cm, a right intrarenal aneurysm measuring 1.8 cm, and additional smaller bilateral aneurysms.

Treatment Options/Results: Consultation with the urology team deferred management to interventional radiology. Surgical resection of the angiomyolipomas had previously been deferred by general surgery secondary to the high associated risk of morbidity and increased bleeding. Complete embolization of the renal artery was discussed but ultimately deferred secondary to presumed residual renal function (baseline Cr 2.8). The patient was brought to interventional radiology and underwent successful coil embolization of a 1.9 cm left and a 1.8 cm right aneurysm. The additional smaller aneurysms were treated with microsphere embolization. The patient's condition stabilized and she was discharged after a brief hospital stay.

Discussion: Angiomyolipomas are benign neoplasms comprised of blood vessels, smooth muscle, and fat. Lacking elastin, the blood vessels are abnormal and are prone to rupture and also aneurysm formation, as seen in this case. Multiple treatment options were considered, but ultimately direct coil and microsphere embolization of the aneurysms was selected due to preference for renal preservation.

Take-home points: Coil embolization of aneurysms secondary to angiomyolipoma may help avoid surgical intervention and preserve residual renal function.

P-839**Single kidney salvage: endovascular thrombolysis, thrombectomy and stenting salvages a single ischemic kidney with large renal artery thrombus**L. Murray¹, J. Halpin¹, S. Rahimi², L. Casserly³, A. Dorman⁴, S. McGrane², T. Scanlon²*¹Medicine, University Hospital Limerick, Limerick, IE, ²Radiology, University Hospital Limerick, Limerick, IE, ³Nephrology, University Hospital Limerick, Limerick, IE, ⁴Pathology, Beaumont Hospital, Dublin, IE*

Clinical History/Pre-treatment Imaging: A 57-year-old male presented with a 17-day history of acute kidney injury and oliguria, secondary to gastroenteritis-induced dehydration and non-steroidal anti-inflammatory drug (NSAID) usage. His estimated Glomerular Filtration Rate (eGFR) on admission was 2.3ml/min/1.73m². A renal ultrasound revealed a solitary, enlarged right kidney with normal echotexture. The patient was unaware of his single kidney status. A CT renal angiogram confirmed a single kidney with minimal-to-no enhancement, a large thrombus within the renal artery, stump occlusion and a subtle flow channel with very poor flow distal to the thrombus. Histopathological evidence of ischemia was apparent on renal biopsy

Treatment Options/Results: The Interventional Radiology team attempted endovascular intervention with the aim of reperfusion of the ischemic kidney and avoiding the need for lifelong haemodialysis or renal transplantation. Partially-successful reperfusion was achieved with a combination of thrombolytic therapy and suction thrombectomy. A balloon stent was deployed resulting in satisfactory restoration of blood flow. Successful reperfusion improved eGFR to 27.6 ml/min/1.73 m² and the patient was discharged 7-days post-procedure. Follow-up in the Nephrology Department confirmed maintenance of this eGFR

Discussion: There is a lack of consensus in the literature regarding a universally acceptable cut-off time to salvage an ischemic kidney. It has been suggested that thrombolytic therapy in acute renal artery occlusion is not indicated once ischemic time has exceeded 90mins.

Take-home points: This unique case of a single ischaemic kidney, with sub-acute thrombosis for a prolonged period, highlights that all necessary measures should be employed by the interventional radiology team to salvage the kidney.

P-840**Residual iatrogenic dissection of superior mesenteric artery (SMA) involving jejunal branches treated by a new bare stent deliverable through a microcatheter**

E. Calleja Cartón, A. Alvarez Luque, M. González Leyte, M. Echenagusia Boyra, C. Ballano Franco

Vascular and Interventional Radiology, Hospital General Universitario Gregorio Marañón, Madrid, ES

Clinical History/Pre-treatment Imaging: We report a case of a 59-year-old male with SMAostial stenosis and AAA. Prior to the aorto-aortic bypass surgery the AMSstenosis was successfully handled by a 7mm balloon expandable stent placement (EXPRESS Boston Scientific®). Within the first 48 hours after surgery the patient showed abrupt abdominal pain and clinical signs of bowel ischemia. CTA depicted a iatrogenic focal dissection and a 6mm distal pseudoaneurysm.

Treatment Options/Results: A selective viscera SMA angiogram showed focal dissection involving the proximal jejunal branches. SMA pseudoaneurysm was also confirmed.

Pseudoaneurysm was successfully excluded using a 7mm balloon covered stent (Advanta™ V12, Getinge). No therapeutic action was initially carried out over the dissection. Persistence of severe mesenteric angor and weight loss lead us to complete SMA revascularization.

Through a 2.0F microcatheter the true lumen was reached and after microballoon angioplasty 3.5x40 mm (NeuroSpeed®, Acandis), 2 telescoped non-covered stents 4.5x35mm and 3.5x35mm (ACCLINO® flex Stent, Acandis) were delivered. Stenting remodeling was carried out using the microballoon. Final angiogram showed the focal dissection resolved with complete patency of proximal jejunal branches.

Discussion: Iatrogenic dissection of the superior mesenteric artery (IDSMA) is a rare vascular complication. However, isolated spontaneous SMA dissection (SDSMA) is much more less scarce. Both morphological courses management protocol has yet not been established.

Conservative therapy has been proposed as the primary treatment if no bowel ischemia or arterial rupture is noted in the CTA images. Anticoagulation therapy alone or combined with antiplatelet agents is the usual treatment.

Classical endovascular interventions or surgical treatments have been reserved for patients showing aggravation, peritoneal irritation signs, or bowel infarction on CTA.

Take-home points: Endovascular intervention of SMA dissection might result very challenging. The use of bare-stents delivered through a microcatheter helps to accomplish better procedural results with lower complications rates.

P-841

Endovascular embolisation of a hypogastric aneurysm: be aware of anastomosis

F. Formiconi¹, M. Ruschioni¹, M. Varrassi², S. Carducci³, A.V. Giordano⁴, C. Masciocchi¹

¹Applied Clinical Sciences and Biotechnology, University of L'Aquila, L'Aquila, IT, ²Neuroradiology and Interventional Radiology, S. Salvatore Hospital, L'Aquila, IT, ³Biotechnological and Applied Clinical Sciences, San Salvatore Hospital, L'Aquila, IT, ⁴Radiology, Ospedale S. Salvatore L'Aquila, L'Aquila, IT

Clinical History/Pre-treatment Imaging: An 81-year-old man underwent CTA in our department to re-evaluate a known left hypogastric aneurysm, increased compare to previous follow-up examination. Patient previously went on intervention for aneurysmectomy for infrarenal AAA rupture, and surgical left iliac-femoral bypass due to occlusion of left common iliac artery. CTA confirmed a large, mainly thrombosed aneurysm measuring about 9cm, apparently supplied by vessels of gluteal origin. (Fig.1) Patient underwent angiographic examination (DSA) with catheterization of right hypogastric artery and left iliac-femoral bypass artery. DSA showed an arterial supply to the sac from branches of the upper right gluteal artery and from branches of the left obturator and left epigastric arteries. (Fig.2)

Treatment Options/Results: After right-left iliac crossover, selective catheterization of the iliac-femoral bypass and of left external iliac artery stump (retrograde) was performed. Subsequently super-selective catheterization of left inferior epigastric artery up to the anastomosis with the left obturator artery was performed. At this level embolisation coils were released. (Fig.2) Super-selective catheterization of the right gluteal artery and of the right-left anastomotic branches was performed, until navigating distally to the aneurysm until reaching left superior gluteal artery where coils were released. Finally, embolisation coils were further released backward in the right superior artery. (Fig.2)

Discussion: Hypogastric artery aneurysms represent uncommon lesions that even when mainly thrombosed, require treatment whenever they present tendency to grow, due to mass effect and to risk of rupture.

Take-home points: In partially thrombosed hypogastric artery aneurysms, the angiographic treatment is an excellent therapeutic option in elderly, unstable patients or with contraindications to surgery.

P-842

Coil embolization of renal artery aneurysm: 6Fr sheath catheter to carry out tripple microdevice

J. Otaka¹, T. Saguchi¹, D. Yunaiyama¹, T. Moriya¹, S. Ikenaga², K. Saito¹

¹Radiology, Tokyo Medical University, Tokyo, JP, ²Radiology, Tokyo Medical University Hospital, Tokyo Nishishinjyuku, JP

Clinical History/Pre-treatment Imaging: We report a case of successful transcatheter coil embolization of renal artery aneurysm using triple microdevices carried out from a single sheath catheter.

Case: 59-year-old male with no particular past history was referred to our institute for bilateral renal artery aneurysm.

CECT revealed 20 mm aneurysm on the right and left renal artery.

Treatment Options/Results: Initial TAE was planned on the right aneurysm, which was wide necked and had two outflow vessels. Neck plasty of each branch was considered necessary to protect the distal blood flow. Right femoral artery was punctured and the tip of 6 Fr sheath catheter was placed at the right renal artery. Two micro balloon catheters (Scepter C) for neck plasty and one microcatheter (Excelsior SL-10) for delivering coils was provided from the sheath catheter.

Coil packing was completed with 9 detachable coils. Post-procedural DSA showed no flow in the aneurysm.

Discussion: During coil embolization in abdominal visceral artery, there are situation when multiple microdevices are necessary. We have previously reported the usefulness of 4.5Fr sheath catheter (ParentPlus 45)

to provide two microdevices from a single route. However, there are situation when more microdevices are needed. To deal with such cases we developed a 6Fr Shephard-hook type sheath catheter (ParentPlus 60) with a lumen large enough to provide two microballoon catheter and a microcatheter simultaneously from a single access route. The usage of this device may provide another treatment option for IRists.

Take-home points: The usage of large lumen sheath catheter may provide a new treatment option.

TIPS and portal vein intervention

P-843

Tips and tricks of emergency TIPS in patients affected by severe portal hypertension

A. Borzelli¹, A. Paladini², F. Pane³, F. Amodio⁴, E. Cavaglià⁴, R. Niola⁴
¹U.O.C. Neuroradiologia, AORN "A.Cardarelli", Naples, IT, ²SCDU Radiologia Diagnostica ed Interventistica, AOU "Maggiore della Carità"-Novara, Novara, IT, ³Advanced Biomedical Sciences, AOU Federico II Napoli, Naples, IT, ⁴Vascular and Interventional Radiology, Cardarelli Hospital, Naples, IT

Purpose: Evaluate the main causes of failure in TIPS performed in emergency setting in critical patients affected by severe portal hypertension.

Material and methods: Between Jan 2015 and Jan 2019 we retrospectively considered 72 TIPS performed in emergency setting in critical patients (medium patient age 52; 45 M 27 F) with severe portal hypertension and affected by variceal bleeding (42), refractory ascites with hepatorenal syndrome (15) and hepatic coma (15). In all cases we used an e-PTFE covered stent and in all cases we employed a US-assisted technique to reach the portal vein system once catheterised one of the hepatic vein.

Results: In 12 cases TIPS was not possible. In 7 patients we observed a marked distortion in liver anatomy due to chronic liver disease with loss of normal anatomic relationship between portal vein system and hepatic veins, which were too thin. In 3 cases due to anatomical distortion it was possible to reach only a small peripheral portal vessel, with subsequent impossibility to make the shunt; in 1 case we noticed a iatrogenic lesion of portal vein during the procedure with subsequent thrombosis of the stent; in 1 case malpositioning of the stent with early thrombosis not solved by proximal and distal extension of the shunt.

Conclusion: The main cause of technical unsuccess of emergency TIPS performed in critical patients with severe portal vein hypertension is the marked anatomical distortion of the liver, in particular its vascular anatomy. It is necessary, to reduce the failure rate, to employ a US-assisted approach and, if required, a percutaneous sentinel-catheter into the main branch of portal vein, to guide the radiologist during the procedure.

P-844

Transjugular intrahepatic portosystemic shunt for management of refractory ascites in cirrhotic patients with complete portal vein thrombosis or cavernoma: clinical outcome

R. Miraglia¹, L. Maruzzelli¹, B. Cimo², C. Cannataci³, K. Cortis³, A. Luca¹

¹Diagnostic and Therapeutic Services, Mediterranean Institute for Transplantation and Advanced Specialized Therapies (ISMeTT), Palermo, IT, ²Department of Medicine - DIMED, Radiology Institute, Padova, IT, ³Medical Imaging Department, Mater Dei Hospital, Malta, MT

Purpose: To determine the effectiveness of transjugular intrahepatic portosystemic shunt (TIPS) in cirrhotic patients with complete portal vein thrombosis (CPVT) or portal cavernoma (PC) and refractory ascites (RA) as clinical indication for TIPS creation

Material and methods: Between August 2009 and September 2018, 459 patients underwent TIPS, using an e-PTFE covered stent, in a single centre. 26/459 (5%) procedures were attempted in cirrhotic patients

with RA and CPVT (n=19) or PC (n=7) and represent our study group. Technical success, clinical success, complications and survival rate were retrospectively analyzed.

Results: 9/26 patients had a MELD score ≥ 18 . All patients underwent large volume paracentesis the day before the procedure. TIPS was successful in 96% (25/26) of patients via a transjugular approach alone (n = 23), a transjugular/transhepatic approach (n = 1), and a transjugular/transsplenic approach (n = 1). Mean portosystemic pressure gradient decreased from 17.9 ± 4.9 mmHg to 8.1 ± 3.4 mmHg. No patients had major procedural complications. At a mean follow-up of 16.6 months (± 26.6 , range 3 – 105.6) clinical success was obtained in 15/25 patients (60%). Grade II-III encephalopathy was observed in 4/25 patients (16%). Overall survival rate was 64%. TIPS revision was performed in 8 patients (32%). Two patients underwent liver transplant with end to end portal vein anastomosis 3 and 47 months after TIPS.

Conclusion: Although technically demanding, TIPS in the management of RA in cirrhotic patients with CPVT or PC, had levels of technical success, clinical efficacy and complications rates similar to those reported in the literature in cirrhotic patients with RA but without CPVT or PC.

P-845

TIPS creation using the new controlled-expansion e-PTFE covered stent in cirrhotic patients with refractory ascites: mid-term outcome

R. Miraglia¹, L. Maruzzelli¹, B. Cimo², C. Cannataci³, A. Luca¹
¹Diagnostic and Therapeutic Services, Mediterranean Institute for Transplantation and Advanced Specialized Therapies (IsMeTT), Palermo, IT, ²Department of Medicine - DIMED, Radiology Institute, Padova, IT, ³Medical Imaging Department, Mater Dei Hospital, Malta, MT

Purpose: To evaluate mid-term outcome of transjugular intrahepatic portosystemic shunt (TIPS) creation using the new controlled-expansion e-PTFE covered stent (VCX), in adult cirrhotic patients with refractory ascites (RA) as complication of portal hypertension.

Material and methods: Between 7/2016 and 12/2018, 70 consecutive cirrhotic patients with RA received TIPS using VCX in a single centre. 48 /70 patients have a follow up longer than 3 months and represent our study group.

Results: Mean patient age 58.8 ± 8.5 y/o; male/female 35/13; viral/non viral cirrhosis 16/32. Non occlusive portal vein thrombosis was present in 17/48 patients (34%). Mean follow-up 9.2 months (± 5.5 , range 3-28). In 43/48 patients (89%) TIPS was dilated to 8 mm of diameter reaching the hemodynamic target of a portosystemic pressure gradient < 12 mmHg. In 5 patients, not reaching the hemodynamic target, the stent was dilated to 10 mm of diameter during the same session. Overall clinical success was achieved in 41/48 patients (85%). Overall encephalopathy was observed in 11/48 patients (23%). Grade II-III encephalopathy was observed in 4/48 patients (8%). TIPS revision with stent dilatation to 10 mm was performed in 6/48 patients (12%); in detail: 4 patients with ascites persistence, without evidence of stent dysfunction, and in 2 patients for stent stenosis. No patient underwent stent reduction. 10 patients (20%) died during follow-up for causes not related to TIPS. Six patients (12%) underwent liver transplant.

Conclusion: VCX for TIPS creation in cirrhotic patients with RA is associated with a good clinical mid-term outcome with a reasonably low complications rate.

P-846

Percutaneous transhepatic embolisation of gastroesophageal varices combined with access closure with n-butyl-2-cyanoacrylate for patients with recurrent variceal bleeding

G.A. Sobolev, A.D. Kiselev, A.N. Ivanenko, I.S. Semin, V.A. Pyatkov, I.L. Bakhtin

Interventional radiology, Arkhangelsk Regional Clinical Hospital, Arkhangelsk, RU

Purpose: To evaluate rate of complications and 6-month follow up of percutaneous transhepatic embolization of gastroesophageal varices combined with access closure with n-butyl-2-cyanoacrylate (Histoacryl, B. Braun) for patients with liver cirrhosis and recurrent variceal bleeding.

Material and methods: Retrospective analysis of 5 patients (average age 45 (33-57); F/M-3/2), who underwent percutaneous transhepatic embolization of gastroesophageal varices.

Simultaneous access closure with n-butyl-2-cyanoacrylate (Histoacryl, B. Braun) was performed due to high bleeding risk related with access site because of hypocoagulation (average PLT $93 \times 10^9/l$, average INR 2.16) and portal hypertension.

Effectiveness of percutaneous transhepatic embolization of gastroesophageal varices was evaluated by the absence of bleeding from gastroesophageal varices in 6-month period.

Results: All patients underwent percutaneous transhepatic embolization of gastroesophageal varices combined with access closure with n-butyl-2-cyanoacrylate (Histoacryl, B. Braun). Technical success was obtained in 100% of cases. Average hospitalization time was 12 days. No cases of postoperative access site complications was reported. None of patients had recurrence of bleeding in 6-month period.

Conclusion: Use n-butyl-2-cyanoacrylate (Histoacryl, B. Braun) for percutaneous transhepatic embolization of gastroesophageal varices combined with access closure helps to avoid access site complications in patients with high risk of bleeding.

P-847

Lipiodol devoid BRTO for treatment of large gastric varices: experiences from a tertiary care centre in India

P.S. Khara¹, P.K. Garg¹, N.K. Bhargava², B. Sureka¹, S. Tiwari¹, T. Yadav¹

¹Diagnostic and Interventional Radiology, All India Institute of Medical Sciences, Jodhpur, IN, ²Gastroenterology, SN Medical College and Associated Hospitals, Jodhpur, IN

Purpose: To evaluate the long term efficacy and safety of BRTO (Balloon occluded transvenous obliteration) by using sodium tetradecyl sulphate (STS) foam.

Material and methods: 15 patients underwent BRTO at our institute during a 35 month period (Feb 2016-Jan 2019). A total of 16 procedures were performed for 15 patients. The same were analysed for technical success, intra and post procedure complications and clinical outcome. Clinical follow up was done in Radiology OPD at one week, four weeks, 3 months and 1 year.

Results: Technical success of the procedure was 93% (14/15 cases) with one case being a technical failure due to non cannulation of GRS.

11 cases underwent BRTO for emergency bleeding, 3 for chronic bleeding and 1 for recalcitrant HE. Of the 15 treated cases one patient died after 2 hours due to severe upper GI bleed in the ICU, another died at 3 months due to non-procedure related cause. All other cases are on regular follow up with no recurrence of bleed or hepatic encephalopathy and no exacerbation of portal hypertension.

Minor intra procedure complications such as shunt rupture and reflux of sclerosant into portal circulation occurred in 3 cases (20%) with no clinical repercussions.

Average procedure time was 125 minutes (95%CI: 114-140 min) with shunt cannulation being the most difficult step technically. Average volume of sclerosant used was 12 ml.

Conclusion: BRTO using foam sclerotherapy is a reasonably easy, safe and economical procedure with excellent clinical outcomes to treat cases of portal hypertension leading to large bleeding gastric varices and HE.

P-848

Portal vein embolization using N-butyl cyanoacrylate versus gelatin sponge for hypertrophy of the future liver remnant: comparison of liver volumetry and clinical outcomes

H.H. Chu, C. Park, J.Y. Kim, M. Park, J. Hur, J.W. Kim, J.H. Kim, J.H. Shin, D.I. Gwon

Radiology, Asan Medical Center, Seoul, KR

Purpose: To compare the liver volumetry and outcomes of portal vein embolization (PVE) using N-butyl cyanoacrylate (NBCA) + AMPLATZER Vascular Plug (AVP) and gelatin sponge + AVP or coil.

Material and methods: Between June 2016 and July 2018, 210 patients underwent PVE using NBCA + AVP (n = 72) and gelatin sponge + AVP or coil (n = 138) for hypertrophy of future liver remnant (FLR) prior to major hepatectomy. Using a computed tomography (CT) volumetry, we retrospectively evaluated the liver volume before and after the PVE. The groups were compared using Mann-Whitney U and χ^2 test.

Results: Technical success of PVE was 100% in NBCA group and 98.6% in gelatin sponge group. In the linear regression analysis, we found statistically significant positive correlation ($R^2 = .701$) between CT volumetry and actual weight of resected segments of the liver ($P < .001$). Degree of hypertrophy ($13.0\% \pm 4.7$ vs $9.7\% \pm 4.2$, $P < .001$) was greater in the NBCA group versus the gelatin sponge group. The NBCA group required less fluoroscopic time ($13.2 \text{ min} \pm 6.9$) compared with the gelatin sponge group ($18.5 \text{ min} \pm 5.9$; $P < .001$). There was no significant difference between the two groups in terms of the rates of procedure-related complications, the ability to have surgery, and causes of aborted surgery.

Conclusion: PVE with NBCA + AVP results in greater hypertrophy compared with gelatin sponge + AVP or coil with less fluoroscopic time and a similar rate of procedure-related complications and ability to have surgery.

P-849

Jejunal variceal embolization with or without portal vein stent placement of jejunal variceal bleeding after hepatopancreatobiliary surgery

S. Ogawa¹, A. Yamamoto², T. Nota¹, K. Murai², M.M. Nakano¹, K. Kageyama², A. Jogo², E. Sohga³, S. Hamamoto², Y. Miki²

¹Diagnostic and Interventional Radiology, Osaka City University Graduate School of Medicine, Osaka, JP, ²Diagnostic and Interventional Radiology, Osaka City University, Osaka, JP, ³Radiology, Osaka City University, Osaka, JP

Purpose: Extrahepatic portal hypertension after surgery involving the duodenum or jejunum might result in massive ectopic variceal bleeding. This investigation aims to evaluate feasibility of jejunal variceal embolization with or without portal vein stent placement.

Material and methods: We retrospectively analyzed consecutive 7 patients who underwent jejunal varices embolization for jejunal variceal bleeding after surgery between July 2015 to July 2018. The period from surgery to first bleeding was 75 to 1814 days. Four patients were treated with varicose embolization only, the remaining 3 patients were treated with portal vein stent placement and varicose embolization. Procedure was performed via percutaneous transhepatic route in one patient, and transileocolonic vein route in 6 patients. As an embolic agents, coil, ethanolamine oleate iopamidol containing gelatin sponge or NBCA was used. The rates of technical and clinical success, complications, and clinical outcomes were evaluated.

Results: Jejunal variceal embolization was successful in all 7 patients. Additional portal vein stent placement was performed in 4 cases. There were no procedure-related complications. Clinical success, defined as the cessation of bleeding without recurrence within 1 month, was achieved

in 6 of 7 patients with technical success. One patient developed recurrent bleeding after first embolic therapy and was successfully treated with additional variceal embolization. During the follow-up period (range, 78-1076 days), one patient occurred stent occlusion occurred and placed the stent again 6 months after the initial treatment.

Conclusion: Jejunal variceal embolization with or without portal vein stent placement appears to be a safe and effective treatment for jejunal variceal bleeding after hepatopancreatobiliary surgery.

P-850

Outcome of embolizing gastro-renal shunt by n-butyl 2-cyanoacrylate after balloon-occluded retrograde transvenous obliteration

M. Ozawa, M. Yamamoto, E. Hoshino, S. Inui, A. Suzuki, R. Zako, S. Toshimasa, T. Yokoyama, J. Toda, H. Kondo

Radiology, Teikyo University School of Medicine, Tokyo, JP

Purpose: After balloon-occluded retrograde transvenous obliteration (BRTO), the balloon catheter typically remains placed overnight in Japan. This increases the risk of bleeding and infection at the puncture site and force the patient to rest in bed. Therefore, we examined the effect and safety of removing the catheter immediately after embolizing gastro-renal shunt by n-butyl 2-cyanoacrylate (NBCA).

Material and methods: From October 2016 to May 2018, we retrospectively analyzed 12 patients who underwent embolizing gastro-renal shunt by NBCA after BRTO. All patients removed the catheter immediately after the procedure and required rest in bed only two hours. Technical success rate, clinical success rate and complications were collected from electronic medical records. Technical success was defined as the sclerosant agent remaining in the varices after embolizing gastro-renal shunt by NBCA. Clinical success was defined as the reduction or disappearance of the gastric varices by endoscopic examination at 1 month follow-up.

Results: Technical success rate and clinical success were 100% and 92%, respectively. One patient had abdominal pain due to intravascular injury during procedure (improved during observation). Pulmonary embolism or ectopic embolisms related to NBCA were not observed.

Conclusion: Technical and clinical success and complications associated with our method are equivalent to those of BRTO reported in the past. This methods may be effective and safe to reduce the burden on patients.

P-851

Colapinto needle set vs Rosch-Uchida needle set: a systematic review of portal vein puncture-related complications during transjugular intrahepatic portosystemic shunt creation

B. Cimo¹, C. Cannataci², L. Maruzzelli³, K. Cortis², R. Miraglia³

¹Department of Medicine - DIMED, Radiology Institute, Padova, IT, ²Medical Imaging Department, Mater Dei Hospital, Malta, MT, ³Diagnostic and Therapeutic Services, Mediterranean Institute for Transplantation and Advanced Specialized Therapies (IsMeTT), Palermo, IT

Purpose: Transjugular portal vein puncture is considered the riskiest step in transjugular intrahepatic portosystemic shunt (TIPS) creation with possible incidence of portal vein puncture-related complications (PVPC) such as intrahepatic bleeding, haemoperitoneum, haemobilia and hepatic artery injury. Two different needle-set designs are available: Colapinto needle set and Rosch-Uchida needle set. No comparison studies are available. We performed a systematic review of studies on TIPS creation to evaluate if the needle-set used influences the PVPC rate.

Material and methods: Pertinent studies were retrieved through MEDLINE (2008-2018). All TIPS studies reporting a number of patients ≥ 30 , the needle set used and the incidence of PVPC were included. From the described search, 1500 articles were identified and 46 met the inclusion criteria. Outcome measured was the incidence of PVPC.

Results: The 46 studies included 7106 patients. Overall 229 PVPC were reported (3.2%). In 33 studies, involving 4854 patients, the Rosch-Uchida

needle set was used with 159 PVPC reported (3.3%); in 13 studies, involving 2352 patients, the Colapinto needle set was used with 70 PVPC reported (2.9%) ($p=0.46$).

Conclusion: PVPC in TIPS creation are not related to the choice of needle set used in the procedure.

P-852

Novel double contrast sandwich (DCS) technique to embolize a large portosystemic shunt using glue and coils: initial experience of 3 cases

M. Inoue¹, S. Nakatsuka¹, H. Yashiro², M. Shinohara³, M. Miyabayashi³, J. Tsukada⁴, N. Ito¹, M. Mitsu², H. Torikai⁵, R. Ogawa¹, Y. Furukawa¹, S. Matsui¹, M. Hase¹, M. Jinzaki⁶
¹Diagnostic Radiology, Keio University School of Medicine, Tokyo, JP, ²Diagnostic Radiology, Hiratsuka City Hospital, Hiratsuka-city, JP, ³Department of Radiology, Ogikubo Hospital, Tokyo, JP, ⁴Diagnostic Radiology, Nihon University Itabashi Hospital, Tokyo, JP, ⁵Diagnostic Radiology, Keio University Hospital, Tokyo, JP, ⁶Radiology, Keio University School of Medicine, Tokyo, JP

Purpose: To evaluate the feasibility of double contrast sandwich (DCS) technique to embolize a large portosystemic shunt for patients with refractory hepatic encephalopathy.

Material and methods: This retrospective study includes three patients (mean age, 89; male 1, female 2) with refractory hepatic encephalopathy (HE) due to a large extrahepatic portosystemic shunt (ePSS). All patients underwent embolization of ePSS by (DCS) technique. Drainage veins of ePSSs were cannulated using a balloon catheter. A microcatheter was inserted to the PSS through the balloon catheter as distal as possible. After using some coils to reduce flow of the shunt, glue was injected through the microcatheter followed by strong flushing glue out of the microcatheter using 5% glucose solution to adhere glue to venous wall under balloon inflation. A thin layer of glue was remaining on the venous wall: Double contrast method. The same technique was performed repeatedly through the same microcatheter all the way of the PSS. Finally, we embolize the exit of the shunt using coils. Glue is sandwiched with coils (Sandwich method). Sheath were removed.

Results: HE was improved significantly in all patients. There is no major complication.

Conclusion: Balloon-assisted retrograde transvenous occlusion is useful technique; however, it needs large amounts of sclerosant to embolize a large ePSS. Plug-assisted retrograde transvenous obliteration cannot be performed for a large PSS without a narrow neck. Recurrence of HE was reported by Coil-assisted retrograde transvenous obliteration. DCS technique is feasible and can control the embolization area precisely. DCS could be one of the treatment option for a large PSS.

P-853

Outcomes of retrograde transvenous obliteration for the treatment of portosystemic shunting in high risk patients at a single institution

A. Lichliter¹, S. Rodich², J. Oros¹, M. Cura¹
¹Radiology, Baylor University Medical Center, Dallas, TX, US, ²Medicine, Texas A&M Health Science Center, Dallas, TX, US

Purpose: The purpose of this study is to evaluate outcomes of patients with high MELD scores ≥ 17 and portosystemic shunts treated with BRTO or CARTO.

Material and methods: Retrospective analysis of BRTO and CARTO procedures in the last four years at a single institution was performed. Patients with MELD scores ≥ 17 were included. Data included demographics, pre- and post-procedure labs, techniques and complications. Pre MELD scores were obtained ≤ 48 hours before the procedure. Post MELD was categorized as immediate (within 30 days) and delayed (30-90 days). Comparisons were completed using paired t-test.

Results: Eleven patients were included (mean age, 66 y; range, 49-74 y), with underlying gastric varices (8) or complications of liver transplant (3). All had a portosystemic shunt successfully occluded. Mean pre MELD was 24 (range, 17-39). Three early deaths occurred within 7 days post procedure (multiorgan failure, 2, and fulminant hepatic transplant failure, 1). There were 2 deaths within 30 days (ventilator associated pneumonia and discharge to hospice). For the remaining 6 patients, mean follow up duration was 17 months (range, 3-26.5 months). Six patients had an immediate MELD; 5 had a delayed MELD. The MELD score did not significantly improve in either period (mean, pre 28 vs immediate 25, $P=0.65$; pre 21 vs delayed 17, $P=0.17$).

Conclusion: BRTO and CARTO of portosystemic shunts in patients with a high MELD (≥ 17) is a safe procedure. There was no significant improvement in MELD score, whether immediate or delayed. However, patients who survived the acute period had a mean survival of >1.5 years.

P-854

TIPS: a 9 year audit at an Australian quaternary liver transplant hospital

A. Lamanna¹, G. Mitreski², Y. Ren¹, A.R. Owen¹, M. Goodwin³, T. Schelleman³, D. Ranatunga³
¹Department of Radiology, Austin Hospital, Heidelberg, VIC, AU, ²Radiology Department, Austin Hospital, Geelong, VIC, AU, ³Interventional Radiology Service, Austin Hospital, Heidelberg, VIC, AU

Purpose: Transjugular Intrahepatic Portosystemic Shunt (TIPS) aims to treat complications of portal hypertension, typically refractory ascites and variceal haemorrhage. We present the results of a 9-year retrospective audit of all TIPS procedures performed at the liver transplant hospital of Victoria, Australia.

Material and methods: Clinical data of all patients who underwent TIPS at our institution between January 2010 and January 2019 were retrospectively obtained from electronic medical records and reviewed. Patient demographics, procedural technique, indications, complications and 12-month stent patency were recorded.

Results: 87 TIPS procedures were performed during this period. 47 procedures were elective and 40 were emergent. Elective TIPS was most commonly performed in patients with Child-Pugh B cirrhosis ($n=38$; 83%) and emergent TIPS in patients with Child-Pugh B ($n=20$; 50%) and C ($n=17$; 43%) cirrhosis. The commonest indications were refractory ascites ($n=39$; 45%) and variceal haemorrhage ($n=36$; 41%). Technical success rate was 100%. Periprocedural complication rate was 39% ($n=34$) with encephalopathy ($n=16$; 18%) and sepsis ($n=9$; 10%) the most common. 30-day mortality rate was 9% and occurred predominately in patients with Child-Pugh C cirrhosis ($n=5$; 63%). All deaths followed emergent TIPS, most commonly performed for refractory variceal bleeding ($n=4$; 50%). 10 patients (11%) experienced stent dysfunction within 1-year. 96% of patients had a patent TIPS stent at a median of 12 months follow-up (IQR 3-24).

Conclusion: At our institution TIPS has excellent technical success and 12-month patency. There were moderate risks of periprocedural complications and death, the latter largely confined to patients with Child-Pugh C cirrhosis requiring emergent TIPS for variceal bleeding.

P-855

Balloon angioplasty without metallic stenting for treatment of pediatric liver transplant postoperative venous anastomotic stenosis: long term results

A.S. Gomes¹, P.A. Monteleone¹, S.V. McDiarmid², D. Farmer³

¹Radiological Sciences, David Geffen School of Medicine at UCLA, Los Angeles, CA, US, ²Pediatric- Gastroenterology, David Geffen School of Medicine at UCLA, Los Angeles, CA, US, ³Surgery-Live and Pancreatic Transplantation, David Geffen School of Medicine at UCLA, Los Angeles, CA, US

Purpose: To describe our long-term experience using balloon angioplasty for treatment of portal and venous anastomotic stenosis in pediatric orthotopic liver transplant (OLT) patients without concomitant use of metal stents.

Material and methods: With IRB approval, we retrospectively reviewed our pediatric OLT database for patients with significant venous anastomotic stenosis requiring treatment. Parameters analyzed included age at time of initial angioplasty, time from OLT to stenosis treatment, primary patency rate, time to stenosis recurrence, and long-term follow-up.

Results: Nineteen patients (12 female) underwent 37 angioplasty procedures. Eight patients had more than one OLT. In all patients, angioplasty was performed on their last liver. Mean age at first angioplasty was 6.3 years. Technical success was 100%. Treatment sites consisted of portal vein (13), IVC (5), mesocaval shunt (1). In the 12 (63%) patients requiring only one angioplasty, long-term patency post angioplasty was observed throughout their follow-up period (mean follow-up 8 years (range 1 yr. – 18.3 years). Seven patients (37%) received more than one angioplasty. For those undergoing more than one angioplasty the mean interval between treatments was 18.8 months (median 10.1 mos, range 2 weeks - 18 yrs.). On long-term follow-up, 4 patients expired, unrelated to the procedure. Time from last treatment to time of death was 10.2 yrs., 8.6 yrs., 2.3 yrs. and 0.1 yrs., respectively.

Conclusion: Balloon angioplasty is an effective and durable method for the treatment of portal and venous anastomotic stenosis in pediatric liver transplant patients, avoiding use of metallic stents in growing children.

P-856

Clinical significance of liver volume change after portal vein embolization and hepatofugal collateral obliteration - the bigger the better?

M. Kishino¹, S. Nakaminato¹, Y. Kitazume¹, M. Takahashi¹, K. Kimura¹, K. Nishida¹, T. Takeguchi², Y. Takeguchi², S. Yanai³, Y. Saïda¹, U. Tateishi¹

¹Department of Diagnostic Radiology, Tokyo Medical and Dental University, Tokyo, JP, ²Diagnostic Radiology, Musashino Red Cross Hospital, Musashino-shi, JP, ³Diagnostic Radiology, Ome Municipal General Hospital, Ome City, JP

Purpose: To evaluate the relationship between liver function and liver volume change after percutaneous trans-hepatic portal embolization (PTPE) and balloon-occluded retrograde transvenous occlusion (B-RTO).

Material and methods: This retrospective study included 28 cases of PTPE and 23 cases of B-RTO. Regarding PTPE, 26/28 cases were non-cirrhotic and 22/23 cases of B-RTO involved liver cirrhosis with portal hypertension. Pre- and post-procedural residual (unembolized lobe) liver volume of the PTPE group and whole liver volume of the B-RTO group were evaluated. Patients with an increase rate over 5% were included in the enlarged group. Changes in liver function tests, including serum albumin, total bilirubin, and prothrombin time percentage activity, were evaluated. Liver function in the early (within a week) and late (3 weeks) period post-procedure for PTPE and pre- and post-procedure for B-RTO was compared.

Results: The residual liver volume in the PTPE group ($p = 0.00$) and serum albumin level in the B-RTO group ($p = 0.02$) were significantly increased.

In the PTPE group, the serum albumin increase was significantly higher in the enlarged liver group ($p = 0.01$) and a positive correlation was found between serum albumin and liver volume change ($p = 0.01$). On the other hand, in the B-RTO group, the serum albumin increase rate was lower in the enlarged liver group ($p = 0.04$).

Conclusion: The increase of portal blood flow will lead improvement of liver function. However, liver volume increase does not directly relate to liver function, which may depend on the spare hepatic capacity for portal blood flow increase.

P-857

Stent placement for portal venous stenosis after hepatobiliary and pancreatic surgery

T. Sanomura, T. Norikane, Y. Nishiyama

Radiology, Faculty of Medicine, Kagawa University, Kagawa, JP

Purpose: The purpose of this study was to evaluate the efficacy and safety of stent placement for portal venous stenosis after hepatobiliary and pancreatic surgery.

Material and methods: From October 2012 to December 2018, portal venous stent placement was attempted in ten patients (age range, 62-85 years; five men and five women) with postoperative portal venous stenosis. Portal stenosis was caused by postoperative change with thrombus ($n=5$) and without thrombus ($n=5$). A total of 13 stents (12 bare metal stents and 1 covered stent) were placed by percutaneous transhepatic approach in five patients and by transileocolic approach in the other five patients. In addition, three patients were used in combination with thrombolytic therapy. Technical success, treatment efficacy, clinical success and primary stent patency rate were analyzed.

Results: Stents were successfully placed in all patients. Clinical manifestations improved in all patients. There were no procedure-related complications. Portal venous blood flow was maintained during the follow-up period ranging from 45 days to 892 days (mean, 347.6 days) in all patients.

Conclusion: Stent placement appears to be a safe and effective treatment for portal venous stenosis following major abdominal surgery.

P-858

Feasibility and effectiveness of hepatic artery guiding technique in transjugular intrahepatic portosystemic shunt

E.T. Kim¹, S.-Y. Song², Y.K. Cho³, W. Choi⁴

¹Radiology, Hanyang University Guri Hospital, Guri, KR, ²Department of Radiology, Hanyang University Hospital, Seoul, KR, ³Department of Radiology, Kangdong Seong-Sim Hospital, Hallym University College of Medicine, Seoul, KR, ⁴Radiology, Joongang University, Seoul, KR

Purpose: To evaluate the feasibility and effectiveness of the hepatic artery guiding technique in Transjugular Intrahepatic Portosystemic Shunt (TIPS) procedure.

Material and methods: From January 2009 to December 2018, 41 patients (36 men, 5 women; mean age, 57.9 years; range, 33–77 years) who performed TIPS were retrospectively evaluated. Total procedure time, puncture time, sum of radiation dose of total procedure as radiation quantity (mGy) and dose area product (μGym^2) of each procedure were compared between simple blind puncture group and hepatic artery guiding technique group by Mann-Whitney U test.

Results: Technical success was achieved in all patients. Out of 41 patients, simple blind puncture was done in 11 patients (26.8%) and hepatic artery guiding technique was done in 30 patients (73.2%). No complication was developed in each group. Mean puncture time of hepatic artery guiding technique group (26.67 ± 11.46 minutes) was significantly shorter than simple blind puncture group (38.50 ± 29.69 minutes) ($p=0.045$). There was no statistical significance in total procedure time and radiation dose ($p>0.05$).

Conclusion: Hepatic artery guiding technique could facilitate the portal vein puncture in TIPS without significant increase in radiation dose.

P-859

Stenting of acute (< 24 hs) portal vein thrombosis after living donor liver transplantation in children under 3 years old

R.D. García-Mónaco¹, M. Czerwono², J. Pekolj³, O. Peralta¹, E. de Santibañes³, M. de Santibañes³

¹Interventional Radiology, Hospital Italiano de Buenos Aires, Buenos Aires, AR, ²Image Guided Minimally Invasive Surgery, Hospital Italiano de Buenos Aires, Buenos Aires, AR, ³Hepato Pancreatic Biliary Surgery, Hospital Italiano de Buenos Aires, Buenos Aires, AR

Purpose: Pediatric living donor liver transplantation (LDLT) in low weight recipients is a complex procedure with portal vein complications being as high as 19%. We present a short series of cases of children with immediate (< 24 hs) post-operative acute portal vein thrombosis (PVT) that was successfully with endovascular stenting.

Material and methods: Between 2015 and 2017, 5 children complicated with acute PVT after LDLT were treated with stenting. Portal recanalization was performed at the OR during LDLT (n=2) or in a hybrid room (n=3) if detected after surgery. The inferior mesenteric vein was isolated and a 5F introducer was placed under Seldinger technique. After a direct angiography, endovascular portal recanalization with aspiration thrombectomy and stenting was performed. Embolization of gastric veins in the same session was performed at operator's discretion.

Results: Five children (mean age 17,6 months; mean weigh 8,74 kg) were treated with self-expandable stents. Gastric veins embolization with alcohol and coils was performed in 2 patients. All procedures were technically successful and there were not complications related to the endovascular procedures. There were neither deaths nor graft losses and all patients show portal vein patency at 2 years follow up

Conclusion: Portal stenting of acute PVT during or immediately after LDLT has shown to be safe and effective in this short series. Mid-term portal and stent patency was high despite continuous growth in children.

P-860

Transjugular intrahepatic portosystemic shunt creation for portal vein thrombosis

P.B. García Jurado¹, S. Lombardo Galera², M.E. Perez Montilla², J.J. Espejo Herrero², I.D. Domínguez Paillacho¹, L.J. Zurera Tendero³

¹Vascular Intervencionismo, Hospital Universitario Reina Sofía, Córdoba, ES, ²Interventional Radiology, University Hospital Reina Sofía, Córdoba, ES, ³Serv. Radiodiagnóstico, Hospital Universitario Reina Sofía, Córdoba, ES

Purpose: To evaluate the technical success and outcomes of transjugular intrahepatic portosystemic shunt (TIPS) procedures performed in patients with portal vein thrombosis (PVT).

Material and methods: Single-centre retrospective study of patients with PVT and variceal bleeding or ascites treated with TIPS between June 2006 and August 2018.

Results: 28 patients with PVT were analyzed (8 acute PVT, 4 chronic PVT without cavernomatosis and 16 chronic PVT with cavernomatosis). The average age was 44,1 ± 20,6 years, 20 males and 8 females. Three approaches have been used to access the target portal vein and to further facilitate recanalization of the thrombosed portal vein: classic transjugular approach (57,1%), a combined transjugular and transhepatic approach (25%) and a combined transsplenic approach (17,1%). As a target was used: balloon (28,6%), colateral vein (10,7%) and biliary duct (7,1%).

The portosystemic pressure was decreased from 16,6 ± 5,6 mmHg before TIPS to 8,3 ± 4,1 mmHg after TIPS (p<0,05).

At 3, 6, 9, 12, and 24 months, primary patency rates were 88%, 76%, 62,3%, and 45,7%. During follow-up period (media, 38,2 ± 25,8 months)

9 patients required another intervention. At 3, 6, 9 and 12 months, secondary patency rates were 100%, 100%, 100%, and 87,5%.

The overall mortality was 23,1% with an average time until the death of 15,8 months.

Conclusion: TIPS was found to be effective in reducing portal hypertension in patients with PVT, presenting high patency rates.

P-861

Transjugular intrahepatic portosystemic shunt in patients with cirrhosis: 10 years single center experience

F. Frenzel¹, A. Buecker¹, A. Ecker², A. Massmann¹, J. Stroeder¹, P. Jagoda¹, P. Minko¹

¹Diagnostic and Interventional Radiology, Saarland University Medical Center, Homburg, DE, ²Department of Gastroenterology, Saarland University Medical Center, Homburg, DE

Purpose: To assess longterm results and the efficacy of transjugular intrahepatic portosystemic shunt (TIPS) using an 8 or 10 mm PTFE-covered stent in patients with liver cirrhosis having refractory ascites and/or variceal hemorrhage.

Material and methods: During 01/2007-12/2017 198 patients (68 female; mean 58±12.3 years) underwent 245 TIPS procedures. This included TIPS placement using an 8 or 10 mm PTFE-covered stent (VIATORR, GORE®), control and revisions. Laboratory values (e.g. bilirubin and INR) were collected for each patient. Mean follow-up time was 1172±996 days.

Results: TIPS creation was successful in 94.1%. Portosystemic pressure gradient reduction was significantly lower (p=0.0019) in 8 mm stents (mean 7.4±5.9 mmHg) vs. 10 mm stents (10.8±7.0 mmHg). Compared to baseline, bilirubin levels increased significantly in patients with 8 mm stents (2.2±5.0 mg/dl) vs. 10 mm stents (0.53±2.8) at discharge after TIPS placement (p=0.018). Need for paracentesis was reduced from 53% to 22.4% in patients receiving an 8 mm stent compared to a reduction of 71.5% to 17.1% in patients receiving a 10 mm stent. Mean hospital stay after TIPS creation was 14.7±11.5 days in 8 mm stent vs. 10.2±8.9 in 10 mm stent placements. The mortality rate was 36.7% in 8 mm stents vs. 23.8% in 10 mm stents after TIPS placement.

Conclusion: TIPS using a 10 mm stent leads to significant reduction for the need of paracentesis compared with an 8 mm stent. Implantation of a 10 mm stent resulted in an earlier discharge from hospital and a lower mortality rate in comparison to an 8 mm stent placement.

P-862

Beyond the average trans-jugular intrahepatic portosystemic shunt

D. Raissi, Q. Yu

Radiology, University of Kentucky, Lexington, KY, US

Learning objectives: Review the theory and methodology behind TIPS Pictorial review of TIPS and myriad of scenarios of associated procedures in extreme cases

Background: TIPS has proven benefit in overt portal hypertension by directly lowering the portosystemic pressure gradient and thus alleviating symptoms such as ascites and variceal hemorrhage. In our institution, TIPS revisions, recanalizations, and additional portal venous system are performed routinely to maximize its therapeutic value in complex cases and extreme scenarios with limited options.

Clinical Findings/Procedure Details:

Case 1-2: Trans-splenic TIPS access for patients with thrombosed portal and splenic veins.

Case 3: Acute TIPS thrombosis in a patient with large spontaneous portosystemic shunt identified as competing mesenterico-renal shunt via the left gonadal vein. Thrombectomy Coil embolization of the competing shunt was performed. TIPS shunt patent at 6 months f/u.

Case 4: Sustained ascites and varices recalcitrant to TIPS revision and recanalization of the splenic and portal vein. Superior mesenteric, splenic

and inferior mesenteric venous stents placed to allow for optimal hepatic flow into the TIPS stent.

Case 5: Routine TIPS performed for ascites. Patient developed hepatic encephalopathy not responsive to medical management. TIPS stent luminal reduction using a balloon expandable covered stent alongside a newly placed restricted Viatorr stent.

Case 6: Recurrent lower GI bleed from rectal varices secondary to portal hypertension managed with inferior mesenteric vein Onyx embolization. After IMV embolization, newly developed bleeding esophageal varices was managed with TIPS.

Conclusion: Theory and methodology behind TIPS

How to exploit TIPS's therapeutic value in complex cases

Discuss other mesenteric venous interventions in Portal hypertension.

P-863

Strategies for successful portal vein puncture during TIPS: a pictorial review

G. Mitreski, A. Lamanna, A.R. Owen, M. Goodwin, T. Schelleman, D. Ranatunga

Department of Radiology, Austin Hospital, Heidelberg, VIC, AU

Learning objectives:

1. To understand indications for TIPS and hepatic venous anatomy.
2. To describe different portal vein access techniques illustrated with appropriate clinical examples.
3. To trouble-shoot difficult TIPS cases.

Background: A transjugular intrahepatic portosystemic shunt (TIPS) is usually inserted to treat the complications of portal hypertension, usually refractory ascites or recurrent variceal bleeding. The most difficult aspect of TIPS insertion is achieving portal vein (PV) access. This review describes various PV access methods and strategies for technical success.

Clinical Findings/Procedure Details:

1. Wedged Portography:

Early TIPS were created using a 'blind' approach from the cannulated hepatic vein into the portal vein. In contemporary practice, contrast or carbon dioxide (CO₂) wedged hepatic portography is used to opacify the portal vein and facilitate PV puncture.

2. Percutaneous Insertion of a Portal Vein Target:

Intravenous or parenchymal targets such as balloon catheters, pigtail catheters and fiducial wires have been inserted percutaneously into or adjacent to the portal vein to create a fixed radiopaque target for portal vein puncture.

3. Ultrasound-Guided Puncture of Portal vein:

Transhepatic ultrasound is used for real-time guidance of the needle from the hepatic vein to portal vein. This technique typically requires 2 operators (proceduralist and sonographer) and can also be performed retrogradely (i.e. passage of the needle percutaneously through the portal vein and into the hepatic vein). Intravascular US has also been used to successfully create TIPS.

Conclusion: Three different techniques are described to access the portal vein during TIPS. The techniques are illustrated with real clinical examples.

P-864

CO₂ as the only contrast agent for TJLB in ESRD patients: pearls and pitfalls

R. Raymond¹, F.J. Oser², J.G. Caridi³

¹Radiology, Tulane University Medical Center, New Orleans, LA, US,

²Radiology, Tulane University School of Medicine, New Orleans, LA, US,

³Vascular and Interventional Radiology, Tulane University Medical Center, New Orleans, LA, US

Learning objectives: Demonstrate the effectiveness and reliability of using CO₂ contrast, specifically in performing Transjugular Liver Biopsies (TJLB) in ESRD patients.

Review the advantages and common pitfalls encountered with CO₂ contrast.

Review the appropriate applications and current delivery methods of CO₂ contrast.

Background: Patients with ESRD have a high prevalence of HCV and usually require functional liver evaluation during a renal transplant assessment, usually with TJLB. In addition to rising rates of ESRD, iodinated contrast allergies and the complication of contrast induced nephropathy (CIN) make CO₂ an important contrast agent for all interventionalists to be comfortable using. Because the associated difficulties often encountered with CO₂, it is important for experienced interventionalists to share their knowledge and expertise with its use.

Clinical Findings/Procedure Details: Aside from its well-known use to assess portal vein patency, CO₂ is often overlooked for iodinated contrast agents in the assessment of the remaining venous structures, including the hepatic veins and IVC. Due to the high frequency of ESRD patients requiring TJLBs at our institution, we began performing CO₂ as the only contrast agent for the entirety of the procedure with consistent great results and diagnostic images.

Conclusion: CO₂ contrast remains an underutilized tool among interventionalists, possibly due to unfamiliarity with its appropriate applications and delivery devices. It is our hope that by sharing our methods and experiences with CO₂ contrast, we can increase familiarity and confidence with its use in obtaining great diagnostic images, while minimizing iodinated contrast administration in patients.

P-865

Image fusion guidance with three-dimensional CO₂ wedged hepatic portography for transjugular intrahepatic portosystemic shunt placement

T. Leger, N. Sellier, O. Seror, O. Sutter

Radiology, Jean Verdier Hospital (APHP), Bondy, FR

Learning objectives: We describe here an innovative technique for the portal vein puncture guidance during transjugular intrahepatic portosystemic shunt (TIPS) procedure: a three-dimensional (3D) virtual target fluoroscopic display using Cone Beam CT (CBCT) with 3D-CO₂ wedged hepatic portography.

Background: TIPS is a complex procedure and one of the most challenging steps is the intrahepatic puncture of the portal vein which is often performed blindly. Several methods are described to locate the portal vein before puncture with their respective advantages and limits.

Clinical Findings/Procedure Details: TIPS procedure is performed under general anaesthesia. The hepatic vein is first catheterized with a 9-Fr catheter advanced to wedge position. Then, a 3D-CO₂ wedged hepatic portography is obtained by combining a CBCT acquisition and an automatic CO₂ injection during suspended respiration. Once located on the 3D reconstructed images of the CBCT acquisition, main portal vein and portal bifurcation are manually segmented on the workstation to create a virtual target. To enable real-time visualization of the portal vein location, the virtual target is overlaid onto live fluoroscopic images, automatically following the table and C-arm movements. This 3D virtual representation of the right portal branch is targeted during the intrahepatic puncture using several positions of the C-arm if necessary. All other classical steps are subsequently performed.

Conclusion: Virtual target fluoroscopic display using CBCT and 3D-CO₂ wedged hepatic portography is an innovative technique of image fusion guidance during TIPS procedure with the advantages of avoiding preoperative imaging, arterial access and requiring only one operator.

P-866

Transjugular intrahepatic portosystemic shunts (TIPS) and coil embolization as emergency management of bleeding anorectal varices in a cirrhotic woman

A. Boccuzzi¹, G. Lorenzoni², D.V. Meccia¹, E. Bozzi², R. Cervelli¹, I. Bargellini², R. Cioni²

¹Diagnostic and Interventional Radiology, University of Pisa, Pisa, IT,

²Diagnostic and Interventional Radiology, AOU PISA, Pisa, IT

Clinical History/Pre-treatment Imaging: Female patient, 55yrs old, with liver cirrhosis and portal hypertension due to dysmetabolic hepatopathy. She was admitted to our hospital with massive anorectal bleeding, not controlled even after interventional proctoscopy, due to anorectal varices prevalent on the right side. A rectal balloon was placed to control bleeding and stabilize the clinical picture. Despite this, the bleeding restarted immediately after the balloon was deflated.

Treatment Options/Results: After a multidisciplinary consult we considered TIPS placement in combination with variceal embolization the most appropriate intervention.

The TIPS was placed successfully, resulting in a reduction of the portosystemic pressure gradient. The perfusion of the rectal varices decreased but was still substantial, therefore we decided to embolize the right varices through the inferior mesenteric vein with multiple coils.

After the procedure, the venogram confirmed the cessation of flow in the varices and the rectal balloon was deflated gradually.

The day after the balloon was removed and the patient's hematochezia was improved.

Discussion: Although rectal variceal bleeding in patients with portal hypertension is rare, it can be fatal if not appropriately treated.

There is no consensus on the most appropriate management. If conservative treatment, endoscopic intervention or surgery are not effective or possible, TIPS placement and varices embolization can be effectively to induce a short-term hemostatic response and to prevent recurrent variceal bleeding.

Take-home points: This combined approach provides an immediately satisfactory hemostatic effect and eliminated the possibility of rebleeding. Therefore, it could be an available solution to manage uncontrolled rectal varices bleeding in patient with portal hypertension.

P-867

Successful transfemoral intrahepatic portosystemic shunt creation via inferior right accessory hepatic vein

H. Tanaka¹, N. Kawaguchi², T. Mochizuki², T. Yamagami³

¹Radiology, Ehime University Graduate School of Medicine, Matsuyama

Ehime, JP, ²Radiology, Ehime University Graduate School of Medicine,

Toon Ehime, JP, ³Radiology, Medical School, Kochi University, Nankoku, JP

Clinical History/Pre-treatment Imaging: A 50-years man with refractory ascites from hepatitis C related cirrhosis was referred for TIPS creation. Patient underwent radiofrequency ablation therapy for hepatocellular carcinoma and endoscopic sclerotherapy for esophageal varices previously. Liver function test revealed Child-Pugh score 11 points grade C and MELD score 16 points. Computed tomography of the liver revealed agenesis of right hepatic vein and dilated inferior right accessory hepatic vein.

Treatment Options/Results: We decided intrahepatic portosystemic shunt creation from right transfemoral approach and inferior right accessory hepatic vein puncture. Puncture needle was successfully advanced from inferior right accessory hepatic vein into right portal vein. Finally 8mm diameter bare stent was deployed into intrahepatic shunt tract. Portal pressure decompression was obtained and refractory ascites gradually decreased. No complications occurred during procedure.

Discussion: The present report described feasibility of transfemoral approach intrahepatic portosystemic shunt creation via inferior right accessory hepatic vein. There was few report of TIPS creation from inferior right hepatic vein.

Take-home points: Transfemoral intrahepatic portosystemic shunt creation via inferior right accessory hepatic vein is useful safety option with hypoplastic right hepatic vein patients.

P-868

Portal vein embolization of caudate lobe

M. Nakamura, M. Maruyama, H. Kitagaki

Radiology, Shimane University Faculty of Medicine, Izumo, JP

Clinical History/Pre-treatment Imaging: The patient was 71years-old-male who was diagnosed hepatic portal cholangiocarcinoma on left lobe. Enlarged left lobectomy was designed.

Treatment Options/Results: Before curative operation, we embolized left portal vein and caudate portal vein under general anesthesia from trans-iliocolic vein. Embolization was used ethanol and coils under balloon catheter.

Discussion: Portal embolization had two approach, there were trans-hepatic and trans-iliocolic approach. Embolization of caudate portal vein was necessary in some cases. Embolization of caudate portal vein was not easy on transhepatic approach.

Take-home points: Catheterization to caudate portal vein was easy on antegrade approach.

P-869

Modified balloon-occluded retrograde transvenous obliteration (BRTO) to diverge flow in intrahepatic portal vein thrombosis after OLT

P.M. Brambillasca¹, F. Barbosa², S. Bongiovanni³, M.L. Jannone¹, C. Migliorisi², A.G. Rampoldi²

¹Radiologia, Università degli studi di Milano, Milan, IT, ²Interventional

Radiology, Niguarda Hospital, Milan, IT, ³Radiology, Ospedale Santa Croce e Carle, Cuneo, IT

Clinical History/Pre-treatment Imaging: A 61 years-old male patient with single 22mm hepatocarcinoma, refractory ascites with a large (19mm) mesenteric-caval shunt and esophageal varices, treated with OLT associated with Fogarty of the portal vein to reduce partial thrombosis with hepatopetal flow at intraoperative US-Doppler.

In the 1st post-operative day he developed liver failure. Contrast-enhancement CT observed focal intrahepatic portal vein steno-occlusion.

Treatment Options/Results: We excluded portal vein stenting or transjugular portosystemic shunt (TIPS) for possible surgical complications in case of re-OLT. After transhepatic percutaneous access we performed portography observing severe portal vein stenosis, hepatofugal flow and an high-flow via mesenteric-caval shunt. Occlusion-balloon was put into the shunt through the caval side (transjugular access) and we embolized the shunt with sponge and coils. Portography revealed increased flow in the esophageal varices, thus embolized with detachable coils. 2 hours later the balloon was partially deflated and angiography was performed showing minimal recanalization of the shunt, definitely embolized with glue to avoid risk of distal embolization. Last control revealed complete occlusion of the shunt, low-flow in esophageal varices, good hepatopetal flow. Patient dismissed 2 months later in good conditions.

Discussion: Portal vein steno-occlusions are rare (1.5-2%) but life/organ-threatening drawbacks in OLT. In our case portal vein stenosis and perioperative edema led to venous stasis and acute thrombosis with portal steal syndrome. Shunt embolization restored hepatopetal flow without needing a portal vein stenting.

Take-home points: Portal vein thrombosis is a pre-OLT common finding which should be preliminarily managed with PTA and/or TIPS and/or shunt embolization, especially when shunts are larger than 10mm

P-870

A case of jejunal variceal bleeding caused by recurrence of cholangiocarcinoma successfully treated with percutaneous portal vein stenting

T. Uchi¹, S. Kasuya¹, H. Kikuchi², M. Ando³, T. Urita³, J. Toda¹, T. Nakatsuka¹, N. Kitamura¹, T. Inaoka¹, S. Okazumi², H. Terada¹

¹Radiology, Toho University Sakura Medical Center, Sakura, JP,

²Gastroenterology, Toho University Sakura Medical Center, Sakura, JP,

³Gastrointestinal Surgery, Toho University Sakura Medical Center, Sakura, JP

Clinical History/Pre-treatment Imaging: A 70-year-old female presented with melena. One year ago, SSPPD was performed for bile duct carcinoma (pT3N1M0).

Abdominal CT showed the portal vein (PV) occlusion due to the recurrence mass, and jejunal varices of hepaticojejunal anastomosis. No extravasation of the contrast agent.

Treatment Options/Results: We decided that PV reconstruction was necessary for hemostasis and planned percutaneous transhepatic approach. First, PSE using gelatin sponges was performed to prevent extra-hepatic portal hypertension after SMV and PV stenting.

Puncture P3 under echo guide and pass through PV occlusion. Stent-graft (VIABAHN 8 mm x 5 cm) was placed from SMV to PV (SMV diameter 6 - 7 mm and PV diameter 9 mm). The angiography showed no collateral circulation pathway after stenting, and collateral embolization was not done. After the PV reconstruction, bleeding stopped immediately. Anticoagulation therapy (direct oral anticoagulants; DOAC) was started for thromboprophylaxis. Stent-graft lived patency after 3 months CT.

Due to progression of the primary disease, she died after 5 months later. **Discussion:** Extrahepatic PV occlusion after PD often forms jejunal varix. PV stenting by percutaneous transhepatic or transileocolic approach is effective for hemostasis.

In this case, we succeeded with the percutaneous transhepatic approach and selected stent-graft to prevent tumor ingrowth.

After surgery, the stent-graft was patent with DOAC and there was no bleeding from the varix until she died due to the progress of the primary disease.

Take-home points: PV reconstruction is necessary for jejunal varices with postoperative PV occlusion.

Percutaneous transhepatic PV stent-graft placement can be safe and effective treatment for bleeding jejunal varices.

P-871

Bleeding stomal varices: successful treatment with transhepatic portosystemic shunt and embolotherapy

F. Schaab¹, M. Berning², J.-P. Kühn¹, R.-T. Hoffmann¹

¹Inst. u. Pk. f. Radiologische Diagnostik, Medizinische Fakultät Carl-

Gustav-Carus, TU Dresden, Dresden, DE, ²Medizinische Klinik I -

Gastroenterologie, Medizinische Fakultät Carl-Gustav-Carus, TU Dresden, Dresden, DE

Clinical History/Pre-treatment Imaging: A 58-year-old male patient underwent left hemicolectomy with colostomy due to rectum carcinoma. Starting 2 months after surgery the patient repeatedly had to be treated for stomal bleedings with at least 22 hospital admissions over the course of 14 months. With a known history of alcohol abuse a moderate liver cirrhosis (Child A) with portal hypertension was diagnosed and suspected to be the secondary cause of the recurrent bleedings.

Treatment Options/Results: The patient was planned for a transjugular intrahepatic portosystemic shunt (TIPS). During the procedure, an elevated portosystemic pressure gradient showed the anticipated decline after TIPS establishment. Multiple stomal varices with retrograde portal flow were identified and the major vessel was successfully treated with coil embolization. No recurrence was observed in the following 9 months. After that significant bleedings from stomal varices began to present,

following two more transvenous approaches. In both we measured no elevated portosystemic pressure gradient and the TIPS was not further modified, but additional stomal varices were treated, again using coil embolization.

Discussion: TIPS procedure is well established in patients with liver cirrhosis suffering from varix bleedings or ascites. We present an additional indication of bleeding stomal varices, that were likely fed by liver induced portal hypertension. Although TIPS was established successfully rigorous varix embolotherapy was needed to achieve a lasting result. TIPS wouldn't resolve the recurrent bleedings alone, but eases the repeated transhepatic approach and thus yields a lower overall periprocedural risk.

Take-home points: TIPS and Embolotherapy can be considered in patients with stomal varix bleedings and known portal hypertension.

P-872

Sheathless transsplenic glue embolization using microcatheter system for the bleeding gastric varices developed due to splenic venous tumor thrombus

M. Maruno, H. Kiyosue, S. Matsumoto

Department of Radiology, Oita University, Faculty of Medicine, Yufu, JP

Clinical History/Pre-treatment Imaging: A 50-year-old woman with recurrent malignant melanoma was referred to our department because of massive bleeding from gastric varices (GVs). Contrast enhanced CT revealed pancreatic metastasis of malignant melanoma with splenic venous tumor thrombus extending to the splenic hilum. Large GV's developed as hepatopetal collaterals, which were supplied by short gastric veins (SGVs) and draining into left gastric vein (LGV).

Treatment Options/Results: She was in hemorrhagic shock state, required reliable and urgent hemostasis. Therefore, percutaneous transsplenic embolization with glue was performed. An intraparenchymal splenic venous branch was punctured using a 19-gauge elastic needle under ultrasonographic guidance. A microguidewire/microcatheter system was advanced through the needle into an afferent vein of SGV. Selective venography revealed large GV's drained through LGV. Two afferent veins of GV's were embolized using glue. Then, partial splenic arterial embolization including the territory of the puncture site was performed. Puncture tract was embolized with glue while the puncture needle was withdrawn. No complication was observed. Gastroscopy after embolization showed marked regression of GV's and disappearance of red color sign. No rebleeding was observed for 3 months follow-up period.

Discussion: Bleeding GV's were developed as hepatopetal collateral pathway due to splenic venous tumor thrombus. Percutaneous transsplenic approach is only way to access the afferent veins. Sheathless procedure using small elastic needle and microcatheter system, additional splenic arterial embolization and plugging the tract using glue can reduce bleeding risk at the puncture site.

Take-home points: Percutaneous transsplenic embolization is an effective and alternative treatment option for bleeding GV's which is difficult to treat by other techniques.

P-873

Life threatening ectopic variceal bleeding

M. Arroyo Lopez, A. Pla Romero, R. Villar Esnal, A. Sanchez Guerrero
Vascular Interventional Radiology, Hospital Universitario 12 de Octubre, Madrid, ES

Clinical History/Pre-treatment Imaging: A 54-year-old woman with a history of virus/alcohol-related cirrhosis and portal hypertension (Child Pugh B8/MELD 13) was admitted at the emergency department with hypovolemic shock due to upper gastrointestinal bleeding.

Abdominal CT angiography showed duodenal active bleeding in the fourth portion secondary to an ectopic varix.

Treatment Options/Results: Endoscopic management of the variceal bleeding was initially considered but the location in the duodenum made it technically challenging.

The patient underwent transhepatic portography that revealed many collateral pathways and a high portosystemic pressure gradient (21 mmHg). The varix responsible for the bleeding was detected. It originated from the superior mesenteric vein. Supraselective variceal embolization was performed by "sandwich" technique with two Amplatzer vascular plug 4° and Onyx® liquid agent with clinical satisfactory result.

TIPS was planned but finally not performed because pressure gradient was reduced to 8 mmHg.

Discussion: Duodenal variceal bleeding is uncommon and sometimes cannot be treated successfully with an endoscopic approach.

Trans-hepatic or -splenic embolization may be the only local haemostatic alternative.

Liquid agents are effective and safe reducing bleeding recurrence in coagulopathy.

Take-home points: 1) Remember that ectopic variceal bleeding is difficult to manage. Transhepatic venous embolization may be considered in some cases.

2) Liquid embolic agents are strongly recommended in cases of coagulopathy in liver disease.

3) Consider performing TIPS in patients with elevated portosystemic pressure gradient in order to reduce rebleeding risk.

P-874

Transjugular intrahepatic portosystemic shunt performed with CO₂ contrast and ultrasound in a patient with known anaphylaxis to iodine

C. O' Hare, N. Masson, S.H. Lim

Radiology, Royal Infirmary of Edinburgh, Edinburgh, UK

Clinical History/Pre-treatment Imaging: 62 year old female presented to a district general hospital with oesophageal variceal bleeding.

Day 1–variceal bleed, endoscopic banding and discharged from ITU.

Day 9–rebleed, unable to get endoscopic control. Sangstaken tube sited.

Day 10–transferred to tertiary referral centre for emergency TIPSS procedure.

Past medical history:

- Cryptogenic cirrhosis with associated varices and ascites.

- IHD

- COPD

- Low BMI

- Treated breast cancer

- Osteoporosis

- Chronic kidney disease

- Iodine allergy (anaphylaxis)

- Prior to presentation, this patient was being worked up for potential liver transplant.

Issues on current admission:

- Acute kidney injury

- Hyponatraemia

- Derranged coagulation

Pre-treatment imaging: No cross sectional imaging on presentation or during acute admission due to anaphylaxis to iodine.

Treatment Options/Results: -Emergency TIPSS procedure performed with CO₂ as contrast agent (anaphylaxis to iodine contrast agent).

- Sengstaken tube to remain in situ and reassess with endoscopy

- Maximal medical/supportive therapy

- No active treatment - palliate

Discussion: Wedge CO₂ in the hepatic veins used to identify portal vein location. Blind puncture of portal vein using Roche Uchida technique (Cook). Access into portal vein confirmed by identifying wire in the SMV using ultrasound. Position of hepatocaval junction confirmed with CO₂ venography. Waist of the porto-systemic stent/dilating balloon in the tract was used as a marker for portal vein puncture site.

Take-home points: Despite suboptimal interpretative quality in comparison to iodine contrast, CO₂ was used successfully in this patient with anaphylaxis to iodine to site a porto-systemic shunt for the treatment of acute variceal bleed. The patient was transfer to DGH ICU five days following TIPSS procedure.

P-875

Recanalisation of portal venous thrombosis using a percutaneous mechanical rotational thrombectomy system

T. Heller

Diagnostik & Interventional Radiology, University Medicine of Rostock, Rostock, DE

Clinical History/Pre-treatment Imaging: There are many therapeutic options in the treatment of portal venous thrombosis (PVT), as systemic medical treatment, conservative anticoagulation, interventional approaches like local thrombolysis, aspiration and newer endovascular methods as PMT or mechanical thrombectomy as well as PTA & stents with several pros and cons. We present 3 cases of portal venous thrombosis in which we demonstrate the usefulness, safeness and efficacy of PMT in these particular cases.

Treatment Options/Results: We present 3 cases of portal venous thrombosis, 1 acute, 1 acute on chronic and 1 chronic in which we demonstrate the usefulness, safeness and efficacy of PMT. TIPS-approach were used in combination with rotational thrombectomy device (Aspirex®S, Straub Medical). The thrombosed portal vein was punctured with a modified Ross-needle. All portal venous branches were visualised by phlebography. No additional lysis was performed. After removal of the acute and chronic clots, the 10 F sheath was replaced by an 4F Pigtail-Catheter until the control-phlebography. Follow-up examinations were done by duplex ultrasound. Primary technical success was 100%. No minor or major complications as bleeding, ascites, pleural effusion, liver hematoma, vascular injury was observed. After one year follow-up all portal veins are still patent and no portal hypertension developed.

Discussion: PMT recanalised portal veins effective in PVT. It has low risks, less adverse effects than other endovascular approaches, no lysis-drug, reduces time of ICU stay, is able to remove thrombotic material very effective.

Take-home points: With a mechanical thrombectomy via the TIPS-approach we do have a potential treatment option for patients with subacute portal vein thrombosis

P-876

DIPS using percutaneous ultrasound guidance with subsequent BRTO for a patient with huge bleeding gastric varices and small portal vein

H. EL Khudari, R. Varma, K. Mahmoud, A.K. Abdel Aal

Interventional Radiology, University of Alabama at Birmingham, Birmingham, AL, US

Clinical History/Pre-treatment Imaging: 59 year old patient with NASH cirrhosis, presented with hematemesis secondary to gastric variceal bleeding. Esophagogastroduodenoscopy was unsuccessful. CT showed huge gastric varices with spontaneous splenorenal shunt, atretic right portal vein, and small main portal vein. The patient failed prior attempt of BRTO secondary to the large size of the varices and the high flow and pressure.

Treatment Options/Results: Treatment options included; second attempt of BRTO, attempting TIPS, DIPS, or surgical intervention. We proceeded with DIPS. A right internal jugular vein (IJV) access obtained. A 22-gauge Chiba needle was advanced into the proximal portal vein, through the liver and into the IVC. A V-18 wire was then placed into the IVC. A snare was placed through the IJV sheath and used to snare the wire. An 0.35 QuickCross catheter was then placed over the V-18 wire and the wire was removed. The QuickCross catheter was aspirated and pulled back slowly until blood return was achieved. A Glidewire was then advanced

into the portal vein. We then proceeded with DIPS in the usual fashion. We brought the patient in 3 days and a successful BRTO was performed.

Discussion: We present a case of huge gastric varices and small portal vein which failed BRTO attempt. Our case show that DIPS can be safely performed even with small portal vein and can help reducing the pressure and the flow for subsequent BRTO procedure.

Take-home points: DIPS can be safely performed with small portal vein and can help reducing the pressure and the flow for subsequent BRTO procedure.

P-877

Pediatric transjugular intrahepatic portosystemic shunts: early experience from a hospital in Latin America

J.A. Fernández De La Hoz, D.A. Piñeros Nieto, J.G. Caviedes, J.M. Pérez Hidalgo, J.F. Forero Melo
Radiología, Fundación Cardioinfantil, Bogotá, CO

Clinical History/Pre-treatment Imaging: We present three pediatric cases with portal hypertension complications, which did not respond to medical management and had indication for TIPS. We will review the indications, contraindications, special considerations and procedure complications. The subjects were between 7 to 12 years old, with diffuse liver disease, debuted with gastrointestinal bleeding to variceal origin refractory to medical and endoscopic treatment. Portosystemic gradient up to 28mmHg was decided to perform TIPS as bridge therapy with posterior portosystemic gradient between 4 and 12 mmHg.

Treatment Options/Results: The technique starts with reverse puncture of the hepatic vein, it is advanced through the liver parenchyma to the portal vein. The resulting tract catheterizes, dilates and evaluate the previous portosystemic gradient; an expandable stent is deployed along the tract to permeabilize the canal. Finally, portal system venography is performed after the stent is placed, the placement is verified and the portosystemic gradient after TIPS is obtained.

Discussion: In our institution, we only perform TIPS as a bridge therapy for transplantation in the pediatric population with complications associated to portal hypertension that does not respond to management. An adequate selection of the patient must be made we could lean towards the use of PELD for the selection of patients; however, although it guides on the possible outcome, it has not yet been validated and its implementation can be very debatable.

Take-home points: TIPS in children is most often used as a bridge to transplant.

The small vessel diameters encountered in pediatric TIPS render the procedure technically difficult.

Adequate selection of the patient must be made.

P-878

Transjugular intrahepatic portosystemic shunt (TIPSS) after interventional embolization of splenic artery aneurysm (SAA) with splenic arteriovenous fistula (SAVF)

N. Mandruzzato¹, F.L. Gatti², A. Mazzaro², M. Iannelli², A. Contro³, G. Mansueto²

¹Radiology, Ospedale "G. Rossi" Borgo Roma, Verona, IT, ²Radiology, Policlinico Universitario G.B. Rossi, Verona, IT, ³Institute of Radiology, Vascular and Interventional Radiology Unit, University Hospital G.B. Rossi, A.O.U.I-Verona, Verona, IT

Clinical History/Pre-treatment Imaging: A multiparous 43-year-old woman, accesses the emergency room with abdominal pain, hematemesis and rectorrhagia (no evidence of liver disease).

The patient performs a CT scan, that shows a SAA with SAVF and massive ascites.

The patient undergoes to the embolization of SAA (coils) for three times, because of its recurrence, complicated by splenic infarct.

After some days, her symptoms get worse: hematemesis, melena and more abdominal pains. A CT scan shows: massive portal thrombosis (PT) involving also the superior mesenteric vein, increased ascites and considerable pleural effusion. The patient's symptoms are related of intestinal venous congestion, in relation to the conspicuous portal hypertension, caused by PT.

To resolve the hematemesis, it's performed a sclerotization of esophageal varices by endoscopy.

The invasive measurement through a portal branch, demonstrates a massive portal hypertension (>80mmHg).

Treatment Options/Results: To decrease the portal hypertension, we decided to carry out the TIPSS. During the treatment, the pressure in the portal vein dropped from 80 mmHg to 25 mmHg. The patient was free of abdominal symptoms in the following months, and the CT scan and color ultrasound showed the decrease of the PT and the disappearance of the ascites.

Discussion: Splenic arteriovenous fistula (SAVF) with splenic artery aneurysm (SAA) is an extremely rare cause of portal hypertension. In our case the SAVF was considered secondary to erosion of the SAA. This procedure can lead to potentially fatal PT.

Take-home points: The patient cured with the TIPSS combined interventional embolization of SAVF with SAA may be a good way to prevent PT.

P-879

Isolated umbilical vein embolisation

P.S. Dhillon¹, A. Shah²

¹Radiology, Nottingham University Hospitals NHS Trust, Nottingham, UK,

²Interventional Radiology, Queen's Medical Centre, Nottingham University Hospitals NHS Trust, Nottingham, UK

Clinical History/Pre-treatment Imaging: A 43 year-old fit and well man, with a history of excess alcoholic intake presented haemodynamically unstable (BP 84/64mmHg) with spontaneous bleeding of approximately 750ml from the umbilicus. Following fluid resuscitation, a dual phase (arterial and porto-venous) contrast-enhanced computed tomography (CT) abdomen demonstrated cutaneous contrast extravasation from a recanalised umbilical vein. No background of liver cirrhosis, other varices or ascites were identified.

Treatment Options/Results: Percutaneous umbilical vein embolisation was decided upon following discussion with the Gastroenterologist, in the absence of known portal hypertension or liver cirrhosis at the time of the presentation. Direct Ultrasound-guided puncture and introduction of a 4Fr sheath into the umbilical varix demonstrated active bleeding from the recanalised umbilical vein. The umbilical varix was successfully embolised from its origin using Cook Retractable® detachable and Nester® coils with sodium tetradecyl sulfate (STS) Fibroven 3% (Air : Fibroven 2:1) as a sandwich technique, with resultant cessation of bleeding. Subsequent transjugular liver biopsy and portal pressures revealed a pressure gradient of 20mmHg in keeping with portal hypertension. Conservative management with alcohol abstinence was advised and no early or late complications have been recorded after follow-up at 18 months.

Discussion: Direct percutaneous puncture and embolisation of the umbilical vein is a viable treatment option in the immediate setting for patients with an isolated umbilical varix, even in the presence of portal hypertension, whilst a Transjugular Intrahepatic Porto Systemic Shunt (TIPS) can be avoided or delayed in such a setting.

Take-home points: Isolated percutaneous umbilical vein embolisation can be considered in active variceal bleeding.

P-880

Ultrasound-guided transhepatic puncture of the portal and hepatic vein for TIPS placement in transplanted liver: a case report

A. Di Martino¹, D. Morosetti², A. Raso¹, F. Salimei², A. Bozzi², R. Gandini³

¹Department of Diagnostic Imaging, Molecular Imaging, Interventional Radiology and Radiation Therapy, University Hospital Policlinico Tor Vergata, Rome, IT, ²Department of Diagnostic Imaging, Molecular Imaging, Interventional Radiology and Radiation Therapy, University Hospital Policlinico Tor Vergata, Rome, IT, ³Diagnostic and Interventional Radiology, Policlinico Tor Vergata, Rome, IT

Clinical History/Pre-treatment Imaging: We report a case of a 39-year-old female patient affected by ADPKD presenting with refractory ascites complications in 2018 following a liver transplantation from a CMV positive donor in 2017. The CT scan during follow-up showed hepatomegaly associated with ascites and an acute angle at the anastomosis between the hepatic vein and the inferior vena cava. The refractory ascites was controlled placing a trans-jugular intrahepatic portosystemic shunt.

Treatment Options/Results: Medical therapy failed to control ascites. Therefore, a first attempt at TIPS placing with the traditional technique was performed with no technical success.

Discussion: Considering the acute angle between the donor hepatic vein and the recipient inferior vena cava at the surgical anastomosis, we decided to puncture the left portal vein branch and the hepatic vein directly and in a single pass, using a 21-gauge needle under ultrasound guidance. A 300 cm long 0.0014 guidewire was placed through the needle from the portal vein and through the inferior vena cava and into the previously placed trans-jugular sheath, thus achieving through-and-through access. Afterwards the TIPS was placed using the traditional technique.

Take-home points: In cases presenting with complex anatomy, such as low anastomosis between the hepatic vein and the inferior vena cava, hepatomegaly and lateral deviation of the vena cava (as usually occurs in transplanted livers), the direct puncture of the left portal vein branch and the hepatic vein in a single pass, placing a 300 cm guidewire and thus giving stability and pushability, is a valid and safe alternative to the conventional technique.

Urinary tract intervention

P-881

Impact of pelvic arterial anatomy on PAE procedure

T. Franiel¹, G.F. Enderlein¹, T. Lehmann², C.-F. von Rundstedt³, M.O. Grimm³, U. Teichgräber⁴, R. Aschenbach⁴

¹Diagnostic and Interventional Radiology, University Hospital Jena, Jena, DE, ²Medical Statistic, University Hospital Jena, Jena, DE, ³Urology, University Hospital Jena, Jena, DE, ⁴Radiology, University Hospital Jena, Jena, DE

Purpose: To determine the influence of prostate artery (PA) origin and individual iliac artery elongation on dose area product (DAP), fluoroscopy time (FT), amount of contrast material (CM) and technical success of PAE procedure.

Material and methods: Cone beam CT's of 80 patients were retrospectively used to determine the PA origin (44/160 vesical, 38/160 obturator, 37/160 internal pudendal artery, 31/160 common gluteal/ pudendal trunk, 5/160 inferior gluteal trunk, 4/160 others) and to classify the iliac arteries into mild (44%), moderate (46%) and severe (10%) elongated. Data of DAP, FT, CM were documented and technical success was classified into failure, unilateral and bilateral embolization.

Results: DAP, FT, CM showed highest values if PA originated from vesical artery with means of 540Gy*cm² (p=0.09), 50min (p=0.01), 133ml (p=0.18) respectively. In contrast, lowest values of mean DAP, FT, CM

were obtained if PAE originated from obturator artery with 341Gy*cm² (p=0.03), 29min (p=0.10), 115ml (p=0.26). FT and CM increased with increasing anatomical elongation of PA, with mean FT of 27min, 41min, 47min and mean CM of 112ml, 132ml, 141ml for mild, moderate, severe elongated arteries (p=0.008 to 0.064). Embolization failure occurred in 4%, 5%, 12%, unilateral in 12%, 18%, 25% and bilateral embolization in 84%, 77%, 63% for mild, moderate, severe elongated arteries.

Conclusion: Individual arterial anatomy is important for PAE procedure planning since the origin of PA and iliac artery elongation showed a significant impact on DAP, FT, CM and technical success rate was negatively related to the iliac artery elongation.

P-882

Use of auto-expandable metal ureteral stents in the treatment of ureter stenosis in kidney transplanted patients

I.D. Domínguez Paillacho¹, M.E. Perez Montilla², J.J. Espejo Herrero², S. Lombardo Galera², J. García Revillo¹, P.B. García Jurado¹, L.J. Zurera Tendero³

¹Vascular Intervencionismo, Hospital Universitario Reina Sofía, Córdoba, ES, ²Interventional Radiology, University Hospital Reina Sofía, Córdoba, ES, ³Serv. Radiodiagnóstico, Hospital Universitario Reina Sofía, Córdoba, ES

Purpose: To evaluate the medium and long-term complications of using double-layered, coated, ureteral self-expanding metallic stents (UVENTA and ALLIUM'S) for managing benign ureteric strictures in kidney transplanted patients.

Material and methods: Between April 2014 and October 2018, 11 self-expanding coated stents were placed in patients with ureteral stenosis of the kidney graft. In 100% of cases, they were placed due to early double-J obstruction. UVENTA stents were used in 9 patients (82%) and Allium's in 2 patients (18%). The placement was antegrade in 5 cases (45%) and retrograde in 6 cases (55%).

Results: The technical success rate was 100%, without complications during the procedure and resolution of hydronephrosis. The mean follow-up time after stent placement was 17.5 months. Currently, 8 patients (73%) have functional stents, with minimal or no hydronephrosis in the control ultrasound. The mean creatinine value was reduced from 2.2 mg / dL to 1.83 mg / dL. Before placement of the stent, patients were treated with periodic replacements of the double J catheter, with a mean follow-up time of 18.2 months and a total of 15 hospital readmissions. After ureteral stent placement, there were 16 hospital readmissions, mainly secondary to urinary tract infection.

Conclusion: In certain renal transplant patients with ureteral stenosis who have an immediate obstruction of the double-J catheter the use of self-expandable coated stents is a technically simple treatment option with low morbidity. In the short and medium term, it provides effective results with a low complication rate and without the need for surgical replacement of the double J catheter periodically.

P-883

Arterio-ureteral fistula: clinical characteristics and endovascular management

S.Y. Noh¹, W.J. Yang², J.H. Shin³, H.H. Chu³, S. Park⁴, W.-H. Lee⁵

¹Radiology, Soon Chun Hyang University Hospital, Seoul, KR, ²Radiology, Korea University Guro Hospital, Seoul, KR, ³Radiology, Asan Medical Center, Seoul, KR, ⁴Radiology, Gachon University Gil Medical Center, Incheon, KR, ⁵Radiology, Soonchunhyang University Cheonan Hospital, Cheonan, KR

Purpose: To demonstrate the angiographic diagnosis and endovascular management of arterio-ureteral fistula (AUF).

Material and methods: From January 2009 to December 2018, eight patients with AUF from two tertiary referral centers were included. Clinical data including previous pelvic surgery or radiotherapy, indwelling

ureteral stents, primary vascular pathology, initial presenting symptoms, angiographic findings and treatment, and recurrence were analyzed.

Results: One patient developed AUF due to underlying iliac artery aneurysm, and the rest were due to secondary cause such as prior pelvic surgery, radiotherapy, and ureteral stent placement. Six patients had a history of indwelling ureteral stent for median 5.5 months. AUF developed in mid to distal ureter in 5 patients, ileal conduit 2 patients, and left ureteral stump in 1 patient. The location in the artery was as follows; common/external iliac artery in 6 patients, internal iliac artery (IIA) in 1 patient, and infrarenal aorta in 1 patient. All the patients presented with hematuria. Angiographies were diagnostic in 6 patients, while ureterographies in two patients. All patients were successfully treated by endovascular management; six patients with stent graft only, one patient with stent graft after embolization of IIA aneurysm, one patient by ureteral occlusion stent placement after fistulous tract embolization. For the median follow up of 987 days, there was no disease-specific mortality. Three patient had recurrence of disease in mean 6.3 months. One patient was treated by surgery while the others by endovascular treatment.

Conclusion: The high suspicion with early diagnosis is critical to AUF, especially those with predisposing factors. AUF can be successfully treated by endovascular management.

P-884

Medium-term follow-up results after prostatic artery embolization (PAE) in 285 patients

A.G. Rampoldi¹, F. Barbosa¹, P.M. Brambillasca², A. Alfonsi³, E.M. Fumarola², F. Di Bartolomeo², D. Volterra², S. Secco⁴, M. Nichelatti⁵, A. Galfano⁴, M. Spinelli⁶, R. Vercelli¹, C. Migliorisi¹, M. Solcia¹, A.M. Boccardi⁴

¹Interventional Radiology, Niguarda Hospital, Milan, IT, ²Radiologia, Università degli studi di Milano, Milan, IT, ³Radiology, Campus Biomedico University of Rome, Rome, IT, ⁴Urology, Niguarda Hospital, Milan, IT, ⁵Service of Biostatistics, Niguarda Hospital, Milan, IT, ⁶Spinal Unit, Niguarda Hospital, Milan, IT

Purpose: Prospectively assess medium term results of PAE. Need of indwelling bladder catheter (IBC), changes of International Prostate Symptom Score (IPSS), Quality Of Life (QoL), Qmax, Post Void Volume (PVV), PSA and prostate volume (PV) after PAE.

Material and methods: From November 2013 to May 2018, 285 patients underwent PAE due to benign prostatic hyperplasia: 117 with IBC and 168 with LUTS. Comorbidities were assessed by Charlson Comorbidity Index (CCI). Patients were followed for at least 6 months and evaluated for IPSS, Quality Of Life (QoL), Qmax, PVV, PSA and PV. Statistical Analysis was carried out by Student's t-test for paired data, after checking for normal distribution with the Shapiro-Wilk test. Comparisons of categorical or nominal data were done by Fisher-exact-test. ANOVA-Regreat-measure were used to assess changes in mean score.

Results: Of 117 patients with IBC, the median follow-up time was 21 months (6-61 months), median age was 77.3 ys (51-91), median CCI was 6 (2-14), median PV was 76 cm³ and median time of IBC was 6 months (1-49). Of 168 patients with LUTS the median follow up time was 16 months (6-61 months), median age was 69 ys (52-89), median CCI was 4 (2-9) and median PV was 82 cm³. IBC was removed in 87/117 patients (74%), IBC was required in 6/168 (3.6%) patients with LUTS. After PAE were significantly reduced IPSS score (20.48 to 12.93, p<0.00001), QoL (4.9 to 1.8, p<0.00001), PVV (109.6 to 40.2, p<0.001), PSA (4.4 to 2.6, p<0.00001) and PV (84.8 to 61.6, p=0.0193). Qmax increased significantly (9.41 to 15.16, p<0.001).

Conclusion: Our data of medium term follow-up confirm the huge improvement of urinary symptoms after PAE.

P-885

Dynamic contrast enhanced MRI derived pharmacokinetic parameters and the relationship to outcomes following prostate artery embolisation

R. Geevarghese, J. Harding, C. Hutchinson, C. Parsons
Clinical & Interventional Radiology, University Hospitals Coventry & Warwickshire NHS Trust, Coventry, UK

Purpose: Imaging follow-up of patients who have undergone prostate artery embolisation (PAE) is commonly undertaken with dynamic contrast enhanced (DCE) MRI. DCE-MRI derived pharmacokinetic parameters have been shown to be predictive of prostate volume change following medical treatment of benign prostatic hyperplasia in a canine model. We sought to investigate the relationship of DCE-MRI derived pharmacokinetic parameters to imaging and clinical outcomes following PAE.

Material and methods: A retrospective study of 11 consecutive patients who had undergone PAE at our institution was undertaken. DCE-MRI data at 3-months post-PAE was extracted. DCE-MRI pharmacokinetic parameters (K-trans, Kep, Ve and relative enhancement ratio) were derived using an open-source software package (DCE Tool). Separate values were derived for the central and whole gland. Linear regression modelling was used to examine the relationship of baseline and 12-month change in clinical/imaging outcomes (IPSS, Q-max, post-void residual and prostate volume) with extracted pharmacokinetic parameters.

Results: PAE was technically successful in all patients.

Average baseline patient characteristics were: Age (66 years), IPSS score (20.7), Q-max (8.7 ml/s), prostate volume (61.1 ml) and post-void residual volume (71.2 ml).

No statistically significant relationships were found between DCE-MRI derived pharmacokinetic parameters and baseline or 12-month change in outcomes of interest.

Conclusion: DCE-MRI derived pharmacokinetic parameters, at 3-months post-PAE, are not related to baseline or 12-month outcomes following PAE.

P-886

Prostate artery embolisation (PAE): correlation of experience with procedural duration, radiation dose and technical success

C. Bent¹, D. Beckett², H. Cavenagh¹

¹Interventional Radiology, Royal Bournemouth and Christchurch Hospitals, Bournemouth, UK, ²Radiology, Royal Bournemouth and Christchurch Hospitals, Bournemouth, UK

Purpose: PAE is a technically challenging procedure. Due to multiple anatomical variants and increased age with consequent atherosclerotic disease at clinical presentation, access to target vessels can be difficult requiring use of varied equipment and embolisation techniques. This study aims to demonstrate how increasing procedural experience affects radiation dosages and technical success.

Material and methods: Between 2014 and 2018, 120 patients underwent PAE. Procedural data, radiation dosages and clinical outcomes were recorded prospectively.

Results: Of the 120 PAE procedures performed, 97 patients underwent bilateral and 12 unilateral prostate artery embolisation. 11 procedures were abandoned (2 stenoses, 8 high risk bowel, bladder or penile anastomoses, 1 vasospasm). Bilateral PAE was achieved in 73% during 2014, increasing to 88% in 2018. Protective coil embolisation was utilized in 18% of procedures in 2014 increasing to 21% in 2018. Average procedural duration, dose area product and skin dose reduced from 32.59 mins, 36691.32 mGy², 3165.43 mGy in 2014 to 32.50 mins, 17385 mGy², 1457 mGy in 2018 respectively. Protective coil embolisation did not lengthen the procedural duration or dosages significantly. No major complications were reported.

Conclusion: Increasing operator experience improves technical success of PAE whilst simultaneously significantly reducing procedural duration and radiation dosages. Due to procedural complexity there is a learning

curve to the PAE technique and operators are required to be fastidious in their technique to achieve optimum outcomes.

P-887

Risk factors for urinary collecting system (UCS) injury of renal cryoablation

K. Enoki

Radiology, The Jikei University School of Medicine, Kashiwa Hospital, Chiba, JP

Purpose: To determine the risk factors for UCS injury associated with the percutaneous cryoablation (PCA) for renal masses.

Material and methods: Consecutive 231 cases (177 men and 54 women, mean age 66.9 ± 13.6 year) who underwent PCA between September 2011 and December 2018 were retrospectively reviewed. The tumor diameter, the tumor location including renal nephrometry score, the number of cryoneedles used, the iceball location and the presence of UCS injury after the PCA were evaluated using computed tomography images during the PCA and 1,3,6 and 12 months after PCA.

Results: Ten of 231 (4.3%) cases of the UCS injury (9 cases of hydronephrosis and one case of urinoma) were observed. Five of 10 UCS injuries required temporary urethral catheter placement, any permanent sequelae was not observed. Five cases of UCS injury occurred in 33 cases that the iceball involved uretero-pelvic junction (UPJ) and/or ureter during procedure ($P=0.007$, Odds ratio=6.9). The tumor diameter measuring larger than 3cm and inner-lower tumor location had significant higher incidence of UCS injury ($P=0.015$ and $P=0.014$ respectively, Odds ratio: 6.9 and 5.5 respectively) resulting from the multivariate analysis.

Conclusion: Even the UCS injury is rare in renal PCA, the iceball involvement of UPJ and/or ureter should be avoided. The tumor diameter larger than 3cm and inner-lower lesion tumor location are the risk factors of the UCS injury.

P-888

Clinical predictive factors in prostatic artery embolization (PAE) for symptomatic benign prostatic hyperplasia

F. Sun, C. Báez Díaz, F.M. Sánchez Margallo

Endoluminal Therapy and Diagnosis, Jesús Usón Minimally Invasive Surgery Centre, Cáceres, ES

Learning objectives: This study aims to evaluate potential clinical predictors of outcome after PAE.

Background: PAE has been approved as a treatment option in the management of symptomatic BPH by the UK's National Institute of Health and Care Excellence (NICE) based on its medium- and long-term outcomes on clinical efficacy and safety in the past decade. With increasing clinical practice, prediction of clinical outcomes after PAE have gained more interest to guide patient selection and counseling or to help modify subsequent treatment planning after PAE.

Clinical Findings/Procedure Details: Predictors are classified into 3 types. Type I predictors serve to optimize patient selection, including baseline data (age, prostate volume, transition zone volume, and TZ index), clinical characteristics, and pathological feature. Type II predictors provide predicting information for short- and medium-term outcomes, including perioperative PSA, C-reactive protein, and early MRI detection of prostate infarction. Type III predictors are obtained 1-3 months after PAE for predicting long-term outcomes, such as, prostate volume reduction, prostate infarction. Current evidence on potential predictors remains conflicting due to different study designs, inclusion and exclusion criteria, definitions of clinical success and failure, and statistical analyses.

Conclusion: Baseline prostate volume, transition volume, TZ index, perioperative C-creative protein, and early detection (1-month post-PAE) have potential in prediction of treatment outcomes. Patients with Adenomatous-dominant BPH or with indwelling bladder catheter before

PAE may have more benefits from PAE. The predicting capability of patient age, early reduction of prostate volume needs further validation.

P-889

Primary interventional urethral realignment (PIUR) with combined suprapubic and transurethral access – a minimally invasive technique for high-grade urethral injury

T. Simpanen¹, M.R. Akhtar¹, Z. Ali², L.F. Arenas da Silva², A. Almushatat², T. Fotheringham¹, J. Kyaw Tun¹

¹Interventional Radiology, Barts Health NHS Trust, London, UK,

²Department of Urology, Barts Health NHS Trust, London, UK

Learning objectives:

1. To understand the role of PIUR in patients with high-grade urethral injury.
2. To understand the procedure technique and perioperative considerations.

Background:

- High-grade urethral transection secondary to pelvic trauma is challenging to treat and can result in significant morbidity due to urethral stricturing, incontinence and impotence.

- There remains debate as to the most appropriate treatment, which include primary open repair, suprapubic catheter insertion with delayed primary open repair, and primary endoscopic realignment.

- Recent evidence favours the latter due to its less invasive nature and reasonable chance of clinical success without need for further intervention (30% of patients).

- We describe our alternative radiological approach to urethral alignment used at our major trauma centre, which may offer some advantages when compared to the more established but also more invasive endoscopic approach.

Clinical Findings/Procedure Details: This poster will discuss:

- Multi-disciplinary approach to managing urethral injuries including considerations for the polytrauma patient.

- Indications for PIUR

- A step-by step guide to performing the procedure.

- Merits and potential issues of PIUR when compared to conventional urological surgery.

- Recommendations for post-procedure management and follow-up

Conclusion: High-grade urethral trauma is challenging to treat especially in polytrauma patients. PIUR is a minimally invasive technique, which may offer benefits over conventional urological reconstructive techniques. A multidisciplinary approach is required to ensure timely intervention and best clinical outcome.

P-890

Managing the complicated ureter: a review of tips, tricks and bail-out techniques

J.B. Henneby, A.E. Stroiescu, C.A. Byrne, M.P. Bolger, L. Greene,

A.G. Ryan

Division of Interventional Radiology, University Hospital Waterford, Waterford, IE

Learning objectives: To recognise complicated ureteric pathology when present and to be familiar with "tricks of the trade" when dealing with challenging obstructions, occlusions and /or fistulae.

Background: Many intrinsic (stones, tumour and infection), mural (post-stone, radiotherapy, instrumentation or ischemic strictures) and extrinsic (infection, adenopathy, tumour, endometriosis and retroperitoneal fibrosis, vascular) pathologies can result in ureteric obstruction and / or perforation, leading to pain, renal failure and life-threatening sepsis. Traversing ureteric obstructions may be straightforward, but can also be amongst the most challenging procedures in IR, particularly if the lesion is complicated, leading to fistulae, or if the obstruction is absolute, requiring percutaneous extra-anatomic bypass (nephro-vesical stenting).

Clinical Findings/Procedure Details: The indications and contraindications to antegrade ureteric stenting in the presence of the aforementioned complications will be discussed. Tips and tricks for successful management will be illustrated including the use of dilation catheters (including cutting balloons), microcatheters, aggressive wire and needle techniques, coiling and stent graft placement. The range of stents available and their relative advantages and disadvantages will be reviewed.

Conclusion: This exhibit will provide an overview of disparate techniques for dealing with particularly challenging ureteric pathologies and their complications.

P-891

Navigating the pitfalls and challenges of prostate artery embolisation

A.C. Macdonald¹, T. Barge¹, P. Boardman², C.R. Tapping³

¹Department of Radiology, Oxford University Hospitals NHS Foundation Trust, Oxford, UK, ²Radiology, Churchill Hospital, Oxford, UK, ³Radiology Department, Churchill Hospital, Oxford University Hospitals NHS Foundation Trust, Oxford, UK

Learning objectives:

1. Variant anatomy of the prostate artery and implications for PAE.
2. Identifying and managing shunts/anastomoses.
3. Identify and managing complications following PAE.

Background: One of the major benefits of PAE over conventional surgical therapy for benign prostatic hyperplasia is an excellent safety profile. Nonetheless, in-depth knowledge of the potential pitfalls and challenges of PAE is essential to achieve safe and effective embolisation.

Clinical Findings/Procedure Details: Variant origins of the prostate artery are reviewed, with particular attention to those that may make the procedure more challenging, time consuming or risk a higher rate of technical failure. The need for bilateral access is also discussed along with the role and limitations of pre-procedural cross sectional imaging. Examples of intra-prostatic and extra-prostatic shunts and vascular anastomoses are presented along with strategies for their management. Cases of non-target embolisation are reviewed from the literature along with their presentation, immediate management and natural history. Strategies for the management and prevention of post-operative pain and infection are also discussed.

Conclusion: Prostate artery embolisation is a safe and effective procedure when attention is paid to avoiding the many potential pitfalls.

P-892

Single-step retrograde insertion of bander ureteric stents in ureteroileal conduits complicated by ureteroileal anastomotic strictures

B. Kawa¹, J. Donohue², P. Ignatus¹, A. Shaw¹

¹Interventional Radiology, Maidstone and Tunbridge Wells NHS Trust, Maidstone, UK, ²Urology, Maidstone and Tunbridge Wells NHS Trust, Maidstone, UK

Learning objectives: To describe the technique and outcomes for retrograde fluoroscopic insertion of Bander ureteric stents in patients with ureteroileal conduit strictures with a pictorial review.

Background: Urinary diversion following radical cystectomy is a common surgical procedure for malignancies involving the urinary bladder. A follow-up study of 1000 patients demonstrated 10% had stenosis at the site of the ureteroileal anastomosis. These are often managed antegrade stent insertion requiring percutaneous pelvic access. We describe a technique using retrograde access through the existing stoma site.

Clinical Findings/Procedure Details: Prior CT studies are reviewed to identify the ileoconduit configuration and site of stenosis. Following written consent, a loopogram is performed to visualise the ileal conduit. The site of the obstructed ureteroileal anastomosis can be identified by searching for triangular peaks within the contour of the ileoconduit.

A catheter and hydrophilic guidewire is passed into the stoma and the peak is probed until the wire passes beyond the stricture. The wire and catheter are advanced into the renal pelvis and the proximal pigtail of a Bander ureteric stent (Cook Medical) is deployed into the renal pelvis. The distal end of the stent is then placed within the stoma bag allowing easy retrieval and exchange.

Conclusion: Retrograde ureteric stent insertion for ureteroileal anastomosis strictures is a safe and effective single-step procedure which avoids the need for pelvic access and nephrostomy insertion following conventional retrograde stent insertion. It is completely painless, does not require sedation or anaesthetic and should be attempted first prior to an antegrade approach.

P-893

Prostate artery embolisation – beware the diseased internal pudendal artery!

A.C. Macdonald¹, M. Hadi², P. Boardman³, C.R. Tapping⁴

¹Department of Radiology, Oxford University Hospitals NHS Foundation Trust, Oxford, UK, ²Interventional Radiology, Oxford University Hospitals, Oxford, UK, ³Radiology, Churchill Hospital, Oxford, UK, ⁴Radiology Department, Churchill Hospital, Oxford University Hospitals NHS Foundation Trust, Oxford, UK

Clinical History/Pre-treatment Imaging: Anastomoses between the prostate artery and branches of the anterior division of the internal iliac artery, in particular the internal pudendal, are encountered not infrequently during PAE.

One common management strategy is to perform protective coil embolisation to avoid non-target distal embolisation.

We, however, present several cases where previously unknown severe disease or absence of the contra-lateral internal pudendal artery were discovered alongside a significant anastomosis on the ipsilateral side. In these cases coil-embolisation may have lead to significant penile, perineal or scrotal ischaemia.

Treatment Options/Results: We present the management from these cases that allowed safe embolisation. However, in one of these cases safe embolisation could not be performed and the procedure was abandoned. In addition, we discuss potential strategies for identifying diseased contra-lateral vessels.

Discussion: Non-target embolisation is a feared complication of PAE, particularly given the sensitivity and importance of the adjacent organs. However, it is imperative that prior to coil embolisation to protect adjacent structures, the vascular anatomy is clearly demonstrated bilaterally as this may not be apparent from preoperative CTA.

In instances where the contra-lateral side has not been imaged angiographically in select cases this may even require bilateral puncture.

Take-home points: Before undertaking coil embolisation of prostatic artery anastomoses during PAE, care should be taken to determine the patency and adequacy of other feeding vessels to avoid unintended ischaemic complications.

P-894

Varicocele embolization, beware of variant anatomy

N.R. Patel, N. Qazi, A. Alsafi

Imaging, Hammersmith Hospital - Imperial College Healthcare NHS Trust, London, UK

Clinical History/Pre-treatment Imaging: A 34-year-old man was referred for symptomatic left varicocele embolization.

Treatment Options/Results: Attempts at cannulating the left renal vein from a right internal jugular venous approach failed. Although a wire could be advanced to the left renal vein, multiple attempts at advancing the catheter over it failed. Variant anatomy was suspected and cross-sectional imaging arranged. A CT demonstrated a compressed, upgoing, retro-aortic left renal vein. The patient was therefore readmitted for an

attempt from a femoral approach. The left testicular vein was catheterized and embolized with coils and sclerosed 3% STD with resolution of the varicocele.

Discussion: Varicocele embolization is a safe and effective treatment. Variant anatomy can make the procedure more challenging. While the cause of the varicocele in this case may well be the compression of the retro-aortic renal vein, varicocele embolization, remained an effective treatment.

Take-home points: Variant anatomy can make varicocele embolization challenging.

Cross sectional imaging may be helpful in cases of previous failed attempts.

The operator must be prepared to change their preferred access route in challenging cases.

P-895

Loop nephrostomies: our institutions experience on its indications, suitability and its effect on patient quality of life

D. Annan¹, S. Pathak²

¹Imaging Department, The Royal London Hospital, London, UK, ²Imaging Department (Whipps Cross), Barts Health NHS Trust, London, UK

Clinical History/Pre-treatment Imaging: We describe the case of a 58 year old lady who was diagnosed with metastatic ovarian cancer and had not responded to final line chemotherapy. She was therefore being palliated. Unfortunately, due to the extent of her disease, she presented multiple times to the interventional radiology department with recurrent bilateral hydronephrosis related to her primary diagnosis, for which she required recurrent nephrostomies +/- nephrostomy catheter exchanges every few weeks.

Treatment Options/Results: The patient had been in and out of the department multiple times with common complications associated with nephrostomy catheters; namely, blockage and migration. Following discussion with the patient, and following her fully informed consent, her images were reviewed to assess her suitability for the loop nephrostomy and to guide our approach for inserting this. This procedure occurred smoothly with no immediate or early complications encountered.

Discussion: The literature on loop nephrostomies is scarce and this technique is very seldom used in clinical practice due to its relative novelty. Loop nephrostomies do not require catheter exchanges as often as conventional nephrostomies. They are also more likely to stay in situ and not get blocked. All things considered, the use of loop nephrostomies more readily in clinical practice like in the case described above can drastically change the quality of life of these patients who are in the palliative stages of their lives.

Take-home points: Loop Nephrostomies are underutilised in clinical practice and have the potential to transform the quality of life of patients like ours who are in their palliative stages of life.

Venous intervention and IVC filters

P-896

Thrombectomy devices in massive acute pulmonary embolism treatment: initial single center experience with a novel technique using Aspirex through right jugular access

B. Freitas¹, E.C. Alves², W.B. Mandinga², D.L.P. Espíndola², A. Lima², M. Amorim², A. Schmidt³, D. Scheinert⁴

¹Vascular Surgery - Faculty of Medicine, Federal University of Alagoas, Maceió, BR, ²SAVE - Endovascular and Interventional Radiology Department, Santa Casa de Maceió Hospital, Maceió, BR, ³Interventional Angiology, University Hospital - University of Leipzig, Leipzig, DE, ⁴Angiology and Cardiology, University of Leipzig Heart Center, Leipzig, DE

Purpose: To describe the technique and report our experience with a novel technique for patients with massive acute pulmonary embolism (APE) using Aspirex®.

Material and methods: Analysis of patients admitted with massive APE from July/2016 to August/2018. Patients underwent imaging investigation and were referred to the specialist. Treatment was performed through right jugular vein access, selective catheterization and thrombectomy with a 10F Aspirex. Demographic, clinical/periprocedural, post-operative, complication and adjunct intervention data were reviewed. Technical success was defined as recanalization of the pulmonary trunk and lung perfusion.

Results: 16 patients (mean age 59.6 ± 21.7 years) underwent intervention for massive APE using thrombectomy devices. Dyspnea was the most common complaint on admission (93.75%), with thoracic pain (81.25%) shock (68.75%) and syncope (12.5%) as the main clinical referral presentation at admission. 13 patients had suggestive CT signs of APE on admission. Endovascular revascularization was performed through the right jugular vein with a mean procedural time of 29 ± 21 minutes. Primary use of thrombectomy devices was performed in all patients, with a technical success rate of 100%, with intraoperative thrombolysis (6/16; 37.5%) and catheter-assisted aspiration in 12.5% (2/16) of patients. Average time between admission and angio-CT was 3.1 ± 1.6 h and between admission and interventional procedure was 4.2 ± 1.3 h. Complications directly related to the endovascular procedure occurred in two patients, represented by self-limited small access hematomas. Overall 30-day mortality was 12.5% (n=2), none as a result of complications related to the procedure.

Conclusion: The initial results with this technique are promising, being a technically feasible and reasonably fast and safe procedure. Further studies are necessary on this field to confirm these findings.

P-897

Perivascular hyaluronan – new cure for venous insufficiency

J.P.C. Grünwald¹, J.C. Ragg²

¹Interventional Phlebology, Angioclinic, Berlin, DE, ²Interventional Radiology, Angioclinic Vein Centers, Berlin, DE

Purpose: Injectable hyaluronan gels offer three options to treat venous insufficiency: 1) Percutaneous Valvuloplasty (PVP), aiming at the restoration of local valve function; 2) Focal Venoplasty (FVP), aiming at diameter reduction to reduce reflux, and 3) Segmental Venoplasty (SVP), aiming to reduce venous diameters as an adjunct to endoluminal procedures.

Material and methods: PVP was studied in 22 patients (14 f, 8 m, 32 – 54 y., GSM valves, diameter 7.0 – 12.0 mm), using a prototype hyaluronan (XL type, Vivacy). FVP was evaluated in 16 patients (11 f, 5 m, 46 – 69 y.) for reflux reduction in GSV or sidebranch insufficiency (L-type, Vivacy). SVP was investigated in 20 cases (13 f, 7 m, 41 – 72 yrs.) with GSV or SSV insufficiency, adjunctive to Biomatrix sclerofoam (Venartis), using another hyaluronan (S-Type, short durability, Vivacy). For this collective, target segments were split and randomized to hyaluronan vs. NaCl 0.9%.

Results: PVP established orthograde flow in 22/22 cases. With FVP, 13/16 cases were successful (81.3%) in obtaining alternate (n = 10) or orthograde flow (n = 4), correlating well with clinical improvement. With SVP, technical success (> 50% lumen reduction) was obtained in all cases (20/20). In all hyaluronan compressed segments, there were no postinterventional complaints, compared to 18/20 cases (90%) after standard procedures. All hyaluronan applications were without adverse reactions.

Conclusion: PVP is effective and safe to restore valve function. Also FVP for hemodynamic purposes showed feasibility, effectivity and safety, while clear indications need further studies. SVP adjunctive to endovenous ablation significantly improves post-treatment comfort.

P-898

Initial experience using a novel magnetic-catheter based IVC filter retrieval device

S. Periyasamy¹, K. Moore¹, W. Flanagan², J. Ashley², A. Doersch², E. Foran², B. Struthers², M.A. Woods¹, P.F. Laeseke¹

¹Radiology, University of Wisconsin-Madison, Madison, WI, US,

²Biomedical Engineering, University of Wisconsin-Madison, Madison, WI, US

Purpose: To report our initial preclinical experience with a magnetic-catheter based device for forming wire loops during IVC filter retrievals.

Material and methods: The prototype consists of two modified 5Fr catheters (one reverse-curve, one straight) with neodymium ring magnets attached to the tips. Initial testing utilized a vinyl IVC phantom (caval diameter ~25mm) with an implanted Bard Denali filter. Wire loops were created by passing the two magnetic catheters around opposite sides of the filter, coupling the magnets, advancing a guidewire through the catheters, decoupling the magnets and removing the catheters over the wire. Time to form wire loops with the prototype was compared to the conventional method, which utilizes a reverse-curve catheter, wire and snare (t-test, n=15 per group). Percent of wire loops bisecting the filters were compared between groups. In both groups, a loop snare technique was then used to retrieve the filters. Preliminary in-vivo testing was performed in two ~50kg swine. A Cook Celect filter was deployed within the IVC, and wire-loops were formed using the prototype.

Results: Mean ($\pm$ SD) time to form a wire loop in the phantom using the prototype (2.5 $\pm$ 0.4 minutes) was significantly shorter than the conventional method (6.0 $\pm$ 0.4 minutes, P=0.01). Ninety-three percent (14/15) of wire loops formed using the prototype bisected the filter compared to 53% (8/15) in the conventional group. In in-vivo testing, all ten attempts to form the wire loop using the prototype were successful.

Conclusion: In preclinical testing, a magnetic-catheter based device enabled faster and more accurate wire loop formation during IVC filter retrievals.

P-899

The midterm result of B-RTO for gastric varices using CANDIS system

T. Oda¹, M. Tsurusaki², M. Wakana², A. Suzuki², I. Numoto², T. Kadoba³, Y. Yagyu², N. Kashiwagi², K. Ishii²

¹Radiology, Kindai Hospital, Osakasayama, JP, ²Radiology, Kindai University, Faculty of Medicine, Osakasayama, JP, ³Radiology, Tenri Yoru Soudansho Hospital, Tenri-city, JP

Purpose: Balloon-occluded retrograde transvenous obliteration (B-RTO) has become widely accepted in Japan as a minimally invasive, highly effective treatment for gastric varices (GV). However, in some cases that involve complex types of afferent or draining veins, the use of standard B-RTO for the treatment of GV is associated with difficulties that can lead to unfavorable results. In such cases, additional techniques are required for successful treatment. A new coaxial balloon catheter system (CANDIS system) developed in Japan by Tanoue et al. (CVIR 2016) that is characterized by a 5 Fr catheter has a high flexibility and can be

coaxially inserted into the guiding catheter in advance. The purpose of this study is to evaluate the midterm results of B-RTO for gastric varices using the CANDIS system.

Material and methods: Between 2012 and 2017, 25 cases (male: female = 9: 16 average age 69.5 years) were treated by B-RTO with CANDIS system for GV. The procedures, including technical success rate (maneuverability of the catheter and successfully injected sclerosing agent), clinical success rate (disappearance of gastric varices after 6 months), and complications were evaluated retrospectively.

Results: The technical success rate was 100% (25/25 cases), the cases which the CANDIS system was effective was 81.8% (18/22), the clinical success rate was 100% (20/20). Minor vascular injuries occurred at 12% (3/25). Development of esophageal varices were seen at 46.7% (7/15).

Conclusion: B-RTO procedure using the CANDIS system is feasible. GV can be treated more simply by using this catheter system.

P-900

The clinical impact of the endovenous management of chronic venous insufficiency in patients with chronic venous occlusive disease

T. Hall¹, B. Braithwaite², R. O'Neill¹, S. Habib³

¹Interventional Radiology, Queens Medical Centre, Nottingham, UK,

²Department of Vascular Surgery, QMC, Nottingham, UK, ³Radiology Department, Nottingham University Hospitals-QMC, Nottingham, UK

Purpose: The efficacy of endovenous stenting for iliofemoral stenosis or occlusion in chronic venous insufficiency (CVI) is unproven. This study analyses the outcomes of venous stenting in CVI for patients in whom conservative and/or prior surgical treatment modalities had failed.

Material and methods: Operative and clinical records were retrospectively analysed in all patients who had endovenous stenting for CVI. Baseline demographics, procedural details and symptom severity based on CEAP and Villalta scores were collected. Stent patency was assessed by follow-up duplex ultrasound. Clinical follow-up included Villalta score and a subjective assessment of improvement.

Results: Fifteen patients with a mean Villalta score of 11 were treated. Two were lost to follow-up. Technical success was 100% with no major complication. Two minor complications (self-limiting bleeding) occurred. At follow-up, stent patency, by Duplex ultrasound, was 71.4% at 13 (range 5-54) weeks. 53.8% (n=7) of patients reported subjective improvement in their symptoms, 30.8% (n=4) of patients reporting no improvement and 15.4% (n=2) of patients reporting worsening of their symptoms. The mean Villalta score at follow-up was 8.5; a significant reduction (p=0.049) from the pre-procedural score.

Conclusion: Endovenous stenting for CVI can be performed safely and with a high technical success rate. Patency rates are reasonable and are associated with a significant reduction in Villalta scores.

P-901

Quantification of mechanical properties of long-term in vivo used silicone catheter lines according to DIN 10555-3

H. Guerreiro¹, H. Schröder², F.D. Busch¹, J. Spretke¹,

K. Sellenschloh¹, G. Huber², G. Adam¹, H. Ittrich¹, J.D. Busch³

¹Diagnostic and Interventional Radiology and Nuclear Medicine, University Medical Center Hamburg-Eppendorf, Hamburg, DE,

²Biomechanics, Hamburg University of Technology, Hamburg, DE,

³Diagnostic and Interventional Radiology and Nuclear Medicine, Section of Pediatric Radiology, University Medical Center Hamburg-Eppendorf, Hamburg, DE

Purpose: Totally implantable central venous access port devices (TIVAD) play an important role in the intravenous application of chemotherapeutics in oncology and long-term i.v. therapy in patients with chronic disease. Complications include material fracture and thrombosis. We intend to investigate the mechanical properties of unused and in-vivo removed

catheters using a previously described method for uniaxial tensile tests according to DIN 10555-1.

Material and methods: 5 unused, originally packed silicone catheters were cut into 6 segments of 50 mm: 3 segments were subsequently purified in a cleaning solution (n=15) and 3 segments were left unattended (n=15). The distal segments (50 mm) of long-term in vivo used silicone catheters were purified and cut (n=34). The mechanical behavior of all specimens was tested in a custom made self-centering, torsion free carrier. Maximum force (F_{max}), stress at break (σ_{0B}), strain at break (ϵ_B) and elastic modulus (E-modulus, E) were determined and statistically analysed.

Results: Purified and non-purified unused catheters showed no significant difference for all the tested parameters and were therefore merged for further analysis. Previously in vivo removed catheters showed in comparison to the unused catheters significant lower maximal force ($p > 0.001$; $\beta=1$), strain at break ($p > 0.001$; $\beta=1$), and elastic modulus ($p=0.004$; $\beta=0.845$). In our experiments stress at break was proportional to maximum force. Different in-dwell times failed to show a significant effect in the tested parameters.

Conclusion: In vivo long-term used silicone catheters showed significant lower mechanical robustness when compared to unused silicone catheters. Further studies to test for possible factors influencing catheter insufficiency in TIVADs are necessary.

P-902

Treating the untreatable: innovative plug & foam technique for tortuous varicosities beyond the reach of thermal ablation techniques and stand-alone sclerotherapy

S.S. Joshi¹, R. Basapure¹, A.S. Joshi¹, P. Khandelwal², K. Kankani²

¹Vascular and Interventional Radiology, The Vein Center, Mumbai, Mumbai, IN, ²Anaesthesiology, The Vein Center, Mumbai, Mumbai, IN

Purpose: To develop a technique to achieve consistent closure of dilated varicosities that are inaccessible with thermal ablation techniques.

Material and methods: Inconsistent closure of large dilated (> 5mm) tortuous varicosities of post stand-alone sclerotherapy patients caused frequent patient dissatisfaction forced us to develop a better technique. The procedure started with EVLA for incompetent GSV, SSV, AAGSV and other accessory trunks followed by closure of such varicosities by the given technique.

The Plug and Foam Technique:

10 ml Dextrose is injected at the origin of varicosity, with the perforator access directed away from the deep system, followed by injection of Dextrose (1.5ml) and NBCA glue (0.5ml), which forms a "plug". Then, Sodium Tetradecyl Sulphate (Fibrovein-3%, 2ml) mixed with air (8ml) and made into foam is injected within varicosity by another access taken distally. NBCA plug at perforator origin causes stasis within varicosity and hence, preventing washout and thereby increasing the contact time of SDS foam. Patients received a followed up ultrasound examination post-operatively on 7th day and after 2 months.

Patient Selection:

1. Patients with large dilated varicosities more than 5mm diameter and tortuous (unable to allow placement of the laser fiber device) were selected.
2. Patients presenting with recanalization post stand-alone sclerotherapy.

Results: All 25 patients undergoing post-operative follow up after 2 months, show consistent closure of the treated varicosities with no recanalization.

Conclusion: The Plug and Foam method using NBCA glue and SDS foam together is a promising technique in treating dilated varicosities that are inaccessible with conventional thermal ablation techniques.

P-903

Catheter-directed therapy is superior to anticoagulation for sub-massive and massive pulmonary embolism: updated outcomes

A. Khan, G. Woodhead, H. McGregor, M. Patel, D. Ruiz, J. Hannallah, C. Hennemeyer

Department of Interventional Radiology, University of Arizona, Tucson, AZ, US

Purpose: Compare outcomes of catheter-directed treatment of pulmonary embolus versus anticoagulation alone in massive and submassive PE.

Material and methods: A retrospective review of 105 patients with massive and submassive PEs over two years was performed. 36 patients (9 massive, 27 submassive) were treated with CDT, consisting of aspiration thrombectomy (18), ultrasound-assisted thrombolysis (8) or both (10). 43 patients (8 massive, 35 submassive) were treated with anticoagulation alone. Primary outcome was improvement of RV/LV ratio 24-48 hours after treatment. Safety outcomes included 90-day mortality, bleeding complications, and hospital readmissions. Subgroup analysis based on severity of RV dilation was performed. Mild RV dilation was defined as an RV/LV ratio of 0.9-1.3, moderate 1.3-1.9, and severe >1.9).

Results: Mean RV/LV ratio decreased from 1.91 ± 0.61 to 1.28 ± 0.45 ($p < 0.001$) in the CDT group and from 1.40 ± 0.37 to 1.25 ± 0.32 ($p = 0.01$) in the anticoagulation group. In submassive PEs with mild and moderate RV dilation (RV/LV ratio 0.9-1.9), RV/LV ratio was significantly lower in the CDT group at 24-48 hours (1.05 ± 0.38 vs 1.20 ± 0.31 , $p < 0.001$). In submassive PEs with severe RV dilation (RV/LV ratio >1.9), no difference was noted. Ninety-day mortality and incidence of bleeding complications did not significantly differ. Thirty-day readmission rates were 8% in the CDT group and 26% in the anticoagulation group ($p = 0.04$).

Conclusion: CDT significantly improves RV dysfunction at 24-48 hours compared to anticoagulation alone and may lower hospital readmission rates for acute massive and submassive PE. CDT may be more advantageous in patients with mild to moderate RV dysfunction.

P-904

Ultrasound-assisted catheter-directed thrombolysis in intermediate-high risk acute pulmonary embolism: a new indication?

F. Barbosa¹, R. Guerrieri², A. Alfonsi³, F. Morelli⁴, I. Bossi², S. Di Domenico², J. Oreglia⁵, A. Sacco⁵, N. Morici⁵, A. Basile², C. Migliorisi⁶, M. Solcia⁶, R. Vercelli¹, A. Bellone², F. Oliva⁵, A.G. Rampoldi¹

¹Interventional Radiology, Ospedale Niguarda, Milan, IT, ²Emergency Department, Niguarda Hospital, Milan, IT, ³Radiology, Campus Biomedico University of Rome, Rome, IT, ⁴Radiology, San Paolo Hospital, Milan, IT, ⁵Coronary Unit, Niguarda Hospital, Milan, IT, ⁶Interventional Radiology, ASST Grande Ospedale Metropolitano Niguarda, Milan, IT

Purpose: The aim of this study is prospectively assess the safety and efficacy of the ultrasound-assisted catheter-directed thrombolysis (UACDT) in intermediate-high risk patients with acute pulmonary embolism (APE) in a tertiary referral hospital, preliminary results.

Material and methods: Prospective study including all consecutive intermediate-high-risk APE patients treated with UACDT (EkoSonic Endovascular System-EKOS, Bothell, Washington, US) and 20mg of local alteplase using bilateral catheters plus heparin (20,000UI in 24 hours). Primary end-point was the change of haemodynamic pattern in the first 24 hours (RV/LV ratio, TAPSE, PAPs), assess the complications, mortality and APE recurrence, days of hospitalization and late pulmonary hypertension.

Results: Thirteen intermediate-high-risk APE patients (8 men), mean age 60 years, were included. 5/14 are neoplastic, 2/14 had previous major trauma (ISS>15), 1 had fronto-temporal intraparenchymal haematoma with ventricular flooding two months before, 5/14 had deep venous thromboembolism. Important improvement of haemodynamic conditions within 24h after UACDT (RV/LV ratio, TAPSE, PAPs) was observed in all patients. No APE recurrence, late pulmonary hypertension or death

were observed. One patient was in the second post-operative day when had APE, in this patient blood transfusion for bleeding was requested. One access site haematoma was observed. The median hospitalization was 10 days (5-21).

Conclusion: The preliminary data are encouraging and the UACDT seems to be an effective and safety tool to treat patients with intermediate-high risk APE.

P-905

Gianturco Z-Stent placement for the treatment of chronic central venous occlusive disease: implantation of 208 Stents in 137 symptomatic patients

J. McDevitt¹, D. Goldman², J. Bundy³, A. Hage³, N. Jairath³, J.J. Gemmete⁴, R. Srinivasa⁴, J.F.B. Chick⁵

¹Department of Radiology, University of Texas Southwestern Medical Center, Dallas, TX, US, ²Department of Radiology, Icahn School of Medicine at Mount Sinai, New York City, NY, US, ³Department of Radiology, Division of Vascular and Interventional Radiology, Ann Arbor, MI, US, ⁴Vascular and Interventional Radiology, University of Michigan Health Systems, Ann Arbor, MI, US, ⁵Department of Cardiovascular and Interventional Radiology, Inova Alexandria Hospital, Alexandria, VA, US

Purpose: To report the technical success, adverse events, and long-term stent patencies of Gianturco Z-Stent placement for management of chronic central venous occlusive disease.

Material and methods: 137 patients, with mean age 49 ± 16 years (range: 16-89 years), underwent placement of Gianturco Z-Stents for chronic central venous occlusion. Number of stents placed, stent implantation location, stent sizes, technical success, adverse events, need for re-intervention, follow-up evaluation, stent patencies, and mortality were recorded. Technical success was defined as recanalization and stent reconstruction with restoration of in-line venous flow. Adverse events were defined by the Society of Interventional Radiology Adverse Event Classification criteria. Primary and primary-assisted stent patencies were analyzed using Kaplan-Meier analysis.

Results: 208 total Z-Stents were placed. The three most common placement sites were the inferior vena cava (n=124; 60%), superior vena cava (n=44; 21%), and brachiocephalic veins (n=27; 13%). Technical success was achieved in 133 (97%) patients. There were two (1.5%) severe adverse events (two cases of stent migration to the right atrium), one (0.7%) moderate adverse event, and one (0.7%) mild adverse event. Mean follow-up was 44 ± 53 months. Estimated 1-, 3-, and 5-year primary stent patency was 84%, 84%, and 82%, respectively. Estimated 1-, 3-, and 5-year primary-assisted patency was 92%, 89%, and 89%, respectively. 30- and 60- day mortality rates were 2.9% (n=4) and 5.1% (n=7), none of which were directly attributable to Z-Stent placement.

Conclusion: Gianturco Z-Stent placement is safe and effective for the treatment for chronic central venous occlusive disease with durable short- and long-term patencies.

P-906

How long should venous access procedures take in the interventional radiology department? Retrospective analysis of 295 cases in a high volume unit

D.T. Ryan, G.M. Healy, S. Sharpe, C. Cantwell

Department of Radiology, St. Vincent's University Hospital, Dublin, IE

Purpose: There are no published data regarding standardised durations for interventional radiology procedures. This makes managing workflow and scheduling of procedures difficult. Venous access makes up an important component of these procedures. This study seeks to identify the most common venous access procedures performed in our University Hospital IR department and evaluate the average duration needed for each procedure category.

Material and methods: We performed a retrospective analysis of the venous access procedures carried out in a calendar year in our department using the Radiology Information System (RIS). The time that each patient enters and leave our IR suite is also routinely recorded separately.

Results: Approximately 12578 IR procedures were performed in our hospital in 2018. Venous access constitutes 21% of total IR workload. In 2018, we inserted 907 peripheral inserted central catheters (PICCs), 107 Portacaths, 93 tunneled dialysis lines (Hickman and Permcaths) and 68 Vascaths. During the three months of the study, 218 PICCs, 32 Portacaths, 29 tunneled dialysis lines and 16 Vascaths were inserted. The mean time within the IR room for these procedures was; 43 minutes for PICCs, 64 minutes for Portacaths, 85 minutes for Permcaths, 66 minutes for Hickman and 50 minutes for Vascaths.

Conclusion: This work provides valuable data which can be used to improve departmental scheduling. We have also established a baseline upon which other centres can account for IR productivity in relative value units.

P-907

Predictors of post-thrombotic syndrome in patients with iliofemoral deep venous thrombosis who underwent catheter-directed thrombolysis

M.S. Kim¹, H.S. Park², D. Hyun³, S.K. Cho³, K.B. Park³, S.W. Shin², Y.-S. Do⁴, S.W. Choo², D.-I. Kim⁵

¹Department of Radiology, Kangbuk Samsung Hospital, Sungkyunkwan University School of Medicine, Seoul, KR, ²Department of Radiology and the Center for Imaging Science, Samsung Medical Center, Sungkyunkwan University School of Medicine, Seoul, KR, ³Radiology, Samsung Medical Center, Seoul, KR, ⁴Department of Radiology, Samsung Medical Center, Sungkyunkwan University School of Medicine, Seoul, KR, ⁵Surgery, Samsung Medical Center, Sungkyunkwan University School of Medicine, Seoul, KR

Purpose: To identify predictors of post-thrombotic syndrome (PTS) in patients with iliofemoral deep venous thrombosis (DVT) who underwent catheter-directed thrombolysis (CDT).

Material and methods: Fifty-two consecutive patients who underwent CDT were included in this retrospective study. In addition to CDT, aspiration thrombectomy or stent placement was performed if needed. All patients were evaluated by duplex ultrasound within 1 week after CDT. At 6 months, duplex ultrasound was performed to assess iliofemoral patency, residual thrombus, and deep venous reflux. Post-thrombotic syndrome was assessed using the clinical, etiologic, anatomic and pathophysiologic (CEAP) classification (PTS present ≥ 3 on a scale from 0 to 6). Univariate analysis and multivariate logistic regression were used to identify predictors of PTS.

Results: Median follow-up was 52 months and PTS developed in nine patients (17.3%). In univariate analysis, stent placement (odds ratio [OR] 0.16, $p=0.022$) was negatively associated with PTS, whereas early re-thrombosis within 1 week after CDT (OR 9.50, $p=0.008$) and residual thrombus with reflux at 6 months (OR 13.22, $p=0.002$) were positively associated with PTS. Multivariate analysis indicated that stent placement was associated with reduced risk of PTS (OR 0.12, $p=0.024$) and early re-thrombosis was associated with increased risk (OR 12.07, $p=0.009$). Mediation analysis showed that stent placement and early re-thrombosis was related to PTS through the mediating effect of residual thrombus with reflux.

Conclusion: Stent placement and early re-thrombosis, respectively, were important protective and risk factors for PTS in patients who underwent CDT. These associations were mediated by residual thrombus with reflux.

P-908

Regression of varicose veins after cyanoacrylate closure of incompetent great saphenous veins without a localized concomitant procedure

S.W. Park¹, J. Min²

¹Radiology, Konkuk University Medical Center, Seoul, KR, ²Radiology Department (B1), Konkuk University Medical Center, Neungdong-ro, Gwangjin-gu, KR

Purpose: To evaluate the effectiveness and safety of endovenous cyanoacrylate closure (CAC) of incompetent great saphenous vein (GSV) and to assess the regression of varicose vein following CAC without a concomitant procedure.

Material and methods: A total of 63 limbs in 48 patients treated with CAC because of an incompetent GSV between December 2016 and November 2017 were retrospectively evaluated. Duplex ultrasound, Venous Clinical Severity Score, degree of regression of varicose veins, and adverse events were examined at intervals of 1 week, 1 month, 3 months, 6 months, and 12 months.

Results: In 63 limbs, of which 60 were available for follow-up, all treated GSVs showed complete closure during the follow-up period (8.4 ± 3.0 months). Venous Clinical Severity Scores at the time of all follow-up visits were significantly lower ($P < .001$) than those before CAC. Complete resolution of varicose veins was noted in 38 limbs (71.7%) after 3-month follow-up. The proportion of limbs showing $>50\%$ varicose vein regression reached 90.6%. The more that varicosity entry was covered ($P = .002$) and the farther down the leg the access site was located ($P = .024$), the more complete resolution of varicose veins was observed. Phlebitis occurred in 10 limbs (16.7%), and hyperpigmentation occurred in 8 limbs (13.3%).

Conclusion: CAC is safe and effective for the treatment of an incompetent GSV. It also shows a satisfactory result with the regression of varicose veins. Covering the entry of varicosities and accessing lower down the leg are associated with more complete resolution of varicose veins.

P-909

Pain improvement after percutaneous sclero-embolization of male varicocele using NBCA-MS

N. Gennaro¹, D. Volpe¹, R. Muglia¹, I. Bolengo¹, F. D'Antuono², D. Poretti², V. Pedicini², L. Pasini³, E. Lanza²

¹Radiology, Humanitas University, Rozzano, IT, ²Diagnostic and Interventional Radiology, Humanitas Research Hospital, Rozzano, IT, ³Urology Department, Humanitas Research Hospital (Humanitas University), Rozzano, IT

Purpose: To evaluate safety and efficacy of male varicocele embolization using n-butyl-cyanoacrylate methacryloxy-sulfolane (NBCA-MS) in a single-center.

Material and methods: From January 2016 to December 2018, 47 male patients (mean age=27 years; range=17–46) underwent varicocele (42/47 left-sided, 2/47 bilateral, 3/47 right-sided varicocele) embolization using NBCA-MS (Glubran 2; Gem, Viareggio, Italy) mixed with Lipiodol (Guerbet, Villepinte, France) in a 1:1 ratio.

We reported grade of preoperative groin pain or discomfort in a 4-point scale questionnaire (grade 0=no pain; grade 4=unbearable pain), procedural time, clinical and spermogram variations, recurrence of symptomatic varicocele. All patients were followed on average 18 months ($SD=16$) after intervention, by phone or with a clinical visit, and we repeated the pain questionnaire. Moreover, we acquired spermograms performed before and after embolization, whenever available.

Results: All procedures were technically successful. No complications occurred. Mean procedural time was 39 minutes. Twenty-nine patients completed the follow-up questionnaire. The pain score decreased significantly from an initial mean of 1.25 ($SD=1.2$) to 0.34 ($SD=0.5$, Friedman test, $X^2_r = 7.76$, $N = 29$, $p < .005$). Among the 10/47 patients with pre- and post-procedural spermograms, 90% achieved an improvement. Two

patients over twenty-nine (7%) had a recurrence, being symptomatic in only one case (grade 1).

Conclusion: Percutaneous sclero-embolization of male varicocele using NBCA-MS is a quick and safe procedure, effective in reducing patient groin pain and discomfort.

P-910

Aiming for the bottom corner: how to score a goal when landing venous stents in May-Thurner syndrome

R. Bajwa¹, D. Bergin², G.J. O'Sullivan¹

¹Interventional Radiology, Galway University Hospital, Galway, IE, ²Radiology, University Hospital Galway, Galway, IE

Purpose: To report an iliac venous stent landing technique using fluoroscopy only in patients with May-Thurner syndrome (MTS).

Material and methods: 65 patients (mean age 50, 69% female) who had venous stents deployed for symptomatic MTS were retrospectively analysed between February 2007 – January 2019. The right lower corner of the cephalic venous stent was deployed to the right of the lumbar vertebra spinous process (SP, left goalpost), but not beyond the right pedicle (right goalpost) using fluoroscopy only. Mode stent diameter and length were 14 mm (Range 12-18mm) and 120 cm (Range 60-180cm), determined by venography, respectively. The anatomical positions of the right common iliac artery (RCIA, goalkeeper), inferior vena cava (IVC) and stent were assessed relative to these bony landmarks on CT venography.

Results: Mean goalkeeper position lay between the goalposts, mean distance 12 mm (± 8 mm) to the right of the SP and 13 mm (± 7 mm) left of the right pedicle. Mean IVC right lateral wall position lay 1 mm (± 6 mm) to the right of the right pedicle and 26 mm (± 12 mm) to the right of the SP. Mean right lower corner of the cephalic venous stent position was 10 mm (± 10 mm) to the right of the RCIA. Mean space between the right lower corner of the cephalic venous stent and the IVC right lateral wall was 5 mm (± 5 mm). 88% overall patency at one year.

Conclusion: Fluoroscopy only deployment of venous stents is possible: the cephalic stent right lower corner lying beyond the May-Thurner lesion, with adequate right common iliac venous drainage.

P-911

Five-year outcomes of mechano-chemical ablation of primary great saphenous vein incompetence

N.D.E. Thierens¹, S. Holeywijn², W.H.P.M. Vissers³, D.A.B. Werson⁴, J.P.P.M. de Vries⁵, M.M.P.J. Reijnen²

¹Vascular Surgery, Rijnstate, Arnhem, NL, ²Department of Vascular Surgery, Rijnstate, Arnhem, NL, ³Department of Vascular Surgery and Dermatology, Rijnstate, Arnhem, NL, ⁴Department of Vascular Surgery, St Antonius Hospital, Nieuwegein, NL, ⁵Department of Surgery, Division of Vascular Surgery, University Medical Centre Groningen, Groningen, NL

Purpose: The aim of the study is to report long term results after mechanochemical ablation (MOCA) for treatment of GSV incompetence.

Material and methods: MOCA was performed using the ClariVein device with polidocanol as the sclerosans. Clinical, Etiologic, Anatomic and Pathophysiologic (CEAP) classification, Venous Clinical Severity Score (VCSS), RAND-SF36 and the Aberdeen Varicose Vein Questionnaire (AVVQ) were obtained pre-procedural and during six weeks, six months, one, three and five years follow-up. Data was obtained by clinical examination, questionnaires and duplex ultrasonography.

Results: 94 patients (113 GSV's) were included in the study. At five year follow-up the freedom from anatomical failure was 78.7% with 64.6% having an improvement in the VCSS ≥ 1 . A total of 5 reinterventions of the treated segment were performed through 5 years with a median time to reintervention of 38 months. The VCSS at 5 years was 2 (IQR 1 ; 4) and was still significantly improved compared to baseline ($p < 0.001$). A deterioration of the VCSS was observed in 21.5%.

Conclusion: The current series was the first large prospective trial after introduction of MOCA and has proven it to be safe and effective at the short-term. Through five-year follow-up there are a significant number of anatomical and clinical failures in this series. Adaptations in treatment protocol and increased experience might provide improved anatomical results in later series.

P-912

Late clinical outcome of manual aspiration thrombectomy and hybrid catheter intervention for life-threatening acute massive pulmonary thromboembolism

H. Tajima¹, T. Kaneshiro¹, N. Takenoshita¹, H. Kawamata¹, T. Ueda², S. Onozawa³, S. Murata⁴, N. Tajima⁵
¹Center for Minimally Invasive Treatment, Nippon Medical School Musashi-Kosugi Hospital, Kawasaki, Kanagawa, JP, ²Radiology, Nippon Medical School, Tokyo, JP, ³Radiology, Teikyo University Mizonokuchi Hospital, Kawasaki, Kanagawa, JP, ⁴Radiology/Interventional Radiology Center, Teikyo University Chiba Medical Center, Chiba, JP, ⁵Radiology, Iri Clinic, Sakado, Saitama, JP

Purpose: Interventional radiology for life-threatening acute massive pulmonary thromboembolism is receiving a lot of attention because of the remarkable therapeutic effects. However, the late mortality rates associated with this kind of therapy have not yet been reported. The objective of the study was to retrospectively analyze the late outcome of these catheter intervention.

Material and methods: Forty patients with hemodynamic impairment were treated with manual aspiration thrombectomy or hybrid catheter intervention. Fifteen patients received only catheter-directed thrombolysis and manual clot aspiration with a large lumen-guiding catheter. On the other hand, twenty-five patients received an intrapulmonary injection of recombinant human-tissue plasminogen activator and after embolus fragmentation, underwent manual clot aspiration with a large lumen-guiding catheter. Patient's status was checked by the medical records and telephone interview. The median follow-up was 162 months (115-208 months).

Results: All patients discharged after the procedure. The 1-, 5-, and 10-year survival rates of the manual aspiration thrombectomy group were 100%, 75.0%±12.5%, and 75.0%±12.5%, respectively, while the same rates of the hybrid catheter intervention group were 87.5%±6.8%, 83.3%±7.6%, and 74.5%±9.0%, respectively. Ten patients of manual aspiration thrombectomy group and five patients of hybrid catheter intervention group died of intercurrent disease during follow-up. There was only one recurrence of pulmonary thromboembolism of the hybrid catheter intervention group because of drug withdrawal by self-judgement, but no chronic pulmonary thromboembolism was observed.

Conclusion: Patients who underwent manual aspiration thrombectomy and hybrid catheter intervention for life-threatening acute massive pulmonary thromboembolism have both an acceptable late outcome.

P-913

Outcome of percutaneous transluminal balloon angioplasty (PTBA) with respect to hepatic vein targeted in patients with Budd Chiari syndrome (BCS)

M.D. Sarfraz¹, H. Rana¹, A.I. Rana², Z.A. Khan²
¹Radiology, Shifa International Hospital, Islamabad, PK, ²Interventional Radiology, Shifa International Hospital Islamabad, Islamabad, PK

Purpose: Budd-Chiari syndrome (BCS) is a rapidly deteriorating however potentially treatable disease. Percutaneous transluminal balloon angioplasty (PTBA) is the first-line treatment option in majority of patients. We aim to evaluate the outcome of PTBA with respect to vein targeted.

Material and methods: Between January 2013 and December 2018, 38 consecutive patients with BCS underwent PTBA, which was followed with Doppler ultrasound or angiography. Data was collected retrospectively.

Results: PTBA was technically successful in all patients. Of 38 patients with BCS, 26 had isolated hepatic venous obstruction (HVO), 8 had combined IVC-HVO and 4 had isolated IVC obstruction. The right hepatic vein (RHV) was selected as the target vessel in 14 patients, left hepatic vein (LHV) in 6 patients, middle hepatic vein (MHV) in 6 patients, combined IVC with single hepatic vein in 7 patients, combined IVC with two hepatic veins in 1 patient and IVC alone in 4 patients. The mean diameter of the balloon for angioplasty was 14.21 mm (range 10–20 mm). Two BCS patients underwent percutaneous transhepatic route creation after transvenous catheterization failure.

The cumulative primary patency rates at 6, 12, 24 and 36 months were 97.3%, 92.1%, 89.4%, and 89.4% respectively. Primary patency rates at 36 months for RHV, MHV, LHV, combined IVC-hepatic venous and isolated IVC group are 75%, 100%, 67%, 50% and 100% respectively. Early repeat intervention was required in patients with combined IVC and hepatic venous obstruction.

Conclusion: PTBA is effective treatment with good primary patency rates. Chances of re-stenosis are higher for patient who had combined IVC and hepatic venous obstruction.

P-914

Comparison of large-diameter uncovered stents and covered stents for the treatment of malignant superior vena cava syndrome

J.W. Kim, D.I. Gwon
 Radiology, Asan Medical Center, University of Ulsan College of Medicine, Seoul, KR

Purpose: To compare the effectiveness of large-diameter uncovered stents (LDS) and expanded polytetrafluoroethylene-covered stents (CMS) in patients with malignant superior vena cava (SVC) syndrome.

Material and methods: Between August 2015 and December 2017, 44 consecutive patients (36 men, 8 women; mean age, 64.3 years; range, 25-83 years) who underwent LDS (20-30 mm in diameter) placement for SVC syndrome were retrospectively reviewed. Their data were compared with retrospective data of 46 consecutive patients (39 men, 7 women; mean age, 60.7 years; range, 28-81 years) who underwent CMS (8-14 mm in diameter) placement for SVC syndrome between October 2008 and April 2012. Stent patency and patient survival rates were calculated by using the Kaplan-Meier method, and groups were compared with the log-rank test.

Results: The LDS and CMS groups were well balanced in terms of baseline variables. Stent placement was technically successful in all patients. Complications did not occur in either group. The two groups did not differ significantly in terms of stent patency ($P = .160$), patient survival ($P = .491$), and clinical success ($P = .324$). The respective cumulative patency rates at 1, 3, 6, and 12 months were 95%, 93%, 93%, and 87% for LDS and 88%, 83%, 74%, and 74% for CMS.

Conclusion: Endovascular placement of LDS appeared to be a safe and effective method to treat patients with malignant SVC syndrome and seemed to be similar to CMS in terms of stent patency and patient survival.

P-915

EVLA (endovenous laser ablation) using nalbuphine / propofol based conscious sedation: pain-free for patients, stress-free for the IR - a South-Asian perspective

P. Khandelwal¹, S.S. Joshi², R. Basapure², A.S. Joshi², K. Kankani²
¹Anaesthesiology, The Vein Center, Mumbai, Mumbai, IN, ²Vascular and Interventional Radiology, The Vein Center, Mumbai, Mumbai, IN

Purpose: Majority of patients presenting with varicose veins to the Interventional radiologist (IR) in South-Asian communities fall in the category C3 (CEAP classification) and beyond. As the procedure (endovenous laser ablation -EVLA) needed in such patients would require multiple needle punctures to give tumescent anaesthesia along the

dilated veins, it warrants the need of an anaesthetic technique which provides adequate sedation and analgesia in a conscious patient with early postoperative recovery and discharge.

Material and methods: In the operating room, all patients received Oxygen by ventimask FiO_2 0.5 followed by premedication with midazolam 20 $\mu\text{g/kg}$ and paracetamol 1gm intravenously(i.v). Patients were administered nalbuphine 50 $\mu\text{g/kg}$. A bolus of propofol i.v 0.75mg/kg followed by an infusion at 0.015mg/kg/min was started. Tumescant anaesthesia was given by the IR (interventional radiologist) as required. Sedation was monitored using Modified Ramsay Sedation Scale(MRSS) and propofol infusion titrated to achieve MRSS score 2 - 4. Intra-operative pain was assessed using Behavioral Pain Scale- Non-intubated(BPS-NI) with a target BPS-NI scores $\leq$ 4. Vital parameters were observed intra-operatively(BP, HR, SpO₂, ECG). Patients were observed post-procedure in terms of any complications, patient satisfaction(Likert scale) and discharge time.

Results: All 40 patients achieved adequate sedation(MRSS score 2-4), 39/40 patients achieved optimal pain relief(BPS-NI $\leq$ 4). None of the patients had any intra or post procedure complications. Patient satisfaction was high on Likert scale and all patients were discharged on the same day.

Conclusion: Propofol / Nalbuphine based conscious sedation with tumescant anaesthesia can be used as a safe and effective technique for patients undergoing EVLA.

P-916

Endovascular intervention for complete occlusion of ilioacaval venous stents

R. Goldman, J. Hui, D.Y. Sze, W.T. Kuo, L. Hofmann

Vascular and Interventional Radiology, Stanford University, Stanford, CA, US

Purpose: Iliocaval stenting is associated with favorable patency rates, but stent occlusion can be problematic. We report results of endovascular management of ilioacaval stent occlusion in a single quaternary care institution.

Material and methods: A retrospective review of all 293 patients presenting for 588 endovascular venous procedures from 2011 through 2015 identified 28 patients (14 male, 14 female; mean age 41 y, range 16-66 y) treated for occluded ilioacaval stents. Acute, subacute, and chronic thrombus was identified in 9, 4, and 15 cases, respectively. Technical success, techniques for recanalization, and periprocedural complications were recorded. Patency was analyzed using Kaplan-Meier estimates.

Results: Technical success was achieved in 79% of initial recanalization procedures. Failure to recanalize in-stent occlusion occurred in 4 procedures and failure to establish adequate in-flow occurred in 2. Successful techniques consisted of guidewire recanalization (20/22), sharp recanalization (2/22), laser assisted thrombectomy (5/22), catheter directed thrombolysis (10/22), pharmacomechanical thrombectomy (5/22), and overnight thrombolysis (8/22). Coaxial stent placement was performed in 19 of the 22 successful recanalization cases. Stents were deployed to reline the existing segments in 7 of 19 cases with extension of the stented region in the remaining 12. A single major periprocedural complication of acute complete rethrombosis required reintervention. Primary, primary-assisted, and secondary patency rates were 34%, 48%, and 94% at 12 months and 23%, 48%, and 86% at 36 months.

Conclusion: Recanalization of occluded ilioacaval stents is safe and effective in managing in-stent obstruction with favorable technical success and secondary patency rates. Attentive follow-up is recommended as additional interventions are likely be necessary.

P-917

Comparing renal dysfunction from endovascular treatment of acute iliofemoral deep vein thrombosis between pharmacomechanical thrombectomy and catheter-directed thrombolysis

A.K. Gupta¹, A.L. Pouncey², L. Fiengo², A. Diamantopoulos³, N. Karunanithy¹, S. Black², N. Thulasidasan¹

¹Interventional Radiology, Guy's and St. Thomas' Hospitals NHS

Foundation Trust, London, UK, ²Vascular Surgery, Guys and St Thomas'

Hospital, London, UK, ³Interventional Radiology, Guy's and St. Thomas'

NHS Foundation Trust, King's Health Partners, London, UK

Purpose: Pharmacomechanical thrombectomy (PMT) causes haemolysis and haemoglobinuria, which have been associated with increased risk of acute kidney injury (AKI). We aimed to evaluate the risk of renal impairment following PMT with or without adjuvant catheter-directed thrombolysis (CDT) relative to the use of CDT alone in treatment of iliofemoral deep vein thrombosis (IFDVT).

Material and methods: A retrospective cohort study of all patients presenting to a tertiary centre between 2011 and 2017 for treatment of symptomatic acute IFDVT was performed. Patients were treated with PMT with or without adjuvant CDT, or with CDT alone. Patient demographics, thrombosis risk factors and incidence of complications were recorded, along with pre-procedural estimated glomerular filtration rate (eGFR) and creatinine, peak creatinine within 72 hours of intervention and highest baseline eGFR in the subsequent 6 months.

Results: 63 patients were treated with PMT and 76 with CDT alone. Baseline factors were comparable. Renal impairment on admission was present in 60.3% of PMT vs. 48.0% of CDT cases ($p=0.2$). There was no difference in mean creatinine rise 72 hours post procedure: PMT 1.24 times (95%CI:1.11-1.37), vs. CDT 1.08 times (95%CI:0.88-1.29) ($p=0.23$). More frequent AKI was seen after PMT (14.04%) than CDT (2.94%) ($p=0.042$). The majority of patients (82.5% PMT vs. 85.71%) returned to baseline eGFR within 6 months.

Conclusion: Treatment of IFDVT carries a risk of renal impairment regardless of modality. Use of PMT was associated with a greater transient rise in serum creatinine and acute kidney injury than CDT alone, but no difference was observed in return to baseline renal function.

P-918

Outcomes of retrograde transvenous obliteration for the treatment of bleeding gastric varices: a single center retrospective review

J. Oros¹, S. Rodich², A. Lichliter¹, M. Cura¹

¹Radiology, Baylor University Medical Center, Dallas, TX, US, ²Medicine, Texas A&M Health Science Center, Dallas, TX, US

Purpose: Balloon-occluded retrograde transvenous obliteration (BRTO) and modified techniques utilizing coils (coil assisted retrograde transvenous obliteration (CARTO)) are widely utilized in the treatment of bleeding gastric varices due to portal hypertension. This study was performed to evaluate and compare the outcomes of patients with bleeding gastric varices treated with BRTO and CARTO.

Material and methods: A retrospective review of patients who underwent BRTO or CARTO for the treatment of bleeding gastric or gastroesophageal varices. Clinical information included patient demographics, technique, pre- and post-procedure esophagogastroduodenoscopy (EGD), and procedural complications. Clinical success was defined as absence of recurrent variceal bleeding. Follow-up was carried out to the patient's last known encounter at the institution or death.

Results: 15 patients were included in the study (mean age, 62.3 years; range, 49-77 years; 8 male). Mean MELD score was 15.7 (range, 6-36). BRTO was performed in 7 patients and CARTO in 8 patients. Mean follow-up duration was 8.1 months (range, 0-33 months). One patient had clinical failure due to variceal re-hemorrhage requiring subsequent endoscopic banding. One patient had clinical failure due to recurrent bleeding from

gastric varices. There was one death related to balloon rupture and pulmonary embolization of sclerosing agent. 80% of patients had resolution of varices on EGD. Between BRTO and CARTO, there was no statistically significant difference in clinical success ($P=0.92$), EGD results ($P=0.60$), or fluoroscopy time (27.1 vs 38.4 min respectively, $P=0.39$).

Conclusion: BRTO and CARTO were equally safe and effective in the treatment for bleeding gastric varices from multiple causes, with an acceptable major complication rate.

P-919

Impact on post-thrombotic syndrome by temporary presence of IVC filter - evaluation using Villalta score

A. Shrivastava¹, L.-M.N.J. Boucher², A. Al Kindi², A. Gotra², A. Bessissow¹, D.A. Valenti¹

¹Radiology, McGill University, Montreal, QC, CA, ²Radiology, McGill University Health Centre, Montreal, QC, CA

Purpose: Some studies have suggested increase caval thrombosis in patients with IVC filters. We wanted to assess impact of temporary IVC filters on post-thrombotic syndrome as measured by Villalta score (VS).

Material and methods: Retrospective study from January 2016-December 2018 of all patients having an IVC filter inserted and removed during this time line. Patients with no VS measured, because of reasons such as inability to communicate or to evaluate legs, were excluded. VS were compared using a paired t-test between time of insertion and removal.

Results: 239 IVC filters were inserted and removed. 36 were excluded because of trauma intubation, stroke, procedure associated with OR surgery ($n=11$) or because VS scores were not recorded ($n=25$). 114 patients were not anti-coagulated at insertion and 136 were anti-coagulated at removal. Average filter dwell time was 124 days.

Average VS at insertion was 1.12 (range 0-22) and 0.31 at removal (range 0-13), statistically significant ($p=0.005$). 157 patients had no change in VS (77.3%), 39 had decreases (19.2%), and 7 had increases (3.4%). Among patients whose VS increased, the average increase was 2.6 points. Among patients whose score decreased, the average drop was 4.7 points.

Significant filter thrombus was noted in 8 patients, needing continued anti-coagulation to later retrieval. Of these, DVT was present at insertion in 4 patients. None of these patients demonstrated increase in the VS.

Conclusion: Temporary placement of IVC filters was not associated with an increase Villalta PTS severity score in this study.

P-920

Percutaneous upper extremity access for malignant SVCS stenting

N.V. Matthaïou, N. Galanakis, E. Kehagias, N. Kholcheva, D.K. Tsetis
Unit of Angiography and Interventional Radiology, University Hospital of Heraklion, Iraklion, GR

Purpose: Superior vena cava syndrome (SVCS) is the result of blood flow impairment through the superior vena cava. It is a medical emergency which requires immediate diagnostic evaluation and treatment. The purpose of this study is to evaluate the technical success and clinical outcome of SVC stenting in malignant SVCS through the upper limb and to correlate the efficacy of different types of nitinol stents used.

Material and methods: Between July 2006 and July 2018, 156 patients (132 male) with a median age of 62 (range 33-81) were treated with self-expanding nitinol stents. The main causes of malignant SVCS were bronchogenic carcinoma, metastases and lymphoma. The diagnosis of SVCS was based on clinical symptoms/signs and imaging studies. Patients were followed-up for a mean duration of 8 months.

Results: Technical success achieved in 98% of cases. There were 2 cases of migration to the right atrium and pulmonary artery and 1 case of death due to SVC rupture. Upper limb vein puncture was performed successfully without complications in all cases. The follow-up showed an overall survival of 92%, 56% and 22.8% and an overall primary patency of 93.4%,

83.6% and 79.9% at 1 month, 6 months and 1 year respectively. There were no statistically significant differences in primary patency between venous dedicated and peripheral use stents ($p>0.05$).

Conclusion: Stent placement through the upper limb seems to be a safe effective and quick treatment option for patients suffering from malignant SVCS with no significant difference between venous dedicated and peripheral use nitinol stents.

P-921

Is it safe to anticoagulate during IVC filter retrieval?

R.H. Kassamali¹, K. Burlak², H. Kavnoudias², G.S. Goh³, G. Harisis³, G. Aberdein³, J. Lee³, W. Clements⁴

¹Department of Radiology, University Hospitals Birmingham, Heartlands Hospital, Birmingham, UK, ²Imaging, Alfred Health, Melbourne, VIC, AU,

³Radiology, The Alfred Hospital, Melbourne, VIC, AU, ⁴Radiology and Nuclear Medicine, Alfred Health, Prahran, VIC, AU

Purpose: To assess the safety of IVC filter retrieval in anticoagulated patients, compared to a non-anticoagulated cohort.

Material and methods: A retrospective analysis of patients who underwent IVC filter retrieval between 2012 and 2018 was carried out using the RIS, PACS and EPR. Information about patient demographics, anticoagulation, tilt, major and minor complications were collected. Major complications were defined as: IVC intussusception, IVC injury without haemorrhage, IVC injury with haemorrhage, retained filter fragment, filter fracture and filter embolisation. Minor complications were defined as: neck haematoma and puncture site infection. A total of 357 patients (age 18-95, Male: 231, Female: 126) underwent IVC filter retrieval. Of these 182 patients were anticoagulated and 175 patients were not anticoagulated.

Results: Successful IVC filter retrieval in all 349 patients. 5 major complications (1.4% of retrievals) and no minor complications (0% of retrievals) recorded. In the anticoagulation cohort there were 2 major complications (1.1% of retrievals) both related to bleeding (IVC injury with haemorrhage x 2). Both patients were therapeutically anticoagulated. In the non-anticoagulated cohort there were 3 major complications (1.7% of retrievals) all unrelated to bleeding (1 x filter embolisation, 1 x IVC injury without haemorrhage, 1 x filter fracture).

Conclusion: IVC filter retrieval is a safe procedure with major complication rates of 1-2%. Being anticoagulated does not increase the risk of a major complication. IVC filter retrieval is safe to perform in patients currently taking prophylactic or therapeutic anticoagulation. In known challenging retrievals requiring advanced techniques anticoagulation should be ceased prior to retrieval.

P-922

Proposal of a venographic classification for the left common iliac vein compression in acute/subacute lower extremity deep vein thrombus

N. Dincer¹, S. Yilmaz¹, M.S. Aygün², S. Deniz², L. Oguzkurt²

¹School of Medicine, Koç University, Istanbul, TR, ²Radiology Department, Koç University Hospital, Istanbul, TR

Purpose: May Thurner syndrome is a definition of anatomic dissection study. There is no venographic classification of the compression. The aim of this study is to describe a venographic classification of iliac vein compression which could help decision for stent placement in patients with acute deep vein thrombosis (DVT).

Material and methods: A total of 147 consecutive patients who had lower extremity acute/subacute iliofemoral DVT and were treated with endovascular methods were evaluated. After thrombectomy / catheter-directed thrombolysis, detailed venography findings of the left common iliac vein were evaluated. Severity of the compression was classified as: Grade 1: No compression, Grade 2: Mild compression, Grade 3: Severe compression with intimal changes, Grade 4: Occlusion secondary to chronic compression.

Results: Ninety six of the patients (65%) had left-sided DVT. Seventeen patients (17.7%) had grade 1, 19 (19.8%) had grade 2, 36 (37.5%) had grade 3, and 22 (22.9%) had grade 4 compression. Patients with severe compression (group 4) had lower mean and median ages than the other groups. The number of patients in Group 3 was significantly higher than other groups. None of the patients with no or mild compression had stent placement, whereas all patients with grade 4 compression had stent placement.

Conclusion: A venographic classification for iliac vein compression in patients with DVT is important. Severity of the compression differs in different May Thurner syndrome patients. Age distribution shows a clustering in severe compression group (grade 3 compression). Mild compression may not need stent placement.

P-923

Early experience of the Cook Celect Platinum inferior vena cava filter in the United Kingdom

I. Wilson¹, G.J. Robinson², J. McCann-Brown³, S. Sherman³, R.G. McWilliams⁴

¹Department of Radiology, University Hospital Southampton NHS Trust, Southampton, UK, ²Dept of Radiology, Hull Royal Infirmary, Hull, UK,

³Scientific Research, Cook Research Incorporated, West Lafayette, IN, US,

⁴Radiology, Royal Liverpool University Hospital, Liverpool, UK

Purpose: To describe early experience in the United Kingdom (UK) with the Celect Platinum inferior vena cava (IVC) filter (Cook Medical), an iterative design improvement intended to aid visibility, thereby aiding filter assessment on imaging.

Material and methods: This retrospective data collection was conducted across three institutions in the UK between January 2013 and November 2015. Data gathered included patient demographics, indications for filter placement, insertion and retrieval characteristics and outcomes, filter-related events, and morbidity.

Results: During the study period 110 filters were placed in 110 patients for both therapeutic and prophylactic indications. No recurrent pulmonary embolus (PE) or new deep vein thrombosis (DVT) were experienced while the filter was indwelling. No filter fracture, embolization, or IVC thrombosis were observed. One filter migration (12 mm) and 7 filter perforations (affecting the IVC or paracaval fat) were observed on imaging but none of these were associated with clinical sequelae. Filter retrieval was attempted in 80% of patients designated as requiring temporary IVC filtration (80/100), of which 7 were unsuccessful. The mean duration of filter placement prior to retrieval was 51 days (min-max; 1-330 days). There were no access site complications at placement or retrieval. Overall, the filter retrieval success rate was 91%.

Conclusion: This early post-market experience under routine clinical care in the UK shows safe and effective filter usage with an overall high rate of successful retrieval.

P-924

Relation of segmental distribution of the great saphenous vein insufficiency to symptoms of varicose veins

N. Dincer¹, S. Yilmaz¹, S. Deniz², L. Oguzkurt²

¹School of Medicine, Koç University, Istanbul, TR, ²Radiology Department, Koç University Hospital, Istanbul, TR

Purpose: To relate the presence and severity of commonly observed signs and symptoms in great saphenous vein (GSV) insufficiency to segmental distribution of the insufficiency.

Material and methods: A total of 212 limbs from 170 patients with GSV insufficiency diagnosed with color Doppler ultrasonography were evaluated. Reflux pattern of venous insufficiencies were classified into 5 types as: Type 1, GSV reflux under the knee without malleolar involvement; type 2, reflux under the knee with malleolar involvement; type 3, reflux above the knee without saphenofemoral junction (SFJ) involvement; type 4, reflux above knee involving the SFJ; and type 5, diffuse reflux involving

both the SFJ and the malleolar region. Symptoms of GSV insufficiency and clinical scorings (CEAP classification and venous clinical severity scores) were evaluated and compared with respect to the segmental distribution of the GSV.

Results: Of the patients, 33 patients had type 1; 23 had type 2; 24 had type 3 and 131 had type 4 and 63 had type 5. The most common symptom was pain (62.7%). Swelling, feeling of tiredness and night cramps followed pain as common symptoms (60%, 51.2%, and 51.2%, respectively). The reason that lead them to seek medical help were pain (33.3%), cosmetic concerns (31.9%), prevention of progression (17.4%), night cramps (5.8%), and others (11.6%).

Conclusion: The most common segmental distribution was type 4. The main symptom of patients with venous insufficiency was pain, followed by swelling, feeling of tiredness and night cramps. The main reasons to seek medical help were found to be cosmetic purposes and pain.

P-925

Perfused Thiel embalmed human cadaver structural heart model – venous model for preclinical device testing and simulation training

H. Donald-Simpson¹, R. Duncan², J.G. Houston³

¹Image Guided Therapy Research Facility, University of Dundee, Dundee, UK, ²School of Medicine, University of Dundee, Dundee, UK, ³Clinical Radiology, Ninewells Hospital, Dundee, UK

Purpose: The purpose of this research was to develop an In vivo structural human heart model with extracorporeal perfusion for preclinical medical device testing and simulation training using Thiel embalmed human cadavers.

Material and methods: The Anterior chest wall of 15 Thiel embalmed human cadavers was removed surgically to expose the thorax. Lungs were wrapped and bound (to restrict flow during perfusion of the model). The pericardium was opened by longitudinal incision of 10 cm to expose the great vessels. The pulmonary artery was dissected and a transverse incision of 2 cm made proximal to the pulmonary valve and secured with a cable tie. A 24Fr shortened sheath of 5 cm length (Dry seal, Gore) was inserted into the incision and passed over the pulmonary valve. The right jugular vein is accessed using Seldinger technique and an 18 Fr port (Checkflo, Cook) is located. An Extracorporeal perfusion circuit with continuous or pulsatile flow of up to 1 Litre per minute is delivered via any one of the three ports prepared. Image guided interventions are conducted from the femoral or jugular vein port. Further endoscopic views are achieved by accessing one of the ports with an endoscope (Storz).

Results: Prototype preclinical devices for tricuspid valve replacement have been evaluated in 2 cadaveric models. 13 cadaveric models demonstrated training applications in ventricular pacemaker insertion under fluoroscopic guidance. All interventions utilized the unique endoscopic view to capture the procedure.

Conclusion: Thiel embalmed human cadavers provide a robust and versatile model for simulation training and preclinical device testing.

P-926

Prevalence of May-Thurner syndrome in patients with iliofemoral deep venous thrombosis at a large medical referral center

T. Heller

Diagnostik & Interventional Radiology, University Medicine of Rostock, Rostock, DE

Purpose: We set out to investigate the prevalence of May-Thurner syndrome (MTS) in a cohort of patients diagnosed with iliofemoral deep venous thrombosis at a large medical referral center.

Material and methods: We retrospectively analyzed a cohort of 496 patients who were referred to the emergency unit of a large medical referral center with suspected VTE and were diagnosed with deep venous thrombosis of the iliac veins and/or the thigh on ultrasound. We

retrospectively assessed the presence of MTS in the primary ultrasound examination and on additional imaging (available in n=193 patients).

Results: Across all 496 patients with iliofemoral deep vein thrombosis, median age was 70 years. 238 patients (48%) were female. The thrombosis was left-sided in 263 cases (53%), right-sided in 208 cases (42%) and bilateral in 24 cases (5%). In the subgroup of patients with left-sided and bilateral thrombosis, the growth pattern was classified as ascending in 142 patients (50%), descending in 104 patients (36%) and unclear in 41 patients (14%). Additional imaging tests were available in 193 patients: 119 patients (41%) underwent CT, 18 patients (6%) MRI and 30 patients (10%) a phlebography. Within the subgroup of patients with left-sided and bilateral thrombosis MTS was confirmed in 88 patients (31%), imaging findings in 17 patients (6%) were highly suspicious of MTS. In 86 patients (30%) a differentiation was not possible and in 96 patients (33%) MTS was excluded.

Conclusion: Underlying MTS is not uncommon in the selected cohort of patients with DVT at a large referral center and should be excluded by imaging.

P-927

Retrospective analysis of the efficacy and safety of interventional techniques in the treatment of severe, acute pulmonary embolism

T. Heller

Diagnostik & Interventional Radiology, University Medicine of Rostock, Rostock, DE

Purpose: Retrospective analysis of the efficacy and safety of interventional techniques in the treatment of severe, acute pulmonary embolism

Material and methods: Some single case reports and single center studies figured out the role of endovascular approaches in the treatment of severe acute pulmonary embolism (PAE). Randomised clinical trials are missing. In our retrospective single center study we investigated the efficacy, safety and the clinical outcome of different minimal invasive endovascular procedures. Between 1998 and 2015 90 patients (pts) with CT- and clinically-proven severe central PAE were treated with local catheter directed thrombolysis, aspiration thrombectomy in combination with local thrombolysis, mechanical thrombus fragmentation with dormia-basket or pigtail-catheter also in combination with local thrombolysis and ultrasound enhanced pharmacomechanical thrombolysis (EKOS) or rotational thrombectomy (ClotBuster, AspirexS). Depending on the method used controls were performed clinically, with cardiac ultrasound or by angiography.

Results: In the last years newer IR-techniques were used more frequently. Independent of the method used 4 pts were not successfully treated. Two nonlethal parenchymal bleedings occurred as a major complication. 4 pts suffers from a puncture side-bleeding as a minor complication. Two pts died during the intervention due to severe, cardiopulmonary resuscitation-resistant right heart failure. In all of the other pts the symptoms of the PAE disappeared. In 43 pts the recanalization was incomplete.

Conclusion: In the treatment of severe PAE interventional methods are a safe and effective alternative compared to the systemic thrombolysis.

P-928

The epidemiology of inferior vena cava filter use: indications for placement and their relationship with insertion complications, length of stay and retrieval rate: a single center retrospective review

A.M. Cahalane¹, D. Daye¹, V.F. Furtado², L. Pletsch-Borba³, M. Chittle¹, G. Oliveira¹, T.G. Walker⁴, Z. Irani⁵, G.M. Salazar⁶

¹Radiology, Massachusetts General Hospital, Boston, MA, US,

²Department of Internal Medicine, University of Massachusetts,

Worcester, MA, US, ³German Cancer Research Center (DKFZ),

Heidelberg, DE, ⁴Vascular Interventional Radiology, Massachusetts

General Hospital, Boston, MA, US, ⁵Radiology, Division of Interventional

Radiology, Massachusetts General Hospital, Boston, MA, US, ⁶Vascular

Imaging and Intervention, Massachusetts General Hospital, Boston, MA, US

Purpose: Inferior vena cava filters (IVCFs) have increasingly been incorporated into treatment algorithms for venous thromboembolism management, leading to their increased use. In tandem with this, literature has emerged demonstrating the complications of IVCFs left in place permanently or for unnecessarily long periods.

This study aims to categorize IVCF placement indications by both SIR and ACR criteria and identify their relationship with complication rate, IVCF length of stay and retrieval rate.

Material and methods: This study was a single center retrospective review of a prospectively maintained database of IVCFs placed by Interventional Radiology in the authors' institution between 2011 and 2016. Patients' electronic medical records were reviewed to identify demographics, IVCF insertion indication by SIR and ACR appropriateness criteria guidelines, complication rate, filter dwell times, length of stay and retrieval rates.

Results: 494 IVCFs placed by IR at our institution had an overall retrieval rate of 45.1%. For those IVCFs that were retrieved, the average dwell time was 215.8 days (Std Dev: 180.3 days). Filter status at the time of data review (active, retrieved, permanent etc.) was significantly influenced by ACR Appropriateness criteria at the time of insertion ($P < 0.05$). Age ($P < 0.0001$) and an underlying diagnosis of malignancy ($P < 0.05$) are associated with a statistically significant lower IVCF retrieval rate. The use of a Gunther Tulip IVCF is associated with a significantly higher retrieval rate ($P < 0.05$).

Conclusion: Long term IVCF status is significantly associated with ACR Appropriateness Criteria. This should be factored into patient follow up to optimize retrieval rates and minimize complications of unnecessarily long IVCF placement.

P-929

Combined IR and cardiology pulmonary vein stenting for stenosis following catheter ablation procedure - case series and literature review

R.A. Rippel¹, G.C. Makris², A.K. Allouni³, R. Uberoi¹

¹Radiology, John Radcliffe Hospital, Oxford, UK, ²Interventional

Radiology, Oxford University Hospitals, Oxford, UK, ³Radiology, Oxford

University Hospitals, Oxford, UK

Learning objectives: This study demonstrates current state of art in treatment of pulmonary vein stenosis secondary to ablation procedures and suggests new areas of development into the future.

Background: This is a retrospective single centre experience of pulmonary vein stenting to look at the outcomes of a combined IR and cardiology procedure to deal with post ablation pulmonary stenosis.

Clinical Findings/Procedure Details: Retrospective review of all cases requiring treatment for pulmonary vein stenosis post ablation at a single institution over a 8 year period. A systematic review of the literature was also undertaken to review the incidence, treatment options and outcomes. This case series and systematic literature review showed that pulmonary vein stenting for post ablation stenosis is a relatively infrequent, however,

effective treatment option. This paper summarises a single centre experience (n=5) of pulmonary vein stenting. In addition systematic review identified 11 papers summarising up to date knowledge about the disease and treatment option. Use of bare metal stents of diameter over 10 mm appears to lead to improved long term patency rates. Low number of cases and large variability of methods used is a major obstacle in acquiring good quality data on best treatment options.

Conclusion: Pulmonary stenosis is a serious complication post ablation procedures. It can be successfully treated by utilising the combined interventional radiology and cardiology skills.

P-930

Chylous reflux syndrome: role of the radiologist from diagnosis to treatment

M. Yamamoto, H. Kondo, S. Toshimasa, R. Zako, A. Suzuki, E. Hoshino, J. Toda, H. Oba
Radiology, Teikyo University School of Medicine, Tokyo, JP

Learning objectives:

1. To summarize normal lymphatic pathway and lymphatic pathway of CRS patients
2. To summarize the physiological mechanism of lymphogenesis and transport in CRS patients
3. To learn about the lymphatic pathways of CRS
4. To discuss treatment for various symptoms of CRS

Background: Primary chylous reflux syndrome is rare. Rupture of dilated lymphatic vessels may result in chylous ascites, chylothorax, or leakage of chyle through chylocutaneous fistulas in the lower limbs or genitalia. However, the cause of lymph duct dilatation is unknown. Chyle may reflux through incompetent lymphatics, causing lymphedema. Although surgical options for CRS have been mainly focused on thus far, here we will explain lymphatic embolization for CRS.

Clinical Findings/Procedure Details: Brief description of lymphatic pathway related to CRS

Summary of technique of ILE

(i) Puncture inguinal lymph nodes under ultrasound guidance; (ii) Inject contrast medium via the puncture needles to pinpoint leakage site; (iii) If the leak is located higher than the cisterna chyli, insert the catheter into the thoracic duct and then embolize the leak. If the leak is lower than the cisterna chyli, embolize the lumbar lymphatic trunk.

Summary of technical implications of CRS

In addition to embolization of the leak point, it is necessary to embolize the superior lymph duct to prevent back flow.

Presentation of cases experienced by us

Conclusion: We illustrate a novel treatment method for CRS. TDE or INE is useful as a treatment for CRS and is also useful to explore the etiological mechanism.

P-931

Bleeding ectopic varices: Understanding the challenge! An IR perspective

Y. Al-Radhi¹, R. Lakshminarayan¹, V. Shrivastava²

¹Radiology Department, Hull Royal Infirmary, Hull, UK, ²Interventional Radiology, Hull Royal Infirmary, Hull, UK

Learning objectives: The aim of this poster is to describe ectopic varices and discuss the strategy for treatment by interventional radiology techniques.

Background: Varices are common complications of liver cirrhosis and portal hypertension which are usually found in the esophagogastric region. Ectopic varices are dilated veins and or dilated portosystemic venous collaterals which occur in the abdomen and pelvis, other than the esophagogastric region. Ectopic varices represent 2-5% of varices secondary to portal hypertension and their aetiology is poorly understood. The risk of bleeding from ectopic varices is four-fold when compared with

esophagogastric varices and tend to be massive and life threatening with a mortality of around 40%. This is complicated by the difficulty in diagnosing and treating them unlike the management of esophagogastric varices which is well established.

Clinical Findings/Procedure Details: Two cases, parastomal varices and scrotal varices secondary to portal hypertension which were managed successfully by vascular interventional radiology are presented. The various procedural options available in interventional radiology to treat ectopic varices based on aetiology, symptoms, clinical status and imaging appearance are discussed.

Conclusion: Interventional radiology offers various techniques to treat ectopic varices with high success rates, good long term outcome and less morbidity when compared with corresponding surgical interventions.

P-932

Portal vein stenting to treat benign portal vein stenosis due to inflammation after surgery

K. Chosa, Y. Baba, W. Fukumoto, H. Mitani, K. Awai
Radiology, Hiroshima University Hospital, Hiroshima, JP

Learning objectives: The aim of this study is to assess the safety and effectiveness of portal vein stenting for postoperative inflammatory stenosis.

Background: Portal vein stent placement is a minimally invasive procedure that has been shown to benefit patients who suffered from symptomatic portal vein stenosis or obstruction due to postoperative hepato-pancreato-biliary inflammation. We evaluated the safety and effectiveness of portal vein stenting in patients with postoperative inflammatory stenosis.

Clinical Findings/Procedure Details: We reviewed 10 patients with symptomatic portal vein stenosis due to postoperative hepato-pancreato-biliary inflammation. All had undergone portal vein stent placement at our institution between September 2004 and November 2018. Their median age was 59.3 years (range 33 - 75 years), 8 were women. Total portal vein occlusion was observed in 8-, portal vein stenosis in 2 patients. The median stenotic length was 3.5 cm (range 2 - 8.5 cm). The initial puncture was via the percutaneous transhepatic approach in all patients; 4 patients required the ileocolic vein approach via additional laparotomy of the abdomen. The procedures were successful in all patients and resulted in good portal blood restoration. However, stent occlusion occurred in 2 patients 66 and 120 days later; they had not received postoperative anticoagulation or antiplatelet therapy. Post-treatment, the physical symptoms improved in 7 patients; 3 patients was lost to follow-up. There were no procedure-related complications.

Conclusion: Portal vein stenting in patients with postoperative stenosis or obstruction due to benign inflammatory mechanisms is relatively safe and effective. When the percutaneous transhepatic approach fails, the ileocolic vein approach might be useful.

P-933

May Thurner syndrome in patients with patent foramen ovale and cryptogenic stroke

C. Teichert¹, T. Heller², M.-A. Weber¹

¹Interventional Radiology, University Medicine of Rostock, Rostock, DE, ²Diagnostik & Interventional Radiology, University Medicine of Rostock, Rostock, DE

Learning objectives: We aimed to investigate the incidence of Patent Foramen Ovale (PFO) and Cryptogenic Stroke (CS) patients with a May-Thurner syndrome (MTS) features on MRV, CT or duplex ultrasound (DUS).

Background: This was a retrospective study. All consecutive patients with MTS features on MRV, CT or duplex ultrasound (DUS) from January 1 st 2013 until March 31 st 2018 at our institute were included in this study.

Clinical Findings/Procedure Details: 109 patients (age 21 - 91 y, mean age 69, range) from January 1 st 2013 until March 31 st 2018 with a MTS enrolled. These patients were predominantly female (60 p, 55%). In

25 patients (total 23%, 11 male, 14 female, mean age 64, range: 37-91 years) a cryptogenic stroke was identified with MRI or CT imaging. Transesophageal echocardiography was performed in 48 % of patients (12 p). PFO was noted in 44% of patients (11 p), demonstrated right to left shunting on transesophageal echocardiography. 5 patients (20%) died before the enquiry, 8 patients (32%) did not wanted a transesophageal echocardiography).

Conclusion: In our study 44% (11 of 25; 5 patients died before the enquiry; 8 patients did not wanted a transesophageal echocardiography) with MTS features on MRV, CT or duplex ultrasound (DUS) had a PFO-related cryptogenic stroke. MTS patients with a PFO is a high risk-stroke population. Yet, there are no published guidelines for the assessment of pelvic veins as part of the stroke workup. Further more prospective studies are needed to define in greater detail the association of MTS with PFO-related cryptogenic stroke.

P-934

Imaging and treatment in nutcracker phenomenon and syndrome

F. Libra¹, I. Vizzini¹, C. Desiderio¹, D. Meo¹, A. Modica¹, M.C. Calcagno¹, E.F. Santonocito¹, S. Seminatore¹, D. Falsaperla¹, D.G. Castiglione², P.M. Coppolino¹, A. Musumeci¹, S. Palmucci¹, A. Basile¹

¹Radiology Unit I - Department of Medical and Surgical Sciences and Advanced Technologies - University of Catania, Azienda Ospedaliero Universitaria Policlinico Vittorio Emanuele, Catania, IT, ²Di.Bi.Bi.Med., AUOP P. Giaccone, Palermo, IT

Learning objectives: To differentiate the "Nutcracker phenomenon" (NCP) from the "Nutcracker syndrome" (NCS) and describe the different types, the main clinical-radiological characteristics and the therapeutic strategies of the syndrome through some cases taken from our archive.

Background: The NCP is defined as an anatomical condition characterized by extrinsic vascular compression of the left renal vein (LRV) with a consequent obstacle to venous outflow in the inferior vena cava (IVC). The definition of NCS is to be reserved in cases where there are typical associated symptoms.

Clinical Findings/Procedure Details: The most common type of NCS is the compression of LRV between the aorta and superior mesenteric artery (SMA), known as "anterior nutcracker". The presence of retro-aortic or circum-aortic renal vein compressed between the aorta and vertebral body is known like "posterior nutcracker".

Symptoms vary depending on the stage of renal venous hypertension from flank pain and haematuria in the early stages to pelvic varicocele and pelvic congestion syndrome in the late stages.

Diagnosis is made by Doppler ultrasound (DUS), CT, MRI and retrograde venography, which represents the gold standard.

Treatment in symptomatic patients may be surgical or endovascular by LRV stenting.

Conclusion: Nutcracker syndrome is a condition whose symptoms vary depending on the stage and whose characteristics are not specific, overlapping with many other clinical entities, which is why the diagnosis may be difficult and commonly delayed. Hematuria, pelvic pain, and varicocele should lead to suspicion of this syndrome for correct diagnostic-therapeutic management.

P-935

A systematic review of evidence in management of deep venous thrombosis

E. Mastrolonardo¹, A. Chang², K. Kansagra³, J.B. Jia³, G. Vatakencherry⁴

¹Sidney Kimmel Medical College, Thomas Jefferson University, Philadelphia, PA, US, ²Keck School of Medicine, University of Southern California, Los Angeles, CA, US, ³Interventional Radiology, Kaiser Permanente Los Angeles Medical Center, Los Angeles, CA, US, ⁴Vascular and Interventional Radiology, Kaiser Permanente Los Angeles Medical Center, Los Angeles, CA, US

Learning objectives:

1. Understand the optimal treatment algorithm for treatment of deep vein thrombosis (DVT)
2. Compare the efficacy of traditional anticoagulation therapies with direct oral anticoagulants (DOACs)
3. Review endovascular therapies for DVT
4. Comprehensively review current randomized control trials comparing anticoagulant therapies for DVT

Background: In the United States, DVT affects up to 900,000 people annually and results in up to 100,000 deaths annually secondary to pulmonary embolisms. Therefore, it is essential for interventional radiologists to have a comprehensive understanding of DVT patient care.

Clinical Findings/Procedure Details: This exhibit provides a timeline of the major randomized controlled trials on DVT over the past 15 years and a treatment algorithm based on the trials. Based on current literature, DOACs should be used for initial DVT therapy compared with LMWH and warfarin due to non-inferior clinical efficacy with reduced rates of major bleeding events. Post-VTE treatment, rivaroxaban demonstrated superiority to aspirin without increasing bleeding risk, though apixaban and aspirin are still reasonable alternatives. For cancer patients, current recommendation is treatment with LMWH over warfarin; of note, tinzaparin demonstrated decreased non-major bleeding events compared to warfarin. The treatment algorithm provides further detail for unique situations such as superficial venous thrombosis, patients with atrial fibrillation, post-thrombotic syndrome, and IVC filters.

Conclusion: DVT is a common patient problem faced by vascular interventional radiologists. As a result, it is important to understand not only the various treatment options available, but also which options maximize survival outcomes, reduce DVT recurrence, minimize bleeding risk, and optimize quality of life for patients with DVT.

P-936

Endovascular ilioacaval reconstruction: advanced recanalization techniques and stent constructs

I. Theodoulou¹, P. Saha², S. Black², N. Karunanithy³, N. Thulasidasan³

¹School of Medicine, Kings College London, London, UK, ²Vascular Surgery, Guys and St Thomas' Hospital, London, UK, ³Interventional Radiology, Guy's and St. Thomas' Hospital, London, UK

Learning objectives:

1. Recognise common patterns of occlusion in ilioacaval obstructive venous disease.
2. Understand the range of techniques for crossing chronic venous occlusions.
3. Use IVUS imaging to plan appropriate stent constructs for reconstruction.

Background: Endovascular ilioacaval reconstruction is an emerging technique for treating post-thrombotic syndrome or chronic venous insufficiency secondary to ilioacaval venous occlusion. As imaging and stent technology has evolved, more extensive disease can now be successfully treated. Advanced crossing techniques, intravascular ultrasound for stent planning, and novel stent technologies are required to achieve durable clinical outcomes.

Clinical Findings/Procedure Details: Occluded post-thrombotic veins recanalize via microchannels through chronic thrombus, rendering catheter and wire crossing of these segments challenging. Standard catheter and hydrophilic wire combinations are frequently not sufficient to achieve crossing and in these cases more aggressive techniques are required. Sharp recanalisation with the back end of guidewires and multiplanar imaging, the use of re-entry devices in combination with target balloons and the employment of trans-septal needles are techniques that can be employed to achieve recanalization. After crossing, intravascular ultrasound is essential to map venous anatomy and plan a stent construct that will connect two healthy segments of vein. Novel stents are now available with biomechanical properties suitable for various locations within the retroperitoneum and iliacs.

Conclusion: Endovascular ilio caval reconstruction for occluded post-thrombotic veins frequently requires advanced crossing techniques. After successful crossing, intravascular ultrasound for planning and use of novel venous stents increases the extent of disease that can be treated, leading to durable clinical outcomes and symptom improvement.

P-937

IVC filters: when, why and how?

S. Rostampour¹, N.R. Patel², B. Pitrola³, E. Kashef⁴

¹Interventional Radiology, Imperial College NHS Trust, London, UK,

²Radiology, Imperial College Healthcare NHS Trust, London, UK,

³Interventional Radiology, Imperial College Healthcare NHS Trust, London, UK, ⁴Radiology, Imperial College NHS Trust, London, UK

Learning objectives:

1. Revise the indications for insertion and removal of IVC filters – When and Why?
2. Discuss methods for IVC filter removal, including the more complex cases

Background: IVC Filters have been a commonly used tool in the prevention of pulmonary embolism in cases of deep venous thrombosis. They are now increasingly used as a short-term preventative treatment in trauma patients who are at high risk of developing venous thromboembolic disease but in whom anticoagulation is contraindicated eg. Traumatic brain injury, complex pelvic fractures.

The ease of insertion and readily available nature of IVC filter insertions has resulted a significant increase in requests for these procedures.

Clinical Findings/Procedure Details: In this exhibit, we will review and summarize the recent literature for IVC filter use in trauma and demonstrate a trauma-focused pathway for IVC filter insertion and removal.

We will:

- a) Share our local experience and guidelines on who should receive IVC filters
- b) Discuss pre-removal imaging and procedure planning
- c) Share tips and tricks from our own challenging removal cases including the management of complications arising from the procedure

Conclusion: This educational poster will demonstrate an overview of the current evidence for IVC filter use in trauma highlighting procedural tips and tricks for removal.

P-938

There is no “I” in team; but there is in IVC and IR: a multidisciplinary, multimodality approach to IVC filter retrieval

J. Do¹, K. Kansagra², G. Vatakencherry³, A. Keny⁴, A. Rudikoff⁴, A. Hernandez Conte⁴

¹Radiology, Sidney Kimmel Medical College, Philadelphia, PA, US,

²Interventional Radiology, Kaiser Permanente LAMC, Los Angeles, CA, US,

³Vascular and Interventional Radiology, Kaiser Permanente Los Angeles Medical Center, Los Angeles, CA, US, ⁴Anesthesiology, Kaiser Permanente LAMC, Los Angeles, CA, US

Clinical History/Pre-treatment Imaging: A 28 year-old woman presented with a chief complaint of severe chest pain with a past medical history remarkable for a Bard G2 Express filter placed in 2010 due to a history of deep vein thromboses. CT showed caval perforation with an embolized strut in a branch of a right middle lobar artery and another in the right ventricle.

Treatment Options/Results: The patient was taken to the IR suite with cardiothoracic surgical back up available prior to any attempt of retrieval. The IVC filter and the fragment in the pulmonary artery were removed with the loop-snare technique fluoroscopically. However, retrieval of the RV fragment was unsuccessful initially using fluoroscopy due to difficulty of visualization. Ultimately, successful retrieval occurred with cardiac anesthesiology support via transesophageal echo (TEE) guidance using a Gooseneck snare through a Wiseguide catheter. Post procedure, the patient had resolution of her chest pain.

Discussion: IVC filters are controversial due to their associated complications and questionable efficacy. Given poor visualization of the thin IVC filter tine in the RV on fluoroscopy, TEE guidance allowed successful retrieval using the snare loop technique. Our case demonstrates how complex IVC filter retrivals may require a multidisciplinary and multimodality approach.

Take-home points: A feared complication of IVC filter placement is filter fracture with fragment embolization.

An embolized fragment in the RV can be potentially life threatening. Due to the small size of fragments, visualization may be difficult on fluoroscopy.

IRs can consider TEE and a multidisciplinary, coordinated approach to successfully and safely retrieve fragments within the heart.

P-939

Percutaneous recanalization of a segmental inferior vena cava occlusion using a Colapinto needle in a patient with situs viscerum inversus and symptomatic Budd-Chiari syndrome

R. Miraglia, L. Maruzzelli, A. Luca

Diagnostic and Therapeutic Services, Mediterranean Institute for Transplantation and Advanced Specialized Therapies (IsMeTT), Palermo, IT

Clinical History/Pre-treatment Imaging: 67 y/o female patient with abrupt onset of dyspnea and abdominal pain. Past medical history of primary biliary cholangitis and Systemic Lupus Erythematosus. Doppler US and contrast-enhanced CT showed situs viscerum inversus, hepatomegaly, ascites, patent hepatic veins (HV) and a suspected segmental inferior vena cava (IVC) occlusion.

Treatment Options/Results: A cavography confirmed the complete segmental occlusion of the IVC above the HV outflow with multiple collateral vessels draining in the azygos and emiazygos system. Cavo-atrial pressure gradient 16 mmHg. Percutaneous recanalization of the occlusion was performed advancing a Colapinto needle from left jugular approach with fluoroscopic and transabdominal US guidance to reduce the risk of bleeding. After progressive balloons dilatation a 14 mm diameter non-covered stent was deployed with good flow at the cavography. Final cavo-atrial pressure gradient 1 mmHg. The patient is in good clinical condition with patent stent at 6 months of follow-up.

Discussion: Budd-Chiari syndrome results from the hepatic venous outflow obstruction at any level, ranging from the hepatic veins to the junction of the IVC and the right atrium. Complete IVC occlusion is defined as membranous or segmental depending on the length of the involved segment; a stenosis or occlusion measuring less than or equal to 1 cm in length is classified as membranous, whereas a stenosis or occlusion measuring greater than 1 cm in length, as in our patient, is classified as segmental.

Take-home points: Percutaneous recanalization, using a Colapinto needle, can be a safe and effective alternative to surgery in patients with complete segmental IVC occlusion.

P-940

Traversing tough terrain: sharp recanalization of a chronically occluded SVC for port placement

J.J. Mahn¹, J.W. Albright¹, B. DuBois¹, R.W. Dougherty², N. Kafity¹, M.M. Shnayder³, J.J. Gemmete³

¹Department of Interventional Radiology, University of Michigan, Ann Arbor, MI, US, ²Department of Interventional Radiology, Michigan Medicine, Ann Arbor, MI, US, ³Vascular and Interventional Radiology, University of Michigan Health System, Ann Arbor, MI, US

Clinical History/Pre-treatment Imaging: This a 14 year-old male with a prior history of GBM s/p resection and chemotherapy, now diagnosed with lymphoma, requiring long term central access. Due to patient's history of prior chemotherapy and prolonged central line access during hospitalizations, chronic occlusion of the central veins was present, which led to failed surgical port placement. As such, IR was consulted for port placement.

Treatment Options/Results: Initial bilateral upper extremity venogram demonstrated extensive occlusion of the central veins with associated venous collateralization. Right femoral access was acquired to the level of the superior cavoatrial junction, where a amplatzer plug was placed to assist with targeting of BRK needle for sharp recanalization. Next, RIJ access was acquired and sharp recanalization into the SVC was performed with puncture of the amplatzer plug, followed by placement of a V18 wire which was captured within the amplatzer plug and pulled out of the groin for through and through access. Once access was acquired, extensive plasty and stenting of the SVC was performed, followed by successful port placement.

Discussion: Often times, interventionalists must think outside the box to successfully perform procedures which may be as simple as port access. In this case, advance recanalization techniques were necessary for port access.

Take-home points:

1. Simple procedures may sometimes require advanced techniques to be completed successfully.
2. IR frequently may offer options for treatment when surgical options have failed.

P-941

Endovascular treatment for spontaneous external iliac vein rupture caused by May-Thurner syndrome

Y. Koide, T. Okada, M.A.S. Hamada, K. Sasaki, T. Gentsu, R. Tani, E. Ueshima, K. Sofue, M. Yamaguchi, K. Sugimoto, T. Murakami
Department of Diagnostic and Interventional Radiology, Kobe University Hospital, Kobe, JP

Clinical History/Pre-treatment Imaging: A 66-year-old woman denied trauma history and sustained severe hypovolemic shock. Contrast enhanced CT showed a large retroperitoneal hematoma without active extravasation. From the emergency angiography, the left external iliac vein (EIV) rupture due to deep vein thrombosis (DVT) with obstruction of the left common iliac vein (CIV) and May-Thurner syndrome (MTS) were diagnosed.

Treatment Options/Results: Stentgraft placement was selected as the therapeutic option for iliac vein rupture, and two aortic stentgraft limbs were placed to seal the rupture site. However, type 1 endoleak (EL) from distal end occurred. Peri-graft glue embolization was performed, but EL remained, because the venous blood flow stagnated and EIV was expanded by the CIV thrombus. Finally, after an uncovered stent was placed across the thrombosed CIV to improve venous flow, EL disappeared and hemostasis was obtained.

Discussion: Spontaneous iliac vein rupture is a rare but life-threatening emergency. It is commonly seen in association with DVT and MTS. Stentgraft placement is a treatment option for iliac vein rupture. In case which iliac vein rupture is due to MTS, a stentgraft with a larger diameter is necessary to treat the tear of expanded vein. However, in this case, stentgrafts with a proper diameter were not stocked in our hospital and EL occurred. A combined stent in the CIV for the improvement of venous flow could lead to shrink the expanded vein and be helpful in obtaining hemostasis.

Take-home points:

1. DVT and MTS can cause iliac vein rupture.
2. Improvement of venous flow can contribute to hemostasis with stent-graft treatment.

P-942

The imPEnetrable PE - a challenging case

N. Anning¹, L. Villalba²

¹Dept of Vascular Surgery, The Wollongong Hospital, Bondi Junction, NSW, AU, ²Dept of Vascular Surgery, The Wollongong Hospital, Wollongong, NSW, AU

Clinical History/Pre-treatment Imaging: 53YO F presented with retrosternal chest pain and exertional dyspnoea. On examination, she normotensive (SBP 124, HR 90) with pan-systolic heart murmur. CTPA demonstrated a sub-occlusive filling defect in the bilateral main pulmonary arteries (PA) with extension into the pulmonary trunk (PT). TTE confirmed right heart strain - RV moderately, RV/LV ratio >1, PAP 91mmHg, bowing of IVS and IAS. Mild TR. Mild-moderate systolic dysfunction.

Treatment Options/Results: Angiojet catheter directed thrombolysis (CDT) was performed via using an Omni Catheter with power pulse of 7mLs of alteplase via pulse-spray and 4mLs bolus to peripheral pulmonary tree. Second setting CDT was performed to access left PA. TTE demonstrated improved free wall contractility and exercise tolerance. Formal anticoagulation was initiated. Worsening right heart failure recurred <2 weeks. CTPA confirms a persistent sub-occlusive thrombus in PT and bilateral PAs. MRI and PET proved inconclusive. Pulmonary endarterectomy was performed 8 weeks after initial presentation. Histology was consistent with undifferentiated intimal sarcoma.

Discussion: PA angiosarcoma is a rare entity (0.001-0.03%). Most PA sarcoma cases are initially treated as VTE. Failure to respond to anticoagulation / thrombolysis prompts further investigation.

Features favouring angiosarcoma include –

CTPA: uni-lateral filling defect, filling defect of entire vessel diameter, expansion beyond vessel wall, local / distant metastases;
MRI: heterogeneous enhancement.

PET: FDG uptake.

In this case, there were no clearly defined features of angiosarcoma prior to histological diagnosis.

Take-home points: CDT is increasingly utilised to treat massive and sub-massive PEs.

Angiosarcoma is a great mimic of chronic PE. This case highlights key features of pulmonary artery angiosarcoma.

P-943

Successful embolization of arteriovenous fistula secondary to IVC filter retrieval

C. DeSai, D. Lamus, G. Kumar

Interventional Radiology, UT Southwestern Medical Center, Dallas, TX, US

Clinical History/Pre-treatment Imaging: A 48-year-old woman presented for IVC filter (retrievable Option) removal. Advanced retrieval techniques, including endobronchial forceps, were employed. She was admitted with severe abdominal pain post-procedure. Subsequent CT angiography revealed arteriovenous fistula between the right renal artery and IVC (Figure 1). There was near-complete right renal infarction due to renal arterial thrombosis, with sparing of only the upper pole that was supplied by an accessory renal artery.

Treatment Options/Results: Urology service concluded that the kidney had a poor chance for meaningful recovery and suggested nephrectomy if conservative measures were not possible. With the patient's comorbidities, open surgery was not desirable. Initial attempts to use coils were not successful due to the defect size and pressure head in the renal artery. The fistula was successfully closed with a Type IV Amplatzer vascular plug (Figure 2). Follow-up CT angiogram showed no flow through the fistula.

Discussion: There are no previously recorded instances of renal artery-IVC fistula formation secondary to IVC filter placement or retrieval. This unusual complication had an increased potential to develop due to the filter hook position at the level of the right renal artery crossing the IVC. During filter retrieval, dissection of tissue around the hook (embedded in the IVC wall) likely created the channel/ fistula between the right renal artery and IVC.

Take-home points: Advanced filter retrieval techniques may increase the risk of complications.

Vascular plugs are an alternative embolization method when defects are too large for coils and open surgery is not desired.

P-944

Treating giant venous ulcers: ecstasy after agony - a success story

R. Basapure¹, S.S. Joshi¹, P. Khandelwal², A.S. Joshi¹, K. Kankani²

¹Vascular and Interventional Radiology, The Vein Center, Mumbai, Mumbai, IN, ²Anaesthesiology, The Vein Center, Mumbai, Mumbai, IN

Clinical History/Pre-treatment Imaging: A 34 years old, non-smoker salesman, came with c/o skin darkening & painful non-healing ulcers over both ankles since 5 years.

He was being treated at a tertiary hospital with everyday ulcer dressings & compression bandages. The ulcers constantly oozed, causing soaked dressings every single day. Nevertheless, there was no improvement in his ulcers nor any relief from the pain.

Venous Doppler revealed Bilateral SFJ & SPJ incompetence with dilated GSVs, SSVs, Anterior Accessory GSVs(AAGSV), Anterior Circumflex Vein(ACV) of the calf without deep venous thrombosis.

Treatment Options/Results: On the basis of Doppler, diagnosis of Varicose veins was made and bilateral lower limb EVLA was suggested. Bilateral GSVs, SSVs, AAGSV, ACV were ablated. Patient was given class-2 compression stockings. 2months follow-up showed good healing along the ulcer margins. Patient underwent autologous skin-graft to hasten the ulcer healing. 3months post graft status shows good graft uptake with excellent healing of ulcers.

Discussion: Varicose veins are one of the major reasons for non-healing ulcers of the legs. In most cases, diagnosis of the varicose veins is missed due to ignorance & lack of awareness about the disease.

The traditional treatment method includes ablation of GSV with/out SSV. This case report highlights the importance of identifying & treating the accessory channels which reduces the venous pressure on the ulcer and accelerates ulcer healing process.

Take-home points: Awareness about the presentation of Varicose veins helps in early diagnosis thus reducing the morbidity.

Treating accessory channels like AAGSV & ACV of the calf in addition to GSV & SSV is advantageous.

P-945

Filter fracture during removal and migration of strut in right pulmonary artery, managed endovascularly

A. Shrivastava¹, L.-M.N.J. Boucher², D.A. Valenti¹, A. Bessissow¹

¹Radiology, McGill University, Montreal, QC, CA, ²Radiology, McGill University Health Centre, Montreal, QC, CA

Clinical History/Pre-treatment Imaging: A patient presented to the Intervention radiology department for second attempt of IVC filter removal
Treatment Options/Results: Initial attempt at retrieval failed using standard technique and loop snare technique, because of filter tip being embedded into the IVC wall.

Endobronchial forceps were advanced through coaxially placed 12-F and 14F sheaths into the IVC via the right internal jugular vein. The forceps managed to dislodge the hook of the filter. The sheath was advanced over the forceps holding onto the hook of the filter. However, during this maneuver, a leg of the filter broke and embolized into the right pulmonary artery. The residual filter was removed. Using femoral access, we advance an APC catheter into the right pulmonary artery securing it in position with a 0.016 micro-wire placed in an upper right pulmonary artery branch. A guide-catheter and Snare were used to snare the embolized filter leg and retrieve it.

Follow up angiogram of the IVC and pulmonary artery demonstrates no thrombosis or other complication.

Discussion: Recently, more aggressive maneuvers to retrieve embedded IVC filters have been developed including the use of forceps. With these maneuvers comes the risk of increased complications such as filter fracture which may need further procedure to correct, including individual removal of loose fragments.

Take-home points: Unsuccessful IVC filter retrieval by conventional technique can be removed by forceps with caution. Visual inspection of the removed IVC filter is critical to reduce the chances of a missed fractured strut. Endovascular techniques can be successfully used to remove such fragments.

P-946

Unusual case of benign thrombotic central venous occlusion treated with combined catheter directed thrombolysis and mechanical thrombectomy, followed by SVC recanalization

J.D. Vasani¹, S. Venkat²

¹Interventional Radiology, University of Miami, Miami, FL, US, ²Vascular Interventional Radiology, University of Miami-Miller School of Medicine, Miami, FL, US

Clinical History/Pre-treatment Imaging: 45 y.o. male with history of CLL, and left upper extremity DVT (treated with warfarin) admitted to the hospital with presyncope. CT chest with contrast showed extensive superior vena cava thrombus around the indwelling right internal jugular port-a-catheter, along with thrombosis of the left-sided basilic, subclavian, internal jugular and brachiocephalic veins. Patient was immediately started on heparin drip and Interventional radiology team was consulted
Treatment Options/Results: Using left basilic vein access, the thrombotic occlusion in the left axillary and subclavian vein was crossed with a guidewire followed by placement of an EKOS catheter for thrombolysis. Next day, repeat venogram demonstrated significant improvement of the clot burden with persistent thrombosis of the left brachiocephalic vein and SVC. Using Zelante angiojet device under IVUS guidance, pharmacomechanical thrombectomy was performed resulting in complete patency of the brachiocephalic vein and proximal SVC however, distal SVC remained occluded.

On Postop day 4, blunt recanalization of SVC was performed via the existing right subclavian port followed by sequential venoplasty with

high-pressure balloon upto 18mm, resulting in near complete patency of the SVC.

Discussion: Venous thromboembolism, including deep vein thrombosis and pulmonary embolism, occur in up to 900,000 people per year in the US. Endovascular therapies, like catheter-directed thrombolysis, mechanical thrombectomy, and pharmacological catheter directed thrombolysis have developed to provide minimally invasive therapy, while minimizing complications. Depending on each case, these treatments can be performed individually or combined in a staged approach.

Take-home points: Our case highlights the importance of understanding the pathophysiology, presentation and available minimally invasive treatment options in management of chronic venous thromboembolism.

P-947

SVC recanalization for central venous access. Do I have to stent?

N.R. Patel, A. Alsafi

Imaging, Hammersmith Hospital - Imperial College Healthcare NHS Trust, London, UK

Clinical History/Pre-treatment Imaging: A 74-year-old man was referred for Hickman line insertion for supplemental parenteral nutrition. He had been on haemodialysis for four years via tunnelled central venous catheters (CVC), prior to receiving a renal transplant twelve years previously. A right internal jugular venous puncture was performed but venography demonstrated a right brachiocephalic vein and superior SVC occlusion secondary to previous CVCs.

Treatment Options/Results: The options were to attempt to recanalize the SVC or consider alternative access sites including femoral, hepatic or trans-lumbar venous access. These are associated with increased infection risk and morbidity respectively. SVC recanalization was therefore attempted. The SVC occlusion was traversed using a 5Fr catheter and hydrophilic wire, followed by balloon dilatation and insertion of a single-lumen Hickman line. The line remains patent at one year.

Discussion: The right IJV was patent with enough distance to the occlusion to allow recanalization. Balloon angioplasty created a temporary channel facilitating line insertion. No SVC stent was required as there were no SVCO symptoms due to well-developed collaterals. SVC stenting, particularly with self-expanding stents, poses a risk of stent migration during line insertion, if performed at the same sitting. Once SVC stents are occluded, these are often more difficult to recanalize compared with native SVC occlusion.

Take-home points: Recanalizing a chronically occluded SVC is a safe, often overlooked, method for inserting tunnelled central venous catheters. No stent is usually required, as only a temporary channel is needed to allow insertion of a tunnelled central venous catheter.

P-948

Kissing stent deployment to cover traumatic iliatic venous dissection with flow limitation

C.H. Jeon, C.W. Kim, H. Kwon

Radiology, Pusan National University Hospital, Busan, KR

Clinical History/Pre-treatment Imaging: A 60 year-old-male patient transfer to trauma center due to struck by agricultural machine. CT scan demonstrate hematoma around the iliac venous confluence level. Catheter-directed vena cavography under both common femoral and right internal jugular vein approach demonstrates markedly engorged both iliac vein, because there are flow-limiting dissection and luminal near obstruction at bilateral proximal common iliac vein, confluence level.

Treatment Options/Results: Kissing stents deployment was done to cover dissection from proximal CFV~IVC using 14mmX6cm, 14mmX8cm self-expandable open cell stents, respectively.

Additionally, balloon venoplasty was done for unfully expanded stents using two 10mmX4cm balloon catheters, simultaneously. Completion venography showed restored flow via kissing stents.

Discussion: Abdominal vein injury is rare, but it may causes high mortality rate, The most common site of abdominal vein injury is IVC, followed by portal vein, superior mesenteric vein, and renal vein.

An anatomical approach to venous injury is difficult. The surgical procedure is complicated and the success rate is not high.

There are currently no reliable guidelines for venous injuries. There is also little data available on the interventional approach to the traumatic venous injury, no comparative studies with surgical approaches, or long-term studies.

Take-home points: We report a case of vena cavo-bilateral iliac vein injury treated by intervention.

Barcelona, Spain
September 7-11
CIRSE 2019

PART 4

Author Index

**List of all abstract authors with
presentation numbers**

*Please note that bold numbers
indicate presenting authors and
P-numbers stand for poster
presentations.*

A

- Aarts, B.M. **P-561, P-562, P-563**
 Abadal Villayandre, J.M. **202.1**, P-460
 Abbas, H. P-180, P-181, P-310, P-314
 Abd El Tawab, K. 2206.3
 Abdel Aal, A.K. **1505.6, P-552, P-572, P-574, P-876**
 Abdelaziz, M. **P-682**
 Abdelaziz, O. **705.4**
 Abdelmaksoud, M.A. **P-292**
 Abdelsalam, M. P-581
 Abdulhaq, M.M. P-89
 Abe, T. P-237, P-245, P-415, P-558
 Abed, A. P-541, P-543
 Aberdein, G. P-921
 Abou Areda, M. P-224
 Abouelhoda, A. P-482, P-483
 Abraham, R. **2706.1**
 Abu Hana, R. P-381, **P-512**, P-555
 Accrocca, F. P-466
 Ackerman, D. P-520
 Acosta De Bilbao, F. 104.2
 Acquafredda, F. P-250
 Acquati Lozej, J.G.P. P-708
 Acunas, B. P-736
 Adachi, A. P-715, P-726
 Adachi, S. P-827
 Adam, G. P-438, P-901
 Adamo, D. **P-66**
 Adriaansens, S.O.J.H. 3105.6
 Aebi, M. 607.4
 Affonso, B.B. 2306.5
 Agata Stachno, M. P-165
 Aghajafari, P. P-48
 Aglan, A. P-461
 Aguiar Ferreira, A. P-782
 Aguilar, A. 3106.4
 Aguilar Perez, M. 1407.3
 Aguillo, E. P-646
 Aguinaga, A. P-35
 Ahmad, F. P-207
 Ahmed, I. P-129, P-180, P-181, P-375
 Ahmed, M. 607.2, P-157
 Ahmed, O. P-372
 Ahn, H. P-368
 Ahuja, R. **P-659**
 Akehurst, R. 404.3
 Akhmedov, U.U. P-327
 Akhtar, M.R. 704.3, P-26, P-279, P-889
 Akinfiyev, D. **P-412**
 Akkan, K. P-750, **P-756**
 Akuta, K. P-72
 Al Assadi, A. P-216
 Al Kindi, A. P-919
 Al Masri, A. P-762
 Alabdulghani, F. **P-25**
 Alba Rey, E. P-597
 Albeer, Y. P-421
 Albisinni, U. P-497
 Albright, J.W. P-319, P-363, P-824, P-830, **P-831, P-833, P-835**, P-940
 Alcaraz, A. **2605.2**
 Alchanan, R. P-673
 Aldin, Z.A.H. **607.2**
 Alduk, A.M. **P-73**, P-259, P-445
 Aleman, C. **706.4, P-189**, P-247, P-599, P-674, P-802
 Alexopoulou, E. P-542
 Alfageme Zubillaga, M. P-287
 Alfieri, G. 607.1, 2305.6, 3008.7, P-126
 Alfonsi, A. P-505, P-579, P-817, P-822, P-825, **P-826**, P-884, P-904
 Alghamdi, J. P-371
 Alghareem, N.A. **P-12, P-239**
 Algharras, A.A. P-531
 Alguersuari, A. 3105.7
 AlHabli, I.A. P-89
 Alharbi, A. P-51
 Ali, H. **P-172**
 Ali, T. P-804
 Ali, Z. P-889
 Aliberti, C. P-524
 Alizadeh, L.S. **706.1, 706.6**, P-450
 Aljarie, M. P-371
 AlJuwayed, M.H. P-274
 Alkadhi, H. 2206.1
 Alkhouri, N. **P-629**
 Allimant, C. 2802.2
 Allouni, A.K. P-36, P-929
 Almazedj, B. P-197, **P-406**, P-722
 Almeida, G.G.G. **704.6**
 Almeida, R. P-92
 Almekhlafi, M. P-474
 Al-Moaiqel, M. 1506.4
 Almushatat, A. P-889
 Alonso Burgos, A. **303.1**
 Al-Radhi, Y. **P-931**
 Al-Rekabi, A. **P-208**
 Alsaeed, E.M. P-12, P-239
 Alsafi, A. P-141, P-625, P-820, P-894, P-947
 Al-Samahy, H.A. P-482, P-483
 Alshammari, M.T. **P-274**
 Alshehre, O.Z. **P-371**
 Alsherbini, A. P-610, **P-816**
 Altomare, C. P-576, **P-577**, P-579
 Alvarez Luque, A. P-271, P-684, P-818, P-840
 Alves, E.C. P-896
 Alves, F. P-93
 Alves, F.C. P-92
 Alvi, A.J. **1506.4**
 Alzubaidi, S.J. P-88
 Amann, K. 3106.7
 Amaral, J.F. **1406.4**
 Amarillo, D. P-832
 Ameli-Renani, S. P-413
 Amer, A.H. **P-499**
 Amin, S.S. **P-334**
 Amirabadi, A. P-446
 Amis, S.M. P-701
 Amodio, F. 1204.4, P-40, P-431, P-805, P-806, P-843
 Amorim, M. P-896
 Amoros, S.L. 404.3
 Amos, B.J. P-22
 Andaluz, A. 3106.4
 Ando, M. P-870
 Ando, T. P-303, P-686
 Andrade, G. **2702.3**
 Andrade, J. P-84
 Andrašina, T. 704.1, 1407.1, **2004.4**, P-342
 Andreone, A. 705.3, P-425, P-648, **P-740**, P-837
 Andresen, R. 3104.2, P-713
 Angel, N.L. P-401
 Angileri, S.A. P-112, P-383
 Angle, J.F. P-306, P-321
 Annamalai, G. P-11
 Annan, D. **P-895**
 Anning, N. **P-229, P-447, P-942**
 Anthony, S. P-10, P-311, P-411
 Anton, S. **P-305**, P-707
 Antonietti, A. 704.3, P-279
 Anwar, J. P-571
 Arabi, M. P-51, P-693
 Arai, Y. 2304.2, **3201.4**, P-71, P-162, P-529, P-603, P-611
 Aramaki, T. P-273
 Araujo, S.E.A. 2306.5
 Arbues, G. P-76
 Arenas Da Silva, L.F. P-889
 Arfeen, F. **P-279**
 Argentos, S. P-542
 Argirò, R. P-83, P-119
 Arienzo, F. P-389, P-391
 Arikani Abello, F. P-436
 Arima, Y. P-338
 Arizono, S. P-493
 Arkoudis, N. P-24
 Armengol, J. P-365
 Armijo Astrain, J.E. P-45, P-253, P-254
 Arnold, D. **1703.4**
 Arnold, R. 2305.3
 Arnoldussen, C.W.K.P. **104.1**
 Aronberg, R. P-461
 Aroori, S. P-69
 Arrichiello, A. P-665
 Arrigoni, F. P-110, P-115, P-470
 Arroyo Lopez, M. **P-186, P-873**
 Artrip, R. **P-22**
 Artzner, C. **P-536**
 Arun, A. P-224, P-225
 Asadi, H. 2802.5, P-634
 Asai, S. P-338
 Asakura, K. P-273
 Asatiani, G. 3106.3, P-370
 Asayama, Y. P-509, P-511
 Aschenbach, R. P-881
 Ashida, H. P-133, P-164, P-238, **P-440**
 Ashley, J. P-898
 Asseri, Z.A. 1506.4
 Atar, E. P-351, P-644
 Attallah, K. P-172

Atwell, T.D. P-66
 Auer, T.A. **2004.5**
 Auloge, P. **2004.1**, 3301.4, P-100,
 P-107, P-117, P-152
 Austermann, M. 1408.1, 1408.4, P-308,
 P-309
 Avritscher, R. 1407.5, 2004.3, P-359,
 P-581
 Awad, K. P-172
 Awai, K. P-62, P-433, P-618, P-777,
 P-932
 Awano, K. P-827
 Aygün, M.S. P-922
 Aziz, S. **P-772**
 Azrumelashvili, T. 704.2, 2304.6, 3106.3,
 P-370
 Azzi, F. P-512

B

Baba, Y. P-932
 Bae, S.H. **P-422**, P-681, P-813
 Baek, S.H. **3008.6**, **P-521**
 Baez Alvarado, Y. P-268
 Báez Díaz, C. P-888
 Bagla, S. P-101
 Baheti, A. **P-321**
 Bai, H.X. 1505.2, **P-554**
 Bai, W. 3104.4, P-471
 Baijal, S.S. P-37
 Bailey, C.R. **P-224**, **P-225**
 Bailis, N. P-612
 Bajwa, R. **P-910**
 Bāk, M.B. **P-256**, **P-399**
 Bakhtin, I.L. P-749, P-846
 Balaka, S. P-545, **P-606**
 Balan, S. P-697
 Baldanza, D. P-349, P-378, P-420
 Ballano Franco, C. P-271, **P-684**, P-818,
 P-840
 Ballesteros, F. P-271
 Balzarotti Canger, R.C. P-17
 Bandula, S. P-544
 Bango Garcia, M.J. **P-161**, P-168, P-169
 Bannewitz, C. 1407.3
 Banos, J.-L. 3104.1
 Banz, V. P-153
 Barah, A. P-610, P-816
 Barbati, M.E. 104.5, 304.4, **P-620**
 Barber, J. P-796, P-799
 Barberis, A. P-376
 Barbero, S. P-691
 Barbiero, G. P-78
 Barbosa, D. P-281, P-692
 Barbosa, F. **P-505**, P-817, P-822,
 P-825, P-826, P-869,
P-884, **P-904**
 Barcia, J. P-70
 Barclay, A. P-478
 Barentsz, M.W. P-585
 Barge, T. **2206.5**, P-36, **P-223**,
 P-311, P-891
 Bargellini, I. P-517, P-588, P-866
 Barile, A. 1204.3, P-115
 Barillà, D. P-331, **P-678**
 Barkhausen, J. P-707

Barnacle, A.M. **1805.4**, P-664
 Barnés, D. P-365, P-614, P-792
 Barr, J. P-101
 Barral, P.-A. P-784
 Barrett, B. P-705
 Barrufet, M. P-35
 Bartal, G. P-385
 Bartoli, J.-M. 1407.6, P-711, P-784
 Bartoli, S. P-466
 Bartolotta, T.V. P-174
 Barzakova, E. 2207.3, P-523, **P-549**
 Basapure, R. P-902, P-915, **P-944**
 Bashir, O. **P-51**, **P-693**
 Bashir, U. P-157
 Basile, A. **2604.3**, P-21, P-166,
 P-349, P-378, P-420,
 P-672, P-904, P-934
 P-359, **P-537**, **P-595**
 Basile, D. P-537
 Basile, V. **P-443**
 Basílico, F. P-744
 Basirova, N. P-650
 Bastida Torre, R. P-80
 Batista, L. P-790
 Batrick, N. P-762
 Battini, S. P-78
 Battistel, M. **P-598**
 Battistuzzi, J.B. P-485
 Bauer, J.L. 2306.6
 Baumgart, J. P-698, P-775
 Bausback, Y. P-702
 Bayerle, P. P-629
 Baykal, T. **203.3**, 3008.4
 Beall, D.P. **2605.3**
 Beasley, R.E. P-886
 Beckett, D. 3104.1
 Beelen, R. P-561, P-562, P-563
 Beets-Tan, R.G.H. P-85
 Beidas, K. P-344, P-345
 Bekheet, N.G. P-351
 Belenky, A. P-795
 Belet, U. 2802.2
 Belgour, A. P-804
 Belkhiri, A. P-904
 Bellone, A. **P-351**
 Bendet, A. P-331, P-678
 Benedetto, F. P-165, P-228, P-800
 Benito Santamaria, V. P-763
 Bensimon-Etzol, J. P-600, P-886
 Bent, C. P-629, P-630
 Bentley, R. **608.6**
 Bentrudi, A. P-33
 Benz, D.M. P-576, P-577, P-579
 Beomonte Zobel, B. P-553, P-557
 Bercu, Z.L. P-702
 Berczi, A. 2802.2
 Beregi, J.-P. P-569
 Berezina, N. P-910
 Bergin, D. P-487
 Bergui, M. 3106.4
 Berjano, E. P-528
 Berkhout, W.E.M. P-260
 Berkowitz, E. P-793
 Berkowitz, S. 608.6
 Bernier, P. P-871
 Berning, M.

Beropoulos, E. **P-309**
 Berrier, H. P-101
 Berry-Tony, S. P-260
 Bertaggia, C. P-537
 Bertelli, E. **2605.1**
 Bessar, A.A. **P-547**
 Bessissow, A. 704.5, 705.6, P-179, P-381,
 P-531, P-919, P-945
 Bettencourt, C. P-763
 Betz, J. P-224, P-225
 Bevilacqua, A. P-59
 Bex, A. P-561
 Beyer, L.P. P-546
 Bezzi, M. **302.1**, 1802.3, P-443
 Bhargava, N.K. P-847
 Bhasker, M. P-526
 Bhatia, S.S. **P-209**
 Bhatia, V. 1204.6
 Bianchi, G. **1204.3**, P-110, P-111,
P-115, P-120, P-390
 Bibok, A. **P-613**
 Bicknell, C.D. P-13, P-317
 Bienek, S. 1506.7
 Biguri, A. P-760
 Bilbao, J.I. **302.2**, P-591
 Bilhim, T. **605.2**, **2206.6**
 Bin Hajar, A. 1506.4
 Biondetti, P. **P-202**, P-623
 Bippus, R. P-438
 Birkfellner, W. P-760
 Bischoff, P. 2206.2
 Bito, K. P-354
 Black, S. **1302.4**, P-917, P-936
 Blain, M. **P-335**
 Blanco, R. P-130
 Blessing, E. **301.3**, **1702.4**, 2208.7
 Blondel, B. 607.6
 Boardman, P. 2206.5, 2206.7, P-223,
 P-891, P-893
 Boas, F.E. 1505.3
 Boccalon, L. P-312
 Bocciardi, A.M. P-884
 Boccuzzi, A. **P-458**, P-588, P-694,
P-866
 Boddapati, S.B. P-410
 Bodenmann, D. P-439
 Boeken, T. **P-541**, **P-543**
 Bogdanova, N.P. P-374
 Boldrini, G. 704.7
 Bolengo, I. **P-510**, P-909
 Bolger, M.P. 607.5, **P-124**, P-360,
 P-687, P-890
 Bonanno, N. **P-427**
 Bongiovanni, S. P-825, P-869
 Boni, G. P-517
 Böning, G. P-442
 Bonne, V. P-161, **P-168**, **P-169**
 Bonomo, G. P-496, P-506, P-540,
 P-564
 Boo, S. P-241
 Book, M. P-334
 Boolkah, S. P-180, P-181
 Borelli, A. P-105
 Borzelli, A. 1204.4, 3106.1, **P-40**,
 P-398, **P-431**, **P-805**,
 P-806, **P-843**
 Boscarato, P. P-272, P-785

- Bosiers, M. **404.1, 2208.3**
 Bosiers, M.J. **1408.1**
 Bossi, I. P-904
 Botha, A. P-375
 Bottari, A. P-383
 Bouchard, L. 608.6
 Boucher, L.-M.N.J. 704.5, 705.6, P-179, P-283, P-531, P-555, P-919, P-945
 Bouhadiba, N. P-181
 Boulougouri, M. **2208.2**
 Bouwman, F.C.M. P-662
 Bovio, G. P-97, P-815
 Bowker, A. P-406, P-722
 Boyd, D. P-512
 Boyer, L. **706.2**, P-641, **P-763**
 Bozzi, A. P-75, P-473, P-723, P-880
 Bozzi, E. P-517, P-588, P-866
 Braat, A.J.A.T. P-585
 Braithwaite, B. P-900
 Brambillasca, P.M. P-817, **P-869**, P-884
 Branach, C.S. **P-44**, P-319, **P-323**, P-461
 Brandt-Wunderlich, C. 3104.2
 Brassil, M.P. **P-159, P-194**
 Braun, A. P-533, P-582
 Braun, G. **2604.2**
 Bräunlich, S. P-698, P-775
 Braverman, S. P-355, P-356
 Bravo De Laguna Taboada, A. **104.2**
 Bravo Rius, E.F. **P-288**
 Bready, E. 1505.6, P-552, P-572
 Breen, D.J. **2102.3**
 Breen, K.A. P-628, P-655
 Brejt, S.J. P-838
 Brelje, T. P-101
 Brennan, D. **P-160**
 Brennan, S. P-25
 Bress, A. P-101
 Breznik, S. P-720
 Briatico Vangosa, A. P-515, P-593
 Brige, P. 1407.6
 Briggs, J. **P-207**
 Brock, K. 1407.5
 Brodde, M. 1407.3
 Brodmann, M. **101.5**, 404.6, 2208.4
 Brooks, M. 2802.5, P-634
 Brountzos, E. 705.1, 2208.2, **2702.2**, P-7, P-24, P-122, P-123, P-146, P-227, P-570
 Brown, A.H. P-621
 Brown, Jr., R.S. 705.7
 Brunelle, S. P-494
 Bruners, P. 2207.2, 2207.3, 2304.5, 2304.7, P-519, P-523, P-549
 Bruno, A. P-261
 Bruno, F. P-111, **P-120, P-470**
 Bryant, T.J. **605.4**, 2206.4, P-208
 Buccimazza, G. **P-459**, P-665
 Buceta Cacabelos, E. 104.2
 Buecker, A. **2704.3**, 3105.3, P-299, P-861
 Bueno, H. P-85, P-86
 Bukata, S.V. 1204.1
 Bundy, J. P-905
 Bura-Rivière, A. 1504.2
 Burbelko, M. **1802.4**
 Burdette, A. P-22
 Burdi, N. P-83, P-473, P-515, P-593
 Burdío, F. 1406.1, 3106.4
 Burgmans, M.C. 3008.2, P-528
 Burke, N.P. **P-638**
 Burlak, K. P-642, P-921
 Buruk, M.S. P-29, P-30
 Busch, F.D. P-901
 Busch, J.D. P-901
 Busse, H. P-612
 Bustamante, S. P-379
 Butrón Hernández, D. **P-379**
 Butt, S. **P-590**
 Buy, X. **203.1**, P-598
 Bychenko, V. P-412
 Byeon, J.H. 608.7
 Byrne, C.A. **607.5**, P-124, P-360, P-687, P-890
C
 Cabrera, T. 704.5, 705.6, P-179, P-531, P-555
 Cabrera Peña, A. P-190
 Cahalane, A.M. **P-928**
 Calandri, M. P-359, P-537, P-595
 Calcagni, F. P-426, P-753
 Calcagno, M.C. P-21, P-349, **P-378**, P-420, **P-672**, P-934
 Calleja Cartón, E. P-271, P-684, **P-818**, **P-840**
 Callstrom, M.R. **2505.1, 3004.2**
 Caltabiano, G. P-378
 Calvo Imirizaldu, M. P-591
 Camacho, J.C. P-522
 Camisassi, N. P-97, P-815
 Campolina, A.G. P-639
 Campos, B. P-281
 Campos, H.G. **P-639**
 Campos, N. P-782
 Cancellieri, R. P-175, P-466
 Candelari, R. P-272, P-781, P-785
 Candinias, D. P-153, P-551
 Cangiano, G. 1204.4, P-806
 Canipek, E. P-736
 Cannataci, C. P-844, P-845, P-851
 Cannavale, A. **1802.3**, P-443
 Cannita, K. P-115
 Cantarella, R. P-819
 Cantwell, C. P-906
 Cao, P. 1406.6
 Capar, A.E. P-795
 Capece, S. P-819
 Capel Alemán, A. P-35, P-246
 Caporali, C. 2304.3
 Cappelli, A. P-261
 Cappelli, C. P-588
 Cappelli, F. P-492
 Cappio, S. P-17
 Capurri, G. **P-425**, P-740
 Caravasile, D.M. **P-605**
 Carchesio, F. **1406.7**, P-151, **P-645**
 Cardarelli-Leite, L. 2802.4, P-155
 Carducci, S. 1204.3, P-111, P-390, P-841
 Cariati, M. P-38, P-39, P-54, P-182, P-184, P-236, P-297, P-301, P-376, P-396, P-414, P-658, P-712, P-752, P-780
 Caridi, J.G. **304.2**, P-864
 Carini, M. 2605.4
 Carling, U. **P-235**
 Carlos, R. P-400
 Carnevale, F.C. **3202.1**, P-282
 Carpenedo, R. P-119
 Carpentier, S. P-762
 Carrafiello, G. P-38, P-39, P-105, P-112, P-202, P-226, P-236, P-252, P-376, P-383, P-414, P-594, P-623, P-647, P-651, P-658, P-665
 Carraro, A. P-578
 Carretero Lopez, F. P-286
 Carriero, A. 3106.1, P-492
 Carvalho, F.G. P-685
 Carvalho, T. P-281
 Carvalho, V.O. P-84
 Casamassima, N. P-293
 Casanova Sanchez, I.E. P-20, P-379
 Casari, F. 2304.3
 Casero, F. **P-165, P-228**
 Cassagnes, L. 706.2, P-641, P-763
 Casserly, L. P-839
 Cassim, C.R. **P-179**, P-381
 Cassinotto, C. 2802.2
 Castiglione, D.G. P-21, P-174, P-672, P-934
 Castillo García, A. P-246
 Castro Valdes, R. P-186
 Castrucci, T. **P-466**
 Casula, E. P-463, P-801
 Catalano, C. 607.1, 1802.3, 2305.4, 2305.6, 3008.7, P-126
 Catalucci, A. P-470
 Catena, V. 203.1, P-598
 Cathomas, M. P-551
 Caudrelier, J. 2004.1, 3301.4, P-100, P-107, P-117
 Cavaglià, E. 1204.4, P-40, P-431, P-776, P-805, P-806, P-843
 Cavallo, A.U. 607.3
 Cavenagh, C.J. P-149, **P-592, P-794**
 Cavenagh, H. **P-886**
 Caviedes, J.G. P-877
 Cazzato, R.L. 2004.1, **3301.4**, P-100, **P-107**, P-117, P-152
 Ceccato, S. P-78
 Cechova, B. 1407.1, 2004.4
 Cejna, M. **2502.6**
 Ceriani, R. P-510
 Cerit, M.N. P-756
 Cermenati Bahrs, T. P-288
 Černá, M. P-469, **P-764**
 Cerone, G. P-121, P-127
 Cervelli, R. **3301.2**, P-694, P-866
 Cervinka, D. 704.1, P-342

- Chabrot, P. 706.2, P-641, P-763
 Chaix, C. 1505.7
 Chaluvashetty, S.B. **P-410**
 Chammas, M.C. P-125, P-639
 Chan, C. P-490
 Chan, E. 3008.2
 Chan, H.S.-C. **P-64**
 Chan, M.V. P-55, P-56, P-57, P-490
 Chan, S.X.J.M. 3008.2
 Chan, T.Y. P-11
 Chandra, R. 2802.5, P-634
 Chandramohan, S. 3008.2, P-734
 Chang, A. P-935
 Chang, D.-H. P-533, P-582
 Chao, K. P-485
 Charalambous, N. P-42
 Charco Torra, R. P-792
 Chatani, S. **P-63, P-102**
 Chatellier, G. **606.1**
 Chatzioannou, A.N. P-502
 Chaudhary, N. P-488
 Chavan, A. P-334
 Chechenin, G. **P-19**
 Chedrawy, C. P-52
 Chen, C. **P-60**, P-206
 Chen, J. P-495, P-513, P-534, P-538
 Chen, J.X. P-520
 Chen, M. P-513
 Chen, R. P-696
 Chen, W. P-135, P-145, P-495, P-513, P-534, P-538
 Chen, Y.-I. 704.5, 705.6, P-381
 Cheng, H.-M. P-602
 Cheng, H.M.J. P-96
 Cherkashin, M.A. **P-569**
 Chernaya, N.R. P-326
 Chernov, A. P-329
 Chernova, D. P-329
 Chernyavskiy, M. **P-329**
 Chevallier, P. 2207.6
 Chiang, J. **2505.4**
 Chiaradia, M. P-335
 Chiba, K. P-290
 Chick, J.F.B. P-386, P-486, **P-905**
 Chidambaram, R. P-193, **P-809**
 Chihiro, I. P-162
 Chino, S. 1408.7, P-289, P-298
 Chintalapani, G. 1407.5, P-581
 Chircop, K. P-427
 Chişcariu, P.C. **P-615**
 Chittle, M. P-928
 Chivate, R.S. **P-91**, P-263, **P-347, P-514**
 Chng, S.P. 3008.2
 Cho, A.L. **P-262**
 Cho, J.K. **P-520**
 Cho, S. **P-192**, P-397, **P-616**
 Cho, S.B. P-183, P-353
 Cho, S.G. P-718
 Cho, S.K. P-907
 Cho, Y.K. **P-858**
 Choi, B.G. P-559
 Choi, H.C. P-397
 Choi, I.Y. P-353
 Choi, J. 1505.4
 Choi, J.W. **1406.5**, 2207.1
 Choi, S.Y. P-192, P-423
 Choi, W. **P-34**, P-858
 Choi, W.K. P-224, P-225
 Choi, W.S. 1406.5, **2207.1**
 Choke, E.T.C. P-734
 Chon, S.-H. P-340
 Chong, H.S. 2207.5
 Chong, T.T. 3008.2, P-187
 Choo, D. P-350
 Choo, S.P. 2207.5
 Choo, S.W. P-907
 Chosa, K. P-433, P-618, **P-932**
 Chouinard, A. 608.6
 Chovanec, V. P-328
 Chow, K. P-669
 Chow, P. 2207.5
 Christidi, F. 2208.2
 Christie, A.I. P-717
 Christos, G. P-144
 Chu, H.H. 2207.7, P-23, P-195, P-206, P-441, P-787, P-848, P-883
 Chua, J.M.E. 3008.2, P-734
 Chudacek, Z. **P-688**
 Chudakov, G. P-351
 Chun, H.J. P-176, P-559
 Chun, J.-Y. P-794
 Chung, H. **608.4**, **1204.2**
 Chung, H.H. P-183, **P-353**
 Chung, J. 2802.4, P-155, P-652
 Chung, J.W. 1406.5, 2207.1
 Chung, R. P-41
 Ciardullo, M. 704.7
 Ciciliani, L. P-31
 Cicorelli, A. P-694
 Cieslak, J.A. P-85, P-86
 Cifrian Perez, M. **2705.1**
 Cimo', B. P-844, P-845, P-851
 Cina, A. P-83, P-398
 Cindil, E. P-756
 Cioni, R. **202.2**, P-250, P-517, P-588, P-694, P-866
 Cipriano, A. P-92
 Citone, M. **1005.3**
 Clark, T.W.I. **1802.1**, P-755, P-771
 Clavert, P. **3004.1**
 Clements, W. 1504.4, **2802.3**, P-921
 Clerici, G. **902.1**
 Cleveland, T.J. **1101.2**
 Cline, M. P-318, P-461
 Cluney, S. P-369
 Cobianchi Bellisari, F. **P-111**, P-390
 Codina, J. **P-607**
 Coffey, H.M. P-705
 Cohen, A. P-351
 Cohen, S. P-644
 Čolić, M. P-332
 Collado Torres, M.L. **P-287**
 Colletti, G. P-202
 Colletini, F. 2004.5, P-596, P-636
 Collinot, J.-A. P-439
 Colori, B.M.C. P-497
 Comelli, C. P-473
 Comelli, S. 3104.6, P-393, P-473, P-479
 Concejo Iglesias, P. **P-460**
 Congedo, M.T. P-645
 Consoli, A. **2703.5**
 Contegiacomo, A. P-83
 Conti, A. P-672
 Contractor, S. P-47, P-86
 Contreras Padilla, D. P-232, P-653
 Contro, A. P-727, P-878
 Cooper, K.J. P-318, P-659
 Coppola, M. 1204.4, P-806
 Coppolino, P.M. P-349, P-378, P-420, P-672, P-934
 Corbo, B. **P-732**
 Cornelis, F.H. **607.4**
 Corona, M. 1802.3, P-443
 Corot, C. 1407.7
 Corrairie, S. 3104.6, P-393, P-479
 Correa Zapata, J.C. P-365, P-614, P-792
 Corrigall, H. P-36
 Cortellini, A. P-115
 Cortis, K. P-844, P-851
 Corvino, F. 1204.4, P-776, P-806
 Coscojuela Santaliestra, P. P-436
 Cosottini, M. P-458
 Costa, J.F. P-92
 Costa, N.V. 2206.6
 Costanzo, G. P-420
 Cousin, F. **3106.2**
 Cova, M.A. P-743
 Crawford, M. P-804
 Credo, A. P-161, P-168
 Creelan, B. 1505.4
 Crew, J. 2206.7
 Criado Paredes, E. 3105.7, **P-35**
 Criscuolo, S. P-396, P-752
 Crocetti, L. **3201.1**, P-517, P-588
 Cross, C. **P-264**
 Crowley, J.J. P-116
 Crozier, J. P-679
 Cruces Fuentes, E. P-232, **P-653**
 Cruz, M. **P-93**, P-782, **P-803**
 Csobay-Novák, C. P-15
 Cubillo Prieto, D. 104.2
 Cuello, M. P-832
 Cuesta Perez, J. P-286
 Cullen, A. **P-233, P-587**
 Cura, M. P-853, P-918
 Cvetič, V.Z. **P-332**
 Czaplicki, C.D. P-88
 Czerwonko, M. P-859
- ## D
- Da Florencia Ricardo, D. P-533, P-582
 Da Motta Leal Filho, J.M. **605.3**, 2306.5
 Da Ros, V. P-83, P-119, **P-473**
 Dababou, S. 607.1, 2305.4, **2305.6**, **3008.7, P-126**
 Dabbene, D. P-272
 Dabbicco, T. P-753
 D'Agostino, D. 704.7
 Daidj, N. P-491, P-494, P-560
 Dake, M.D. **601.5**, **1504.7, P-728**
 Dall'Ara, S. P-387, P-388, P-765, P-767
 Dallongeville, A. P-284

- D'Amato, D. P-568
Dambach, J. 404.2
Damiani, G. **P-54**, P-182, P-184, P-297, P-301, P-396, P-712, P-752, P-780
Damodharan, K. 3008.2
D'Amuri, F.V. P-59
Danawi, Z. 607.2
Danda, V. **P-755**
Daniels, H. P-662
D'Antuono, F. P-205, P-909
Dariushnia, S. P-553
Darras, M. **P-786**
Das, R. P-413
David, E. P-101
Daviddi, F. P-250
Davisson, N.A. **P-400**
Davlyatov, M.R. P-374
Daye, D. P-928
Dbouk, S. **P-152**
de Assis, A.M. P-282
de Baère, T. 607.7, 1407.4, 1407.7, **2207.6**, P-567
de Castro, M.G. P-282
De Donato, M.C. P-118
De Filippo, M. P-59
De Geus-Oei, L.-F. P-528
de Graaf, R. **1302.3**, 1504.1, 1504.3
de Gregorio, M.A. P-35, P-147, P-646
De Groodt, J. P-743
De La Torre, M. P-591
de Laat, K. 2204.4
de Magistris, G. 1204.4, P-776, P-805, P-806
De Marini, P. 3301.4, **P-100**
de Melo, S. P-384
De Mora, V. P-832
de Oliveira, F.A. P-695
De Robertis, R. P-79, **P-424**, P-578
De Rubeis, G. P-443
de Santibañes, E. 704.7, P-859
de Santibañes, M. 704.7, P-76, P-859
de Vries, J.P.P.M. P-911
Deak, A.P. P-613
Déan, C. 1505.7, P-541, P-543, P-730
Dedone, G. **P-419**, **P-671**
Defilippi, C. P-672
Dejima, I. P-63, P-102
Del Giudice, C. **1504.2**, **2208.5**, **P-730**, **P-731**
Del Sette, B. P-492
Delanerolle, G. **P-668**
Delara, A.M. P-161
Delicque, J. 2802.2
Della Vigna, P. P-496, P-506, P-540, P-564
Deloose, K.R. **301.6**, **404.4**, 2208.4, 2208.6, 3104.1
Delpla, A. 607.7
Denecke, T. P-636
Denis, S. 1407.4
Deniz, S. P-716, P-922, P-924
Denys, A. 2004.6, **3201.3**
Deodhar, K. P-526
Derbel, H. P-335
Derone, G. P-678
Deroose, C. P-563
DeSai, C. **P-943**
Desai, M. **P-679**
Deschamps, F. **607.7**, 1407.4, P-567
Desiderio, C. P-21, P-349, P-378, P-420, P-934
DeSilva, S.G. P-401
Dessy, M. P-202
Dewald, C.L.A. 2306.6, **P-430**, **P-573**
Dhanagana, R. P-173
Dhangana, R. P-148
Dharmarajah, B. **2208.7**, **P-820**
Dhillon, B. **P-804**
Dhillon, P.S. **P-879**
Di Bartolomeo, F. P-505, P-647, P-817, P-822, **P-825**, P-826, P-884
Di Domenico, S. P-904
Di Donna, C. 607.3
Di Gesù, I. P-174
Di Martino, A. P-75, P-473, P-721, P-723, P-880
Di Meo, R. P-112, P-665
Di Pauli Von Treuheim, T. 607.4
Di Sibio, A. P-118, P-390
Di Stasi, C. P-83, P-398
Di Vece, F. P-530
Diacio, D. P-312
Diamantopoulos, A. **104.6**, P-161, P-168, P-169, P-180, P-181, P-369, P-628, P-655, P-732, P-917
Dibarboure, L. P-832
Dick, E. P-790
Diebo, B.G. P-401
Diez Miranda, I. P-365, P-614, P-792
Digklia, A. 2004.6
D'Incan, M. 706.2
Dincer, N. P-716, **P-922**, **P-924**
Dinia, L. **P-436**
Diogo, D. P-782
Dirks, P. P-446
Discalzi, A. P-178, P-706, P-710, P-746
Dixon, R. P-101
Djaber, S. 1505.7
Dmytriw, A. P-358
Do, J. P-938
Do, T.D. P-248, P-640
Do, Y.-S. P-422, P-681, P-907
Dobrovoolec, A. P-99
Dodera, J.A. P-31
Dodt, C. **1705.1**
Doersch, A. P-898
Doi, K. P-303
Dolgushin, B.I. P-74, P-501
Dolmatch, B. **601.1**, **1804.1**
Domingues, L. P-782
Domingues, R.B. P-125
Domínguez Paillacho, I.D. 3105.1, P-860, **P-882**
Donald-Simpson, H. 1506.5, **P-478**, **P-925**
Donas, K.P. 1408.2, P-309
Donato, P. 704.6, P-92, P-93, P-782, P-803
D'Onofrio, A. 607.3, P-721
Donohue, J. P-892
Dooms, G. P-101
Dorenberg, E.J. P-235
Dorman, A. P-839
Doros, A. P-613
Dósa, E. P-702
Doshi, A. 2004.2
Doucet, J. P-512
Dougherty, R.W. P-461, P-940
Douglas, P. P-571
Dourakis, S. P-502
Doyle, M. P-705
Drabkin, M. **1505.3**, P-522
Drelich-Zbroja, A. P-256, P-399
Dresen, R.C. P-562, P-563
Druzhin, S. P-385
Düber, C. P-532, P-637
Dubois, B. P-319, **P-322**, P-323, P-461, **P-486**, P-940
Duda, S. **2703.2**
Dudley, K. **P-696**
Duff, K. P-699
Dumitru, R. P-605
Duncan, R. P-925
Dunn, A. P-167
Duong, F. 2304.5
Duran, R. **302.4**, 2004.6
Duszak, Jr., R. P-400
Duvvuri, M. P-224, P-225
Dyer Hartnett, S. **P-662**
Dziadziuszko, K. P-81, P-82
Dziedzic, R. P-81

E

Earle, M. P-705
Easo, J. P-334
Ebbes, S.C. **P-585**
Eccles, A. **P-2**, **P-9**
Echenagusia Boyra, M. **P-271**, P-684, P-818, P-840
Ecker, A. P-861
Eesa, M. **2706.2**
Egge, J. **1005.1**
Eigentler, T. P-536
Eisner, S. P-644
el Assar de la Fuente, S. **P-190**
El Hgar, Y. P-539
El Khudari, H. 1505.6, P-552, P-572, P-574, P-876
El Mansouri, A. 2206.2
El Zein, A. P-411
Elango, M. **P-43**, **P-798**
Eldergash, O. P-334
Elefsiniotis, I. P-502
Elessawy, K. 705.4
Elessawy, R. 705.4
El-Haddad, G. 1505.4, 2004.3, **P-550**
Elhissi, M.J.H. P-816
Elishev, V. P-385
Elmahdi, E. **P-829**
Elmahdy, A.M.A.A. **P-610**
Elnekave, E. P-351
Elroy, P.W.M. 404.3
Elserwi, A. P-482

Elsharkawy, A. **P-413**, P-664
 El-Sheikha, J. 2206.7
 Elss, T. P-438
 Elwood, C. P-380
 Emad-Eldin, S. 705.4
 Emira, A.K. P-413, **P-664**
 Emmanouil, E. P-502
 Enderlein, G.F. P-881
 Endo, M. P-273
 Endo, S. P-686
 England, R.W. **704.4**
 Enne, P. 3104.6, P-393, P-479
 Enoki, K. P-416, P-821, **P-887**
 Enrich, M. P-733
 Epifani, E. 705.3, P-425, P-648,
 P-740, P-837
 Erasmus, H.-P. 2305.4
 Erdoğan, C. P-480
 Erer, D. P-750
 Ermentrout, M. P-557
 Ermili, F. P-387, P-388, **P-530**,
 P-765, P-767
 Errani, C. P-497
 Escalante Porrua, E. P-597
 Escobar, J.P. P-832
 Espejo Herrero, J.J. 3105.1, P-177, P-860,
 P-882
 Espíndola, D.L.P. P-896
 Essert, C. **2505.3**
 Ettles, D.F. 1506.3
 Evans, J. **P-548**
 Ewertowska, E. **3106.4**
 Ezponda Casajús, A. P-591

F

Fabian, R.C.N. **P-185**
 Fabiano, T. P-692
 Facas, J. **P-92**
 Facchini, G. **P-497**
 Faiella, E. P-576, P-577, P-579
 Falco-Fages, J.F. 3105.7
 Falcone, G. 101.3, 201.4
 Falsaperla, D. P-349, P-934
 Falsarella, P.M. 705.5, **2306.5**, P-84
 Fanelli, F. **101.3**, **201.4**, 1802.3
 Fantoni, M. P-425
 Farmer, D. P-855
 Farrelly, C. P-25, P-233, P-587
 Fasoli, F. P-121, P-127
 Fauconnier, A. 305.2
 Faurie, B. 3104.1
 Fehrenbach, U. P-636
 Feldhaus, F. P-442, **P-636**
 Feliciano, A.L. P-161, P-168
 Femia, M. P-38, P-39, P-54, P-182,
P-184, P-236, **P-297**,
 P-301, P-376, P-414,
 P-658, P-712, **P-752**,
P-780
 Feng, L. P-485
 Ferguson, J. P-193
 Fernández De La Hoz, J.A. **P-877**
 Ferrante, Z. P-387, P-388, P-765, P-767

Ferraresi, R. **701.5**
 Ferrari, A. **3104.6**, **P-393**, P-479
 Ferraro, M.C. **2502.1**
 Ferreira, C. P-93, P-803
 Ferreira Júnior, E.G. **P-685**, **P-695**
 Ferrer, M.D. P-35
 Festas, G. 2208.2, P-227
 Feydy, A. **103.1**
 Fichetti, M. P-272, P-785
 Ficorella, C. P-115
 Fidelman, N. 2004.3
 Fiengo, L. P-917
 Fierro, D. 607.1, 2305.6, 3008.7,
 P-126
 Figueroa, C. P-147
 Filauro, M. P-376
 Filep, R.C. P-615
 Filipe Neto, A. P-685, P-695
 Filippiadis, D.K. 705.1, 705.2, **2605.5**,
P-122, **P-123**, P-144,
 P-146, P-542, P-570
 Fillipiadis, D. P-24, P-502
 Finan, C. **P-244**, P-310, **P-314**
 Finazzi Agrò, E. P-568
 Fiorentini, G. **P-524**
 Fiori, R. 607.3
 Fish, J.E. **P-366**, P-380
 Fisher, R.K. 1408.5
 Fitton, C. **1506.5**
 Flanagan, W. P-898
 Fleckenstein, F.N. P-231
 Floridi, C. P-226, P-252, P-383,
 P-594, P-647, P-651, P-665
 Floris, R. 607.3
 Foà, R.A. P-312
 Foley, N. P-719
 Fondevila, D. 3106.4
 Fonio, P. P-178, P-487, P-706, P-710,
 P-745, P-746
 Fontaine, J. 1505.4
 Fontana, F. P-293
 Foo, M. **2802.5**, **P-634**
 Foran, E. P-898
 Forcina, M. 607.3
 Forero Melo, J.F. P-877
 Formiconi, F. P-110, P-111, P-390, **P-841**
 Fornazari, V.A.V. **2306.4**
 Forschner, A. P-536
 Fotheringham, T. 704.3, P-26, **P-889**
 Foti, P.V. P-21, P-349
 Fotiadis, N.I. **P-157**
 Fournelle, M. 2802.6
 Francois, O. 3104.1
 Frangakis, C. 1505.5
 Franiel, T. **P-881**
 Frank, A. 1408.4, P-308
 Frantsev, D.Y. P-74, P-501
 Freitas, B. **P-698**, **P-775**, **P-896**
 Freitas, R.M.C. **P-125**, P-639
 Frenzel, F. P-299, **P-861**
 Friedrich, H. 607.4
 Fries, F. 3104.7
 Fries, P. 3105.3, P-299
 Frodsham, A.E. 2305.3
 Fronda, M. P-178, P-487, P-706,
P-710, P-745, **P-746**

Fu, W. P-320
 Fuentes, S. 607.6
 Fugazzola, C. P-293
 Fuji, T. P-433, P-618
 Fujii, K. P-689
 Fujimura, N. P-715
 Fujita, A. P-827
 Fujitsuka, S. P-162
 Fujiwara, K. **P-108**
 Fujizuka, S. P-71, P-529, P-603, P-611
 Fukao, T. P-686
 Fukuda, T. P-294
 Fukuhara, S. P-322
 Fukuma, S. P-67
 Fukumitsu, S. P-476
 Fukumoto, W. P-932
 Fumarola, E.M. P-226, P-505, **P-817**,
 P-822, P-825, P-826,
 P-884
 Fumoto, K. P-382
 Funaki, B.S. P-372
 Funovics, M.A. **1506.1**
 Furlough, C.L. **P-8**
 Furtado, V.F. P-928
 Furui, S. P-774
 Furukawa, A. P-382
 Furukawa, Y. P-852
 Furuta, A. P-493
 Fusaro, F. 3104.6, P-393, P-479
 Fusco, M. **P-357**, P-665

G

Gabata, T. P-296, P-339, P-604
 Gabr, A. P-216, P-580
 Gabutti Tomas, J.A. P-379
 Gade, T. P-520
 Gafoor, N.F. P-9, P-69, P-310, P-314
 Gaggini, R. **P-773**
 Gaines, P.A. **1506.6**
 Gala, K.B. 2305.7, P-526, P-663
 Galanakis, N. P-920
 Galanis, S. P-171
 Galastri, F.L. 2306.5
 Galaverni, M.C. P-261
 Galbiati, A. 3106.1
 Galeotti, R. P-387, P-388, P-530,
 P-765, P-767
 Galfano, A. P-884
 Gali, R. P-91, P-263, P-347, P-514
 Gallesio, I. P-691
 Galli, E. **P-268**
 Galli, F. P-105
 Galli, M. **P-142**
 Galloula, A. 1504.2, P-730
 Galuppo Monticelli, R.R. **P-384**
 Galvez, E. P-460
 Ganai, B. P-6
 Ganau, C. 3104.6, P-393, P-479
 Gandini, R. 2208.5, P-75, P-83, P-473,
 P-721, P-723, P-731, P-880
 Ganesan, K. **P-734**
 Ganga, K.P. **P-313**

- Gangi, A. 2004.1, **2102.4**, 3301.4, P-100, P-101, P-107, P-117, P-152
- Ganimede, M.P. P-83, P-515, P-593
- Ganjoo, K. 2004.2
- Gao, F. **1406.3**
- Garategui, L. P-204
- Garcia, F. 3106.4
- Garcia, J. **P-70**
- Garcia, R.G. 705.5, 2306.5, P-84
- García Buen-Abad, R. **P-20**, P-379
- García Gamez, A. P-165, P-228, P-800
- García Jurado, P.B. **3105.1**, P-177, **P-860**, P-882
- Garcia-Mónaco, R.D. 2004.3, **P-204**, **P-859**
- García Revillo, J. P-882
- García Suarez, A. P-287
- Garg, P.K. P-847
- Garg, T. **P-242**, **P-489**
- Garms, M. **P-373**
- Garnon, J. **103.3**, 2004.1, **2704.2**, 3301.4, P-100, P-107, P-117, P-152
- Garriga, M. 1504.5
- Garzillo, G. P-149
- Gasbarrini, A. 1406.7
- Gatti, F.L. **P-727**, P-878
- Gavazzi, F. P-205
- Gazzera, C. P-359
- Gebauer, B. **905.4**, 2004.5, P-217, P-231, P-442, P-636, P-649
- Geevarghese, R. **P-885**
- Geisel, D. P-442, P-649
- Gelabert, M.A. P-607
- Gelling, L. P-668
- Gemignani, A. 705.3
- Gemmete, J.J. P-132, P-488, P-830, P-831, P-835, P-905, P-940
- Geng, X. 1406.6
- Gennaro, N. P-205, **P-909**
- Genova, C. P-174
- Gentsu, T. P-504, P-941
- Geoghegan, T. 3105.4
- Georgiades, C.S. **904.3**, 1505.5, **P-131**
- Gérard, L. 3106.2
- Gerasia, R. P-759
- Ghamar Nejad, O. P-533, P-582
- Giankoulouf, C. P-171
- Giannini, E.G. **P-630**
- Gibbs, R.G.J. 1408.3, P-317
- Gibello, L. P-745
- Gibson, M. 2306.1, P-207
- Gil-Agostinho, A. P-803
- Gil Sánchez, S. P-232, P-653
- Gilbert, P. 608.6
- Gilberto, G.M. P-84
- Ginanni Corradini, L. P-443
- Ginawi, A. **P-65**
- Gioioso, V. **P-838**
- Giordano, A.V. 1204.3, P-110, P-111, P-390, P-841
- Giorgi, L. P-694
- Giretti, C. 404.3
- Giroux, M.-F. 608.6
- Gisone, V. P-83, P-515, P-593
- Gissler, M.C. **P-456**, **P-735**
- Gitto, S. **P-182**, P-184, P-301, P-712, P-752
- Giurazza, F. 1204.4, **P-776**, P-806
- Gizewski, E.R. **2503.4**
- Gkoutzios, P. P-180, P-181
- Glantzounis, G. P-502
- Glover, T. P-157
- Gnesin, S. 2004.6
- Goerig, C. P-248
- Goffette, P.P. 2207.6
- Gogna, A. 2207.5, 3008.2, P-187
- Goh, B. 2207.5
- Goh, G.S. 1504.4, 2802.3, P-642, P-921
- Goldberg, N. 1407.1
- Goldman, D. P-905
- Goldman, R. **P-916**
- Goldman, S.M. 2306.4
- Golfieri, R. P-261
- Goltz, J.P. P-707
- Gombert, A. 104.5, 304.4, P-620
- Gomes, A.S. **1204.1**, **P-855**
- Gomez, J. P-463, P-801
- Gómez, F.M. P-561
- Gonçalves, A. P-128
- Gonen, K.A. **P-480**
- Gonsalves, M. P-592
- González Costero, R. P-287
- González-Huebra, I. **P-591**
- Gonzalez-Junyent, C. P-365, P-614, P-792
- González Leyte, M. P-271, P-684, P-818, P-840
- González Mandly, A. 607.6
- Gonzalez Nieto, C.J. P-45, P-253, P-254
- Gonzalez Toranzo, R.S. P-113
- Gonzalo Carballes, M. P-365, P-614, **P-792**
- Goo, D.E. P-176
- Goodwin, M. P-854, P-863
- Gordon, T. **P-139**, **P-395**
- Gordon-Smith, J. P-571
- Gorga, G. P-594
- Gorkum, R.V. 2802.6
- Gorsi, U. **1204.6**, P-410
- Gorycki, T. P-81, P-82, P-275
- Goshima, S. P-266, P-303, P-686
- Gotra, A. P-919
- Gouëffic, Y. **301.1**
- Gouveia, H. P-281, P-692
- Gouzou, E. P-763
- Govender, P. P-159, P-194
- Goverde, P. 2208.6
- Goyal, M. P-474
- Gozzo, C. **P-21**
- Gradinariu, G. P-732
- Graef, K. P-435
- Gramegna, L.L. P-436
- Granata, G. **P-226**, P-252
- Grange, R. **P-494**
- Grass, M. P-438
- Grasso, R.F. **2705.4**, P-349, P-378, P-576, P-577, P-579
- Grasu, M.C. P-605
- Gravis, G. P-494
- Gray, W.A. **201.1**, 404.3, **902.2**, **1101.5**
- Graziano, M. P-387, P-388, P-530, P-765, **P-767**
- Grebenev, E. P-385
- Greciano, S. P-786
- Greene, J. P-355, P-356
- Greene, L. 607.5, P-124, P-360, P-687, P-890
- Greffier, J. 2802.2
- Gregoire, E. P-784
- Gregorio, A. P-35
- Greiser, S. 2802.6
- Griffiths, R.I. 404.3
- Grigolini, A. P-458
- Grillo, P. P-226, P-252, P-651
- Grimm, M.O. P-881
- Gritti, A. 705.3
- Gromov, D. P-622
- Groot Jebbink, E. 1506.2
- Grosse, U. P-536
- Grözing, G. P-536
- Gruber-Rouh, T. 1406.2
- Grunwald, I.Q. P-474
- Grunwald, T. 2802.6
- Grünwald, J.P.C. **P-897**
- Guazzaroni, M. P-175, P-466
- Gübitz, M. **P-49**
- Guerin, L. P-762
- Guerreiro, H. **P-901**
- Guerrero, J. P-147
- Guerrero Hernandez, M. P-20, P-379
- Guerrieri, R. P-904
- Guersen, J. 706.2, P-763
- Guesnier, M. 706.2
- Guglielmo, F. P-453, P-589
- Guigui, J. P-598
- Guillén, G. P-614
- Guillet, B. 1407.6
- Guimaraes, M. **304.3**, **2702.1**
- Guirola, J.A. P-35, P-147, P-646
- Guitart, J. 3105.7
- Guiu, B. **905.1**, 2207.6, 2802.2
- Gul, A. 607.2
- Gulati, G.S. P-1
- Gulia, A. 2305.7
- Gullipalli, R. P-705
- Gummalla, K. 3008.2
- Gunji, N.K. **P-230**
- Gunn, A.J. 1505.6, P-552, P-572, P-574
- Günther, R.W. P-231
- Guo, C.Y. 1406.6
- Gupta, A.K. P-129, P-369, **P-375**, P-628, **P-655**, P-732, **P-917**
- Gupta, S. P-583
- Gupta, Y. P-6
- Gurevich, M. P-644

Gurgitano, M. P-105
 Gursale, A.A. **P-667**
 Gutiérrez Ramírez, M.C. P-246
 Gutowski, P. P-291
 Guzzardi, G. 3106.1, P-492
 Gwon, D.I. 2207.7, P-23, P-219, P-441, P-848, P-914
 Gyánó, M. 706.6, 1408.6, **P-15**, P-448, P-450, P-451

H

Habermann, C.R. 706.5, 706.7, P-769, P-770
 Habib, A.-R. P-55, P-56, P-57
 Habib, N. 704.2, 2304.6, 3106.3, P-370
 Habib, S. P-900
 Hackert, T. P-248, P-640
 Hacking, N. 2206.4, P-208
 Haders, F. P-565
 Hadi, M. **P-10**, **P-166**, **P-352**, P-893
 Hadjichristou, N. P-369
 Hadjivassiliou, A. 2802.4, P-155, P-652
 Hage, A. P-905
 Hahn, F. **P-532**
 Haimoto, S. P-102
 Hak, J.-F. 1407.6, P-711
 Hakim, W. P-317
 Hakyemez, B. P-480
 Halak, M. P-697
 Hall, T. **P-900**
 Hallal, N. P-704
 Hallisey, M.J. P-403
 Halpin, J. P-839
 Hama, M. **P-343**
 Hamada, M.A.S. **P-504**, P-941
 Hamady, M.S. 607.2, 1408.3, 3105.5, P-13, P-316, P-317, P-625
 Hamaguchi, S. P-18, P-257, P-498
 Hamamoto, S. P-300, P-324, P-849
 Hamanaka, Y. P-382
 Hamm, B. 2004.5, P-217
 Hammerstingl, R. 1406.2
 Han, K. 3008.6, P-521
 Han, S. **P-386**
 Hanna, L. **1408.3**
 Hannallah, J. P-903
 Haralampopoulos, G. P-122
 Harbater, O. 1407.7
 Harborne, K. 706.4
 Harders, F. P-566
 Harding, J. P-885
 Hardwigsen, J. P-784
 Harisis, G. P-921
 Harris, M.R. 2206.4, P-208
 Hartley-Blossom, Z. **1505.1**
 Harward, S. P-502
 Hase, M. P-277, P-666, P-852
 Hasebe, T. **306.2**, P-87, P-95, **P-354**, P-726
 Hasegawa, T. P-63, **P-71**, P-102, P-162, P-529, P-603, P-611
 Hasegawa, Y. P-133, P-164, P-440
 Hashem, E.Y. 2206.3
 Hashida, K. 306.2
 Hashimoto, K. P-18, P-257, **P-498**
 Hashimoto, T. 1408.7, P-289, **P-298**
 Hashizume, T. P-307
 Haskal, Z.J. P-757
 Hassaballa, A.S. P-5
 Hassan, F. 705.4
 Hassel, F. 607.6
 Hatamikia, S. **P-760**
 Hatopp, A. P-248
 Hattori, K. P-102
 Hausegger, K.A. 404.2, **606.4**
 Hawkins, C.M. P-116
 Hawthorn, B.R. **P-149**, P-413
 Hay, C. P-139
 Hayami, S. P-170
 Hayashi, N. **P-267**, **P-338**
 Hazar, C. **P-243**, **P-797**, P-799
 He, K. P-531
 He, K.S. **P-531**, P-555
 He, Y. **3104.4**, **P-471**
 Healey, T. 1505.1
 Healy, D. P-719
 Healy, G.M. P-394, P-906
 Heilala, A. **P-421**
 Heindel, W. P-565, P-566
 Heinzl, A. 2207.2, 2207.3
 Heiss, C. P-143
 Heller, T. **P-875**, **P-926**, **P-927**, P-933
 Helmberger, T.K. **302.6**
 Hemingway, A.P. P-418
 Hendriks, P. **P-528**
 Henkes, H. 1407.3
 Hennebray, J.B. 607.5, P-124, P-360, P-687, P-890
 Henedige, T. 2207.5
 Hennemeyer, C. P-903
 Hennessy, M. P-163, **P-304**, P-717
 Hennessy, N. P-600
 Héon, H. P-512
 Hérin, E. P-335
 Hernandez Conte, A. P-938
 Hernandez Morales, D. P-436
 Hernández Villegas, A.C. P-379
 Hernesniemi, J. P-295
 Herten, M. 1408.4, P-308
 Heverhagen, J. P-153, P-551
 Hickson, G. 706.4
 Hidal, J.T. 705.5
 Higaki, M. P-95
 Higashigawa, T. 1408.7, P-289, P-298
 Higashihara, H. P-158, P-337
 Higuchi, S. **P-294**
 Higuchi, T. P-416, P-821
 Hilgers, K.F. 3106.7
 Hilliard, N. P-725
 Hillman, D. P-421
 Hinrichs, J.B. 2306.6, P-430, P-573
 Hirakawa, M. **P-511**
 Hiraki, T. P-67
 Hiramatsu, H. P-266
 Hirota, T. P-338
 Hirschberg, S. **P-644**
 Hitpaß, L. **2304.7**
 Ho, S. 2802.4, P-652
 Hocquet, A. 2004.6
 Hoff, A.O. P-125, P-639
 Hoffman, C.A. **P-428**, **P-429**, **P-437**
 Hoffmann, R. P-536
 Hoffmann, R.-T. P-871
 Hofmann, L. P-916
 Hohl, C. **301.2**
 Holden, A. **601.2**, **701.6**, **1002.4**
 Holewijn, S. P-911
 Holtzman, N. 1407.7
 Homola, M. P-764
 Hong, H.P. P-556
 Hong, K. 704.4, P-407
 Hong, K.C. P-718
 Hongyo, H. P-273, P-337
 Hopf-Jensen, S. **2503.3**
 Hopkins, T. P-101
 Hori, Y. 3104.3, P-294
 Horinouchi, H. P-504
 Horny, M. P-400
 Hoshino, E. P-200, P-850, P-930
 Hosoi, K. P-257
 Hotta, A. P-354
 Houlihan, D. P-394
 Houston, J.G. 1506.5, P-478, P-925
 Howard, D. P-10
 Hrechikhin, H. P-606
 Hsu, M. P-793
 Hu, H.T. 1406.6
 Hu, Z. P-838
 Huang, C.-C. **P-602**
 Huang, H.L. 2207.5
 Huang, I.K.H. P-138
 Huang, L. P-14
 Huang, M. 2304.4
 Huang, S. P-109
 Huang, X. P-14
 Huber, G. P-901
 Huber, T.C. **P-306**
 Huespe, P. 704.7, P-76
 Hughes, D.R. P-400
 Hui, J. P-916
 Hui, M.H. P-669
 Hui, T.C.H. **P-350**
 Huml, K. P-764
 Hunt, S. P-520
 Huo, Y.R. **P-55**, **P-56**, **P-57**, **P-490**
 Huppert, P.E. **3102.2**
 Hur, J. 2207.7, **P-23**, P-441, P-848
 Hur, S. 2207.1
 Hussain, A. 704.3, **P-26**, P-279
 Hustinx, R. 3106.2
 Hutchinson, C. P-885
 Hutt, K. P-729
 Hwang, G. 2004.2
 Hwang, J.H. **P-199**
 Hynes, D. **P-48**, **P-675**
 Hyodo, R. P-619
 Hyon, S.H. **704.7**, **P-76**
 Hyun, D. P-681, P-907

I

Iannelli, M. P-878
 Ianni, G. P-466

- Iarussi, T. P-515, P-593
 Ichihashi, S. P-330, P-333, **P-715**, P-726, **P-751** 3104.3
 Ide, S. P-38, P-39, P-112, P-202, P-236, P-252, P-376, P-383, P-414, P-623, P-658
 Ierardi, A.M. 1406.7, P-151, P-645
 Iezzi, R. P-366, P-380, P-892
 Ignotus, P. **P-67**
 Iguchi, T. P-50
 Ihara, K. P-493
 Iizuka, Y. **P-315**
 Ikeda, O. **P-265**, P-842
 Ikenaga, S. P-170, P-343
 Ikoma, A. **P-750**, P-756
 Ilgit, E.T. **P-144**, **P-146**, **P-542**
 Iliadis, G. P-169
 Ilyas, S. P-303
 Imada, H. P-306.2, P-346, P-354
 Imai, Y. **P-72**, P-493
 Imamine, R. P-629
 Imawari, M. **P-249**
 Imran, M. P-63, P-102
 Inaba, Y. P-814, P-870
 Inaoka, T. **P-174**
 Incandela, F. P-524
 Inchingolo, R. P-79
 Infante, M. **P-325**
 Inmutto, N. P-346
 Inoue, A. P-604
 Inoue, D. P-777
 Inoue, K. **P-277**, **P-666**, P-726, **P-852**
 Inoue, M. P-315
 Inoue, S. P-294
 Insausti Gorbea, I. **3202.4**
 Inui, S. P-200, P-850
 Ioannidi, M. **705.1**
 Iraha, T. P-18, P-290
 Irani, F. **2207.5**, 3008.2
 Irani, Z. P-928
 Iriz, E. P-750
 Irurzun, J. **2504.1**, P-232, P-653
 Isaev, D.E. **P-326**
 Isfort, P. 2207.2, 2207.3, 2304.5, 2304.7, P-519, P-523, P-549
 Ishida, N. P-303
 Ishii, K. P-201, P-203, P-586, P-724, P-791, P-899
 Ishikawa, M. P-768
 Ishikawa, R. P-814
 Ishimatsu, K. P-509
 Ishisaka, Y. P-255
 İşik, B. P-29, P-30
 Isoardo, T. 1407.4
 Isoda, H. P-493
 Itkin, M. **P-656**
 Ito, C. P-529, P-603
 Ito, K. P-50
 Ito, N. P-277, P-666, P-852
 Itoh, C. P-71
 Itoh, H. P-341
 Itoi, T. P-525
 Itou, C. P-611
- Ittrich, H. P-901
 Iturralde Garriz, A. **P-650**
 Ivanenko, A.N. P-749, P-846
 Iwai, K. P-273
 Iwai, T. P-346
 Iwakoshi, S. P-330, P-715, P-751
 Izaaryene, J. **P-491**, P-494, **P-560**
 Izawa, Y. P-808
 Izumi, N. 705.7, P-629
 Izumozaki, A. P-296
 Izzo, A. 1204.3, **P-110**, P-111, P-390
- J**
- Jackson, J. P-655
 Jackson, J.E. P-141, P-820
 Jackson, J.I.F. **P-628**
 Jacob, F. P-707
 Jacquier, A. P-711, P-784
 Jaffer, O.S. 704.3
 Jaffro, M. P-4
 Jagia, P. P-1, **P-465**
 Jagoda, P. P-861
 Jairath, N. P-905
 Jalaieian, H. P-48, P-675
 Jalaie, H. **104.5**, **304.4**, P-620
 Jamil, O. **P-47**
 Jandurova, L. 2004.4
 Jang, H. **P-472**
 Janne D'Othee, B. P-48, P-675
 Jannone, M.L. P-869
 Jaraysa, Y. 1406.2
 Jargielto, T. P-28, P-256, P-399, P-417, P-661
 Jarmin, M. P-679
 Jaschke, W. **1301.1**
 Jazmati, T. P-47
 Jedrzejczak, T. P-291
 Jehanzeb, Q. P-674
 Jelitto-Gorska, M.M. P-674
 Jenkins, M.P. **P-81**, **P-82**
 Jenkins, P.E. P-317
 Jennings, J.W. P-2, P-9, **P-69**, **P-310**, P-314
 Jeon, C.H. 2305.1, **2705.3**
 Jeon, G.S. P-948
 Jeon, Y.S. **P-423**
 Jeong, Y.S. P-718
 Jesurajan, J. 1406.5, 2207.1
 Jhaveri, A. P-550
 Jia, J.B. **P-446**
 Jia, Z. P-935
 Jiang, T. **2208.1**, **P-778**
 Jiang, Z. P-27
 Jiaping, L. 2304.4
 Jin, D. P-145, P-534, P-538
 Jinzaki, M. P-262, P-696
 Joe, W. P-277, P-666, P-852
 Jog, V. 1505.6, P-552, P-572, P-574
 Jogo, A. 2306.7
 Johnson, D.T. P-300, P-324, P-849
 Johnson, E. 304.3, 2702.1
 Jonczyk, M. P-66
 Jones, R.G. 2004.5, **P-217**, **P-442**, P-636
- Joshi, R. P-189, P-251
 Joseph, T. 2802.3
 Joshi, A.S. P-902, P-915, P-944
 Joshi, D. **P-6**
 Joshi, S.S. **P-902**, P-915, P-944
 Jouannic, A.-M. P-439
 Joudanin Seijoo, J. P-597
 Juarez Marazzo, P. P-113
 Judd, R. P-372
 Julien, T. P-762
 Jumaa, K. **2207.4**
 Junaide, S.E. P-361, P-670
 Jung, H.D. P-218, P-608
 Juracek, J. 1407.1
 Jurca, I. **P-445**
 Juza, T. 704.1, **P-342**
 Jüni, P. **201.3**
- K**
- Kaanan, C.I. P-528
 Kadoba, T. P-201, P-203, P-377, P-586, P-724, P-791, P-899
 Kadowaki, M. P-266
 Kafity, N. P-363, **P-824**, P-830, P-831, P-833, P-835, P-940
 Kaga, T. P-303
 Kageyama, K. P-300, P-324, P-849
 Kaito, D. P-808
 Kajihara, A. P-827
 Kajita, K. P-303
 Kajiwara, K. **P-62**, P-508, **P-777**
 Kakeda, S. P-476
 Kakihara, D. P-509
 Kalami, T. P-406
 Kaliev, A. P-744
 Kalmath, S. **P-234**, **P-601**
 Kalra, N. 1204.6, P-410
 Kamada, K. P-518, P-747
 Kamei, S. 306.2, P-87, P-95, P-354
 Kamisako, A. P-170, P-343
 Kamiya, M. **P-266**
 Kamiya, N. P-814
 Kammermeier, J. P-369
 Kamo, M. **P-680**
 Kamomae, T. P-619
 Kanas, A.F. **P-282**
 Kanasaki, S. **P-382**
 Kanazawa, S. P-67
 Kaneshiro, T. P-912
 Kang, B. 1406.5, 2207.1
 Kang, C.H. P-258
 Kang, H.-Y. **P-104**
 Kang, M. 1204.6, P-410
 Kang, U.R. **P-779**
 Kang, Y.J. P-218, P-434, **P-516**, P-608, P-677
 Kania, L. P-453, P-589
 Kankani, K. P-902, P-915, P-944
 Kano, R. P-416
 Kano, T. 705.7, P-629, P-630
 Kanou, R. P-133, P-164
 Kansagra, K. **P-485**, P-659, P-935, **P-938**
 Kapoor, A.K. **P-37**
 Kappadath, S.C. P-581

- Karaddi, N.K. 3008.2
 Karashima, T. P-777
 Karatoprak, S. P-29, P-30
 Karkhanis, S. P-241, P-599
 Karnabatidis, D. 608.2, P-24
 Kartashov, M. P-385
 Karul, M. 706.5
 Karunanithy, N. **104.3, P-114**, P-168, P-180, P-181, P-369, P-628, P-655, P-917, P-936
 Kase, K. P-808
 Kashani, N. P-474
 Kashef, E. P-418, P-790, P-937
 Kashiwagi, N. P-201, P-203, P-377, P-586, P-724, P-791, P-899
 Kassamali, R.H. **P-642, P-921**
 Kasthuri, R. P-571
 Kasuya, S. P-814, P-870
 Kato, H. **P-404**
 Kato, K. P-808
 Kato, M. P-63, P-102
 Kato, N. 1408.7, P-289, P-298
 Kato, S. P-63, P-814
 Kato, Y. P-266
 Katsanos, K.N. **201.2**, 608.2, P-24, P-732
 Katsargyris, A. 1408.6
 Katsari, S. P-149, P-664
 Kattipatanapong, T. P-325
 Katz, M. 2306.5
 Katzen, B.T. **2704.1**
 Kauczor, H.U. P-248, P-640
 Kauffmann, J.R. P-282
 Kaufman, C. **2305.3**, P-264
 Kaufman, J.A. **101.1, 2502.4**, P-384
 Kavnoudias, H. 2802.3, P-921
 Kawa, B. P-366, **P-380, P-892**
 Kawada, H. **P-303**, P-686
 Kawaguchi, N. P-867
 Kawahara, S. P-493
 Kawahara, Y. P-278, P-738
 Kawai, N. P-303, P-686
 Kawamata, H. P-912
 Kawamoto, S. P-402
 Kawasaki, R. P-700, P-726
 Kaya, J.-M. 607.6
 Kazimierzczak, A. **P-291**
 Kcholcheva, N. P-920
 Kearns, D. 2206.7
 Keasler, E. 1505.6, P-552, P-572
 Kedev, S.A. 3104.1
 Kee, S. **1704.3**
 Keefe, N. **P-757**
 Keelan, S. **P-719**
 Kehagias, E. P-920
 Keil, S. P-519, P-549
 Kelekis, A.D. **203.2**, 705.1, P-24, P-122, P-123, P-146, P-502, P-542
 Kelekis, N.L. 705.1, **2604.1**, 2605.5, P-122, P-123, P-146, P-502, P-542, P-570
 Kemp, S. P-380
 Kenawi, A. P-89
 Kennedy, C. P-65
 Kenning, L. 1506.3
 Keny, A. P-938
 Kepuladze, O. 3106.3, P-370
 Kettenbach, J. P-760
 Khafagy, R.T.M. 2206.3
 Khaitovich, B. P-697
 Khajja, M. P-318, P-319, P-322, P-323, P-363, P-824, P-833
 Khamidova, L. P-326
 Khan, A. P-903
 Khan, K. **1408.5**
 Khan, N. P-295
 Khan, S. P-167
 Khan, Z.A. P-913
 Khandelwal, P. P-902, **P-915**, P-944
 Khankan, A.A. **P-89**
 Kharazov, A. **P-744**
 Khati, I. **P-784**
 Khayrutdinov, E. **P-622**
 Khera, P.S. **P-847**
 Kiakidis, T. P-502
 Kichikawa, K. P-330, P-333, P-715, P-726, P-751
 Kieffer, C. P-152
 Kijima, S. P-278, P-738
 Kikuchi, H. P-814, P-870
 Kilbridge, M. P-222
 Killguss, H. P-248
 Kim, C.W. **306.1**, P-948
 Kim, D.-I. P-907
 Kim, D.R. P-367
 Kim, E.H. P-559
 Kim, E.T. 608.7, P-858
 Kim, G.M. 3008.6, P-521
 Kim, H.-C. 1406.5
 Kim, H.-O. P-218, **P-434**, P-516, P-608, **P-677**
 Kim, H.S. **P-559**
 Kim, I.J. 608.7, P-423
 Kim, J. P-3, P-302, P-632, P-690
 Kim, J.-H. **3301.3**
 Kim, J.H. 2207.7, P-23, P-199, P-441, P-848
 Kim, J.K. P-218, P-434, P-516, P-608, P-677
 Kim, J.S. P-344, P-345
 Kim, J.W. 2207.7, P-23, **P-219**, P-302, P-441, P-848, **P-914**
 Kim, J.Y. **2207.7**, P-23, P-441, P-848
 Kim, K.Y. P-344, P-345
 Kim, M.D. 3008.6, P-521
 Kim, M.S. **P-556, P-907**
 Kim, M.U. P-192, P-616
 Kim, S. **P-761, P-766**
 Kim, T. **2306.2**
 Kim, Y. P-206
 Kim, Y.H. P-183, P-353, P-779
 Kim, Y.J. P-176, P-367, P-368
 Kim-Fuchs, C. P-153
 Kimura, K. P-856
 Kimura, S. P-71, P-162, P-529, P-603, **P-611**
 Kimura, Y. P-158, **P-337**
 Kind, K. P-638
 Kinoshita, M. P-700
 Kiproff, P. P-167
 Kirstein, M. 2306.6, P-430, P-573
 Kis, B. **1505.4**
 Kisiaki, S. P-133, P-164, **P-240**, P-440
 Kiselew, A.D. **P-749**, P-846
 Kishida, H. P-330, P-751
 Kishida, N. P-618
 Kishimoto, N. P-324
 Kishino, M. **P-856**
 Kisilevsky, N. P-285
 Kiso, K. P-294
 Kiss, J. P-448
 Kiss, J.P. 706.6, 1408.6, P-450
 Kisza, P. P-85, P-86
 Kitagaki, H. P-868
 Kitamura, E. P-484
 Kitamura, N. P-814, P-870
 Kitazume, Y. P-856
 Kitrou, P.M. 608.2, **608.5, 1804.3**, P-24
 Kiyosue, H. **3104.3**, P-276, P-872
 Klass, D. **2802.4, P-155, P-652**
 Kleedehn, M. **2306.7**, P-53
 Klein, W. P-662
 Klejch, W.J. **P-372**
 Kloeckner, R. P-340, P-532, **P-637**
 Klompenhouwer, E.G. P-561, P-562, P-563
 Klotz, E. 2206.1
 Knebel, J.-F. 2004.6
 Knuttinen, M.-G. P-88
 Ko, I. P-761, P-766
 Ko, S. P-813
 Kobayashi, M. P-341, P-433, P-618
 Kobayashi, S. P-296, P-339, P-604
 Kobayashi, T. P-774
 Kobe, A. **2206.1**
 Kobeiter, H. P-335
 Koch, G. 2004.1, 3301.4, P-100, P-107, P-117
 Köcher, M. **P-469**, P-764
 Kocijančič, I.J. P-99
 Koda, W. P-296, P-339, P-604
 Kodani, E. P-783
 Koehler, M. **P-565, P-566**
 Koganemaru, M. **P-237**, P-245, **P-415**, P-558
 Kohli, A. **P-539**
 Kohn, S. P-493
 Koide, Y. P-504, **P-941**
 Koike, M. P-343
 Koitabashi, N. P-280
 Kok, H.K. 2802.5, P-634
 Kokabi, N. P-260, P-400, P-553, P-557
 Kokov, L.S. P-326
 Koledinskii, A.G. P-754
 Kolhe, M. P-669
 Komada, T. **P-619**
 Komaki, T. P-67
 Komura, Y. P-737, P-741
 Kondo, H. P-200, P-768, P-774, P-850, P-930
 König, A.M. P-156
 Konijn, L. 404.5
 Kono, A. P-294
 Konstantopoulos, D. **P-24**
 Konstantos, C. P-570
 Koo, B. P-725

- Koo, S.-L. 2207.5
 Kopetsch, C. 3104.2
 Kopetz, S. P-359
 Korogi, Y. P-476
 Koskinas, J. P-502
 Kotecha, D. P-788
 Kotoku, A. P-18, P-290
 Kotoku, J. P-768, P-774
 Kotta, P.A. P-43, P-798
 Koukounaras, J. 2802.3, P-642
 Koukourou, A. P-773
 Kountouras, D. P-502
 Kovács, A. **2206.2**
 Kowald, T. P-334
 Koyama, T. P-72, P-170, P-255, P-343
 Koyashiki, Y. **P-278**, P-738
 Kozachenko, A. P-412
 Kozakova, V. P-328
 Kozerke, S. 2802.6
 Kozlova, A. P-412
 Krajina, A. **2703.6**
 Kral, M. P-469
 Krasnoselskyi, M. P-606
 Kratimenos, T. **1705.3**
 Kratz, K.M. P-771
 Kresic, E. P-73, **P-259**, P-445
 Kriegshauser, J.S. **P-88**
 Krings, T. P-358, P-446
 Krishnamurthy, V. P-386
 Kroencke, T.J. P-812
 Krokidis, M.E. P-725, P-828
 Kronreif, G. P-760
 Kryveshko, A. **P-631**
 Kubale, R. 3105.3, P-299
 Kuban, J. P-109, P-581, P-596
 Kubiak, A. **P-85**, **P-86**
 Kubo, T. P-71, **P-162**
 Kubota, M. P-18
 Kücükçaya, A.S. P-231
 Kuczyńska, M. P-28
 Kudaev, Y. P-329
 Kufuji, D. P-180, P-369
 Kugiyama, T. P-237, P-245, P-415, P-558
 Kuhara, A. P-237, **P-245**, P-415, P-558
 Kuhelj, D. **P-99**
 Kuhl, C.K. 2207.2, 2207.3, 2304.5,
 2304.7, P-519, P-523,
 P-549
 Kühn, J.-P. P-871
 Kujirai, D. P-808
 Kuklik, E. P-28
 Kulbak, V. P-744
 Kulcsar, M.A.V. P-125, P-639
 Kulkarni, A.V. P-446
 Kulkarni, S.S. 2305.7, P-526, P-663
 Kum, S. **701.2**
 Kumar, G. P-943
 Kumar, P. 3008.2, P-734
 Kumar, S. 2305.5, P-1, P-207, P-313
 Kumita, S.-I. P-341, P-783, P-807
 Kunitomo, N. P-278, P-738
 Kuo, W.T. P-916
 Kuriu, A. P-269
 Kurosaki, M. 705.7
 Kurose, T. P-433, P-618
 Kurtasov, D.S. **P-754**
 Kurup, A.N. **3004.3**
- Kusmierczuk, M. **1506.7**
 Kusumoto, M. P-71, P-162, P-529, P-603,
 P-611
 Kutlu, R. **P-29**, **P-30**
 Kütting, D. 1407.2, 3106.5
 Kuwamura, H. **P-46**
 Kwak, J.W. P-183
 Kwan, J. P-138
 Kwiecinski, J. P-352
 Kwon, H. **P-948**
 Kwon, J.H. 3008.6, P-521
 Kwon, S.H. **P-454**, **P-455**, P-836
 Kwon, Y. P-3, P-302, P-632, P-690
 Kyaw Tun, J. **704.3**, P-279, P-889
 Kyuragi, R. P-715
- ## L
- La Corte, F. P-331
 Laasch, H.-U. **3102.4**, P-340
 Lachenmayer, A. P-153, P-551
 Laenen, A. P-562
 Laeseke, P.F. 2304.1, 2306.7, P-428,
 P-429, P-437, P-898
 Laghi, A. P-657
 Lahoti, A.M. **P-633**
 Lakshminarayan, R. 1506.3, P-931
 Lal, A. P-410
 Lam, J. P-403
 Lam, L. P-679
 Lam, M.G.E.H. P-585
 Lamanna, A. P-854, P-863
 Lambert, G. **1504.5**
 Lamborelle, P. 3106.2
 Lamus, D. P-943
 Lanaret, M. P-763
 Lanciego, C. **3102.1**, P-35
 Landgraf, L. 2802.6
 Langhoff, R. 3104.1
 Langleib, M. **P-832**
 Langley, N.R. P-88
 Lanza, E. P-94, P-205, P-510, P-909
 Lapteva, M.G. P-74, **P-501**
 Larger, E. P-730
 Latic, I. **2305.2**, P-32
 Lauretti, D.L. P-458
 Laurino, F. P-657, P-703, P-828
 Lavian, J.D. P-401
 Lazzarin, M. P-78
 Lazzarotti, G.A. P-458
 Le Roy, J. 2802.2
 Lea, W.B. **2705.2**
 Leati, G. P-312
 Lebedev, S.S. P-19
 Leclerc, L. **P-117**
 Lee, B.C. **P-218**, P-434, P-516,
P-608, P-677
 Lee, D.K. **P-183**
 Lee, D.Y. 3008.6
 Lee, F. 2305.2
 Lee, G. **P-823**
 Lee, H.G. P-559
 Lee, H.N. **P-681**, P-813
 Lee, I.J. P-302
 Lee, J. 3008.6, P-521, P-921
 Lee, J.H. 608.7
- Lee, J.M. P-3, P-176, **P-258**, **P-632**,
P-690, P-787
 Lee, K.H. P-559
 Lee, M.J. 2802.5, 3105.4, P-160,
 P-634
 Lee, S. P-183
 Lee, S.-H. 2306.2, P-104
 Lee, S.H. P-353
 Lee, S.J. P-423
 Lee, S.M. P-397, **P-624**
 Lee, W.-H. P-258, P-813, P-883
 Lee, X.W. 2207.5
 Lee, Y.U. P-397
 Leger, T. **P-865**
 Leggieri, R. P-515, P-593
 Legiehn, G. P-652
 Lehmann, T. P-881
 Leifels, L. **P-612**
 Leitão, J.B. P-128
 Lembranca, L. P-84
 Lencioni, R. **1703.2**
 Lenz-Habijan, T. **1407.3**
 Leon Guevara, D. P-597
 Leon Rocha, B. P-288
 Leoncini, A. **P-17**
 Leong, S. 3008.2, 3106.6, P-103
 Leroy, F. P-762
 Levy, J. P-101
 Lewandowski, R.J. P-216, P-580
 Lewis, M. P-804
 Lewis, T.K. **P-136**
 Leyva Vásquez Caicedo, M. **P-45**, **P-253**, **P-254**,
P-481, **P-660**
 Li, C. **2802.1**
 Li, D. P-535
 Li, H.L. 1406.6
 Li, K. **P-464**
 Li, M. 2304.4
 Li, X. P-336
 Lian, F. P-495, P-513
 Liang, B. **P-507**
 Libra, F. P-349, P-378, P-420,
P-934
 Lichliter, A. **P-853**, P-918
 Lichtenberg, M. **404.6**, **1504.1**, **1504.3**,
2208.6
 2207.2, 2207.3
 Liebl, M. P-105
 Liguori, A. **P-457**
 Lim, D.Y. P-544
 Lim, E. P-138
 Lim, G.H.T. 2207.5
 Lim, K.H. 2802.5, P-634
 Lim, R. **P-571**, P-874
 Lim, S.H. P-896
 Lima, A. **P-84**
 Lima, C. 1407.5, P-583
 Lin, E.Y. **P-116**, P-148, **P-173**,
 P-222
 Lindquister, W.S. **P-295**
 Lindström, I.A. P-235
 Line, P.-D. **P-705**
 Linehan, V. **P-27**, P-372
 Lionberg, A. P-602
 Liou, J.-Y. P-744
 Lisin, S. 2206.7, **2306.1**, P-207
 Little, M.W.

- Liu, B. P-464
 Liu, C. **P-41, P-535**
 Liu, D.M. 2802.4, P-155, P-555, P-652
 Liu, F. P-336, P-503
 Liu, H. P-145, P-495, P-513, P-534, P-538
 Liu, Y. P-145, P-495, P-513, P-534, P-538
 Llewellyn, O. **3105.5**
 Lo, R.H.G. 3008.2
 Lobeek, D. P-662
 Loeschner, S. **P-713**
 Logeman, J. 1505.4
 Loh, P.-L. 2306.7
 Lohle, P.N.M. **305.3, 3105.6**
 Loke, K. 2207.5
 Lombardo Galera, S. 3105.1, P-177, P-860, P-882
 Lonjedo, E. P-463, P-801
 Loos, M. P-248, P-640
 López Rueda, A. P-477
 López Zárraga, F. P-650
 Lopez-Benitez, R. P-33
 Lorenzoni, G. P-866
 Louie, J. 608.4
 Lourenco, P. P-381
 Lu, H. **P-198**
 Luca, A. P-844, P-845, P-939
 Lucarelli, N.M. P-83, P-473, P-515, P-593
 Lucatelli, P. P-443
 Lucente, G. **P-426, P-753**
 Lučev, J. P-720
 Luchkin, V. P-744
 Luedemann, W.M. **P-231, P-649**
 Luerken, L. **P-546**
 Lui, I. P-55, P-56, P-57
 Lukić, B. P-332
 Lummer, K.B. **P-374**
 Lunardi, A. **905.3, P-250**
 Lund, G. P-438
 Luo, J. **2304.4**
 Luo, Y.-H. **P-408**
 Lupescu, I. P-605
 Lurje, G. 2304.5
 Lutereau, J.F. 1504.5
 Lutman, F.R. P-94
 Luzi, M. P-436
 Lylyk, P. P-285
- M**
- Ma, G.M.Y. **P-134, P-358, P-446, P-484**
 Maaloul, F. **P-762**
 Maas, C. 607.4
 Macchi, E. P-293
 Macchini, M. **P-272, P-781, P-785**
 Macdonald, A. 2206.5, P-223
 Macdonald, A.C. **2206.7, P-36, P-891, P-893**
 MacDonald, K. P-512
 Machan, L. P-652
 Machenko, I.P. P-374
 Macho Fernández, J.M. P-477
 MacKinnon, T. 2206.7
 Maclean, D. 2206.4, P-208
 Macpherson, R. 2206.7
 Madoff, D.C. **905.2**
 Maeda, S. P-333
 Maeder, R. 706.1
 Maegawa, S. P-354
 Maessen, M. 404.5
 Maestretti, G. 607.6
 Mafeld, S. P-11
 Maffei, M. P-17
 Magaribuchi, T. P-255
 Magazzeni, M. P-182
 Maggi, L. **P-594**
 Magnus, M. **P-275**
 Mahmood, S.U. **P-788**
 Mahmoud, H. 607.2
 Mahmoud, K. 1505.6, P-552, P-572, P-574, P-876
 Mahn, J.J. P-132, **P-319, P-322, P-323, P-363, P-461, P-486, P-488, P-824, P-830, P-831, P-833, P-835, P-940**
 Mahnken, A.H. **2605.6, P-156, P-704**
 Mähringer-Kunz, A. P-532
 Mahvash, A. **P-581**
 Maiettini, D. P-496
 Mailli, L. P-149, P-413, P-664
 Maingard, J. 2802.5, P-634
 Maiwald, B. P-612
 Makris, G.C. P-36, P-311, P-411, P-929
 Malagari, K. **3201.2, P-502**
 Malekzadeh, S. **P-439**
 Maleux, G. **1407.7, P-562, P-563**
 Malhotra, R. 2305.5
 Mali, W.P.T.M. 404.5
 Malka, V. P-679
 Mallon, D. 3105.5, P-790
 Maltzef, N. P-175, P-466
 Mancini, A. P-178, P-706, P-710
 Mandal, I. P-544
 Mandinga, W.B. P-896
 Mandruzzato, N. **P-878**
 Manenti, G. P-568
 Manfredi, R. 1406.7, P-645
 Mangiafico, S. **2703.3**
 Mansueto, G. P-727, P-878
 Manyonda, I.T. P-413
 Manzi, M.G. **701.4**
 Marabelle, A. 1407.4
 Marcato, C. 705.3, P-425, P-648, P-740, P-837
 Marcia, S. **203.4, 607.6, P-175, P-626**
 Marcos, V.N. P-125, P-639
 Marek, P. 1504.2
 Maresca, D. **P-647**
 Margaritora, S. P-645
 Mărginean, L. P-615
 Marín Suárez, Á. P-477
 Marini, S. P-175
 Mariotti, G.C. 705.5
 Maritati, G. P-753
 Marko, X. P-824
 Marquez, S. P-106
 Marrocchio, C. 607.1, **2305.4, 2305.6, 3008.7, P-126**
 Marsico, S. **P-568**
 Martin, H.S. P-281, P-692
 Martin, L.G. P-553
 Martin, S. 1406.2
 Martín Sanchez, A. 104.2
 Martinetti, L. **P-708**
 Martinez Cutillas, M.J. **P-246**
 Martinez Roje, N. P-288
 Martinez Saez, E. P-436
 Martino, M. P-118
 Martins, R.B. P-84
 Maruhashi, T. P-290
 Marukyan, N. **1504.6**
 Maruno, M. **P-276, P-872**
 Maruyama, K. **P-700**
 Maruyama, M. P-868
 Maruzzelli, L. P-759, P-844, P-845, P-851, P-939
 Masala, S. **904.2**
 Mascagni, L. **P-496, P-703**
 Maschke, S.K. 2306.6, P-430, P-573
 Masciocchi, C. 1204.3, P-110, P-111, P-115, P-118, P-120, P-390, P-470, P-841
 Maslennikov, M. P-348
 Maslov, A. P-744
 Massari, F. **P-101**
 Massmann, A. **3105.3, P-299, P-861**
 Masson, N. P-874
 Mastrolonardo, E. **P-935**
 Masuda, H. P-814
 Masuda, K. P-238
 Matchar, D. 3008.2
 Mathy, R.M. **P-533, P-582**
 Matkulčik, P. 704.1, 2004.4, P-342
 Matsuda, H. P-294
 Matsui, S. P-266, P-852
 Matsui, Y. P-67, **P-133, P-164, P-238, P-416, P-440**
 Matsumoto, J. P-296, P-339, **P-604**
 Matsumoto, S. P-276, P-872
 Matsumoto, T. 306.2, **P-87, P-95, P-354**
 Matsumura, K. P-808
 Matsumura, T. P-619
 Matsuo, M. P-303, P-686
 Matsuo, E. P-354
 Matsushima, M. P-619
 Matthaiou, N.V. **P-920**
 Mattolin, C. **P-78**
 Matzko, M. **305.5**
 Maurer, M.H. **P-153, P-551**
 Mauri, G. 3105.2, P-496, P-506, P-540, **P-564**
 Maxeiner, A. P-217
 Maybody, M. P-230
 Maynar Moliner, F.J. P-650
 Mazioti, A. 705.1, P-122, P-123
 Mazioti-Filippidis, A. P-542
 Mazza, O. P-76
 Mazzaro, A. P-727, P-878
 McCafferty, I.J. P-247, P-251
 McCann, J. P-394

- McCann-Brown, J. P-923
McDevitt, J. P-905
McDiarmid, S.V. P-855
McGrane, S. P-839
McGregor, H. P-903
McHugh, S. P-719
McKenzie, S. P-224, P-225
McLean, K. P-757
McWilliams, R.G. P-829, P-923
Meccia, D.V. **P-250, P-694**, P-866
Medero, R. P-437
Mees, B. **601.4**
Mehdi, A. P-790
Mehmedovi, A. 1406.2
Mehrzad, H. P-241, P-802
Mehta, S. P-136, P-793
Meier, M.A.J. P-561
Meijerink, M.R. **102.2**
Meine, T.C. **2306.6**, P-430, P-573
Meli, A. **P-293**
Melzer, A. **2802.6**, P-612
Menard, A. **2706.3**
Mendes, G. 705.5, P-84
Méndez Alonso, S. P-287
Méndez Montero, J.V. P-45, P-253, P-254
Menendez, P.J. P-31
Menezes, C.S.S. **P-281, P-692**
Menon, K. **2004.2**
Menozzi, R. 705.3
Meo, D. **P-349**, P-378, P-420, P-934
Meram, E. P-428, P-429
Mercadante, M. P-520
Merolla, S. P-721
Messas, E. 1504.2, P-730
Meyer, B.C. 2306.6, P-430, P-573
Meyrignac, O. P-781
Mezhybovsky, V. P-644
Micelli, M.V.M. 1204.3, P-470
Michelagnoli, S. **1101.6**
Michimoto, K. **P-416**
Midiri, M. P-174
Miele, V. **1705.2**
Migliara, B. **3008.3**
Migliorisi, C. P-505, P-817, P-822, P-826, P-869, P-884, P-904
Miki, Y. P-300, P-324, P-849
Milanese, G. P-59
Miles, R. P-244
Miller, C. **P-197**
Mimura, H. P-18, P-257, P-290, P-498
Min, J. **P-210**, P-908
Minamiguchi, H. P-62, P-508, P-777
Mincarelli, C. P-785
Mine, T. P-726, P-807
Minervini, A. 2102.2, 2605.4
Minko, P. P-861
Miraglia, R. **P-759, P-844, P-845, P-851, P-939**
Mironov, O. **902.3**
Misu, M. P-852
Mitani, H. P-433, P-932
Mitchell, D. P-453, P-589
Mitchell, S. P-224, P-225
Mitreski, G. **P-854, P-863**
Mitsuhashi, T. P-67
Mittag, A. 1506.7
Miura, H. P-338
Miyabayashi, M. P-852
Miyairi, T. P-290
Miyamoto, N. **P-827**
Miyazaki, M. P-280
Miyazawa, R. P-680
Mizandari, M. **704.2, 2304.6, 3106.3, P-370**
Mo, K.M.C. **P-96**
Moattari, C.R. P-401
Moche, M. 2505.2
Mochizuki, T. P-867
Moda, P. P-515
Modestino, F. P-261
Modi, S. 2206.4, **3202.2**, P-208
Modica, A. P-349, P-378, **P-420**, P-934
Moelker, A. **3102.3**
Mohamad, A. **3105.6**
Mohammad, H. **P-527**
Mohd, S. 2305.7, P-526, P-663
Moine, L. 1407.4
Moiseeva, O. 1504.6
Molina Nuevo, J.D. **2204.3**
Molinari, N. 2802.2
Molino, J.A. P-614
Moll, X. 3106.4
Mom, T. P-641
Monaco, D. **P-515, P-593**
Monami, M. **902.6**
Mondaini, F. **2504.3**
Moneley, D. P-719
Monfardini, L. P-506, P-540
Monreal Beortegui, R. 3202.4
Monstadt, H. 1407.3
Monteleone, P.A. 1204.1, P-855
Montemezzi, S. P-79, P-424, P-578
Monzon, L. P-180, P-181, P-369
Moon, S. P-270
Mooney, S.M. P-401
Moore, K. **P-361**, P-670, P-898
Moore, K.J. **2304.1, P-53**
Moore, N. P-757
Moosavi, B. **704.5**, P-381
Mor, E. P-644
Morales, M.I. P-591
Morales García, M. P-286
Mordasini, P. **2204.1, 2503.1**
Moreira, A.M. P-282
Moreland, A. **P-407**
Morelli, F. **P-623**, P-826, P-904
Moreno, F.L. P-113, P-150
Moreno Casas, S. 104.2
Moreno Negrete, J. P-477
Morgan, D. 2306.7
Morgan, R.A. P-413
Moriarty, H.K. **1504.4**
Moribata, Y. P-255
Morici, N. P-904
Moriguchi, M. P-273
Morikawa, K. P-238
Morimoto, R. P-635
Morisaki, A. P-300, P-324
Morishita, H. 2304.2
Morita, K. P-509
Moriya, J. P-257, P-498
Moriya, T. P-842
Morkos, J. 1505.5
Morlock, M. P-438
Morosetti, D. **P-75**, P-83, P-119, **P-721, P-723, P-880**
Morris, J. P-101
Morton, C.A. **P-580**
Moschouris, H. P-502
Mosconi, C. P-261, P-672
Moser, S. P-180, P-181, P-369, P-418
Motohashi, K. P-821
Motreff, P. 706.2
Mouli, S. P-580
Moulin, B. **P-567**
Moussa, A. 1505.3, **P-522**
Moussa, N. **2504.2**, P-541, P-543
Moya, C. P-147
Moya Ochoa, C.P. P-288
Muchantef, K. 704.5, 705.6, P-179, P-196
Muglia, R. **P-205**, P-510, P-909
Mühl-Benninghaus, R. **3104.7**
Mujoomdar, A. 2207.4
Mukundu Nagesh, N. **P-263**
Mulholland, D. P-160
Müller, L. P-532
Müller, M. 1408.4, P-308
Müller-Hülsbeck, S. **404.2, 404.3, 1002.3**, 2208.6, **3104.1**, P-166
Müller-Wille, R. **303.2**
Munaó, R. P-309
Munetomo, Y. P-133, **P-164**, P-440
Murai, K. P-300, P-324, P-849
Murakami, K. P-62, **P-518, P-747**
Murakami, T. P-300, P-504, P-700, P-941
Murakami, Y. P-346, **P-476**
Muranishi, H. **P-737, P-741**
Murata, S. P-63, P-102, P-341, P-343, **P-409**, P-783, P-807, P-912
Murata, Y. **P-808**
Muratore, P. P-706, P-710
Murray, L. **P-839**
Murshed, A.S. **P-575**
Murthy, R. P-581
Musacchia, G. 2304.3
Muscogiuri, G. P-184
Mustafa, S.A.R. P-788
Mustaq, N. P-742
Musumeci, A. P-349, P-420, P-672, P-934
Mutalib, M. P-369
Muthusami, P. P-134, P-358, P-446, P-484
Muzumdar, S. **P-621**
N
Nadolski, G.J. P-520, P-656
Nagai, K. P-158, P-337, **P-444**
Naganawa, S. P-619

- Nagar, H.J. P-823
 Nagata, S. P-303, P-686
 Nagatomi, S. **P-330**, P-715, P-751
 Nagel, H.D. 706.5, 706.7
 Naguib, N.N. 706.1, P-435
 Naidu, S.G. P-88
 Nakahira, S. P-269
 Nakai, H. P-493
 Nakai, M. P-170, P-343
 Nakai, T. P-330, **P-333**, P-751
 Nakajima, K. **1408.7**, P-289, P-298
 Nakama, R. P-808
 Nakaminato, S. P-856
 Nakamura, H. P-278, P-738
 Nakamura, M. P-269, **P-868**
 Nakano, M.M. **P-300**, P-324, P-849
 Nakatsuka, S. P-277, P-666, P-852
 Nakatsuka, T. P-814, P-870
 Namba, F. P-827
 Naperov, E. P-569
 Napoli, A. **607.1**, 2305.4, 2305.6, 3008.7, P-126
 Narang, A. P-663
 Narayanan, G. **2901.1**
 Nardella, M. P-524
 Nardis, P.G. P-443
 Nasser, F. 2306.5
 Nath, A. **P-163, P-717**
 Natoli, S. P-119
 Natsuyama, Y. 306.2
 Naughton, P. P-719
 Nault, J.C. P-584
 Navales, I. P-614
 Navas-Campo, R. P-646
 Negroni, D. 3106.1
 Nemes, B. P-15, P-729
 Nesbitt, J. 2305.1
 Nesher, E. P-644
 Nesrallah, A.J. P-282
 Nestola, M. P-524
 Neven, P. P-562, P-563
 Newell, E.W. 2207.5
 Newsome, J.M. P-400
 Nezami, N. **P-32**
 Nezzo, M. P-83, P-119, P-568
 Ng, D. 2207.5
 Ng, H. P-609
 Ng, J.C. P-457
 Ngo, A. **705.6, P-381**
 Ngu, W.P. **P-452**
 Nguyen, D.T. **P-702**
 Nichelatti, M. P-884
 Nicholas, N.W. **P-796**, P-799
 Nicolini, A.F. P-708
 Nicolino, G.M. **P-112**
 Niekamp, A.S. **P-109**
 Niimi, T. P-619
 Nikitina, N. P-569
 Niklas, C. 3105.3
 Nimitrungtawee, N. P-325
 Niola, R. 1204.4, P-40, P-431, P-776, P-805, P-806, P-843
 Nishida, K. P-856
 Nishie, A. P-509, P-511
 Nishimaki, H. P-290
 Nishimori, M. P-62, P-777
 Nishiyama, T. P-680, **P-811**
 Nishiyama, Y. P-405, P-857
 Nisii, T. P-294
 Nitta, N. P-346
 Nizzoli, R. P-59
 Njuguna, N.K. **P-98**
 N'Kontchou, G. P-584
 Noda, Y. P-303, P-686
 Nogueira, V.H.V. **P-362**
 Noh, S.Y. P-195, P-206, **P-883**
 Noji, M. P-520
 Noriega, D.C. **607.6, P-626, P-627**
 Norikane, T. **P-405**, P-857
 Nota, T. P-300, **P-324**, P-849
 Nour-Eldin, N.-E.A. 1406.2, P-435, P-547
 Nourzaie, R. **P-180, P-181**
 Novelli, L. P-284
 Novotná, V. P-342
 Nowakowska, M. P-256, P-399
 Nozawa, Y. P-238
 Numoto, I. P-201, P-203, P-377, P-586, P-724, P-791, P-899
 Nunes, T.F. 2306.4
 Nuñez Peynado, E. P-246
 Nutbeam, T. P-2
 Nuth, L. 608.3, 706.3
 O
 O' Hare, C. **P-874**
 Oba, H. P-200, P-774, P-930
 Ocampo Toro, W.A. P-460
 Ocete Ocete, A. P-246
 Ochiai, T. 705.7, P-629, P-630
 O'Connell, W. P-101
 Oda, T. P-201, P-203, P-377, P-586, P-724, **P-791, P-899**
 Odisio, B.C. **1407.5**, P-359, P-581, **P-583**
 Ogawa, H. P-269
 Ogawa, R. P-852
 Ogawa, S. P-300, P-324, **P-849**
 Ogawa, Y. **P-18**, P-257, **P-290**
 Oggero, A.S. 704.7, P-76
 Ogi, T. P-296, P-339, P-604
 Oguzkurt, L. P-716, P-922, P-924
 Oh, J.H. P-454, P-455, P-836
 Oh, J.S. P-559
 Oh, J.Y. **P-836**
 Ohm, J. P-258
 Ohta, K. P-307, P-444
 Ohta, Y. P-294
 Ohwada, K. P-267
 Ojha, V. P-313
 Ojiri, H. P-133, P-440
 Okada, M. **P-50**
 Okada, T. P-504, P-700, P-941
 Okafor, C. P-27
 Okamoto, S. P-67
 Okamoto, T. P-338
 Okamoto, Y. P-354
 Okazumi, S. P-870
 Okba, A.A.M.B. 2206.3, **P-482, P-483**
 Oklu, R. P-88
 Oksala, N. P-295
 Okubo, S. P-269
 Okuhira, R. P-343
 Okumura, A. P-255
 Okumura, K. P-296, **P-339**, P-604
 Okuno, Y. 2306.3, P-108, P-209
 Oliva, A. P-753
 Oliva, F. P-904
 Oliva, V.L. 608.6
 Oliveira, A.G. 2206.6
 Oliveira, G. P-928
 Oliveira, P.G. P-93, P-803
 Oliver, B. **P-318**
 Olondo, G. P-113
 Omar, A. P-610, P-816
 Omata, K. P-635
 Omura, A. P-294
 Onal, Y. P-736
 Ōnal, B. P-750, P-756
 Onaya, H. P-63, P-102
 O'Neill, D.C. P-160
 O'Neill, R. P-900
 Ong, S.J. P-797
 Onishi, Y. P-71, P-162, **P-529, P-603**, P-611
 Ono, A. P-493
 Ono, T. P-493
 Ono, Y. P-158, P-337, P-635
 Onorati, M. P-204
 Onozawa, S. P-409, P-807, P-912
 Oonuma, Y. P-518, P-747
 Ordi-Camprubi, Q. **P-462**, P-597
 Oreglia, J. P-904
 O'Reilly, M.K. **3105.4**
 Orellana Gonzalez, S.N. **P-648**
 Orgera, G. P-657, P-703, P-828
 Óriás, V.I. 706.6, 1408.6, **P-448**, P-450, P-729
 Ormeño Anturiano, C. P-190
 Oros, J. P-853, **P-918**
 Orsi, F. **302.5**, P-496, P-506, P-540, P-564
 Ortiz, D. **P-147**
 Ortiz Calvo, G.J. P-288
 Osaki, Y. P-629
 Oser, F.J. P-864
 Oser, R. P-552, P-572
 Osmanov, O. P-744
 Osuga, K. P-158, P-269, P-337
 O'Sullivan, G.J. **1302.2**, 1504.7, P-910
 Osváth, S. 706.6, 1408.6, P-448, P-450, P-451
 Ota, S. **P-346**
 Otaka, J. **P-842**
 Otal, P. P-4
 Ouchi, T. 1408.7, **P-289**, P-298
 Oussama, A. P-134
 Owen, A.R. P-854, P-863
 Oyama, K. P-269
 Ozawa, M. **P-850**
 Ozeki, M. P-686
 Özer, A. P-750
 Ozkan, O. 2304.1
 Ozturk, M. 2306.7, P-53

P

- Pacella, C.M. 3105.2, P-564
Pacella, G. **P-576**, P-577, **P-579**
Paci, A. 1407.4
Paci, E. P-272, P-781, P-785
Paganoni, S. 3105.2
Pagnini, F. P-59
Paik, H. P-755
Paladini, A. 1204.4, **3106.1**, P-40, **P-398**, P-431, **P-492**, P-805, P-806, P-843
Paladini, I. **705.3**, P-425, P-648, P-740, **P-837**
Palaniswamy, M. P-234, P-601
Palavecino, P. P-288
Palena, M. **902.4**
Palialexis, K. 2208.2, P-7, P-24, P-123, P-227, P-570
Palkhi, E. P-797
Palkhi, E.Y.A. **P-799**
Palmucci, S. P-21, P-349, P-420, P-672, P-934
Palumbo, P. 1204.3, P-115, P-120
Palussire, J. 203.1, P-598
Pampati, R.A. **P-132**, P-319, **P-488**
Pampin lvarez, E. P-650
Pan, F. **P-248**, P-640
Pancholi, J. P-788
Pandey, N. 606.3, P-465
Pandher, T. P-244
Pandolfi, E.M. P-121, P-127
Pandolfi, M. **P-105**
Pane, F. **1204.4**, P-40, P-431, P-492, P-805, **P-806**, P-843
Panebianco, L. P-470
Pang, J.W.S. P-157
Pang, S.C. P-187
Pankhania, A. P-143
Panov, A. P-606
Pantel, M. **904.4**
Papadimatos, P.N. **608.2**
Papadoulas, S. 608.2
Papageorgiou, G. **2502.2**
Papasotiriou, M. 608.2
Papsin, B. P-134
Paquet, F. P-179
Parhomenko, M.V. P-326
Park, C. 2207.7, P-23, **P-441**, P-848
Park, H.S. P-907
Park, J. P-222
Park, J.-H. **P-344**, **P-345**
Park, J.Y. **P-718**
Park, K.B. P-681, P-907
Park, K.M. P-718
Park, M. 2207.7, P-23, P-441, **P-848**
Park, S. P-195, **P-206**, P-883
Park, S.E. **P-397**, P-616
Park, S.W. P-210, **P-908**
Parquet Villagra, G. P-31
Parsons, C. P-885
Prssinen, H.E. **P-130**
Partouche, S. P-644
Parvulescu, F. P-548
Pascual Robles, M.D. P-653
Pasini, L. P-909
Pastroma, A. P-146
Patatas, K. **P-42**
Patel, A. 3008.2
Patel, I.J. P-88
Patel, M. P-903
Patel, N.A. P-132
Patel, N.R. 3105.5, **P-13**, P-316, P-317, **P-418**, P-625, **P-790**, **P-894**, P-937, **P-947**
Patel, R. P-10, P-311
Patel, S. **P-129**
Patel, U. P-794
Patelli, G. **3105.2**
Pathak, S. P-895
Patil, M.S. **P-260**, **P-553**
Patrone, L. 2208.7
Patsiogiannis, V. P-592
Patten, P. 1505.6, P-552, P-572
Pal, L. P-607
Pecorilla, M. P-252, **P-665**
Pedersoli, F. 2207.2, **2207.3**, 2304.5, 2304.7, P-519, P-523, P-549
Pedicini, V. P-205, P-510, P-909
Pedrazzi, G. P-59
Peixoto, A. **P-128**
Pekcevik, R. **P-68**
Peker, A. **P-725**
Pekolj, J. 704.7, P-859
Pelage, J.-P. 305.2, **305.6**
Pellerin, O. **1505.7**, **1705.5**, P-541, P-543
Pena, C.S. **1702.2**
Peralta, O. P-204, P-859
Perandini, S. P-424
Perazzini, C. **P-641**
Pereira, B. 706.2
Pereira, M. 1505.4
Pereira, P.C.D.M. **P-80**
Pereira, T. P-80
Pereira, V.M. P-446
Perez, N. **P-285**
Prez Hidalgo, J.M. P-877
Prez Lafuente, M. P-35, P-365, P-614, P-792
Perez Lozada, J.C.L. P-32
Perez Montilla, M.E. 3105.1, **P-177**, P-860, P-882
Periyasamy, S. P-437, **P-898**
Perkins, J. P-10
Pernot, S. P-541
Perreault, P. 608.6
Perretta, T. P-568
Perri, M. **P-118**
Perrone, O. P-517, P-694
Pescatori, L.C. P-38, P-39, P-236, P-376, P-414, P-658
Peta, G. **P-261**
Petermann, A. P-4
Petersen, T.-O. P-612
Petit, A. 607.6, **P-284**, P-584
Petres, A. P-191
Petrillo, M. P-112, P-252, P-383, P-665
Petrocelli, F. P-38, P-39, **P-97**, P-658, **P-815**
Petsatodis, E. **P-171**
Pfammatter, T. 2206.1, P-432
Pflugmacher, R. 607.6
Phan, K. 2802.5, P-634
Philip Thomas, R. P-156
Phillips, J. P-484
Piacentino, F. P-293
Piana, G. P-491, P-494, P-560
Piazza, P. P-740
Piccoli, F. **P-94**
Pieper, C.C. **1407.2**, **3106.5**
Pierre-Yves, I. **P-711**
Pilasi Menichetti, C. **2502.5**
Pillai, A.K. P-772
Pillai, R. P-676
Pillai, S.S. P-682
Pieros Nieto, D.A. P-877
Pinheiro, L.C. 2206.6
Pinilla, A.J.M. **P-232**, P-653
Pinna, F. P-236, P-414
Pinto, E. P-803
Pinto Dos Santos, D. **P-340**, P-637
Pipit, N. P-331, P-678
Piron, L. **2802.2**
Pisano, A. **P-657**, P-828
Pisco, J. 2206.6
Pisco , J.M. 2206.6
Pitrola, B. P-13, **P-141**, **P-316**, P-317, P-625, P-937
Pitton, M.B. P-637
Pizzi, G. 3106.1, P-492
Pizzuto, S. 2304.3
Pla Romero, A. P-186, P-873
Planert, M. P-707
Pletsch-Borba, L. P-928
Podlasek, A. **P-474**
Podrabsky, P. P-649
Pogrebnyakov, I. **P-475**
Pollard, A. P-161
Pompili, G. P-623, P-647, P-651
Ponce-Dorrego, M.D. P-35
Ponsen, K.J. **1705.6**
Ponti, A. 2004.6
Ponz, M. 302.2
Pool, K.-L. 1204.2
Popov, V. P-191
Poretti, D. P-205, P-510, P-909
Porosnicu Rodriguez, K. **1505.5**
Portilha, M.A. P-782
Portilho, A.S. 2306.5
Posa, A. 1406.7, **P-151**, P-645
Pouncey, A.L. P-917
Pozzi Mucelli, R.A. P-743
Pozzi-Mucelli, F. P-743
Pramesh, C.S. P-526
Prampolini, F. **2304.3**
Prashar, A. P-369
Pril, V. P-469, P-764
Preciado, D. P-607
Prevoo, W. **303.4**, P-561
Prior, J. 2004.6

Privorotsky, V. 1504.6
 Prosperi, B. P-392
 Protto, S.M. P-295
 Prutki, M. P-73, P-259, P-445
 Ptohis, N.D. **1802.2**
 Pu, X. **P-14**
 Pua, U. **103.2**, 3008.2, P-138, P-350
 Puchkov, D. P-569
 Puechmaille, M. P-641
 Puippe, G. 2206.1
 Punie, K. P-562, P-563
 Puntel, G. **P-79**, P-424, **P-578**
 Puppala, S. P-797
 Puppini, G. P-79, P-424, P-578
 Puri, A. 2305.7
 Putnam, S. P-52
 Puyalto De Pablo, P. P-165, P-228, P-800
 Pyatkov, V.A. P-749, P-846
 Pyra, K. P-28, P-256, P-399, P-417, P-661

Q

Qamhawi, Z. **P-311**
 Qanadli, S.D. **104.4**, P-439
 Qattan, A.Y. P-274
 Qazi, N. P-894
 Quaia, E. P-78
 Quak, W.Y. P-544
 Queiroz, M.R.G. 705.5
 Quek, L.H.H. 3008.2, P-138
 Quencer, K. P-264
 Quesada, R. 1406.1, 3106.4
 Quintana Blanco, D. P-650
 Quintero Bernabeu, J. P-792

R

Rabinowitz, D. P-656
 Radosevic, A. **1406.1**
 Rafart Martínez, G. **P-800**
 Ragg, J.C. P-897
 Rahal Jr, A. **705.5**, P-84
 Rahbar, K. P-565, P-566
 Rahimi, S. P-839
 Raissi, D. **P-758**, **P-862**
 Raja, U. P-129, P-375
 Rajagopal, R. **2305.5**
 Rajan, A. P-601
 Rajan, D.K. **1804.4**
 Rajaretnam, N. P-69
 Ramachandran, V. P-699
 Rampoldi, A.G. **3202.3**, P-505, P-817, P-822, P-825, P-826, P-869, P-884, P-904
 Rana, A.I. P-913
 Rana, H. P-913
 Ranatunga, D. P-854, P-863
 Rand, T. P-166
 Randhawa, K. P-742
 Rao, P.P. 2004.1
 Rao, S. P-526
 Raskin, D. P-697

Raso, A. P-75, P-473, P-721, P-723, P-880
 Ratnam, L. **1805.2**, P-413, P-664
 Raupach, J. **P-328**
 Raymond, R. **P-864**
 Raynor, B.L. 2305.1
 Razavi, M.K. 104.5, **301.5**, 304.4
 Razman, M. P-669
 Rea, F. P-78
 Rea, V. P-134, P-446, P-484
 Reale, M. P-691
 Reb, P. 1505.7
 Rebonato, A. P-524
 Reddy, J. **P-789**
 Reddy, K. **P-369**, P-375
 Reekers, J.A. **701.1**
 Reeves, C. **P-403**
 Regent, B. P-81, P-82, P-275
 Reijnen, M.M.P.J. 1506.2, P-911
 Reinhardt, M. **2505.2**
 Reith, W. 3104.7
 Ren, Y. P-854
 Renfrew, I. 704.3, P-26
 Renier, H. 3106.2
 Renne, J. P-430
 Renzulli, M. P-261
 Reppas, L. 705.1, 2208.2, P-7, P-24, P-123, **P-227**
 Rescigno, A. P-819
 Revel-Mouroz, P. **P-4**
 Reyes Del Castillo, T.A. **P-33**
 Reyes Perez, R. P-190
 Reynolds, D. P-571
 Rho, M.H. P-556
 Riaz, A. P-216, P-580
 Ribette, J. P-598
 Ribo, M. **2703.1**
 Ricci, A. P-470
 RiChard, J. **P-216**
 Richter, G.M. P-248, P-640
 Ricke, J. **606.2**
 Ridley, L. P-55, P-56, P-57
 Riffai, M. P-5
 Riga, C.V. P-317
 Rigamonti, P. P-38, P-39, P-54, P-182, P-184, P-236, P-297, P-301, P-376, P-396, P-414, P-658, P-712, P-752, P-780, P-178, P-487, P-706, P-710, P-745, P-746
 Righi, D. **1805.3**
 Rilling, W.S. **P-697**
 Rimon, U. **P-365**, **P-614**, P-792
 Rios-Vives, M.A. **P-929**
 Rippel, R.A. 704.7
 Ritacco, L. P-20
 Riveros Gilardi, B. P-763
 Rizzi, Y. 1407.7
 Rizzitelli, S. 1407.7
 Robert, P. **1005.2**
 Roberts, A.C. P-699
 Roberts, L. **1705.4**, P-163, P-220
 Robertson, I. 1407.7
 Robic, C. P-923
 Robinson, G.J. **P-793**
 Robinson, R.B. P-443
 Rocco, B.

Rocha, D.M. P-80
 Rocha-Singh, K. **101.2**, **1702.3**
 Rodà, G. P-623
 Rodà, G.M. P-226, **P-651**
 Rodich, S. P-853, P-918
 Rodriguez, A. P-70
 Rodríguez-Fraile, M. P-591
 Rohan, T. **704.1**, 2004.4, P-342
 Romero, N. 3105.7
 Ronot, M. 2207.6
 Rosasco, N. P-204
 Rosati, M. P-272, P-781, P-785
 Rosella, F. P-398
 Røsok, B. P-235
 Ross, R. 1506.5
 Rossato, D. P-706, P-710
 Rossi, D. **P-506**, **P-540**
 Rossi, G. P-497
 Rossi, M. P-496, P-657, P-703, P-828
 Rossi, U.G. **P-38**, **P-39**, P-182, P-184, **P-236**, P-297, P-301, **P-376**, **P-414**, **P-658**, P-712, P-752, P-780, P-815
 Rostampour, S. P-13, P-316, **P-317**, P-418, **P-625**, **P-937**
 Roth, M. 2305.1
 Rothfuchs, D. 706.5, 706.7, P-769
 Rousseau, H. 1504.2, P-4, P-781
 Rovira Cañellas, A. P-436
 Rowlands, C. **P-220**, **P-654**
 Roy, U. 2802.6
 Rudarakanchana, N. P-732
 Rudikoff, A. P-938
 Rudolph, R. P-679
 Ruffino, M.A. P-178, P-487, P-706, P-710, P-745, P-746
 Ruggiero, M. P-753
 Ruhnke, H. P-812
 Ruiz, A. P-463, P-801
 Ruiz, D. P-903
 Rundback, J.H. **701.3**
 Ruschioni, M. P-110, P-111, P-390, P-841
 Russo, R. P-487
 Russo, U. **P-59**, P-425, P-740, **P-819**
 Rutledge, N. **P-394**
 Ruzsa, Z. P-448, **P-729**
 Ryan, A.G. 607.5, **3004.4**, P-124, P-360, P-687, **P-890**
 Ryan, D.T. **P-906**
 Ryan, M.D. P-360
 Rybalko, N.V. P-326
 Rynio, P. P-291
 Rytkin, E. **P-348**
 Saad, K.R. P-695
 Saad, P.F. P-685, P-695
 Saad, W.E.A. **1302.1**
 Saba, L. P-626
 Sabarwal, K.S. **P-143**
 Sabatino, V. P-59
 Sabharwal, T. P-375
 Sabir, S.H. P-109
 Sabri, S. P-306

- Sacco, A. P-904
 Sachar, R. **301.4, 1101.3**
 Sacrini, A. P-226, P-623, P-647, P-651
 Sadaoka, S. P-821
 Sadik, T. 607.2
 Saeed, A. P-361, P-670, P-788
 Sáez De Ocariz García, A. 3202.4
 Saguchi, T. P-842
 Saha, P. P-936
 Saibudeen, A. **P-411**
 Saida, Y. P-856
 Sainz-Sánchez, I. P-646
 Saito, H. P-341, P-409, P-783
 Saito, K. P-842
 Saito, T. P-619
 Sajan, A. P-106
 Sakai, K. P-338
 Sakai, Y. P-300
 Sakamoto, N. 2304.2
 Sakata, E. P-72, P-255
 Sakisuka, T. P-269
 Saksonov, M. P-351
 Sakuhara, Y. **P-768**
 Sakuma, H. 1408.7
 Sakurai, Y. P-290
 Salahia, G. P-361, **P-670**
 Salahia, S. **P-5**
 Salazar, G.M. 2306.4, P-928
 Salei, A. 1505.6, P-552, P-572
 Salem, R. P-216, P-580
 Salimei, F. P-75, P-83, P-473, P-723, P-880
 Salman, R. P-371
 Salsano, M. P-682
 Salvador, J. **P-463, P-801**
 Salvatori, F. P-272, P-781, **P-785**
 Salviato, E. P-387, P-388, P-530, P-765, P-767
 Samad, R. P-291
 Sampere Moragues, J. P-165, P-228, P-800
 Samuelson, S. P-193
 San Martín Luque, V.A. **P-286**
 Sanak, D. P-469
 Sanchez, R. P-31
 Sanchez Blanco, F. P-232
 Sanchez Guerrero, A. P-186, P-873
 Sánchez Margallo, F.M. P-888
 Sanchez Parrilla, J. 1406.1
 Sandhu, A. P-790
 Sandhu, M.S. 1204.6, P-410
 Sandoval, O.B. P-150
 Sangro, B. P-591
 Sanomura, T. P-405, **P-857**
 Santagostino, E. P-708
 Santini, G. P-389, P-391
 Santoni, M. 1802.3
 Santonocito, E.F. P-349, P-378, P-672, P-934
 Santos Martín, E.G. P-230
 Santucci, D. P-576, P-577, P-579
 Sapoval, M.R. **605.5**, 1504.2, 1505.7, P-541, P-543
 Saraf, R. P-242, P-489
 Saratzis, A. P-732
 Sarfraz, M.D. **P-913**
 Sarioglu, O. **P-795**
 Sarti, D. P-524
 Sarti, G. **P-389, P-391**
 Sartori, S. P-530, P-564
 Sasaki, K. P-504, P-941
 Sasaki, T. P-278, P-738
 Sato, H. P-170, P-343
 Sato, O. P-267
 Sato, R. **P-273**
 Sato, S. P-346
 Sato, T. P-493, P-726
 Sato, Y. P-63, P-102
 Satoh, F. P-635
 Savoldi, A.P. P-226, **P-252**, P-651
 Sawada, Y. P-307
 Sayre, J.W. 1204.1
 Scaggianti, J. P-75, **P-119**, P-473, P-723
 Scalise, P. **P-517, P-588**
 Scandiffio, R. P-588
 Scanlon, T. P-839
 Scarabello, M. P-182, P-184, **P-301**, **P-712**, P-752
 Scarcia, L. P-576, P-577
 Scardicchio, S. P-426, P-753
 Schaab, F. **P-871**
 Schaefer, N. 2004.6
 Schäefer, A. 2206.2
 Schaible, J. P-546
 Scheer, F. P-713
 Scheffer, H.J. **202.4**
 Scheinert, D. 404.6, P-698, P-775, P-896
 Schelleman, T. P-854, P-863
 Scheller, B. 1506.7
 Schepis, F. 2304.3
 Scheurig-Muenkler, C. **2504.4, P-812**
 Schildmeyer, J.H. P-88
 Schirru, F. 3104.6, P-393, **P-479**
 Schlachter, T. P-32
 Schlaphoff, G. P-539
 Schmid, A. **3106.7**
 Schmidt, A. P-698, P-775, P-896
 Schmidt, F. P-637
 Schmidt, W. 3104.2
 Schmitz-Rode, T. P-519
 Schnabel, J. P-334
 Schnapauff, D. P-217, P-636
 Schneider, G.K. 3105.3
 Schob, S. **3104.5**
 Schoder, M. **2702.4**
 Schotten, S. P-637
 Schröder, H. 404.2, P-901
 Schultze Kool, L.J. **1805.1**, P-662
 Schulze-Hagen, M. 2207.2, 2207.3, **2304.5**, 2304.7, P-519, P-523, P-549
 Schurmann-Kaufeld, S. 1506.7
 Schuster, J. P-775
 Schwartz, K. P-101
 Schwenke, M. **P-355, P-356**
 Scipione, R. 607.1, 2305.4, 2305.6, 3008.7, P-126
 Sconfienza, L.M. **904.1**
 Secco, S. P-884
 See, T.C. P-725
 Seedat, S. 1506.3
 Seehofer, D. **302.3, 1704.4**
 Seiji, K. **P-635**
 Seike, S. P-700
 Seike, Y. P-294
 Sellenschloh, K. P-901
 Sellier, N. P-865
 Semeraro, A. P-672
 Semeraro, V. P-83, P-119, P-473
 Semin, I.S. P-749, P-846
 Seminatore, S. P-349, P-378, P-672, P-934
 Şendur, H.N. P-750, P-756
 Senthivel, N. P-549
 Seo, J.H. **P-813**
 Seo, S. **P-270**
 Seo, T.-S. P-195, P-454
 Seo, T.S. P-353
 Sergeeva, O.N. P-74, P-501
 Sergeant, G. 2207.6
 Seron, A. 1407.7
 Seror, O. P-584, P-865
 Serrano Alcalá, E. **P-477**
 Shafi, B.B.B. **P-453, P-589, P-748**
 Shah, A. P-879
 Shah, A.H. P-823
 Shah, N.V. P-401
 Shaida, N. P-590, P-725
 Shaikh, A. **P-167**
 Shaikh, S. P-796
 Shaker, M. **2206.3**
 Shakhbazyan, R. P-385
 Sharafutdinov, M.R. **P-327**
 Sharma, N. **P-468**
 Sharma, S. **606.3**, 2305.5, P-1, P-313
 Sharpe, S. P-906
 Shaw, A. P-366, P-380, P-892
 Shawyer, A. **P-600**
 Shayesteh-Kheslat, R. P-299
 Shaygi, B. **P-673**
 Sheehan, F.M. P-143
 Sheeran, D. P-306
 Shehata, M. P-5
 Shen, M. 2306.7
 Sherk, W. P-322, P-323
 Sherman, S. P-923
 Sheth, R. P-109
 Shetty, N.S. **2305.7, P-526, P-663**
 Shi, Z. P-320
 Shibamoto, Y. P-307, P-444
 Shibata, T. P-300, P-324, P-715
 Shibuya, K. **P-280**
 Shibuya, M. **2306.3**, P-108, P-209
 Shim, D.J. **608.7**
 Shim, H.J. P-34
 Shim, J.J. P-258, **P-787**
 Shimabukuro, K. P-303
 Shimizu, H. P-493
 Shimizu, K. **P-821**
 Shimohira, M. P-307, P-444
 Shin, J.H. 2207.7, P-23, P-195, P-206, **P-302**, P-441, P-624, P-787, P-848, P-883
 Shin, J.S. **P-16, P-739**

- Shin, S.W. P-907
Shinjyo, Y. P-237, P-245, P-415
Shinmoto, H. P-46
Shinohara, M. P-852
Shirai, S. P-341, P-783
Shiraishi, K. P-774
Shkumat, N. P-358, P-446, P-484
Shlansky-Goldberg, R. P-408
Shnayder, M.M. **P-363**, P-824, **P-830**, P-831, P-833, P-835, P-940
Shorikov, M.A. **P-74**, P-501
Shrestha, P. 705.7, P-630
Shrivastava, A. **P-196**, **P-283**, P-531, **P-555**, **P-919**, **P-945**
Shrivastava, V. P-452, P-931
Shroff, M. P-134, P-358, P-446, P-484
Shukla, P.A. P-85, P-86
Siani, A. P-466
Sibilia, J. P-152
Siboni, S.M. P-708
Sica, V. P-819
Siddiqi, M. P-86
Sideso, E. P-10
Sidhu, A. **P-11**
Sieben, P.F. **2207.2**, 2207.3
Siena, G. **605.6**, **2102.2**, **2605.4**
Sieren, M. P-707
Sierre, S. 1504.5
Sighary, M. **P-106**, **P-401**
Sikaria, D. P-550
Silipigni, S. **P-383**
Sillanpää, N. P-295
Silva, M. P-80
Silva, M.W. 1504.5
Silveira, L.D.M. P-685, P-695
Silvera, S. P-284
Silverberg, D. P-697
Silvério, P.R.B. P-84
Silvestre, M. 1204.4, P-776, P-806
Simgen, A. 3104.7
Simon, A. 607.6
Simpanen, T. P-889
Singh, H. 704.4
Singh, J. P-789
Singh, M.K. P-355, P-356
Sinha, M. **P-1**
Sinitsyn, I.A. P-348
Siviero, F. P-767
Slaby, O. 1407.1
Slanič, A. P-720
Sluijter, J.H. P-528
Smedile, G. P-466
Smeets, A.J. 3105.6
Smith, A.G. **1506.3**
Smith, J. P-550
Sneddon, D. 2802.3
Snow, T.M. 2802.3
So, Y.H. 2207.1, 2306.2
Soares, J. P-809
Soares, J.A.B. **P-193**
Sobolev, G.A. P-749, **P-846**
Sobstyl, J. **P-28**
Socolowski, L.R. P-84
Sodani, G. P-175, P-466
Sofocleous, C.T. 1505.3
Sofue, K. P-504, P-941
Soga, S. P-46
Sohgawa, E. P-300, P-324, P-849
Sojka, M. P-28, P-256, P-417, P-661
Sokolov, V.V. P-326
Solbiati, L. P-506, P-540
Solchaga Álvarez, S. 3202.4
Solcia, M. P-505, P-884, P-904
Soliman, M.I. **3008.1**
Solimeno, L.P. P-708
Solis-Gutierrez, D. **P-646**
Solomon, A. 704.4
Solomon, S.B. 1505.3, P-522
Solovov, V. **P-154**
Someya, Y. P-493
Sommer, C.M. P-248, **P-640**
Somu, A.R. P-234
Soncin, E. **P-178**, P-487, P-706, P-710, **P-745**, P-746
Sone, M. P-71, P-162, P-529, P-603, P-611
Song, H.-Y. P-345
Song, M.G. P-183, P-195, P-353
Song, S.-Y. P-858
Song, S.G. P-434, P-677
Sonoda, A. P-346
Sonomura, T. P-170, P-343
Soo, E. **P-669**
Soppelsa, G. P-743
Sorbi, F. **305.4**
Sosa, M. P-150
Sotirchos, V.S. **P-137**
Sótonyi, P. P-448
Soulen, M.C. **2004.3**
Soulez, G. 608.6, 1407.6, P-512
Spadafora, P. P-54, **P-396**
Speakman, M.J. **605.1**
Speck, U. 1506.7
Speicher, D. 2802.6
Speirs, A. P-207
Spies, J.B. **305.1**
Spiliopoulos, S. **1002.1**, 2208.2, 2604.1, P-7, P-24, P-122, P-227
Spina, J.C. 704.7
Spinazzola, A. **P-312**
Spinelli, A. **P-175**, P-466
Spinelli, D. **P-331**, P-678
Spinelli, M. P-884
Spink, C. **P-438**
Spinnato, P. P-497
Spiritiogliozi, L. **607.3**
Splendiani, A. P-120
Spreen, M. 404.5
Spretke, J. P-901
Sprinkart, A.M. 3106.5
Squarza, S. P-182, P-184, P-301, P-712, P-752
Srinivasa, R. P-386, P-905
Srinivasan, S. P-41
Srisuwan, T. P-325
St Pierre, K. 607.2
Stabile, E. **1101.4**
Stacul, F. **3301.1**
Stagno, A. P-383
Stahlberg, E. **P-707**
Stahnke, S. 404.2
Stavropoulos, S.W. P-137
Steffen, P. 706.7, P-769, P-770
Stegger, L. P-565, P-566
Steiner, S. P-698
Steinke, T.M. **608.1**, **608.3**, **706.3**
Steinmetz, E. 2208.4
Stirling, A. P-25
Stöhr, F. P-637
Stojanovic, S. P-191
Stove, C. P-163, P-717
Stranieri, G. **P-359**, P-537, P-595
Stringam, J. **P-596**
Strocka, S. P-612
Stroeder, J. P-861
Stroiescu, A.E. 607.5, P-124, **P-360**, **P-687**, P-890
Stroszczyński, C. P-546
Struffert, T. **2503.2**
Struthers, B. P-898
Studniarek, M. P-81, P-82
Suarez Anzorena, A.M. **P-150**
Suarez Anzorena Rosasco, F.J. **P-31**, **P-113**, P-150
Sucapane, P. P-470
Suda, S. 306.2, P-87
Sugawara, S. P-71, P-162, P-529, P-603, P-611
Sugihara, E. **P-402**
Sugihara, F. P-341, P-409, P-783
Sugimoto, H. P-278, P-738
Sugimoto, K. P-504, **P-525**, P-700, P-726, P-827, P-941
Sugino, Y. **P-683**
Sugiura, T. **P-296**, P-339, P-604
Suh, J. P-262
Sukhin, V. P-606
Sukhodolska, O.I. **P-545**, P-606
Sultan, A.A. P-474
Sumikawa, H. P-269
Sun, F. 1407.7, **P-888**
Sundaraiya, S. P-601
Sundareyan, R. **P-599**, **P-674**, **P-802**
Sunenshine, P. P-101
Sung, D.J. P-183
Suprun, K. P-569
Sureka, B. P-847
Suri, V. P-410
Susini, S. 1407.4
Sutter, O. P-584, P-865
Suyama, Y. P-46
Suzuki, A. P-200, P-201, P-203, P-377, P-586, **P-724**, P-791, P-850, P-899, P-930
Suzuki, H. P-814
Suzuki, K. **P-307**, P-409
Svandrlik, S. 3106.7
Svobodova, I. 704.1
Światłowski, Ł. P-28
Syed-Noor, A.S. 607.2
Syha, R. P-536
Szczerbo-Trojanowska, M. **2502.3**
Sze, D.Y. 608.4, **1703.1**, P-916
Szejnfeld, D. 2306.4
Szejnfeld, J. 2306.4

Szhafir, I. 1504.5
 Szigeti, K. 706.6, 1408.6, P-448,
 P-450, P-451
 Szmygin, M. **P-417, P-661**
 Szolics, A. 3104.1
 Szöllösi, D. 706.6, 1408.6, P-448,
 P-450, **P-451**
 Szulman, C. P-31
 Szurowska, E. P-81, P-82

T

Tabotta, F. **2004.6**
 Tacher, V. P-335
 Tacke †, J. 404.2
 Tagliaferro, F.B. **P-703**
 Taguchi, H. P-330, P-751
 Tai, D. 2207.5
 Taieb, J. P-543
 Tajima, H. P-409, P-783, **P-912**
 Tajima, N. P-912
 Tajima-Komatsu, T. **P-255**
 Takagi, M. P-18
 Takahashi, M. P-63, P-102, P-856
 Takahashi, Y. P-300, P-433, P-618
 Takaki, K. P-346
 Takami, Y. P-405
 Takao, S. P-509
 Takase, K. P-635
 Takata, T. P-768, **P-774**
 Takayama, K. **P-726**
 Takayama, Y. P-509
 Takeguchi, T. P-856
 Takeguchi, Y. P-856
 Takenaga, S. **P-238**, P-416
 Takenoshita, N. P-912
 Takeuchi, H. P-525
 Takeuchi, Y. **2304.2**, P-267, P-338
 Takewa, M. P-333
 Takigawa, M. P-689
 Tal, M. **P-188**
 Tam, A. P-109
 Tama, E. P-618
 Tamura, M. **P-519**, P-666
 Tamura, Y. P-315, P-333
 Tan, B.S. **1702.1, 3008.2**
 Tan, C.S. P-187
 Tan, C.W. P-187
 Tan, E. **P-103**
 Tan, G. 3008.2
 Tan, H.Y. **3106.6**
 Tan, J.S.H. P-734
 Tan, K.K.Y. P-804
 Tan, K.T. P-11
 Tan, M.C. **P-699**
 Tan, R.Y. P-138, **P-187**
 Tan, S.H. 2207.5
 Tanahashi, Y. P-303, **P-686**
 Tanaka, F. P-170, P-343
 Tanaka, H. **P-867**
 Tanaka, I. P-341, P-783
 Tanaka, K. **P-158**, P-337
 Tanaka, N. P-237, P-245, P-415, P-558
 Tanaka, R. **P-170**
 Tanaka, T. **102.4**
 Tani, R. P-504, P-941
 Tanitame, K. **P-433, P-618**
 Tanoue, S. P-237, P-245, P-415, **P-558**
 Tanvetyanon, T. 1505.4
 Tanzilli, A. 1406.7
 Tapping, C.R. 2206.5, 2206.7, P-223,
 P-891, P-893
 Tarantino, F.P. P-250
 Tarkhanov, A. **P-385**
 Tateishi, E. P-294
 Tateishi, U. P-856
 Tay, K.-H. 3008.2, P-734
 Teh, S.P. P-187
 Teichert, C. **P-933**
 Teichgräber, U. **601.3, P-733**, P-881
 Teixidor Vinas, M. **3105.7**
 Tellini, R. 2102.2, 2605.4
 Tennak, V. P-644
 Tepe, G. **101.4, 1002.2**, 2208.6
 Teplisky, D.J. 1504.5
 Terada, H. P-814, P-870
 Ter-Akopyan, A. **P-467**
 Terra Rodrigues, C. P-93, **P-782**
 Terzolo, M. P-537
 Tezuka, Y. P-635
 Thabet, B. P-172
 Thakrar, P. P-91, P-263, P-347, P-514
 Tham, C. 2207.5
 Theivacumar, S. 2208.7
 Theodosios, A. P-227
 Theodoulou, I. **P-936**
 Theofanis, M. 608.2, P-24
 Therasse, E. 608.6
 Theumann, N. 607.6
 Thierens, N.D.E. **P-911**
 Thomas, D.V. **P-701**
 Thomas, M. 704.4
 Thomas, R.P. P-334, P-704
 Thomas, W.R. 706.4, P-189, **P-241**, P-247,
P-251, P-599, P-674,
 P-802
 Thomson, B. P-369
 Thornburg, B. P-216
 Thornton, J. 305.2
 Thulasidasan, N. P-161, P-628, P-655,
 P-669, P-917, P-936
 Thüning, J. **P-523**
 Tianxiao, L. 3104.4, P-471
 Tibballs, J. P-834
 Tibbles, J. P-193
 Tiercelin, C. P-730
 Tierny, D. 1505.7
 Tiesi, G. P-52
 Till, V. P-191
 Tinguely, P. P-153, P-551
 Tinoush, P. P-533, **P-582**
 Tipaldi, M.A. P-657, P-703, **P-828**
 Tisnado, J. P-481, P-660
 Tisnado, J. P-481
 Tiwari, S. P-847
 Toda, J. P-200, P-814, P-850,
 P-870, P-930
 Toda, M. P-338
 Todd, A. P-571
 Tofanelli, L. P-647
 Togashi, K. P-493
 Toh, H.C. 2207.5
 Toh, L. 3008.2
 Tokuda, B. P-267
 Tokui, T. 1408.7
 Tokunaga, K. **P-493**
 Tokuyama, K. 3104.3
 Tollot, S. **P-743**
 Toma, M. P-605
 Tomasello Weitz, A. P-436
 Tombesi, P. P-530, P-564
 Tomezzoli, A. P-578
 Tomita, K. 306.2, P-87, **P-95**, P-354
 Tomita, M. P-827
 Tomiyama, N. P-158, P-269, P-337
 Tommasino, E. P-120
 Tomori, T. 3104.7
 Tomozawa, Y. P-346
 Too, C.W. 3008.2, 3106.6, P-103
 Torbica, S. **P-191**
 Torikai, H. P-277, P-666, P-852
 Torre, A. **305.2**
 Torreggiani, W. P-159, P-194
 Torres, C. P-179
 Torres, D. 2206.6
 Torresi, M. P-781, P-785
 Torricelli, P. 2304.3
 Torsello, G. 1408.2, 1408.4, P-308,
 P-309
 Torsello, G.F. **1408.4, P-308**, P-309
 Tortora, S. P-594
 Torzilli, G. P-510
 Toshimasa, S. P-200, P-850, P-930
 Touta, A. 607.6
 Tovar Felice, G.A. P-165, P-228, P-800
 Towsley, M. P-224, P-225
 Tracci, M. P-306
 Tradi, F. P-494, P-711, P-784
 Tramarin, M. P-54, P-182, P-184, P-297,
 P-301, P-396, P-712, P-752,
 P-780
 Tran, N. P-101
 Trerotola, S.O. **1804.2**
 Tretbar, S. 2802.6
 Treurniet, K. 2204.4
 Trudel, D. P-512
 Truhn, D. 2304.5
 Trujillo, M. 3106.4
 Tsapis, N. 1407.4
 Tschinaev, A. 2207.2, 2207.3
 Tselikas, L. **304.1**, 607.7, **1407.4**,
 2207.6, P-567
 Tsetis, D.K. P-920
 Tsitskari, M. **102.1, 705.2, P-570**
 Tsochatzis, A. 2208.2
 Tsuchida, Y. P-618
 Tsukada, J. P-852
 Tsukahara, S. P-307
 Tsukamoto, H. P-63, P-102
 Tsurusaki, M. **P-201**, P-203, **P-377**,
P-586, P-724, P-791,
 P-899
 Tsushima, Y. P-280
 Tullius, T.G. P-27
 Turbanti, A. P-568
 Turco, L. 2304.3
 Turtulici, G. P-419, P-671
 Tutton, S.M. **103.4**
 Twine, C.P. **902.5**
 Tyng, C.J. **P-77**, P-362

U

- Uberoi, R. **2604.4**, P-10, P-36, P-166, P-311, P-352, P-411, P-929
P-814, P-870
 Uchi, T. 3106.7
 Uder, M. P-343
 Ueda, S. P-341, P-409, **P-783**, P-807, P-912
 Uehara, K. P-294
 Ueno, M. P-170
 Ueshima, E. P-504, P-941
 Uflacker, A. 304.3, 2702.1
 Ugajin, A. P-278, **P-738**
 Uher, M. 2004.4
 Ukride, V.K. P-667
 Ülrich, M. P-698, P-775
 Umakoshi, N. P-71, P-162, P-529, P-603, P-611
 Umutlu, M.R. **P-736**
 Unni, M. P-364, P-500, P-676
 Upadhyaya, M. P-180
 Urbano, J. P-35
 Urita, T. P-870
 Urtasun Grijalba, F. 3202.4
 Usai, M.V. **1408.2**
 Usami, Y. **P-810**
 Ushijima, Y. **P-509**, P-511
 Uthappa, M. P-601
 Utili, A. P-97, P-815

V

- Vadlamudi, V. P-486
 Vailati, B.B. 2306.5
 Vajda, Z. 3104.1
 Valcarcel, J. **P-597**
 Valconi, E. P-594
 Valdata, A. P-236, P-414
 Válek, V. 704.1, 2004.4, P-342
 Valenti, D.A. 704.5, 705.6, P-179, P-196, P-381, P-531, P-555, P-919, P-945
 Vallati, G.E. 3106.1, P-398, P-492
 Valle, L.G.M. P-84
 van de Velde, L. **1506.2**
 van Delden, O.M. P-166
 van den Berg, J.C. **2208.4, 2704.4**, P-17
 van den Bosch, V. 2207.3
 van Dijk, L.C. 404.5, **2204.4**
 van Eps, R. 404.5
 Van Ha, T.G. P-27
 van Herpen, N. 404.5
 van Lienden, K.P. **102.3**
 van Overhagen, H. 404.5, 2204.4
 Van Wyk, M.J. **P-834**
 van Zwam, W.H. **2204.2**
 Vance, A.Z. **P-52**, P-755, **P-771**
 Varano, G.M. 302.5, P-496, P-506, P-540
 Varava, A.B. **P-61**
 Vareello, S. P-178, **P-487, P-706**, P-710, P-745, P-746
 Varetto, G. P-745
 Varga, F.V. P-613
 Vargas Solano, A. P-477
 Varin, E. **P-584**
 Varma, R. 1505.6, P-572, P-876
 Varrassi, M. 1204.3, P-110, P-111, P-118, **P-390**, P-470, P-841
 Vasani, J.D. **P-392, P-946**
 Vasiniotis Kamarinos, N. **P-7**
 Vasquez Rios, M. P-244
 Vatakencherry, G. P-935, P-938
 Vauthey, J.-N. P-583
 Vávra, T. P-764
 Vayego, S.A. 2306.4
 Vázquez Mézquita, A.J. P-20
 Vazzana, L.P. P-118
 Vecchietti, F. **P-121, P-127**
 Vega, E.A. P-583
 Veger, H. 404.5
 Végh, E.M. P-729
 Veith, F.J. 1408.2
 Velasco, J. P-583
 Velasco Sánchez, E. **1704.2**
 Velonakis, G. P-146
 Veltri, A. **2102.1**, P-359, P-537, P-595
 Veltri, G. P-151
 Venkat, S. P-946
 Venkatanarasimha, N.K.K. 2207.5
 Venkatesh, H.A. P-500
 Venmans, A. 3105.6
 Verbist, J. 2208.6
 Vercelli, R. P-505, P-817, P-822, P-825, P-884, P-904
 Vergadis, C. P-502
 Verhoeven, B.H. P-662
 Verhoeven, E. **1408.6**
 Verma, V. 2305.5
 Verset, G. 2207.6
 Versluis, M. 1506.2
 Vert Soler, C. P-436
 Vértes, M. P-702
 Veverka, T. P-469
 Viana, P.C.C. P-282
 Vicente Martín, J.M. P-286
 Vidal, V. **1005.4, 1407.6**, P-711, P-784
 Vidali, S. **P-83**
 Vieira, F.A.C. P-84
 Vieriemiei, D. P-545, P-606
 Vigneswaran, G. **2206.4**, P-208
 Villalba, L. P-229, P-447, P-942
 Villalobos, A. **P-557**
 Villanueva, D. P-185
 Villar Esnal, R. P-186, P-873
 Viniol, S. P-156, P-704
 Violago, J. P-167
 Violi, F. **705.7**
 Virshke, E. P-74, P-501
 Visser, I.J. P-528
 Vissers, W.H.P.M. P-911
 Vittoria De Martini, I. **P-432**
 Vivas, I. P-591
 Vizzini, I. P-934

- Vizzuso, A. **P-387, P-388**, P-530, **P-765**, P-767
 Vogel, A. P-101, P-573
 Vogl, T.J. 706.1, 706.6, **1406.2**, **P-435, P-450**
 Vojacek, J. P-328
 Volpe, D. P-909
 Volpi, E.M. 705.5
 Volterra, D. P-817, **P-822**, P-826, P-884
 Von Der Höh, N. P-101
 Von Rundstedt, C.-F. P-881
 Vora, R. P-369
 Vorwerk, D. **1101.1**
 Vos, J.A. **2703.4**
 Vrakas, S. P-502
 Vrzal, D. **P-720**

W

- Wacker, F. 2306.6, P-430, P-573
 Wada, S. P-18, **P-257**, P-498
 Wagoner, D. 3008.4
 Wakana, M. **P-203**, P-791, P-899
 Wakkie, T. **404.5**
 Waldron, J. P-193
 Walker, C.M. P-166
 Walker, S. P-189, **P-247**, P-251, P-599, P-674, P-802
 Walker, T.G. P-928
 Walsh, J.P. P-106, P-401
 Walton, I.J. P-310, P-314
 Walz, J. P-494
 Wang, C. **P-135**
 Wang, D. 2004.2
 Wang, J.C.C. P-734
 Wang, M. 2802.5, P-634
 Wang, M.Q. P-140
 Wang, Y. P-140, **P-145, P-495**, **P-513, P-534, P-538**
 Wanjari, P.T. **P-90**
 Warhadpande, S. **P-148**, P-173, **P-222**, P-659
 Warigaya, K. P-343
 Wassermann, T. P-27
 Watanabe, Y. P-294
 Wauters, J. 2208.3
 Webb, A.G. P-528
 Weber, M.-A. P-933
 Wei, Y. 3008.2
 Weidle, P.A. 607.6
 Weinmann, A. P-532
 Weir, G. P-395
 Weiss, C.R. P-224, P-225
 Wentz, R.M. 706.5, 706.7, P-769, P-770
 Werncke, T. 2306.6
 Werson, D.A.B. P-911
 West, A. P-628, P-655
 West, D. **P-722**
 Wever, J. 404.5
 Weymann, A. P-334
 White, R.D. P-220, P-361, P-654, P-670
 White, S.B. 2004.3
 Wieben, O. P-428, P-429
 Wieners, G. P-217, P-231, P-442, P-649
 Wigham, A.J. **1704.1**, P-311, P-411

Wildgruber, M. P-565, P-566
 Wildiers, H. P-562, P-563
 Wileyto, E.P. 2004.3
 Wilke, H.J. 607.4
 Wilkinson, T. 1506.5
 Williams, D.M. P-318, P-322, P-363, P-824
 Willis, A. P-189, P-251
 Wilson, I. **P-923**
 Win, H.H. 3008.2
 Winterbottom, A. P-725
 Wiseman, D. 2207.4
 Wissgott, C. **3104.2, P-709**, P-713
 Wlderck, A. P-83
 Wlderck, A. P-119
 Wohlgemuth, W.A. **303.3**
 Wojno, M. 1204.2
 Won, J.H. **P-3**, P-632, P-690
 Won, J.Y. **202.3**, 3008.6, P-521
 Won, Y. P-472
 Wong, J.K. 2706.1
 Woo, Y.N. P-367, P-368
 Wood, B.J. **1703.3**
 Woodhams, R. **P-689**
 Woodhead, G. **P-903**
 Woods, M.A. 2304.1, P-53, P-898
 Wressnegger, A. 1506.1
 Wu, J. **1505.2**, P-554
 Wu, R.-H. P-602
 Wu, Y.-W. **P-138**

X

Xi, I.L. P-408
 Xiang, H. P-490
 Xiao, Y.-D. **3008.5**
 Xing, M. P-400, P-553
 Xingwei, S. P-617

Y

Ya, K.Z. **306.3**
 Yabuta, M. P-811
 Yadav, M.K. **P-364, P-500, P-676**
 Yadav, T. P-847
 Yadavali, R.P. P-571
 Yagihashi, K. P-680, P-811
 Yagyu, Y. P-201, P-203, P-377, P-586, P-724, P-791, P-899
 Yakes, W.F. **1204.5, P-211, P-212, P-213, P-214, P-215**
 Yakushiji, H. P-269
 Yamada, D. P-811
 Yamada, K. P-338
 Yamada, R. 304.3, 2702.1
 Yamada, S. P-827
 Yamagami, T. P-62, P-87, P-508, P-777, P-867
 Yamaguchi, H. P-409, **P-807**
 Yamaguchi, M. P-504, P-700, P-941
 Yamamoto, A. P-300, P-324, P-849
 Yamamoto, H. P-715, P-726
 Yamamoto, K. P-63
 Yamamoto, M. P-200, P-774, P-850, **P-930**
 Yamamoto, S. P-87, P-95
 Yamamura, J. P-680
 Yamane, A. P-341

Yamane, K. P-324
 Yamane, T. P-689
 Yamanishi, T. P-62, P-508, P-777
 Yamashita, Y. P-315
 Yamaue, H. P-170
 Yamaura, H. P-63, P-102
 Yan, J.Y. P-140
 Yanai, S. P-856
 Yang, S.B. **P-176**, P-258
 Yang, W.J. **P-195**, P-206, P-883
 Yano, K. P-354
 Yao, Q.J. 1406.6
 Yarakhmedov, T. P-754
 Yardley, I. P-181, P-369
 Yashiro, H. P-666, P-852
 Yasue, S. P-686
 Yasui, D. **P-341**, P-409, P-783
 Yatabe, Y. P-63
 Yeon, K. P-761, P-766
 Yeong, J. 2207.5
 Yeung, C.S.J. **P-544**
 Yevich, S. P-109, P-359
 Yevzlin, A.S. P-188
 Yilmaz, S. P-29, P-30, **P-716**, P-922, P-924
 Yilmaz, U. 3104.7
 Yim, N.Y. P-218, P-434, P-516, P-608, P-677
 Yogarajah, G.A. P-143
 Yokka, A. P-296
 Yokoyama, T. P-200, P-850
 Yonezawa, H. P-324
 Yong, J. **P-617**
 Yoon, C.J. **P-367, P-368**
 Yoon, E. **3008.4**
 Yoon, H.-K. P-206
 Yoon, J. P-454, P-455, P-836
 Yoon, J.T. **2305.1**
 Yoshikawa, H. P-46
 Yoshimatsu, M. P-498
 Yoshimatsu, R. P-62, **P-508**, P-777
 Yoshiyama, Y. P-330, P-751
 Young, N.J. P-220
 Yu, M. **P-221**
 Yu, Q. P-862
 Yuan, B. P-140
 Yuan, H. **1406.6, P-336, P-503**
 Yukimokto, H. **P-269**
 Yunaiyama, D. P-842

Z

Zadro, C. 1504.2, **P-643**
 Zako, R. **P-200**, P-850, P-930
 Zandrino, F. **P-691**
 Zannoni, R. P-425
 Zannoni, S. P-623
 Zapletalova, J. P-469
 Zavadil, J. 704.1, **1407.1**, 2004.4
 Zavridis, P. 705.2, P-570
 Zayed, H. P-732
 Zealley, I. P-220, P-571, P-654
 Zeile, M. **706.5, 706.7, P-769, P-770**
 Zeller, T. **101.6**, 2208.6
 Zerbi, A. P-205
 Zerdin, M. P-720

Zertalis, M. **P-742**
 Zertan, C.C. 2305.1
 Zhang, J. P-557
 Zhang, J.L. **P-140**
 Zhang, K.K. **P-714**
 Zhang, Z.-S. 1505.2, P-408, P-554
 Zhao, D. P-507
 Zhao, Y. 1406.6
 Zheng, C. P-507
 Zherdev, N. P-329
 Zhong, J. **P-609**
 Zhou, A.L. 1505.5
 Zhou, M. **P-320**
 Zhuang, K.D. 3008.2
 Zimmermann, M. 2207.3, 2304.5, 2304.7, P-519, P-523, P-549
 Zingaretti, C.C. P-578
 Ziv, E. 1505.3, P-522
 Zorn, P.E. P-152
 Zugaro, L. P-110, P-115
 Zugazaga, A. 1406.1
 Zurera Tendero, L.J. 3105.1, P-177, P-860, P-882
 Zverev, D. 1504.6
 Zych, I. P-399

IDEAS

2 0 1 9

September 8 - 10

Barcelona / Spain

ABSTRACTS & AUTHOR INDEX

- S534 PART 1: Focus Sessions**
Hot Topic Symposium
S548 PART 2: Author Index

Online Publication Number:
10.1007/s00270-019-02282-x

Cardiovascular and Interventional Radiological Society of Europe

IDEAS

2 0 1 9

September 8 - 10

Barcelona / Spain

PART 1

**Abstracts of
Focus Sessions
Hot Topic Symposium
sorted by presentation
numbers**

Focus Session

The NICE guidelines: nice or not so nice?

901.1

Reasons for NICE

C.J. Hammond

Vascular Radiology, Leeds Teaching Hospitals NHS Trust, Leeds, UK

Learning Objectives

1. To understand the reason for initiating the guidance
 2. To understand the relative importance of cost effectiveness and clinical effectiveness
 3. To understand the likely consequences of the NICE guidance
- The NICE guidance for the management of AAA relies substantially on a health economic evaluation of open surgical repair and EVAR. This talk will explore the philosophical framework in which health economic decisions are made, the concept of 'cost effectiveness' within the context of the wider healthcare economy and the ethical issues raised by the strict utilitarian analysis implied by cost-effectiveness evaluation. Illustrative examples and thought experiments from other areas of healthcare will be offered.

Two potential solutions to the problem of not cost-effective interventions will be discussed: the NHS Cancer Drugs Fund and the NHS Clinical Priorities Advisory Group of NHS Specialised Commissioning. Finally, the evidence from NICE's health economic evaluation of treatments for AAA will be briefly explored in the context of these decision-making frameworks and the likely consequences of the NICE guidance on vascular services and the wider healthcare economy.

901.2

Why NICE cannot be implemented

M.P. Jenkins

Vascular Surgery, Imperial College Healthcare NHS Trust, St Mary's Hospital, London, UK

Learning Objectives

1. To learn what immediate impact there will be for patients
 2. To understand what the impact on hospitals will be
 3. To learn if AAA screening in the UK will still be viable
- In June 2018, NICE released draft guidance on the treatment of abdominal aneurysms. Amongst all the information provided was the controversial suggestion that elective EVAR treatment should not be recommended. The guidance suggested that patients fit enough (not objectively defined) for open repair were recommended to undergo open surgery and those where age or comorbidity conferred an excess risk for open surgery should be advised to have no treatment at all. Whilst it is accepted that such recommendations are made on a cost-effectiveness basis, this is more easily applied on a population basis, than to an individual patient in clinic. Stakeholders contributed to what is probably the most comprehensive response to any draft NICE guidance document. The main thrust of the response included:
- That this guidance was at odds with global recommendations
 - That no account of anatomy and IFU was considered
 - That the randomised data on which the recommendations were based was historical
 - That the potential increase in critical care bed usage and LoS was unfunded
 - That although there is a recognised late failure rate of EVAR, the many successful and durable repairs were ignored
 - That patient choice was ignored
 - That it would make AAA screening in the UK non viable
 - That there was no information on how to implement this guidance
- It is this last point that is most pertinent. Over the last three decades, patients have learnt to expect the increased use of technology and a

more minimally invasive approach to all aspects of surgery. Moreover, increasing fitness into older age has resulted in an expectation for treatment. The guidelines are naively based on evidence from twenty years ago and fail to incorporate contemporary evidence and expectations. Although some of the guidance is sensible and should be incorporated into clinical practice, the binary recommendation with regard to EVAR use seems to be at odds with the ethos of NICE recommendations based on evidence. As a result, the guidance is impossible to implement by an aortic specialist managing individual patients in 2019.

901.3

Why are other guidelines different?

C.S. Pena

Interventional Radiology, Miami Cardiac and Vascular Institute, Miami, FL, US

Learning Objectives

1. To learn what other guidelines there are
 2. To learn what evidence ESVS and SVS have relied on
 3. To understand why they have concluded differently from NICE
- Guidelines and appropriate criteria in the management of our patients are critical to guide and outline the standard and best practice standards for our patients. The NICE EVAR Draft guidelines released for review in 2018 have created healthy discussion in the management of patients with AAA. Now that EVAR technology is over 30 years old, it is important that we reassess our studies, level of evidence and guidelines, as we suggest and define the best practices
- This lecture will focus on evaluating the recently published SVS guidelines and discuss how they differ from previous guidelines and are supported by levels of evidence. Guidelines should focus on patient factors (age, comorbidity, quality of life, life expectancy, renal function), aneurysm factors (size, neck features, access vessels) and treatment factors (type of repair, center experience). How do these differ from ESVS criteria? What are the important factors in guideline determination?
- How does the rapid changes and technology modifications in EVAR effect these recommendations? Are any of these factors sufficient to supersede the findings from EVAR1 and EVAR2?

901.4

How to improve long-term success of EVAR

A. Holden

Radiology, Auckland City Hospital, Auckland, NZ

Learning Objectives

1. To learn whether we should stick with established technology or innovate
 2. To gain insight into whether IFU is key or can be ignored
 3. To learn what % of AAAs are suitable for EVAR in 2019 and how long they will last
- When Juan Parodi performed the first EVAR procedure in 1989, the expectations for this experimental procedure were to achieve a lower peri-procedural and long-term morbidity and mortality compared to open repair (OR), achieve a freedom from rupture similar to OR, treat most aneurysm morphologies, require minimal reintervention to maintain long term seal and avoid the need for long term surveillance. Early on, EVAR was labelled a failed experiment due to the high intervention rate required to maintain freedom from aneurysm rupture. Long term follow-up in the landmark randomized controlled trials has revealed better aneurysm-related and overall survival for OR compared to EVAR. It is this background that influenced the current NICE guidelines. So how do we improve the long-term outcomes of EVAR to get closer to the original goals?
- Large population-based studies using propensity-score matched cohorts has shown late aneurysm rupture is significantly higher for EVAR than OR. EVAR is also associated with significant incidence of aneurysm sac

expansion. A risk factor for sac expansion, loss of seal and late rupture is treatment of patient anatomy outside a device "instructions for use" (IFU) and yet a significant number of patients with "hostile neck anatomy" continue to be treated outside of company IFUs. The current endovascular treatment strategies for hostile neck anatomy include fenestrated EVAR and chimney EVAR. Both techniques have advantages and limitations but there are still patient anatomies that are not well managed by these technologies so a therapeutic gap persists. Chimney EVAS may have a role although its durability remains unproven.

Almost all current EVAR devices use endografts supported by self-expanding stents. These devices are associated with neck dilatation with time, an event that predict late complications including type 1A endoleak and migration. Alternative strategies are important to consider. These include technologies that do not impart chronic outward force on the neck (such as Ovation ALTO) or endoanchors which may protect the neck from subsequent dilatation with conventional endografts.

The contribution of type 2 endoleak to late aneurysm failure is hotly debated. However, type 2 endoleak does predict sac expansion and is associated with higher re-intervention. The concept of endovascular active sac management, analogous to OR was explored with Nellix Endovascular Aneurysm Sealing (EVAS). While this technology did support the proof of concept with a very low all-cause endoleak rate to 2 years, a lack of durability has been a major setback. Interestingly, despite these challenges, Nellix EVAS has been associated with a lower all-cause mortality compared to EVAR, at least to 2 years and this has stimulated pursuit of a next generation EVAS device as well as other sac filling strategies. Finally, a contributor to increased late mortality with EVAR appears to be due to a higher incidence of oncology-related deaths, possibly due to excessive imaging-related radiation exposure during post-procedure surveillance. In this regard, there have been important developments in customizing patients' surveillance based on the quality of seal achieved after EVAR which promise to greatly reduce surveillance, at least in the cohort of patients with optimal seal.

Focus Session

Acute type B dissection

1001.1

How to define the need for urgent TEVAR

M.D. Dake

Falk Cardiovascular Research Center, Stanford University School of Medicine, Stanford, CA, US

Learning Objectives

1. To learn about the clinical and laboratory parameters that influence the decision for urgent TEVAR
2. To understand the imaging criteria that speak for early intervention
3. To learn to differentiate between immediate and early intervention

No abstract available.

1001.2

When is TEVAR alone not enough?

G.M. Richter

Director Clinics for Diagnostic and Interventional Radiology, Klinikum Stuttgart, Stuttgart, DE

Learning Objectives

1. To learn if TEVAR alone is adequate in rupture
2. To learn about the ancillary interventional procedures to optimize the results of TEVAR in malperfusion complicating TBAD
3. To learn about the role of adjuvant surgical procedures and supportive medical management

No abstract available.

1001.3

Primary extended techniques

E. Verhoeven¹, P. Marques de Marino², A. Katsargyris², B. Botos²

¹Vascular and Endovascular Surgery, Klinikum Nürnberg Süd, Nuremberg, DE, ²Department of Vascular and Endovascular Surgery, Paracelsus Medical University Nuremberg, General Hospital Nuremberg, Nuremberg, DE

Learning Objectives

1. To become familiar with these techniques
2. To learn about the various complications that may arise
3. To learn about the outcomes of these techniques

Acute Dissection of any Type is the most common sub entity in acute aortic syndrome. For acute Type A dissection, open surgical treatment is mandated and the golden standard. Acute Type B dissection (TBAD) has always been categorized as uncomplicated and complicated. Hard end points for acute complicated were rupture, malperfusion of visceral arteries, and leg ischemia. Nowadays, softer end points as uncontrollable hypertension, pleural effusion, persistent back/chest pain, collapsed true lumen, and rapid growth are all indicators that categorize patients as complicated. For uncomplicated Type B dissection, best medical treatment (BMT) has been the golden standard. Important with regard to BMT is to have a well elaborated protocol and to pursue all efforts to control the hypertension. For any complicated acute TBAD, thoracic endovascular aortic repair (TEVAR) has become the standard of care over open repair. Treatment of type B aortic dissection (TBAD) has been in constant evolution over the last decade. Even for uncomplicated acute TBAD, conservative treatment with surveillance and blood pressure control is now subject of debate and controversy, and a more aggressive approach towards early TEVAR is being increasingly adopted in many institutions. Global registries have increasingly shown suboptimal long-term results for medically treated uncomplicated TBAD patients with a 5-year mortality of 30-50%.^{1,2} The fact that the disease affects younger patients and many of the deaths during follow-up are aortic related, have put the focus on establishing a treatment that prevents mid-term and late complications, and related mortality on the long-term. The classical definitions of complicated and uncomplicated TBAD have been challenged and some authors suggest that all should be considered a vascular complication requiring repair by an effective and durable strategy, advocating for endovascular treatment of most patients with acute/subacute TBAD.³ The INSTEAD-XL was the first multicentre randomized trial to study endovascular treatment of patients with uncomplicated TBAD.³ The study included 140 patients with uncomplicated subacute/early chronic phase TBAD and aortic diameter < 5.5cm. Complete false lumen thrombosis at the thoracic level was noted in 90.6% of the patients after TEVAR, but no data were reported on abdominal remodelling. TEVAR proved to be better with regard to aorta-specific mortality (6.9% versus 19.3%; P=0.04), and disease progression (27.0% versus 46.1%; P=0.04) after 5 years. This supports the idea that the early operative risk with TEVAR is likely counterbalanced with less complications during follow-up.

One needs however to realise that a number of TBAD patients will not develop an aneurysm during follow-up and (over)treatment of these patients with TEVAR only means operative risk without later benefit. Many studies have aimed to identify predictors of aortic growth in uncomplicated TBAD with the purpose to define subgroups of patients that might benefit (more?) from early TEVAR. Clinical predictors include young age, white race, Marfan Syndrome, high heart rate, etc. Radiologic predictors include initial aortic diameter ≥ 40 mm, patent true lumen with elliptic configuration, large single-entry tear in the inner curvature, false lumen diameter ≥ 22 mm on the proximal descending thoracic aorta, etc.⁴ Most of these predictors originate from small series, often in Asian patients, and contradictory results between studies have been occasionally reported. A critical appraisal is therefore crucial for suitable patient-selection, despite accumulating data favouring TEVAR.

The ADSORB trial was a randomized trial comparing best medical treatment (BMT) alone versus BMT plus TEVAR.⁵ Different than the INSTEAD trial, this study enrolled patients who were treated within 2 weeks from their onset of symptoms (acute phase). No strokes, no paraplegia, and no deaths occurred in either group regardless of TEVAR being done in the acute phase. The trial demonstrated aortic remodeling was noticeably higher in patients undergoing acute-phase TEVAR at one-year follow-up. Beyond treatment in the acute/subacute phase, late distal aneurysmal degeneration after both medical treatment and TEVAR in uncomplicated and complicated dissections is a serious concern and has been subject of discussion in the past years. This has resulted in an attempt to introduce several adjunctive techniques to counteract distal degeneration towards a post-dissection thoraco-abdominal aneurysm. The delicate balance between a durable repair with extensive remodelling and prevention of late complications and the additional risk of surgical/early complications that may occur from more extensive initial treatment with more invasive techniques has led to different strategies between centres.

The first well-studied attempt was the Petticoat technique with additional stenting over the visceral arteries using a non-covered stent (Zenith Dissection Stent, Cook Medical, Bloomington, IN, USA). The aim of this additional stenting was to restore blood flow to all impaired vessels and to re-open the true lumen more extensively. In two trials, the authors showed benefit with regard to true-lumen perfusion but overall, no significant reduction of distal aneurysmal degeneration.⁶

The STABILISE concept was published in a series with 11 patients by Mossop's group in 2014, but did not receive a lot of followers because it seemed very counterintuitive to balloon and disrupt a lamella in a dissected aorta.⁷ This technique indeed includes the use of a stent-graft to cover the proximal entry tear, followed by a non-covered stent over the visceral arteries (like PETTICOAT), and then additional ballooning with a larger balloon to disrupt the dissection flap with the aim to obliterate the false lumen and restore uniluminal flow. Main limitation of the technique is a maximum diameter of the aorta at the level of the visceral arteries (below 40mm, maybe even 36mm). Additional stenting of visceral arteries to maintain flow has been reported by several authors. A technical addition to the technique that was quickly adopted, is to catheterize visceral arteries that originate from the false lumen after the insertion of the bare stent, but before ballooning. This maintains access if the disrupted lamella occludes the inflow to that vessel, and facilitates the required stenting of the artery.

At this moment, the technique is being evaluated in several European centres. Increasing number of studies have arisen analysing its outcomes. The original article from Mossop's group in 2014 showed promising results of aortic remodelling with 100% complete false lumen obliteration in the thoracic aorta and 90% throughout the entire abdominal aorta. These results were confirmed by Melissano et al. in another small series with 10 patients.⁸ Additional stenting was required in 7 renal arteries and 1 superior mesenteric artery to preserve branches arising from the false lumen. More recently this year, Faure et al. published the largest report to date analysing mid-term results of the STABILISE technique in 41 patients with acute/subacute TBAD and abdominal aorta involvement with retrograde flow after TEVAR.⁹ No intraprocedural complications were noted. In this series, 9% of the visceral branches

needed additional stenting. During follow-up, all patients showed complete aortic remodelling at the thoracic/visceral level and 39% had complete remodelling at the non-stented infrarenal aorto-iliac level. The primary visceral patency rate was 93%, with a 20% reintervention rate at 1 year.

STABILISE seems to be the first technique to aim at curing patients from this devastating disease. There are still a lot of questions open with regard to indication and inclusion and exclusion criteria. In our centre, the technique has been used in subacute and early chronic phase TBAD patients with soft end points for treatment, but also in some acute TBAD patients with hard end point complications. Overall, the follow-up imaging studies have shown amazing results with regard to uniluminal flow and disappearance of the false lumen (rather than thrombosis only). Whether these results sustain must be evaluated and reported. Further studies are needed to define subgroups of acute TBAD patients that will more likely have late aortic events, and therefore justify an early treatment with TEVAR. Further studies are also needed to determine the role of STABILISE, and clear indications and contra-indications are required, before widespread use can be advocated. The diameter of the aorta at the visceral level seems to play an important role for success. Melissano, together with us and other colleagues, have worked on the creation of a registry on STABILISE which deserves support, with the aim to monitor the technique, and define in which patients it should be used.

References

1. Suzuki T, Isselbacher EM, Nienaber CA, Pyeritz RE, Eagle KA, Tsai TT, et al. Type-selective benefits of medications in treatment of acute aortic dissection (from the International Registry of Acute Aortic Dissection [IRAD]). *Am J Cardiol* 2012;109: 122-7.
2. Acosta S, Blomstrand D, Gottsater A. Epidemiology and long-term prognostic factors in acute type B aortic dissection. *Ann Vasc Surg* 2007;21: 415-22.
3. Nienaber CA, Kische S, Rousseau H, Eggebrecht H, Rehders TC, Kundt G, et al. Endovascular repair of type B aortic dissection: long-term results of the randomized investigation of stent grafts in aortic dissection trial. *Circ Cardiovasc Interv* 2013;6: 407-16.
4. Trimarchi S, Jonker FH, van Bogerijen GH, Tolenaar JL, Moll FL, Czerny M, et al. Predicting aortic enlargement in type B aortic dissection. *Ann Cardiothorac Surg* 2014;3: 285-91.
5. Brunkwall J, Kasprzak P, Verhoeven E, et al. Endovascular repair of acute uncomplicated aortic type B dissection promotes aortic remodelling: 1 year results of the ADSORB trial. *Eur J Vasc Endovasc Surg* 2014; 48: 285-91.
6. Lombardi JV, Cambria RP, Nienaber CA, Chiesa R, Teebken O, Lee A, Mossop P, Bharadwaj P. Prospective multicenter clinical trial (STABLE) on the endovascular treatment of complicated type B aortic dissection using a composite device design; STABLE investigators. *J Vasc Surg* 2012;55: 629-640.
7. Hofferberth SC, Nixon IK, Boston RC, McLachlan CS, Mossop PJ. Stent-assisted balloon-induced intimal disruption and relamination in aortic dissection repair: the STABILISE concept. *J Thorac Cardiovasc Surg* 2014;147: 1240-5.
8. Melissano G, Bertoglio L, Rinaldi E, Mascia D, Kahlberg A, Loschi D, et al. Satisfactory short-term outcomes of the STABILISE technique for type B aortic dissection. *J Vasc Surg* 2018;68: 966-975.
9. Faure EM, El Batti S, Abou Rjeili M, Julia P, Alsac JM. Mid-term Outcomes of Stent Assisted Balloon Induced Intimal Disruption and Relamination in Aortic Dissection Repair (STABILISE) in Acute Type B Aortic Dissection. *Eur J Vasc Endovasc Surg* 2018;56: 209-15.

1001.4

Outcome of TEVAR for acute type B dissection

C. Nienaber

Cardiology and Aortic Centre, Imperial College, The Royal Brompton & Harefield NHS Trust, London, UK

Learning Objectives

1. To learn about the morphological changes in the TL and FL
2. To learn about the immediate- mid- and long-term outcomes both in complicated as well as uncomplicated TBAD
3. To learn about early and late complications

No abstract available.

Focus Session

Subacute and chronic type B dissection

1501.1

Imaging findings supporting TEVAR

A. Chavan¹, O. Eldergasch², S.S. Amin², J. Schnabel², G. Voshage¹

¹Institut für Diagnostische und Interventionelle Radiologie, Klinikum Region Hannover GmbH, Neustadt Am Rübenberge, DE, ²Institut für Diagnostische und Interventionelle Radiologie, Klinikum Oldenburg, Oldenburg, DE

Learning Objectives

1. To learn about imaging techniques in subacute and chronic dissections
2. To learn about anatomical findings that put patients at higher risk of PDATAA
3. To learn about balancing the pros and cons of TEVAR in subacute and chronic dissections

Proximal entry closure with thoracic endovascular stent-graft implantation (TEVAR) either by itself or in combination with other ancillary interventions, often leads to resolution of symptoms in patients with type B aortic dissection (TBAD) complicated by rupture, organ malperfusion, persistent pain and therapy refractory hypertension.

As opposed to this, there is ongoing controversy as regards the role of TEVAR in patients that do not exhibit the above mentioned clinical features, that is in those with the so-called "uncomplicated" TBAD. A clear cut benefit of TEVAR over medical management could not be demonstrated in the INSTEAD trial with comparable mortalities in both (TEVAR vs. medical management) groups and a higher (non-significant) complication rate in the TEVAR group (1). The ADSORB trial in contrast, showed a lower complication rate for TEVAR as compared to the INSTEAD trial (2). In a later publication, the INSTEAD XL report demonstrated a better aorta-specific survival after 5 years in favour of TEVAR (3). This was confirmed by Fattori and colleagues independently in the same year, based on IRAD data (4). In addition, the above reports demonstrated that false lumen (FL) thrombosis and aortic remodelling are best if TEVAR is performed within the first 6-9 months after the acute episode. Against this backdrop, the decision whether or not to intervene in uncomplicated type B dissections would be simplified, if imaging features were available that would speak in favour of TEVAR.

In such a scenario, an analysis of the natural course of the dissection at long term follow-up after purely medical management may be helpful in defining the sub-class of patients that could benefit from early TEVAR. In a cohort consisting of 136 patients with TBAD treated conservatively, Sailer and colleagues analysed which patients could be at higher risk for developing adverse events at follow-up. Adverse events included delayed rupture, organ ischemia, aneurysm formation, rapid aortic growth ≥ 10 mm within a year and new refractory hypertension or pain. A third of the patients experienced adverse events within 5 years of the initial acute episode. Those patients that showed an increase of aortic diameter of > 5

mm in the first 6 months experienced significantly more adverse events. In non-resolving intramural hematomas (IMH), most adverse events were experienced within the first year (5).

Ray and colleagues analysed the predictors of intervention and mortality at follow-up in conservatively treated uncomplicated TBAD. In an analysis of 156 patients, they were able to demonstrate that the intervention rate at one, 5 and 10 years was significantly lower in patients that presented with an admission aortic diameter ≤ 44 mm. Furthermore, an admission aortic diameter > 22 mm was associated with a decreased intervention-free survival. Age at admission exceeding 60 years as well as admission aortic diameter ≥ 44 mm were predictors for mortality at follow-up (6). Based on the above reports by Sailer and Ray, it appears logical, that early TEVAR may be beneficial to patients with uncomplicated type B dissections if the admission aortic diameter exceeds 44 mm and the admission FL diameter exceeds 22 mm. Furthermore, carrying out TEVAR in those patients that exhibit an increase in total aortic diameter of more than 5 mm in 6 months following the acute episode, may reduce the incidence of adverse events at further follow-up. Worthy of special mention are also the type B dissections restricted to the descending thoracic aorta without extension to the abdominal segment (DeBakey IIIa). TEVAR in such patients may lead to a complete healing of the dissection if all entry tears are covered; consequently one can be liberal with the indication for TEVAR in such TBAD.

In comparison to aortic dissection, there appears to be a difference in the affected plane of the aortic media in intramural hematomas (IMH). In IMH, the outer media (towards the adventitia) is thinner, which explains the higher risk of rupture of IMH as compared to aortic dissection (7, 8). 8-16 % of the IMH's evolve into aortic dissection (8, 9, 10). Considering the fact, that adverse events in non-resolving IMH are commonest in the first year (5), such IMH that evolve into aortic dissection may also benefit from early TEVAR.

In summary, rupture or impending rupture and organ malperfusion are clear indications for urgent TEVAR (11). Imaging findings of rupture include extra-luminal contrast extravasation, mediastinal hematoma, and hemorrhagic pleural effusion. Severe narrowing or occlusion of vessel lumen, organ infarction and diminished organ perfusion (such as diminished opacification of the kidneys, spleen or liver) suggest malperfusion. Difficulty in deciding whether to intervene or not, arises with those patients with uncomplicated TBAD that do not exhibit the above features. Based on evidence in literature so far, early TEVAR may be beneficial in patients with admission aortic diameter exceeding 44 mm, admission FL diameter exceeding 22 mm and those that exhibit an increase in total aortic diameter of more than 5 mm in 6 months. Furthermore, due to its potential to completely cure the dissection, early TEVAR may be helpful in DeBakey IIIa dissections. Similarly, due to the higher risk of rupture, non-resolving IMH should also be considered for early TEVAR.

References

1. Nienaber CA, Rousseau H, Eggebrecht H et al. (2009): Randomized Comparison of Strategies for Type B Aortic Dissection: The Investigation of STEnt Grafts in Aortic Dissection (INSTEAD) Trial. *Circulation*; 120: 2519-2528.
2. Brunkwall J, Lammer J, Verhoeven E, Taylor P. ADSORB: A Study on the Efficacy of Endovascular Grafting in Uncomplicated Acute Dissection of the Descending Aorta. *Eur J Vasc Endovasc Surg* 2012; 44: 31-36.
3. Nienaber CA, Kische S, Rousseau H, Eggebrecht H, Rehders TC, Kundt G, Glass A, Scheinert D, Czerny M, Kleinfeldt T, Zipfel B, Labrousse L, Fattori R and Ince H for the INSTEAD XL Trial. Endovascular Repair of Type B Aortic Dissection: Long-term Results of the Randomized Investigation of Stent Grafts in Aortic Dissection Trial. *Circ Cardiovasc Interv.* 2013; 6: 407-16.
4. Fattori R, Cao P, De Rango P, Czerny M, Evangelista A, Nienaber C, Rousseau H, Schepens M: Interdisciplinary Expert Consensus Document on Management of Type B Aortic Dissection. *J Am Coll Cardiol* 2013; 61: 1661-78.

5. Sailer AM, Nelemans PJ, Hastie TJ et al. Prognostic significance of early aortic remodeling in acute uncomplicated type B aortic dissection and intramural hematoma. *J Thorac Cardiovasc Surg* 2017; 1-9.
6. Ray HM, Durham CA, Ocazonez D, et al. (2016) Predictors of intervention and mortality in patients with uncomplicated acute type B aortic dissection. *J Vasc Surg* 2016; 64(06):1560-1568.
7. Estrera A, Miller C 3rd, Lee TY, et al. Acute type A intramural hematoma: analysis of current management strategy. *Circulation* 2009; 120:S287.
8. Tittle SL, Lynch RJ, Cole PE, et al. Midterm follow-up of penetrating ulcer and intramural hematoma of the aorta. *J Thorac Cardiovasc Surg* 2002; 123:1051.
9. Harris KM, Braverman AC, Eagle KA, et al. Acute aortic intramural hematoma: an analysis from the International Registry of Acute Aortic Dissection. *Circulation* 2012; 126:S91.
10. Evangelista A, Mukherjee D, Mehta RH, et al. Acute intramural hematoma of the aorta: a mystery in evolution. *Circulation* 2005; 111:1063.
11. Frank Manetta, MD, Joshua Newman, MS, Allan Mattia, MD (2018) Indications for Thoracic Endovascular Aortic Repair (TEVAR): A Brief Review. *Int J Angiol* 2018; 27: 177-184.

1501.2

Knickerbockers and candy plugs: do they work?

T. Kölbel

Klinik und Poliklinik für Gefäßmedizin, Universitäres Herzzentrum Hamburg (UHZ), Hamburg, DE

Learning Objectives

1. To learn about technical alternatives to treat PDTHAA
 2. To learn about choices in the treatment of PDTHAA
 3. To learn about outcome of Knickerbocker and Candy Plug
- Chronic aortic dissection includes different previous histories such as residual dissection after surgical repair of a DeBakey type I aortic dissection, dissection after ascending aortic repair for other pathologies, and chronic type B aortic dissection. Despite the different background, the risk for future complications in chronic aortic dissection is mainly related to false-lumen aneurysmal dilatation and rupture. The aim of therapy in chronic aortic dissection is to prevent false lumen dilatation and aortic related death. Endovascular stent-graft therapy aims to reduce or abolish flow in the false lumen.
- Since the introduction of thoracic endovascular aortic repair (TEVAR) for the treatment of aortic dissection type B in 1998, it has become the mainstay of operative treatment for acute complicated type B aortic dissection, offering a clear benefit with lower mortality and morbidity rates compared to open surgical repair. TEVAR in aortic dissection is based on the implantation of thoracic tubular stent-grafts to cover the proximal entry tear and thereby redirect flow into the true lumen. This strategy intends to depressurize and thrombose the false lumen, and promote aortic remodeling in a majority of patients with acute aortic dissection. Response to this treatment strategy is limited in patients with chronic dissections with a reduced capacity for aortic remodeling due to the thickened and fibrotic degenerated intimal flap. A significant proportion of patients have persistent and significant false lumen flow despite placement of a thoracic stent-graft even where long lengths of the thoracic aorta are covered. Large re-entry tears at the level of the visceral aorta or further distally are particularly responsible for persistent false lumen flow.
- This limited response to endovascular treatment in chronic aortic dissection is caused by the continued pressurization from persistent retrograde false-lumen flow to intercostal and bronchial arteries from downstream entry-tears. Retrograde filling and pressurization leads to late aortic expansion in 35% of patients treated by TEVAR for chronic type B aortic dissection. The lack of aortic remodeling and false lumen aneurysmal dilatation caused by continued perfusion of the false lumen causes late

aortic death as has been recently shown by Mani et al. in 2013. In patients with ruptured chronic false lumen aneurysm after type A and B aortic dissection the persisting retrograde filling may lead to continued bleeding despite TEVAR down to the celiac artery to cover the descending aortic entry-tears.

Novel techniques have been introduced recently to prevent retrograde flow into the thoracic false lumen. Fenestrated stent-grafts allow longer segment coverage and thereby to abolish further distal entry tears. Other techniques to exclude the thoracic false lumen from aneurysmal dilatation are the "candy-plug technique" and the "knickerbocker technique", which both aim at false-lumen occlusion at the distal descending thoracic aorta. Residual dissection after previous ascending aortic repair is a specifically challenging condition as treatment usually involves the supra-aortic branches, which might be dissected. Open treatment strategies are often limited due to comorbidities, the previous surgery and the complex anatomy requiring seal of true and false lumen. Hybrid techniques have been introduced using debranching techniques or frozen-elephant trunk repair and early results of these techniques are promising for aortic arch repair, but there is no published data for residual dissections as a subgroup. The introduction of new fenestrated and branched aortic arch endografts have shown promising results in single centers and allow to treat these difficult pathologies without the use for cardiopulmonary bypass. This presentation will focus on newer endovascular strategies for false lumen exclusion and endovascular arch repair for residual dissection.

1501.3

When do we need fenestrated stent-grafts?

K. Oikonomou¹, P. Kasprzak¹, A. Katsargyris², K. Pfister¹, E. Verhoeven²

¹Department of Vascular Surgery, University Medical Center

Regensburg, Regensburg, DE, ²Department of Vascular and

Endovascular Surgery, Paracelsus Medical University, Nuremberg, DE

Learning Objectives

1. To learn about the indications for treatment of PDTHAA
2. To learn about technical options with F/B grafts
3. To learn about balancing the pros and cons of F/B grafts in PDTHAA

Introduction

Current guidelines recommend that Stanford type A dissections should be treated surgically, whereas uncomplicated type B dissections should be treated medically, and complicated type B dissection by thoracic endovascular repair (TEVAR).¹⁻³ As a result of improved management of acute aortic dissection with increased survival, the number of patients presenting with post-dissection aneurysms of the descending thoracic (PD-TAA) and the thoracoabdominal aorta (PD-TAAA) is increasing.

Aortic expansion remains the crucial factor determining long-term survival in patients with an uncomplicated acute type B dissection. Approximately 30% of these patients will develop a post-dissection aneurysm.^{4,5} This long degenerative process is characterized by extensive remodeling of the aorta and increasing fibrotic stiffness of the intimal flap, resulting in an aneurysm that presents diverse technical challenges, as it often involves the thoracoabdominal aorta.

Endovascular repair of type B chronic dissections

In acute and sub-acute dissections coverage of the proximal intimal tear seems to promote false lumen thrombosis and aortic remodeling.⁶ This simple management is however not always effective in a chronic post-dissection aneurysm.

Conventional thoracic endografting can be a viable approach for secondary aneurysms limited to the thoracic aorta. Several studies have reported positive results after endovascular repair of chronic type B dissections with early mortality rates of 0-5% and neurologic complication rates ranging from 0% to 9%.^{7,8} Estimated survival rates of 86%, 82% and 80% at 12, 24 and 36 months respectively, have been reported.⁹ Nevertheless, the postoperative aortic remodeling (i.e. decrease in aortic diameter) in these cases seems to be limited to the stent-grafted segment of the aorta, not influencing the distal untreated segments. Complete thrombosis of the entire false lumen after standard thoracic endografting is uncommon

in patients with extensive dissections.⁹ Recently, TEVAR combined with false lumen embolization techniques has been reported in a small number of patients. This can be a promising technique for aneurysms limited in the thoracic aorta, however currently patient numbers as well as follow up have been very limited.¹⁰

Treatment of a post-dissection aneurysm should aim at the complete exclusion of the aneurysm. In chronic PD-TAAA, complete aneurysm exclusion requires utilization of fenestrated and/or branched stent-grafts (F/B-TEVAR). Favorable results and durability of fenestrated and branched stent-grafts for atherosclerotic thoracoabdominal aortic aneurysms have been demonstrated in several reports. In chronic post-dissecting aneurysms, however, additional technical challenges arise. One specific feature is the usually narrow true lumen and this need to be taken into account when deciding whether to use fenestrations or branches. Branches are more suitable when target vessels present with sharp downward take-off, but require more room in the true lumen. This extra room can be created by deployment of a tube graft first with a distal landing zone a few cm above the visceral branches of the aorta, so as to expand the true lumen. Fenestrations must usually be catheterized from below and require less true lumen space, but require more accurate planning with regard to orientation. A second technical challenge relates to visceral branches originating from different luminae. In such cases, perforation of the stiff chronic dissection flap is required to obtain access to the vessels originating from the false lumen. Puncture of the dissection flap with a needle (e.g. TIPPS needle) or the stiff end of a wire is a good option to address this issue. In the case of complete true lumen collapse with perfusion of all major branches through the false lumen, exclusion of the aneurysm may even be achieved by deployment of the fenestrated/branched endograft in the false lumen, provided there is a suitable proximal and distal landing zone.

Experience with fenestrated endografting for PD-TAAA

Literature on fenestrated and branched endografting for PD-TAAA is limited, with a few centers experienced in endovascular techniques reporting promising early results.^{11,12} Our group has previously reported initial results for F/B-TEVAR in 31 PD-TAAA patients, noting a high technical success and false lumen thrombosis rate.¹³

Our published mid-term experience with this method currently includes 71 patients (mean age 63.8 ± 10.6 years) with PD-TAAA treated with F/B-TEVAR in two vascular institutions from January 2010 to April 2017.¹⁴ Technical success was achieved in 68/71 (95.8%) patients. In-hospital mortality was four (5.6%) patients. Perioperative morbidity was 19.6%. Eleven patients suffered symptoms of spinal cord ischemia (SCI) perioperatively. In nine of these patients, SCI was temporary with paresis of one or both lower extremities, with complete recovery at the time of discharge. Two patients suffered severe SCI with paraplegia that partly recovered to paraparesis at discharge. With increasing experience, staging strategies were applied in both institutions. For fenestrated grafts, staging was carried out either by deployment of the thoracic tube graft(s) as a first step and subsequent deployment of the fenestrated component as well as all bridging stent-grafts 4-6 weeks after the initial procedure, or by delayed deployment of the contralateral iliac limb. For branched grafts, staging was carried out by means of temporary sac perfusion (TASP) through an open branch for the celiac artery which was secured 2-4 weeks following the initial procedure. A comparison between the staged and non-staged groups showed a lower rate of SCI for the staged group (13.8% vs 17.5%). This difference was not significant statistically ($p=0.75$). During a mean follow-up (FU) of 25.3 months cumulative survival rates at 12, 24 and 36 months were $84.7 \pm 4.5\%$, $80.7 \pm 5.1\%$, $70.0 \pm 6.7\%$, respectively. All-cause mortality was 14 patients, 13 of which aneurysm unrelated. Target vessel patency was $98.6 \pm 0.8\%$, $97.2 \pm 1.3\%$ and $96.3 \pm 1.6\%$, respectively. Estimated freedom from reintervention was $80.7 \pm 5.3\%$, $63.0 \pm 6.9\%$, $52.6 \pm 8.0\%$, respectively. The most common reasons for reintervention were endoleaks from the distal end of visceral/renal artery bridging stent-grafts and iliac endoleaks requiring extension. In PD-TAAA remodeling of the aorta seems to facilitate the occurrence of endoleaks over target vessels, therefore the use of longer bridging stent-grafts should be considered. Dissected iliac arteries may be used as a distal

landing zone for an oversized endograft, with the aim of pushing the dissection flap against the aortic wall. In our experience, approximately half of these patients will nevertheless require an extension into the external and internal iliac artery in the mid-term to completely exclude retrograde aneurysm perfusion. Ultimately, there was a significant mean aneurysm sac regression of 9.2 ± 8.8 mm during FU. Complete false lumen thrombosis as an indicator of successful aneurysm exclusion was noted in 85.4% of patients that completed a one year follow-up.

Conclusion

The reason to treat a chronic dissection is almost exclusively the formation of a post-dissection aneurysm. Standard thoracic endografting is an option in a minority of patients, when the aneurysm is limited to the thoracic segment. When addressing PD-TAAA, fenestrated and branched devices can be a feasible solution with low perioperative mortality and morbidity, despite the associated technical challenges. Mid-term results demonstrate a high rate of complete false lumen thrombosis and aneurysm regression. The need for rigorous follow-up due to the significant rate of reinterventions should be noted. A specific point of attention is the selection of bridging stent-grafts for visceral and renal target vessels.

References

1. Riambau V, Böckler D, Brunkwall J, Cao P, Chiesa R, Coppi G, et al. Editor's Choice - Management of Descending Thoracic Aorta Diseases: Clinical Practice Guidelines of the European Society for Vascular Surgery (ESVS). *Eur J Vasc Endovasc Surg*. 2017;53:4-52
2. Erbel R, Aboyans V, Boileau C, Bossone E, Bartolomeo RD, Eggebrecht H, et al. ESC Committee for Practice Guidelines. 2014 ESC Guidelines on the diagnosis and treatment of aortic diseases: Document covering acute and chronic aortic diseases of the thoracic and abdominal aorta of the adult. The Task Force for the Diagnosis and Treatment of Aortic Diseases of the European Society of Cardiology (ESC). *Eur Heart J*. 2014;35:2873-926
3. Oikonomou K, Katsargyris A, Kouvelos G, Renner H, Verhoeven EL. Treatment algorithms for patients with (sub)acute type B aortic dissections. *J Cardiovasc Surg (Torino)*. 2016;57:212-20
4. Fanelli F, Dake MD. Standard of practice for the endovascular treatment of thoracic aortic aneurysms and type B dissections. *Cardiovasc Intervent Radiol*. 2009;32:849-860.
5. Blount KJ, Hagspiel KD. Aortic diameter, true lumen, and false lumen growth rates in chronic type B aortic dissection. *AJR Am J Roentgenol*. 2009;192(5):222-9.
6. Brunkwall J, Kasprzak P, Verhoeven E, Heijmen R, Taylor P; ADSORB Trialists. Endovascular repair of acute uncomplicated aortic type B dissection promotes aortic remodelling: 1 year results of the ADSORB trial. *Eur J Vasc Endovasc Surg*. 2014;48:285-91
7. Zipfel B, Czerny M, Funovics M, et al. Endovascular treatment of patients with types A and B thoracic aortic dissection using Relay thoracic stent-grafts: results from the RESTORE Patient Registry. *J Endovasc Ther*. 2011;18(2):131-43.
8. Parsa CJ, Williams JB, Bhattacharya SD, et al. Midterm results with thoracic endovascular aortic repair for chronic type B aortic dissection with associated aneurysm. *J Thorac Cardiovasc Surg*. 2011;141:322-7.
9. Kang WC, Greenberg RK, Mastracci TM. Endovascular repair of complicated chronic distal aortic dissections: intermediate outcomes and complications. *J Thorac Cardiovasc Surg*. 2011;142(5):1074-83.
10. Rohlfes F, Tsilimparis N, Fiorucci B, Heidemann F, Debus ES, Kölbel T. The Candy-Plug Technique: Technical Aspects and Early Results of a New Endovascular Method for False Lumen Occlusion in Chronic Aortic Dissection. *J Endovasc Ther*. 2017;24:549-555.
11. Kitagawa A, Greenberg RK, Eagleton MJ, Mastracci TM, Roselli EE. Fenestrated and branched endovascular aortic repair for chronic type B aortic dissection with thoracoabdominal aneurysms. *J Vasc Surg* 2013;58:625-634
12. Spear R, Hertault A, Van Calster K, Settembre N, Delloye M, Azzaoui R et al. Complex endovascular repair of postdissection arch and thoracoabdominal aneurysms. *J Vasc Surg*. 2018;67:685-693.

13. Oikonomou K, Kopp R, Katsargyris A, Pfister K, Verhoeven EL, Kasprzak P. Outcomes of fenestrated/branched endografting in post-dissection thoracoabdominal aortic aneurysms. *Eur J Vasc Endovasc Surg.* 2014;48:641-8
14. Oikonomou K, Kasprzak P, Katsargyris A, Marques De Marino P, Pfister K, Verhoeven ELG. Mid-Term Results of Fenestrated/ Branched Stent Grafting to Treat Post-dissection Thoraco-abdominal Aneurysms. *Eur J Vasc Endovasc Surg.* 2019 Jan;57:102-109.

1501.4

Prevention and management of spinal cord ischaemia

M.A. Funovics

Klinik für Radiodiagnostik, Medizinische Universität Wien, Vienna, AT

Learning Objectives

1. To learn about the risks of SCI in dissections
2. To learn about adjunctives to lower the risk of paraplegia
3. To learn about the management of paraplegia post-op

No abstract available.

Focus Session

Endoleaks in EVAR

1801.1

When to embolise pre-operatively?

D. Branzan

Operative Medizin Klinik und Poliklinik für Viszeral-, Trans- plantations-, Thorax- und Gefäßchirurgie Division of Interventional Angiology, Universitätsklinikum Leipzig AöR, Leipzig, DE

Learning Objectives

1. To learn indications and patient selection
2. To learn technique and complications
3. To learn the current evidence

No abstract available.

1801.2

Aneurysm growth without endoleak

I. Loftus

Vascular Institute, St George's Healthcare NHS Trust, London, UK

Learning Objectives

1. To learn imaging workup
2. To learn underlying causes and natural history
3. To learn surgical options and outcome

No abstract available.

1801.3

Reasons and treatment options for late type I endoleaks

S. Michelagnoli

Vascular and Endovascular Surgery Unit, San Giovanni di Dio Hospital, Florence, IT

Learning Objectives

1. To learn the underlying causes
2. To learn intervention strategies
3. To learn supporting evidence for current practice

No abstract available.

1801.4

Reasons and treatment options for late type II endoleaks

A. Chavan¹, N. Mokov¹, O. Eldergasch², S.S. Amin², G. Voshage¹

¹*Institut für Diagnostische und Interventionelle Radiologie, Klinikum Region Hannover GmbH, Neustadt Am Rübenberge, DE,* ²*Institut für Diagnostische und Interventionelle Radiologie, Klinikum Oldenburg, Oldenburg, DE*

Learning Objectives

1. To learn causes and diagnostic protocols
2. To learn techniques and characteristics of pertinent embolic material
3. To learn outcome of current techniques

Type II endoleak is defined as persistent perfusion of the aneurysm sac caused by collateral flow in side branches arising from the aneurysm. The culprit vessels in case of abdominal aortic aneurysms (AAA) are most often the lumbar arteries (LA) and the inferior mesenteric artery (IMA); less frequently, the median sacral artery and accessory renal arteries may also be responsible (1). The incidence appears to be higher in patients receiving anti-coagulant or anti-platelet therapy and in those with large LA and IMA (> 4 mm) prior to EVAR. Single feeder vessels are not the rule; persistent type II endoleaks are most often associated with inflow as well as outflow vessels (2, 3).

Although type II endoleaks may be initially observed in 10-30 % of cases, most resolve within 6 months after initial endovascular aneurysm repair (EVAR) or remain unchanged over long periods of time going into years (4, 5). After disappearing, they are known to reappear spontaneously after variable intervals, even after years.

As type II endoleaks are not associated with a significant risk of rupture, they are generally managed conservatively. Intervention is indicated only if the aneurysm sac continues to grow more than 5 mm in 6 months or 1 cm in 12 months (3, 5, 6).

Traditionally, such endoleaks are treated by transarterial embolization of the feeder vessels. The lumbar arteries are generally accessed via branches of the internal iliac artery, most commonly the ilio-lumbar artery. Access to the IMA is from the superior mesenteric artery via the Rioloan anastomosis. The embolics used include cyanoacrylate, ethylene vinyl alcohol co-polymer (EVOH, Onyx), thrombin and metal coils (7). Although coils were more frequently used in yesteryears, the modern day trend is more in favour of liquid embolics as they enable embolization of the endoleak nidus. It is imaginable, that embolization of nidus leads to better occlusion of the endoleak sac as compared to embolization merely of the feeding vessels that leave the sac open, thus offering the potential of it being perfused via other feeding vessels. Whether embolization of the endoleak nidus combined with embolization of the feeding vessels yields superior results as compared to embolization of the nidus alone, is debatable. In an analysis of 29 patients, Hyeon and colleagues were able to demonstrate, that sac stabilization with 62 % and 63 % was comparable in both groups; however procedural time and radiation exposure were significantly higher in the group undergoing additional embolization of the feeding vessels (8).

Whereas the flow of thrombin is difficult to control after injection, cyanoacrylate and EVOH tend to form a cast in the aneurysm sac and thus offer obvious advantages over thrombin. Worthy of mention is that experience is required with cyanoacrylate as occlusion and catheter entrapment can become "sticky problems"; in contrast EVOH allows a more "leisurely" embolization with the cast propagating further and further away from the catheter tip. The disadvantage of EVOH is the extreme radioopacity that gives rise to annoying and often incapacitating artefacts at follow-up CT examinations.

Transarterial embolization however can be tedious, time consuming and challenging. The average technical success rate is about 62.5 %, ranging between 15 % and 89 % (2, 5). More recent alternatives are the translumbar and the transcaval embolization. Whereas the embolics used are the same as mentioned above, the approaches to the aneurysm sac are different.

The translumbar approach entails direct puncture of the aneurysm sac under CT guidance followed by embolization either over the puncture needle or over a catheter introduced into the aneurysm sac. Transfer of the patient from the CT room to the angiography suite may be cumbersome but increasing availability of Dyna-CT is likely to simplify the procedure logistically in the future. The average technical success rate of the translumbar approach is about 81 %, ranging between 67 % and 100 % (2). Although this appears to be higher than that of the transarterial approach as quoted above, a comparative analysis of the two approaches in 84 patients by Stavropoulos and colleagues showed comparative rates of technical and clinical success as well as of complications (9).

For the transcaval approach, pre-planning is carried out with CT angiography (CTA). With the help of bony landmarks or metal markers on the endografts, the point of aneurysm sac puncture is determined prior to the intervention. In the angiography suite, using the femoral vein as the access vessel, the aneurysm sac is punctured through the medial wall of the inferior vena cava and a catheter advanced into the aneurysm sac to carry out the embolization. In a recent report with 29 patients, Giles and colleagues were able to demonstrate a technical success rate of 83 %. No complications were observed. Five patients required reinterventions. According to the authors, the procedure can also be performed as an out-patient intervention (10). Considering the fact that 13 of the 29 patients had undergone prior procedures, this approach appears to be an attractive alternative, should other approaches fail.

In summary, type II endoleaks are a common occurrence after EVAR and can be largely treated conservatively. Intervention is indicated when the endoleak persists and continuous expansion of the aneurysm sac is observed. The repertoire of the interventionist includes the transarterial, the translumbar and the transcaval approaches. It is presently difficult to make a clear cut recommendation in favour of the one or the other approach. A combination of methods may be necessary to achieve optimal results.

References

1. Chavan A, Chavan A, Schnabel S. Stent-Grafts bei Bauchaortenaneurysmen. In Chavan A (ed.): *Vaskuläre Interventionen* 2017. Georg Thieme Verlag, Stuttgart, New York.
2. Avgerinos ED, Chaer RA, Makaroun MS. Type II endoleaks. *J Vasc Surg* 2014; 60: 1386-91.
3. Gandhi RT, Bryce Y, Ganguli S et al. Management of Type II Endoleaks. *Endovascular Today* April 2016; 15: 42-48.
4. Ameli-Renani S, Pavlidis V, Mailli L, Turner P, Morgan RA. Transiliac Paraendograft Embolisation of Type 2 Endoleak: An Alternative Approach for Endoleak Management. *Cardiovasc Intervent Radiol* 2016; 39: 279-283.
5. Rand T, Ueberoi R, Cil B, et al: Quality Improvement Guidelines for Imaging Detection and Treatment of Endoleaks following Endovascular Aneurysm Repair (EVAR). *Cardiovasc Intervent Radiol* 2013; 36: 35-45.
6. Bryce Y, Schiro B, Cooper K, et al. Type II Endoleaks: diagnosis and treatment algorithm. *Cardiovasc Diagn Ther* 2017; doi: 10.21037/cdt.2017.08.06.
7. Martin ML, Dolmatch BL, Fry PD, et. al.: Treatment of Type II Endoleaks with Onyx. *J Vasc Interv Radiol* 2001; 12: 629-632.
8. Hyeon Yu, Desai H, Isaacson AJ, et al. Comparison of Type II Endoleak Embolizations: Embolization of Endoleak Nidus Only versus Embolization of Endoleak Nidus and Branch Vessels. *J Vasc Interv Radiol* 2017; 28: 176-184.
9. Stavropoulos SW, Park J, Fairman R, Carpenter J. Type 2 Endoleak Embolization Comparison: Translumbar Embolization versus Modified Transarterial Embolization. *J Vasc Interv Radiol* 2009; 20: 1299-1302.
10. Giles KA, Fillinger MF, Randall R, et al. Results of transcaval embolization for sac expansion from type II endoleaks after endovascular aneurysm repair. *J Vasc Surg* 2015; 61: 1129-36.

Focus Session

Radiation exposure: are we doing enough?

2501.1

Radiation exposure of EVAR/TEVAR: present status in the EU

W. Jaschke

Universitätsklinik für Radiologie, Medizinische Universität, Innsbruck, AT

Learning Objectives

1. To gain an overview of radiation doses in EVAR/TEVAR
2. To understand dose differences between EVAR and TEVAR
3. To learn why FEVAR is a "high dose" intervention

Endovascular aneurysm repair is considered the treatment of choice for abdominal and thoracic aortic aneurysms with suitable anatomy. In uncomplicated cases, a bilateral transfemoral approach is used to treat aortic aneurysms. Thus, operators are usually standing opposite of each other at the level of the patient groin. Appropriate steps have to be taken to avoid excessive radiation exposure to operators. Radiation exposure of operators is caused by scattered radiation, manipulation in the direct x-ray beam has to be totally avoided. Scattered radiation is undirected and inhomogenous and originates mostly from patient's body. Radiation exposure can be minimized by increasing the distance between operator and radiation source. The lower amount of scattered radiation originating from the thorax compared with the abdomen and the greater operator-source distance explains why TEVAR implies a lower radiation exposure to operators compared with AAA-EVAR. For radiation protection of operators, under table protective curtains, table mounted lead shields, ceiling mounted lead glass shields and mobile protective shields are available. In addition, the use of aprons, thyroid protection and lead glasses is mandatory. In order to implement these radiation protection measures effectively, operators should establish a standard operating procedure. After preparing the access sites and before using radiation, all mounted or fixed radiation protection devices have to be in place or ready for use. Aprons etc have to be worn when starting the procedure. These measures are especially important for difficult endovascular procedures. For example, FEVAR is a complex endovascular procedure necessitating an approach from above (usually subclavian artery) and below (femoral arteries). In order to protect operators, radiation protection measures have to be adopted to this specific anatomical situation and the higher radiation exposure. Personal real time dosimetry is a good tool to measure personal dose/procedure and to optimize radiation protection of the operator.

Radiation exposure of the patient is directly correlated with fluoroscopy time (FT) and the number of angiographic series (NOAS). Both parameters including dose measurements can be obtained from the DICOM Dose Report which is provided by the angiographic equipment at the end of the procedure. For quantification of patient exposure, Cumulative Air KERMA at reference point (CAK_{ref}) and the cumulative KERMA Area Product (KAP) are given in the DICOM Dose Report. CAK and KAP are the most important quantities for assessing patient radiation dose. CAK is used to estimate Peak Skin Dose (PSD), KAP provides information on how much radiation was used in a procedure. KAP allows also for estimating effective dose to critical organs. However, CAK and KAP depend not only on FT and NOAS, but also on many other factors such as size of the patient, the experience of the operator, complexity of the procedure and imaging protocols which are used. This explains why radiation dose of similar procedures differs so much between operators and institutions. In order to optimize dose for the same procedure, the concept of dose diagnostic reference levels (DRL) was introduced. Although the European Basic Safety Standards Directive mandates that (DRL) are implemented for interventional procedures, DRL are not implemented yet in most member states for EVAR/TEVAR and FEVAR due to the lack of solid dose data. A recent publication (Eur Radiol 2017; 27:4846-4856) showed that dose metrics are not normally distributed and vary to a great degree. For example, KAP varied for "standard" AAA-EVAR between 4 000 to >125 000

μGym^2 . KAP data was skewed to the right with a long dose tail. This was attributed to different standards of practice, differences in experience of operators, different imaging protocols and complexity of procedures. DRL are especially dependent on complexity of the procedure. However, there is no general agreement how complexity can be quantified.

References

1. Tuthill E et al. Investigation of reference levels and radiation dose associated with abdominal EVAR (endovascular aneurysm repair) procedures across several European Centres. *Eur Radiol* (2017) 27:4846-4856

2501.2

How to use high-quality hardware responsibly

G. Bartal

Radiology, Meir MC, Kfar-Saba, IL

Learning Objectives

1. To learn about dose reduction by hardware: tube and detector
2. To learn about fixed protection devices
3. To learn about personal protection devices

The arsenal of interventional radiologist (IR) consists of a variety of equipment that is essential for both diagnostic and therapeutic Image Guided Interventional Procedures (IGIP). Common imaging modalities used include fluoroscopy, ultrasound, CT, and MRI (1, 2). IR must be able to orchestrate the type of procedure, each patient's distinctive characteristics as well as the advantages and disadvantages of each modality. Medical imaging is the essential prerequisite of IR and appropriate, high-quality imaging is crucial for the successful execution of IGIP (3). Yet, the main and routine imaging remain Fluoroscopy and DSA, which represent main sources of intraprocedural patient radiation exposure, while the fluoroscopy should be the only source of staff exposure. Our responsibilities should cover both patients and staff radiation safety. Current modes of image guidance for routine IR procedures comprise C-arm fluoroscopy, DSA, cone-beam computed tomography (CBCT), CT with CT fluoroscopy, MRI, ultrasonography (US), optical imaging, and their combinations.

As any procedure starts from an access initial, very effective and safe image guidance tool is ultrasonography that represents an integral basic equipment for most of the IGIP. IR has to master all imaging modalities for guidance. Ultrasound has almost completely replaced Fluoroscopy as an access tool for most of the interventions. It's safe, real-time, very precise, chip and very handy in right hands.

IGIP for interventional therapies emphasize real-time imaging with reduced radiation burden. Radiation exposure during an IGIP should be restricted to the region of interest, and an acceptable compromise must be made between resolution and dose for real-time imaging (3, 4). Of note is that the science and technology for understanding and implementing those trade-offs is an area of ongoing work.

State-of-the-art IR procedures already comprise real-time imaging that displays the target, interventional devices, and adjacent anatomy in three dimensions. In the near future it will combine anatomical (i.e., tissue morphology) and functional information (organ perfusion and metabolism), in order to monitor treatment and to control outcomes and reduce potential complications. Multimodality image fusion is needed to accomplish this task, because there is no single modality available with such combined imaging features. The emerging technologies of image fusion and integration continue to develop Nuclear medicine techniques of combined positron emission tomography and CT (PET/CT), or combined single photon emission computed tomography and CT (SPECT/CT), may also have an expanding role in future image-guided therapies.

Noticeable result of the recent transition to contemporary interventional radiology equipment is a substantial decrease of radiation exposure levels in IGIP (5).

One of the main limitations of intelligent use of the equipment is the IR her or himself. Limited acquaintance with the hardware as well as available software qualities. Not all machines are the same, each procedure

should be carefully planned knowing the advantages and limitations of the equipment. These parameters are not routinely considered on case by case base. The guidelines and whitepapers of different procedures usually skip this part as are not written for specific Angiography system. Preparation to complex procedure as well postprocedural analysis should consider and include these parameters. Radiographers play an important role in this perspective as they control the equipment and support the IR in safe and responsible use of the hardware.

Combination of fused imaging with real-time computational modelling, robotic navigation and control of interventional tools supported by on-line Artificial Intelligence software will ultimately enhance our confidence and reduce the intraprocedural error and complications rates.

References

1. Solomon S., Silverman S. "Imaging in interventional oncology," *Radiology* 257, 624-640 (2010).
2. Kagadis G. et al. Emerging technologies for image guidance and device navigation in interventional radiology. *Med. Phys.* 39 (9), September 2012: 5768-5781.
3. Rubin GD et al. CT angiography after 20 years: a transformation in cardiovascular disease characterization continues to advance. *Radiology*. 2014 Jun;271(3):633-652.
4. Oda S et al. CT angiography in patients with peripheral arterial disease: effect of small focal spot imaging and iterative model reconstruction on the image quality. *Acad Radiol*. 2016 Oct;23(10):1283-1289.
5. Panick C. et al. Patient Radiation Dose Reduction Considerations in a Contemporary Interventional Radiology Suite. *Cardiovasc Intervent Radiol* (2018) 41:1925-1934.

2501.3

The importance of software in exposure reduction

T. Trabold

Clinic for Diagnostic and Interventional Radiology, Klinikum Stuttgart, Stuttgart, DE

Learning Objectives

1. To learn about dose reduction by software I: guidance tools
2. To learn about dose reduction by software II: preprocedural planning
3. To understand how to use and interpret fusion imaging

Besides the continuous improvement in hardware, manufacturers develop software tools, which are useful to not only reduce the amount of contrast media and allow significant timesaving but also to further reduce radiation exposure.

In TEVAR and EVAR, especially in fenestrated and branched stent grafts, there is a significant radiation exposure for the patient and for the interventionalist. Different approaches can be combined to reduce dose as low as reasonably possible while having sufficient image quality to do the intervention safely.

In preprocedural planning PACS software or dedicated workstations are used to prepare the intervention in terms of knowing anatomy, angulations for the relevant vessels and vessel diameters. A good preparation will shorten fluoroscopy time and thereby lower radiation dose.

Guidance tools superimpose anatomic landmarks (like ostia of target vessels) and vessel structures on the fluoroscopic image in terms of fusion imaging. Fusion imaging uses techniques of augmented reality for fluoroscopy. For planning of endovascular aortic interventions usually a high resolution, thin slice CT dataset is acquired in advance. That CT dataset can be uploaded to dedicated workstations, which allow (semi-) automated detection of vessel structures and anatomic landmarks as well as manual marking of relevant structures like ostia and landing zones. By the time the patient is positioned on the angiography table CT dataset is registered to the patient by a 2D or 3D-registration using fluoroscopy or dyna-CT. After this preparatory work, the software will constantly superimpose landmarks and, if required, vessel structures live on the fluoroscopy image.

A number of factors reduce fluoroscopy time and radiation exposure: The overlay of vessel structures and anatomic landmarks often allows positioning and adjusting of the field of view without using fluoroscopy, it facilitates graft placement and catheterization of the branch vessels, thereby decreasing fluoroscopy time. The need for angulation and laterals views can be restricted to a minimum, as the course of branch vessels is known. Often the superior mesenteric artery can be catheterized in posterior-anterior position. Finally, the need for DSA runs is significantly decreased.

Inaccuracy of the overlay is frequently observed. Main reasons are respiration related differences between CTA and current anatomy, straightening and deformation of vessels by stiff guidewires and delivery devices and overlay inaccuracy due to patient movement. The interventionalist has to be aware that during the intervention anatomy can be altered due to the stiffness of guide wires and delivery systems and thereby can influence the preciseness of the intraoperative 3D overlay. Therefore, the interventionalist needs to be comfortable with manipulating and adjusting the overlay during the procedure. There is a learning curve over time using fusion imaging.

Another strategy to reduce dose is educating awareness of radiation exposure installing real-time personal dosimetry in the angiography suite. In this setting interventionalist, nurse and technician have their own, personal real-time dosimeter, worn above the X-ray protective clothing and displaying current dose on a live monitor. This makes personnel aware of the scattered radiation that is otherwise invisible.

Real-time display of personal radiation exposure has the potential to dramatic improvement by better positioning the personnel in relation to the patient and the radiation source. As the effect of radiation protection equipment like X-ray protective shields gets immediately obvious, the willingness of using this equipment should significantly improve. The influence of fluoroscopy and DSA settings, field-of-view and angulation is illustrated live to the interventionalist. Lower radiation exposure not only for the personnel but also for the patient might be realized. Staff, which is not mandatory to stay in the room during DSA runs etc. will learn to leave the room as often as possible to protect themselves from radiation. In many departments, a competition for low radiation dose on the personal dosimeter will arise.

In conclusion, a combined approach of careful preprocedural planning, using the full capacity of fusion imaging and making personnel aware by real-time personal dosimetry has the potential to substantial reduce radiation exposure for staff and patient.

2501.4

The importance of training and skills in exposure reduction

E. Brountzos

2nd Department of Radiology, ATTIKON University General Hospital, Athens, GR

Learning Objectives

1. To understand the value of hands-on-training
2. To learn about the value of simulator training
3. To learn about personal dose measurements (e.g. RaySafe)

The technological advances in medical imaging and the development of new interventional tools (catheters, stents, etc.) over the last two decades have led to a significant increase in the frequency and complexity of fluoroscopically guided interventional procedures. Fluoroscopically guided interventional procedures usually demand prolonged fluoroscopy times and a large number of cine acquisition series, thereby delivering high radiation doses both to patients and staff. Moreover, as it is well known, ionizing radiation can damage cells, tissues and organs and cause harmful deterministic and stochastic effects. Several articles have reported radiation-induced skin injuries in patients and cataract formation among interventionalists. Therefore, there is an increasing concern regarding the exposure of patients and staff to ionizing radiation and an urgent need for dose optimization.

Among the various dose-reduction strategies and techniques (including exposure parameters, technical factors, radiation protection tools and quality assurance programs), radiation protection training is considered one of the most effective methods for dose management. Training is not only associated with new knowledge but also with new skills and behaviors. The aim of the current presentation is to underline the need and provide the importance of radiation protection training and skills in exposure reduction focusing on fluoroscopically guided interventional procedures.

For several years now, international bodies and authorities have recognized the role of education and training in exposure reduction, especially for high-dose procedures. In 2000, the World Health Organization (WHO) published the "Efficacy and radiation safety in interventional radiology" report, in which specifies the training requirements for personnel involved in interventional radiology. In the same year, the International Commission on Radiological Protection (ICRP), Publication 85, recommended that basic and continuous training in radiation protection should be an integral part of the education for interventionists and additional training should be performed when new x-ray systems or techniques are implemented in a Department. The importance of education and training is also highlighted in the new Directive 2013/59 Euratom. According to the Directive, "Member States shall establish an adequate legislative and administrative framework ensuring the provision of appropriate radiation protection education..." and additionally "Member States shall encourage the introduction of a course on radiation protection in the basic curriculum of medical and dental schools."

However, several publications have shown that there is poor knowledge about radiation and associated hazards among medical staff highlighting the need for the establishment of a radiation protection training program. Training programs should be included in the undergraduate education and followed by periodic lectures and hands-on courses providing knowledge concerning radiation physics, fluoroscopy equipment, biological effects of ionizing radiation, radiation protection principles, regulations and quality assurance programs. Detailed knowledge and skills requirements for health care professionals are described extensively in the "Guidelines on radiation protection education and training of medical professionals in the European Union (Radiation Protection No 175)".

Modern interventionalists must have a thorough understanding of factors that affect radiation exposure and image quality in order to keep the dose as low as reasonably achievable (ALARA principle). Medical staff should be adequately trained to use properly the radiation protection tools, recognize cases that involve high skin doses and manage special population groups like pregnant and children.

In the literature, studies have revealed that Dose Area Product (DAP), fluoroscopy time, skin dose, occupational dose and frame rate are significantly decreased after the implementation of radiation safety training programs. Indeed, in some cases, the occupational dose decreased by approximately 55%. Training also enhances the use of radiation protection tools and facilitates compliance with guidelines. The establishment of radiation safety training programs enables not only the reduction of radiation dose but also the enhancement of radiation risk awareness, the minimization of unsafe operating practices and the improvement of attitudes regarding radiation dose management. Education and training are considered essential components for justification and optimization as well as for the implementation of a strong radiation protection culture. So? Are we doing enough for radiation exposure? Certainly, radiation dose management faces many challenges in clinical practice, but I think that adequately training and education can be a solution.

References

1. Hart D, Wall BF, Hiller MC, Shrimpton PC. Frequency and collective dose for medical and dental X-ray examinations in the UK, 2008. Health Protection Agency 2010, HPA-CRCE-012.
2. Workshop on Efficacy and Radiation Safety in Interventional Radiology (1995: Neuherberg, Germany). (2000). Efficacy and radiation safety in interventional radiology. World Health Organization.

3. ICRP, 2000. Avoidance of Radiation Injuries from Medical Interventional Procedures. ICRP Publication 85. Ann. ICRP 30 (2).
4. European Council Directive 2013/59/Euratom on basic safety standards for protection against the dangers arising from exposure to ionising radiation and repealing Directives 89/618/Euratom, 90/641/Euratom, 96/29/Euratom, 97/43/Euratom and 2003/122/Euratom. OJ of the EU. L13; 57: 1–73 (2014).
5. Nachiappan AC, Horn GL, Spann SC, et al. Operator radiation dose reduction during fluoroscopic interventional procedures. *J Am Coll Radiol*. 2015 May;12(5):527–30. doi: 10.1016/j.jacr.2015.01.001
6. Vano E. Mandatory radiation safety training for interventionalists: the European perspective. *Tech Vasc Interv Radiol*. 2010 Sep;13(3):200–3. doi: 10.1053/j.tvir.2010.03.011.
7. European Commission, RP 175, “Guidelines on Radiation Protection Education and Training of Medical Professionals in the European Union”, Luxembourg, 2014
8. Kirkwood ML, Arbique GM, Guild JB, et al. Surgeon education decreases radiation dose in complex endovascular procedures and improves patient safety. *J Vasc Surg*. 2013 Sep;58(3):715–21. doi: 10.1016/j.jvs.2013.04.004. Epub 2013 May 17.
9. David Gendelberg MD, William Hennrikus MD, Jennifer Slough MD, et al. A Radiation Safety Training Program Results in Reduced Radiation Exposure for Orthopaedic Residents Using the Mini C-arm, *Clin Orthop Relat Res* 2016 474:580–584
10. Hart D, Wall BF, Hiller MC, Shrimpton PC. Frequency and collective dose for medical and dental X-ray examinations in the UK, 2008. Health Protection Agency 2010, HPA-CRCE-012.
11. Workshop on Efficacy and Radiation Safety in Interventional Radiology (1995: Neuherberg, Germany). (2000). Efficacy and radiation safety in interventional radiology. World Health Organization.
12. ICRP, 2000. Avoidance of Radiation Injuries from Medical Interventional Procedures. ICRP Publication 85. Ann. ICRP 30 (2).
13. European Council Directive 2013/59/Euratom on basic safety standards for protection against the dangers arising from exposure to ionising radiation and repealing Directives 89/618/Euratom, 90/641/Euratom, 96/29/Euratom, 97/43/Euratom and 2003/122/Euratom. OJ of the EU. L13; 57: 1–73 (2014).
14. Nachiappan AC, Horn GL, Spann SC, et al. Operator radiation dose reduction during fluoroscopic interventional procedures. *J Am Coll Radiol*. 2015 May;12(5):527–30. doi: 10.1016/j.jacr.2015.01.001
15. Vano E. Mandatory radiation safety training for interventionalists: the European perspective. *Tech Vasc Interv Radiol*. 2010 Sep;13(3):200–3. doi: 10.1053/j.tvir.2010.03.011.
16. European Commission, RP 175, “Guidelines on Radiation Protection Education and Training of Medical Professionals in the European Union”, Luxembourg, 2014
17. Kirkwood ML, Arbique GM, Guild JB, et al. Surgeon education decreases radiation dose in complex endovascular procedures and improves patient safety. *J Vasc Surg*. 2013 Sep;58(3):715–21. doi: 10.1016/j.jvs.2013.04.004. Epub 2013 May 17.
18. David Gendelberg MD, William Hennrikus MD, Jennifer Slough MD, et al. A Radiation Safety Training Program Results in Reduced Radiation Exposure for Orthopaedic Residents Using the Mini C-arm, *Clin Orthop Relat Res* 2016 474:580–584

Hot Topic Symposium Durability: the Achilles heel of EVAR

2902.1

Adherence to IFU: essential to durability?

J.C. van den Berg

Interventional Radiology, Ospedale Regionale di Lugano, sede Civico, Lugano, CH

It is well known that complex anatomy has implications for endovascular aneurysm repair (EVAR). Hostile neck anatomy is considered to be present when there is an angulation of the neck of > 60 degrees, a neck length shorter than 10 mm, associated thrombus and/or a reverse tapered proximal neck configuration.¹ Around 10% of EVAR patients have necks shorter than 15 mm. Over the years the application of EVAR has expanded significantly in this scenario, and this oftentimes leads to off-label use, outside the manufacturer's instructions for use (IFU).

EVAR in short and hostile necks can be performed when a patient unfit for open repair and should try to respect the IFU's of commercially available EVAR devices (with adjunct intraoperative procedures like endo-anchors).² Patients with neck features outside IFU can be treated with EVAR, however higher rates of early and late type I endoleak, early intervention, and late death can be more common in these cases.¹ When performing EVAR on patients with off-label use a significantly higher rate of intraoperative type I or III endoleaks and proximal aortic cuff placement or other adjunctive procedures can also be seen, without differences at mid-term follow-up between the two groups in the rates of type 1b or II endoleaks, sac enlargement, device-limb occlusion or patient survival.³ Conflicting evidence in the literature exists, with some studies demonstrating worse outcomes^{4–7}, and other showing similar results.^{8–13} A higher rate of sac expansion has been seen in non-IFU patients¹⁴, and therefore it seems reasonable to intensify follow-up in patients that were treated in an off-label fashion.^{15,16}

A meta-analysis published in 2013 showed that patients with hostile anatomy had a fourfold increased risk of developing type I endoleak and a ninefold increased risk of aneurysm-related mortality within 1 year of treatment.¹⁷ A more recent meta-analysis that specifically looked at breach of IFU showed that overall mortality and aneurysm related mortality does not seem to differ significantly at long-term. When IFU is not followed higher rates of type I endoleaks are seen, especially in short necks.¹⁸ Proximal neck anatomy continues to be the major determinant for suitability of patients for EVAR, and in real life 20–30% of all EVAR procedures are outside of the manufacturer's IFU. Mandatory continued follow-up of endografts is needed to justify aggressive use of standard outside the IFU during EVAR and ensure durability.

References

1. AbuRahma AF, Yacoub M, Mousa AY, et al. Aortic Neck Anatomic Features and Predictors of Outcomes in Endovascular Repair of Abdominal Aortic Aneurysms Following vs Not Following Instructions for Use. *J Am Coll Surg*. 2016;222(4):579–589.
2. Grisafi JL, Rahbar R, Nelms J, et al. Challenging neck anatomy is associated with need for intraoperative endovascular adjuncts during endovascular aortic aneurysm repair (EVAR). *Ann Vasc Surg*. 2011;25(6):729–734.
3. Matsumoto T, Tanaka S, Okadome J, et al. Midterm outcomes of endovascular repair for abdominal aortic aneurysms with the on-label use compared with the off-label use of an endoprosthesis. *Surg Today*. 2015;45(7):880–885.
4. Herman CR, Charbonneau P, Hongku K, et al. Any nonadherence to instructions for use predicts graft-related adverse events in patients undergoing elective endovascular aneurysm repair. *J Vasc Surg*. 2018;67(1):126–133.

5. Torsello G, Troisi N, Donas KP, Austermann M. Evaluation of the Endurant stent graft under instructions for use vs off-label conditions for endovascular aortic aneurysm repair. *J Vasc Surg.* 2011;54(2):300-306.
6. Troisi N, Torsello G, Weiss K, Donas KP, Michelagnoli S, Austermann M. Midterm results of endovascular aneurysm repair using the Endurant stent-graft according to the instructions for use vs. off-label conditions. *J Endovasc Ther.* 2014;21(6):841-847.
7. Zacharias N, Warner CJ, Taggart JB, et al. Anatomic characteristics of abdominal aortic aneurysms presenting with delayed rupture after endovascular aneurysm repair. *J Vasc Surg.* 2016;64(6):1629-1632.
8. Beckerman WE, Tadros RO, Faries PL, et al. No major difference in outcomes for endovascular aneurysm repair stent grafts placed outside of instructions for use. *J Vasc Surg.* 2016;64(1):63-74 e62.
9. Lee JT, Ullery BW, Zarins CK, Olcott Ct, Harris EJ, Jr., Dalman RL. EVAR deployment in anatomically challenging necks outside the IFU. *Eur J Vasc Endovasc Surg.* 2013;46(1):65-73.
10. Igari K, Kudo T, Toyofuku T, Jibiki M, Inoue Y. Outcomes following endovascular abdominal aortic aneurysm repair both within and outside of the instructions for use. *Ann Thorac Cardiovasc Surg.* 2014;20(1):61-66.
11. Mahajan A, Barber M, Cumbie T, et al. The Impact of Aneurysm Morphology and Anatomic Characteristics on Long-Term Survival after Endovascular Abdominal Aortic Aneurysm Repair. *Ann Vasc Surg.* 2016;34:75-83.
12. Speziale F, Sirignano P, Setacci F, et al. Immediate and two-year outcomes after EVAR in "on-label" and "off-label" neck anatomies using different commercially available devices. analysis of the experience of two Italian vascular centers. *Ann Vasc Surg.* 2014;28(8):1892-1900.
13. Walker J, Tucker LY, Goodney P, et al. Adherence to endovascular aortic aneurysm repair device instructions for use guidelines has no impact on outcomes. *J Vasc Surg.* 2015;61(5):1151-1159.
14. Nakai M, Sato M, Sato H, et al. Midterm results of endovascular abdominal aortic aneurysm repair: comparison of instruction-for-use (IFU) cases and non-IFU cases. *Jpn J Radiol.* 2013;31(9):585-592.
15. Nishibe T, Iwahashi T, Kamiya K, et al. Clinical and Morphological Outcomes in Endovascular Aortic Repair of Abdominal Aortic Aneurysm Using GORE C3 EXCLUDER: Comparison between Patients Treated within and Outside Instructions for Use. *Ann Vasc Surg.* 2019.
16. Hoshina K, Hashimoto T, Kato M, Ohkubo N, Shigematsu K, Miyata T. Feasibility of endovascular abdominal aortic aneurysm repair outside of the instructions for use and morphological changes at 3 years after the procedure. *Ann Vasc Dis.* 2014;7(1):34-39.
17. Antoniou GA, Georgiadis GS, Antoniou SA, Kuhan G, Murray D. A meta-analysis of outcomes of endovascular abdominal aortic aneurysm repair in patients with hostile and friendly neck anatomy. *J Vasc Surg.* 2013;57(2):527-538.
18. Oliveira-Pinto J, Oliveira N, Bastos-Goncalves F, et al. Long-term results of outside "instructions for use" EVAR. *J Cardiovasc Surg (Torino).* 2017;58(2):252-260.

2902.2

Are more fenestrations better for longer durability?

A. Katsargyris, E. Verhoeven

Vascular and Endovascular Surgery, Paracelsus Medical University, Nuremberg, DE

The number of fenestrations in fenestrated endovascular aneurysm repair (FEVAR) depends on the desired proximal landing zone. Standard 2x FEVAR fitting two fenestrations for the renal arteries and a scallop for the superior mesenteric artery (SMA) has been the configuration first used in the treatment of short necked and some juxtarenal AAA. For more complex anatomy with extension of disease at the level of renal arteries

or higher, a stent-graft configuration fitting 3 or 4 fenestrations (3x/4x FEVAR) for the renal arteries, the SMA and the celiac trunk became later available in order to achieve adequate proximal sealing. Having more fenestrations (3 or 4) could have potential advantages for the durability of the repair, as the stent-graft lands higher in the aorta and lengthens the proximal sealing zone. On the other hand one should consider a more complex stent-graft planning and a more complex procedure. This increased complexity in both planning and procedure does not result in higher perioperative mortality and morbidity as shown by high volume centers.^{1,2} As a consequence, many groups including our institution have become far more liberal in using 3x/4x FEVAR instead of 2x FEVAR. At this moment, 3x/4x FEVAR is the golden standard for the vast majority of cases. In 2018, 3x/4x FEVAR represented 98% of FEVAR procedures in our center.

This increase in the number of fenestrations over time reflects partly treatment of more complex anatomies, but is mainly the result of aiming for a longer proximal sealing zone. The length of the proximal sealing zone in our series has increased significantly over the last 8 years (mean proximal sealing zone length excluding the scallop: 26mm in 2010 vs 48mm in 2018, p<0.001).

A longer proximal sealing zone (requiring more fenestrations) is expected to make the repair more durable against extension of disease, but long-term results are needed to prove this hypothesis. An additional advantage of 4x FEVAR is that one can easily extend proximally with a thoracic stent-graft in case of proximal failure/extension of disease over time. A potential disadvantage of 4x FEVAR may be the extra stenting of the celiac trunk (with regard to long-term patency). In some cases this can be avoided by leaving the fenestration of the celiac trunk unstented provided that the graft lies against the wall at the level of the celiac artery, the fenestration is well aligned and there is no sign of endoleak.

References

1. Katsargyris A, Oikonomou K, Kouvelos G, Mufty H, Ritter W, Verhoeven ELG. Comparison of outcomes for double fenestrated endovascular aneurysm repair versus triple or quadruple fenestrated endovascular aneurysm repair in the treatment of complex abdominal aortic aneurysms. *J Vasc Surg.* 2017;66:29-36.
2. Oikonomou K, Kasprzak P, Schierling W, Kopp R, Pfister K. Graft Complexity-Related Outcomes of Fenestrated Endografting for Abdominal Aortic Aneurysms. *J Endovasc Ther.* 2017;24:230-236

2902.3

New devices and adjuncts: will they improve durability?

M.S. Hamady

Interventional Radiology, Imperial College-London -St Mary's Campus, London, UK

No abstract available.

2902.4

Take all the options into consideration

M.P. Jenkins

Vascular Surgery, Imperial College Healthcare NHS Trust, St Mary's Hospital, London, UK

The zenith of enthusiasm for EVAR may have passed.

The upfront advantages of a minimally invasive approach to aortic aneurysm repair are obvious to all, not least patients. However, this enthusiasm has been tempered by concerns about durability. Surveillance data suggests that endovascular treatment for aneurysmal disease is effective for up to 8 years, after which failure of seal leads to increasing problems culminating in fatal rupture in some.

But is this applicable to all? Device failure remains rare, but there is increasing evidence that some patients outgrow their stent grafts. About 25% of patients continue to undergo aortic dilatation. In this group, a

well deployed, appropriately sized device can perform well up to 8 to 10 years, but some then suddenly fail as the aortic seal zone diameter exceeds the maximal diameter of the graft leading to a sudden type 1a endoleak and sac pressurisation. Add to that the rare incidence of graft failure (causing sudden type 3 endoleaks), migration as a result of changes in anatomical configuration (mainly tortuosity) and unexplained sac size increases (unseen endoleaks) and it is clear that, in some patients, EVAR durability is limited.

Device and technique improvements in the last two decades have concentrated on increasing applicability and the relative improved usability and deployment accuracy of newer devices has been used to apply them to more challenging anatomy. This, perhaps combined with a perceived need for lower profile devices has resulted in reduced durability. The focus on national 30 day mortality results and registry data looking at 1 and 2 year outcomes (perhaps together with positive publication bias) has meant that we have been shielded from durability concerns.

That is not to say however, that in many patients, EVAR is not successful and results in lifelong successful aneurysmal exclusion. Selection based mainly on anatomical criteria and life expectancy remains key in decision making criteria. This policy is essential to convince commissioners of the benefit of EVAR technology in those patients, anatomically suitable for it and with sufficient life expectancy to benefit from it. Indiscriminate use in patients with anatomy outside the IFU for the device or in the very elderly or comorbid damages the brand and may lead to restrictive practice being applied to its use. Beware.

Focus Session

Open surgery vs. endoluminal treatment for TAAA

3001.1

Role of open surgery after failed TEVAR in the thoracic and thoraco-abdominal segment

M. Shrestha

Department of Cardiothoracic, Transplantation and Vascular Surgery, Hannover Medical School, Hannover, DE

Learning Objectives

1. To learn about the age of the data we rely on
2. To learn whether 6cm max diameter is a reasonable threshold and whether it should be patient specific
3. To learn whether we have any evidence for post dissection aneurysms and CT patients

No abstract available.

3001.2

When is thoraco-abdominal surgery still needed?

J. Kalder

Klinik für Gefäßchirurgie, Universitätsklinikum Aachen, Aachen, DE

Learning Objectives

1. To learn about contemporary outcomes
2. To understand factors that make an endovascular approach difficult
3. To learn which patient group benefits

No abstract available.

3001.3

De-branching surgery still needed?

F.E. Vermassen

Department of Vascular Surgery, University Hospital Ghent, Ghent, BE

Learning Objectives

1. To learn about results from debranching (visceral hybrid)
2. To understand benefits and drawbacks
3. To understand where its role is in 2019 and if 'off-the-shelf' branch grafts make it redundant

No abstract available.

3001.4

Technical options in endovascular repair

M.S. Hamady

Interventional Radiology, Imperial College-London -St Mary's Campus, London, UK

Learning Objectives

1. To learn about access problems at 24FG
2. To learn about branches of fenestrations considerations and how to deal with multiple renals
3. To understand the advantages and disadvantages of antegrade approach

No abstract available.

IDEAS

2 0 1 9

September 8 - 10

Barcelona / Spain

PART 2

Author Index

**List of all abstract authors
with presentation numbers**

*Please note that bold numbers
indicate presenting authors.*

A

Amin, S.S. 1501.1, 1801.4

B

Bartal, G. **2501.2**
 Botos, B. 1001.3
 Branzan, D. **1801.1**
 Brountzos, E. **2501.4**

C

Chavan, A. **1501.1, 1801.4**

D

Dake, M.D. **1001.1**

E

Eldergasch, O. 1501.1, 1801.4

F

Funovics, M.A. **1501.4**

H

Hamady, M.S. **2902.3, 3001.4**
 Hammond, C.J. **901.1**
 Holden, A. **901.4**

J

Jaschke, W. **2501.1**
 Jenkins, M.P. **901.2, 2902.4**

K

Kalder, J. **3001.2**
 Kasprzak, P. 1501.3
 Katsargyris, A. 1001.3, 1501.3, **2902.2**
 Kölbel, T. **1501.2**

L

Loftus, I. **1801.2**

M

Marques de Marino, P. 1001.3
 Michelagnoli, S. **1801.3**
 Mokov, N. 1801.4

N

Nienaber, C. **1001.4**

O

Oikonomou, K. **1501.3**

P

Pena, C.S. **901.3**
 Pfister, K. 1501.3

R

Richter, G.M. **1001.2**

S

Schnabel, J. 1501.1
 Shrestha, M. **3001.1**

T

Trabold, T. **2501.3**

V

van den Berg, J.C. **2902.1**
 Verhoeven, E. **1001.3**, 1501.3, 2902.2
 Vermassen, F.E. **3001.3**
 Voshage, G. 1501.1, 1801.4