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Cardiovascular and Interventional Radiological Society of Europe

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PART 1

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Cardiovascular and Interventional Radiological Society of Europe

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Special Session
Venous Forum I: Varicose veins

101.1

Patient selection, clinical and imaging assessment

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Learning Objectives
1. To learn about clinical presentation of varicose veins
2. To learn what to assess with ultrasound (superficial and deep system)
3. To learn which patients should rather not be treated with endovascular techniques

No abstract available.

101.2

Thermal ablation

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Learning Objectives
1. To learn about the different thermal options (laser, RFA)
2. To learn how to best use tumescent anesthesia
3. To learn about follow-up care

Symptomatic lower extremity varicose veins represent one of the most common vascular conditions in the adult population. The predominant causative factor of this condition is reflux of either the great saphenous vein (GSV) or the small saphenous vein. The traditional treatment was with surgical saphenofemoral ligation and stripping of the incompetent saphenous vein. In recent years, there have been significant advances in saphenous vein ablation using percutaneous thermal and nonthermal ablation techniques.

Endovenous thermal ablation methods such as laser, radiofrequency, or steam ablation are minimally invasive procedures that safely and effectively treat reflux involving the great and small saphenous veins. These methods has been developed to reduce complications associated with conventional surgery and to improve quality of life. All these methods use target temperature for successful ablation. Temperature increase during laser ablation is fast with a high-peak temperature for a short time, whereas steam ablation and radiofrequency ablation have longer plateau phases and lower maximum temperatures. All these ablation methods proved to be effective in treating incompetency of the saphenous vein.

Endovenous thermal ablation methods offer comparable venous occlusion rates after treatment of primary GSV varices; with none of the modalities proving superior. Tumescent anesthesia with or without anesthetic solution is always applied before any thermal ablation; it is a very important step to protect the tissues surrounding the ablated vein, and to reduce pain during and after the ablation procedure. Successful occlusion rates ranging from 88% to 100% have been reported for all three ablation modalities. CEAP clinical class, clinical severity scores, and overall quality of life score improve in all patients compared with baseline. Thermal ablation methods have similar complications of pain, bruising, tenderness, and phlebitis over the treated vein. Neural damage to the saphenous nerve is rare but possible when one ablates GSV distally. Deep vein thrombosis and pulmonary embolism are extremely rare.

Currently available clinical trial evidence suggests thermal ablation methods are at least as effective as surgery in the treatment of varicose veins secondary to saphenous vein insufficiency.

References

1. Nordon IM, Hinchliffe RJ, Brar R, Moxey P, Black SA, Thompson MM, Loftus IM. A prospective double-blind randomized controlled trial of radiofrequency versus laser treatment of the great saphenous vein in patients with varicose veins. Ann Surg. 2011 Dec;254(6):876-81.
2. Proebstle TM, Alm BJ, Göckeritz O, Wenzel C, Noppeney T, Lebard C, Sessa C, Creton D, Pichot O. Five-year results from the prospective European multicentre cohort study on radiofrequency segmental thermal ablation for incompetent great saphenous veins. Br J Surg. 2015 Feb;102(3):212-8.
3. Milleret R, Huot L, Nicolini P, Creton D, Roux AS, Decullier E, Chapuis FR, Camelot G. Great saphenous vein ablation with steam injection: results of a multicentre study. Eur J Vasc Endovasc Surg. 2013 Apr;45(4):391-6.
4. Murad MH, Coto-Yglesias F, Zumaeta-Garcia M, Elamin MB, Duggirala MK. A systematic review and meta-analysis of the treatments of varicose veins. J Vasc Surg. 2011 May;53:49S-65S.
5. Nesbitt C, Eifell RK, Coyne P, Badri H, Bhattacharya V, Stansby G. Endovenous ablation (radiofrequency and laser) and foam sclerotherapy versus conventional surgery for great saphenous vein varices. Cochrane Database Syst Rev. 2011 Oct;(10):CD005624.
6. Weiss RA, Weiss MA, Eimpunth S, Wheeler S, Udompunturak S, Beasley KL. Comparative outcomes of different endovenous thermal ablation systems on great and small saphenous vein insufficiency: Long-term results. Lasers Surg Med. 2015 Feb;47(2):156-60.

101.3

Non-thermal ablation

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Learning Objectives
1. To learn about the different techniques
2. To learn about the possible advantages
3. To learn about follow-up care

Introduction

Venous disorders of the legs occur frequently, and range in severity from minor asymptomatic incompetence of venous valves to chronic leg ulceration. We know that venous disease is common in the general population, with approximately one third of the population showing some degree of trunk varicose veins.

Varicose veins are a common manifestation of venous incompetence in the lower limb, and appear as dilated, elongated, or tortuous superficial veins. Incompetence of the superficial and/or perforating veins lead to raised venous pressure in the lower leg, which can result in skin changes such as hyper-pigmentation and indurations with eventual ulceration.

Venous disease of the legs causes considerable morbidity and is also costly, with approximately 2% of national healthcare resources being spent on treatment.

The goal of varicose vein surgery is to remove reflux and visible varicose veins with the aim to achieve the most favorable hemodynamic and cosmetic results. Different techniques have been used, but the most common have been and still are the classic saphenectomy with high ligation at the sapheno-femoral junction (SFJ). This could be accompanied with local phlebectomy and ligations of insufficient perforants. Examples of other more exotic techniques are A.S.V.A.L. (Ablation Sélective des Varices sous Anésthesie Locale) and CHIVA (The Hemodynamic Cure of the Venous Insufficiency in Ambulatory).

The last decade management of superficial venous incompetence has changed dramatically from classic surgery to more minimal invasive techniques.

The patients have gain enormously from this change in techniques, especially with respect to post-operative care and post-operative pain. The healthcare systems have found techniques that are much less resource demanding, making it easier to treat the large number of patients suffering from superficial venous incompetence. New national guidelines have developed, like the NICE guidelines for varicose veins in the legs in the UK, recommending endovenous techniques as first line of choice for varicose veins treatment.

The development and acceptance of the thermal techniques have been very fast over the last decade. Radiofrequency ablation (RFA) and endovenous laser ablation (EVLA) have taken the lead and developed from being strictly aimed for treatment of GSV and SSV to be used in insufficient perforants and smaller branches. New on the market is endovenous steam ablation (EVSA).

The development of the endothermal techniques have been successful, but they all require some type of anaesthesia, general or more common local anaesthesia with the use of tumescent. This is normally well tolerated by most patients, but not so few find the distribution of the tumescent quite painful. Due to this alternative methods to endothermal techniques have developed. These techniques can normally be carried out as an office based procedure without any form of anesthesia.

The non-endothermal techniques use either some chemical reaction for ablation like ultrasound-guided foam sclerotherapy (UGFS) or combining this using a mechanical devise to obtain damage to the endothelium (MOCA). The latest contribution to non-endothermal techniques is a chemical adhesive method using catheter delivered glue (cyanoacrylate) to gain truncal occlusion.

Ultrasound-guided foam sclerotherapy

Sclerotherapy have been used for treatment of varicose veins since the 1960s. The technique had high recurrence rates > 70% as a single technique but could be used together with different surgical treatments. The first to describe the technique to mix a sclerosant with air or CO_2 to produce foam was originally Cabrera, mixing Polidocanol and CO_2, and Tessari, mixing STS (sodium tetradecyl sulphate) and air. Using ultrasound as guidance, one injects small volumes directly into superficial varicose veins with the patient in a supine position and the leg to be treated elevated to 45°. The technique can also be used for both primary and recurrent venous incompetence for ablation of the great or small saphenous vein or their main branches. The largest meta-analysis comparing surgery with EVLA, RFA, and UGFS examined 64 eligible studies, which included over 1200 limbs, using Doppler ultrasound findings as outcomes. Average follow-up was 32 months, and estimated pooled success rates at 3 years were highest for EVLA, with 94% closure, followed by RFA (84%), surgery (78%), and UGFS (77%). Adverse events and complications include thrombophlebitis and skin-staining, which could be expected in 15% of cases; but transient visual symptoms have also been reported and are estimated to occur with an incidence of 0.5–1%. They may be reduced by using carbon dioxide instead of air for the mixture of foam.

Mechanochemical ablation (MOCA)

To overcome the infirmity of both endothermal ablation techniques and UGFS, Clarivein™ (Vascular Insights LLC, CT, USA) has been introduced. Clarivein™ is a mechanochemical device for truncal vein ablation and can be used without tumescent anaesthesia. The device consists of a handle unit with a motor that drives a central wire rotating at 3500 rpm inside an infusion catheter system, which protrudes from the catheter lumen. Using simultaneously both mechanical abrasion and chemical abrasion via injection of a sclerosant through a rotating wire, Clarivein™ is intended to overcome the low efficacy rates of truncal vein occlusion for UGFS.

The first published results reported a closure rate at 6-month of 96%, and this rate was maintained at a subsequent 2-year follow-up. A comparison between Clarivein™ and RFA has reported a significantly less pain in the first 14 days after the procedure in favor of Clarivein™. Mechanical problems and inability for the device to work in large diameter veins >15 mm and in recanalized recurrent truncal veins have been reported.

Cyanoacrylate vein occlusion (VenaSeal™ Sapheon™ closure)

The technique is built to eliminate the need for tumescent anesthesia and post-operative compression used with thermal ablation techniques. Using a hydrophobic delivery catheter to deliver the cyanoacrylate adhesive (SCA) developed by Sapheon™ (Sapheon Inc, NC, USA), one will gain permanent closure of incompetent superficial truncal varicose veins.

Cyanoacrylates are well-known tissue adhesives in healthcare. They are of low viscosity and polymerize almost instantly in contact with water or blood. The Sapheon™ delivery system (SCA) is a mixture of n-butyl cyanoacrylate with small amounts of biocompatible additives to retard polymerization, increase viscosity, and produce a flexible adhesive.

The procedure involves standard Seldinger technique access, and the Sapheon™ 5-F sheath is advanced to SFJ. The glue is delivered directly at the SFJ under ultrasound surveillance and compression for 3 minutes. After that, the glue is delivered at 3-cm intervals along the target vein using 30 seconds of compression for each delivery. No compression bandaging or stocking is needed.

Early studies show that the technique is feasible and safe and has a technical success rate of 97% primary closure of GSV and 1-year occlusion rate of 92%. No major adverse events such as DVT or PE were noted. At 30-day follow-up, 6 patients (16%) had thrombophlebitis. The short-term closure rates are well comparable with thermal ablation methods, but longer-term results are still not available. The changes observed in treated veins are consistent with chronic foreign-body type inflammatory response with fibrotic segments.

References

1. McBride K. Changing to endovenous treatment for varicose veins: How much more evidence is needed? Surgeon 2011; 9: 150-159.
2. National Institute for Health and Clinical Excellence. Varicose veins in the legs (CG 168). See http://guidance.nice.org.uk/CG168.
3. Lawson J, Gauw S, van Vlijmen C, Pronk P, Gaastra M, Mooij M, Wittens CHA. Sapheon: the solution? Phlebology 2013; 28 (Suppl. 1): 2-9.
4. Almeida JI, Javier JJ, Mackay EG, Bautista C, Proebstle T. Cyanoacrylate glue great saphenous vein ablation: preliminary 180-day follow-up of a first-in-man feasibility study of a no-compression-no-local-anesthesia technique. J Vasc Surg 2012; 55: 297.
5. Tessari L, Cavezzi A, Frullini A. Preliminary experience with a new sclerosing foam in the treatment of varicose veins. Dermatol Surg 2001; 27: 58-60.
6. van den Bos R, Arends L, Kockaert M, Neumann M, Nijlsen T. Endovenous therapies of lower extremity varicosities; a meta-analysis. J Vasc Surg 2009; 49: 230-239.
7. Jia X, Mowatt G, Burr JM, Cassar K, Cook J, Frase C. Systematic review of foam sclerotherapy for varicose veins. Br J Surg 2007; 94: 925-936.
8. Elias S, Lam YL, Wittens CHA. Mechanochemical ablation: status and results. Phlebology 2013; 28 (Suppl. 1): 10-14.
9. van Eekeren RRJP, Boersma D, Konijn V, de Vries J-PPM, Reijnen MMJP. Post-operative pain and early quality of life after radiofrequency ablation and mechanochemical endovenous ablation of incompetent great saphenous veins. J Vasc Surg 2013; 57: 445-450.

101.4

Ancillary therapies: mini-phlebectomy and foam sclerotherapy

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Learning Objectives
1. To learn how to select the appropriate patients
2. To learn how an IR can adopt mini-phlebectomy
3. To learn about follow-up care

No abstract available.

Special Session
Bariatric embolisation

102.1

Basic considerations, patient selection and indication for treatment

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Learning Objectives
1. To understand the pathophysiological basis that regulates food intake
2. To review the current evidence regarding gut hormones (ghrelin and others) in obese patients
3. To learn about patient triage for currently available interventions

Being critical for survival, energy homeostasis is a highly regulated phenomenon in all living organisms [1] and results from the balance between energy intake and energy expenditure, which promotes the stability of stored energy [2].

The physiological systems that regulate energy homeostasis include brain centers, such as the hypothalamus, brainstem, and reward centers in the limbic system, which via neuropeptides regulate food intake and energy expenditure. These centers are modulated by neural and hormonal signals coming from the periphery, mediated by adiposity signals, such as leptin, and by gastrointestinal hormones [1, 2].

Ghrelin is a gastrointestinal peptide hormone produced primarily by endocrine cells in the gastric fundus that is posttranslationally acylated by ghrelin O-acyltransferase (GOAT) with the addition of an n-octanoic acid moiety, which is required for binding to its receptor [3]. Ghrelin acts in the arcuate nucleus of the basal hypothalamus, stimulating the production and release of NPY and suppressing POMC [4]. NPY is the most potent signal in the central nervous system that stimulates food intake and decreases energy expenditure, while POMC is a precursor protein that through proteolytic cleavage originates α-MSH that decreases appetite and increases energy expenditure [4]. Ghrelin levels rise before meals and decrease with food intake [5].

Ghrelin has been shown to have a long-term effect on energy homeostasis by increasing the respiratory quotient, decreasing utilization of fat as energy, and shifting food preference towards high-fat diet [6]. Chronic ghrelin administration increases body weight gain and adiposity [7], and ghrelin replacement partially reverses the reduction in body weight and body fat in gastrectomized mice [8].

Plasma ghrelin levels correlate inversely with body mass index; thus ghrelin is reduced in most obese individuals when compared to normal-body-weight individuals [9]. Elevated ghrelin levels induced by diet-associated weight loss have been implicated in the rebound weight gain phenomenon [5]. In addition, evidence suggests that suppression of rising ghrelin levels by some bariatric surgery procedures, as observed after caloric deprivation, may also contribute to the success of the surgical treatment [5, 10]. Sleeve gastrectomy is a restrictive bariatric surgery procedure that provides reduction of gastric volume through resection of the stomach along the greater gastric curvature and construction of a tubular gastric pouch [11]. Sleeve gastrectomy is associated with a variable excess body weight loss ranging from 33 to 90% depending on the series [11]. Weight loss attained trough sleeve gastrectomy has been attributed not only to the restriction of the stomach capacity but also to the decrease of ghrelin levels [12], since this surgery involves resection of the majority of the gastric fundus, which is the main location of ghrelin production [12, 13].

Since ghrelin is the only peripheral hormone known to stimulate food intake, it has been considered the most promising target for obesity treatment [14]. The neutralization of ghrelin biologic effects in energy homeostasis, attained through several different experimental models have already been used in order to prove this concept, which included genetic deletion of ghrelin or ghrelin receptor, ghrelin receptor antagonism and GOAT inhibition, the enzyme responsible for ghrelin acylation with subsequent activation.

Ghrelin receptor antagonists have demonstrated to decrease food intake, body weight and improve glucose tolerance in mice, confirming the potential of blocking ghrelin for the treatment of obesity and type 2 diabetes [15] [16]. In addition, ghrelin-neutralizing molecules, such as ribonucleic acid Spiegelmer (SPM), a non-natural nucleic acid with specific binding activity towards a given molecule, has also shown to decrease food intake, promote weight loss, and decrease food efficiency [17]. Antibodies-mediated GOAT inactivation increases metabolic rate and suppresses re-feeding after food deprivation [18] [19], while a GOAT-specific inhibitor, a bisubstrate analog GO-CoA-Tat composed of ghrelin, octanoyl Co-A, and a Tat sequence that allows the analog to penetrate within the cell cytoplasm where ghrelin acylation occurs is able to decrease serum levels of active ghrelin, prevent body weight gain, increase insulin secretion and improve glucose tolerance [20].

Anti-ghrelin vaccination strategies have also reinforced the concept of ghrelin inactivation as a means to treat obesity. The first approaches towards an anti-ghrelin vaccine consisted in passive antibody transfer, using either polyclonal monoclonal anti-acylated ghrelin antibodies that were able to dose-dependently inhibit fast-induced feeding and suppress dark-phase food intake later [21]. In addition, these antibodies were able to inhibit acute ghrelin-mediated orexigenic effects without modifying long-term food intake in mice [22], while a mixture of monoclonal antibodies targeting different ghrelin haptens have been shown to increase energy expenditure during fasting and deprivation-induced food intake, as well as to reduce overall food intake upon re-feeding [23]. Although, representative as a proof-of-concept, passive immunizations have the limitation of lacking long-term effectiveness, due to the reduced half-lives of the antibodies and need of periodic administration, as well as the possibility of activation of compensatory pathways of ghrelin production as may occur with other ghrelin inactivation procedures.

Therefore, active immunization strategies have been pursued with the rationale of inducing a sustained immune response to suppress endogenous ghrelin bioactivity, with the initial attempts using conjugates of ghrelin with bovine serum albumin (BSA) [24] and keyhole limpet hemocyanin (KLH) as carrier proteins and immunogenic substances [25]. However, since these anti-ghrelin vaccination strategies also carried the risk of exacerbated immune response or had restricted use in humans, due to the need of using adjuvants in order to achieve an appropriate antibody response, alternative anti-ghrelin vaccination have been sought. Approaches using virus-like particles (VLPs), which are viral proteins without genetic material, hence with no pathogenic phenotype, has been the most recent advance towards a pharmacological blockade of ghrelin's biological effects [26].

Thus, ghrelin, as the only orexigenic hormone so far identified, has attracted particular attention both in surgical and pharmacological obesity treatment approaches, as a potentially effective means

of decreasing food intake and increasing energy expenditure, both important contributions to establish a negative energy balance and promote weight loss.

Obesity is a chronic disease, as evidenced by the high likelihood of weight regain after weight loss attained by medical therapies. Therefore, as for any chronic condition, there is a need for a long-term approach to the disease [27, 28]. The available weight loss treatments include combinations of diet, exercise, behavioral modification, pharmacotherapy, and bariatric surgery.

Obesity surgery is reserved for severe obesity, namely for patients with body mass index (BMI) over 40 kg/m^2 or over 35 kg/m^2 associated with high-risk co-morbid conditions, as well as for patients in whom medical weight loss treatments have failed and have not shown long-term effectiveness [27].

Pharmacotherapy, to suppress appetite or alter nutrient absorption, is indicated for patients with BMI over 30 kg/m^2 or over 27 kg/m^2 associated with high-risk co-morbid conditions. Drug therapy typically induces only 5 to 10% weight loss, although enough to confer health benefits to the patient and improvement of obesity co-morbidities even if the patient does not reach a normal body weight; however, it cannot be used chronically and is prone to tolerance and secondary lack of effectiveness [29].

In result of the self-evident lack of treatment tools for obese patients with BMIs lower than 35 kg/m^2, ghrelin-suppressive measures arise as a promising and most welcomed therapeutic alternative.

However, it is important to reinforce that the available data suggests that ghrelin suppression, although promising, is unlikely to represent a broad anti-obesity agent. The role of ghrelin in food intake regulation seems to act predominantly in response to conditions of low energy intake, driving hunger, rather than regulating basal food intake or appetite. In addition, most obese patients, with the sole exception of patients with Prader-Willi Syndrome, have low ghrelin levels. So a vaccine is not expected to be effective in the absence of diet-induced ghrelin rise. Therefore, the obese patients who could probably benefit the most from the ghrelin-suppressive approaches are more likely to be individuals with BMI of 27 to 35 kg/m^2 enrolled in a diet and exercise program as adjuvant therapy for weight loss for the prevention of weight regain. Furthermore, since food intake is the result of a highly regulated and redundant network, it is unlikely that the single inhibition of the ghrelin pathway, or any of the other pathways explored so far as a means to interfere with body weight regulation, will be effective for obesity treatment; combination therapies targeting multiple pathways will most likely be needed [30].

References

1. Kalra, S.P., et al., Neuropeptide Y secretion increases in the paraven-*tricular nucleus in association with increased appetite for food*. Proc Natl Acad Sci U S A, 1991. 88(23): p. 10931-5.
2. Schwartz, M.W., et al., Central nervous system control of food intake. Nature, 2000. 404(6778): p. 661-71.
3. Kojima, M., et al., Ghrelin is a growth-hormone-releasing acylated peptide from stomach. Nature, 1999. 402(6762): p. 656-60.
4. Cone, R.D., et al., The arcuate nucleus as a conduit for diverse signals relevant to energy homeostasis. Int J Obes Relat Metab Disord, 2001. 25 Suppl 5: p. S63-7.
5. Cummings, D.E., et al., Plasma ghrelin levels after diet-induced weight loss or gastric bypass surgery. N Engl J Med, 2002. 346(21): p. 1623-30.
6. Tschop, M., D.L. Smiley, and M.L. Heiman, Ghrelin induces adiposity in rodents. Nature, 2000. 407(6806): p. 908-13.
7. Wren, A.M., et al., Ghrelin enhances appetite and increases food intake in humans. J Clin Endocrinol Metab, 2001. 86(12): p. 5992.
8. Dornonville de la Cour, C., et al., Ghrelin treatment reverses the reduction in weight gain and body fat in gastrectomised mice. Gut, 2005. 54(7): p. 907-13.
9. Tschop, M., et al., Circulating ghrelin levels are decreased in human obesity. Diabetes, 2001. 50(4): p. 707-9.
10. Monteiro, M.P., et al., *Increase in ghrelin levels after weight loss in* obese Zucker rats is prevented by gastric banding. Obes Surg, 2007. 17(12): p. 1599-607.
11. Shi, X., et al., *A review of laparoscopic sleeve gastrectomy for morbid* obesity. Obes Surg, 2010. 20(8): p. 1171-7.
12. Langer, F.B., et al., *Sleeve gastrectomy and gastric banding: effects* on plasma ghrelin levels. Obes Surg, 2005. 15(7): p. 1024-9.
13. Cohen, R., et al., *Ghrelin levels and sleeve gastrectomy in super-*super-obesity. Obes Surg, 2005. 15(10): p. 1501-2.
14. Kojima, M. and K. Kangawa, *Ghrelin: structure and function*. Physiol Rev, 2005. 85(2): p. 495-522.
15. Esler, W.P., et al., *Small-molecule ghrelin receptor antagonists* improve glucose tolerance, suppress appetite, and promote weight loss. Endocrinology, 2007. 148(11): p. 5175-85.
16. Maletinska, L., et al., *The Peptidic GHS-R antagonist [D-Lys(3)]* GHRP-6 markedly improves adiposity and related metabolic abnormalities in a mouse model of postmenopausal obesity. Mol Cell Endocrinol, 2011. 343(1-2): p. 55-62.
17. Shearman, L.P., et al., *Ghrelin neutralization by a ribonucleic acid*-SPM ameliorates obesity in diet-induced obese mice. Endocrinology, 2006. 147(3): p. 1517-26.
18. Yang, J., et al., *Inhibition of ghrelin O-acyltransferase (GOAT)* by octanoylated pentapeptides. Proc Natl Acad Sci U S A, 2008. 105(31): p. 10750-5.
19. Mayorov, A.V., et al., *Catalytic antibody degradation of ghrelin* increases whole-body metabolic rate and reduces refeeding in fasting mice. Proceedings of the National Academy of Sciences of the United States of America, 2008. 105(45): p. 17487-92.
20. Barnett, B.P., et al., *Glucose and weight control in mice with* a designed ghrelin O-acyltransferase inhibitor. Science, 2010. 330(6011): p. 1689-92.
21. Nakazato, M., et al., *A role for ghrelin in the central regulation of* feeding. Nature, 2001. 409(6817): p. 194-8.
22. Lu, S.C., et al., *An acyl-ghrelin-specific neutralizing antibody* inhibits the acute ghrelin-mediated orexigenic effects in mice. Mol Pharmacol, 2009. 75(4): p. 901-7.
23. Zakhari, J.S., et al., *Oligoclonal antibody targeting ghrelin* increases energy expenditure and reduces food intake in fasted mice. Molecular pharmaceutics, 2012. 9(2): p. 281-9.
24. Vizcarra, J.A., et al., *Active immunization against ghrelin decreases* weight gain and alters plasma concentrations of growth hormone in growing pigs. Domest Anim Endocrinol, 2007. 33(2): p. 176-89.
25. Zorrilla, E.P., et al., *Vaccination against weight gain.* Proc Natl Acad Sci U S A, 2006. 103(35): p. 13226-31.
26. Andrade, S., et al., *Immunization Against Active Ghrelin Using* Virus-like Particles for Obesity Treatment. Curr Pharm Des, 2013.
27. Schneider, B.E. and E.C. Mun, *Surgical management of morbid* obesity. Diabetes Care, 2005. 28(2): p. 475-80.
28. Kushner, R., *Diets, drugs, exercise, and behavioral modification:* Where these work and where they do not. Surg Obes Relat Dis, 2005. 1(2): p. 120-2.
29. Fujioka, K., *Management of obesity as a chronic disease: nonphar-*macologic, pharmacologic, and surgical options. Obes Res, 2002.10 Suppl 2: p. 116S-123S.
30. Monteiro, M.P., *Anti-ghrelin vaccine for obesity: a feasible alter-native* to dieting? Expert Rev Vaccines, 2011. 10(10): p. 1363-5.

102.2

Preclinical data

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Learning Objectives
1. To review preclinical evidence supporting bariatric embolisation
2. To describe preliminary data using animal models
3. To describe the rationale for BE

Of all hormones that are involved in regulation of appetite, only one hormone actually stimulates hunger. Due to this, ghrelin has been termed the "hunger hormone." Ghrelin-secreting cells are highly concentrated in the fundus of the stomach, with much lower concentrations located elsewhere in the body. Ghrelin levels are depressed after bariatric surgeries that isolate or remove the gastric fundus, and many have hypothesized that this ghrelin depression is contributory to the resulting weight loss. The concept of impairing ghrelin production by selective embolization of the gastric fundus, termed "bariatric embolization," has been evaluated in numerous animal studies. These various studies, in aggregate, give insight into the mechanism, side effects, and efficacy of bariatric embolization in impairing ghrelin production and in energy control. The purpose of this session is to review the existing preclinical data and discuss the findings that may impact the translation of this potential therapy to humans.

References

1. Arepally A, Barnett BP, Montgomery E, Patel TH. Catheter-directed gastric artery chemical embolization for modulation of systemic ghrelin levels in a porcine model: initial experience. Radiology. 2007 Jul;244(1):138-43.
2. Arepally A, Barnett BP, Patel TH, Howland V, Boston RC, Kraitchman DL, Malayeri AA. Catheter-directed gastric artery chemical embolization suppresses systemic ghrelin levels in porcine model. Radiology. 2008 Oct;249(1):127-33.
3. Paxton BE, Kim CY, Alley CL, Crow JH, Balmadrid B, Keith CG, Kankotia RJ, Stinnett S, Arepally A. Bariatric embolization for suppression of the hunger hormone ghrelin in a porcine model. Radiology. 2013 Feb;266(2):471-9.
4. Paxton BE, Alley CL, Crow JH, Burchette J, Weiss CR, Kraitchman DL, Arepally A, Kim CY. Histopathologic and immunohistochemical sequelae of bariatric embolization in a porcine model. J Vasc Interv Radiol. 2014 Mar;25(3):455-61.
5. Bawudun D, Xing Y, Liu WY, Huang YJ, Ren WX, Ma M, Xu XD, Teng GJ. Ghrelin suppression and fat loss after left gastric artery embolization in canine model. Cardiovasc Intervent Radiol. 2012 Dec;35(6):1460-6.
6. Diana M, Pop R, Beaujeux R, Dallemagne B, Halvax P, Schlagowski I, Liu YY, Diemunsch P, Geny B, Lindner V, Marescaux J. Embolization of Arterial Gastric Supply in Obesity (EMBARGO): an endovascular approach in the management of morbid obesity. proof of the concept in the porcine model. Obes Surg. 2015 Mar;25(3):550-8.
7. Diana M, Halvax P, Pop R, Schlagowski I, Bour G, Liu YY, Legner A, Diemunsch P, Geny B, Dallemagne B, Beaujeux R, Demartines N, Marescaux J. Gastric supply manipulation to modulate ghrelin production and enhance vascularization to the cardia: proof of the concept in a porcine model. Surg Innov. 2015 Feb;22(1):5-14.

102.3

Techniques and complications

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Learning Objectives
1. To learn about the technical steps for bariatric embolisation
2. To learn about anatomical variants and physiological conditions that may influence gastric artery embolisation
3. To describe potential complications and how to avoid them

Bariatric arterial embolization (BAE) is an exciting new technique that is currently under investigation for the treatment of morbid obesity. In this presentation, we will discuss the following:
1) The anatomic and technical considerations that are key to safely and effectively performing BAE in humans based on the perspective of ongoing early clinical trials.
2) Potential complications of BAE and how to avoid them.
3) Non-procedure-related aspects of patient care that are proving to be essential to the success of BAE in the morbidly obese patient.

102.4

Early clinical results

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Learning Objectives
1. To learn about the connection between weight loss and gastric bleeding embolisation
2. To review preliminary results of gastric embolisation in order to achieve significant weight loss
3. To discuss future directions for optimising embolisation protocols and clinical outcomes

Bariatric arterial embolization (BAE) is an exciting new technique that is currently under clinical investigation for the treatment of morbid obesity. In this presentation, we will discuss the earliest clinical data that served as supporting evidence for ongoing FDA-approved clinical trials, followed by the safety and efficacy data that the ongoing FDA-approved trials have begun to produce.

Special Session
Management of early-stage hepatocellular carcinoma

103.1

Diagnosis: imaging and biopsy

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Learning Objectives
1. To learn how to diagnose HCC by using non-invasive imaging criteria
2. To learn how to select patients for biopsy
3. To learn how to manage patients with suspected HCC

Surveillance programs of patients at risk of HCC allow diagnosis of early-stage HCCs in asymptomatic patients when potentially curative treatments can be offered: surgical resection, liver transplantation, or ablation(1). Based on the BCLC classification, the very early stage (BCLC 0) corresponds to patients with well-preserved liver

function diagnosed with one nodule < 2 cm who would have excellent outcomes after resection or ablation(2).
Angiogenesis takes place actively in these lesions. Nevertheless, the rate of hypovascular HCCs of such a small size is around 15%(3). The lack of typical vascular wash-in and wash-out pattern makes diagnosis by imaging unfeasible, and biopsy is recommended in nodules between 1 and 2 cm with atypical vascular pattern. The diagnosis of HCC in lesions < 1 cm is seldom achieved, and the recommendation is to follow-up these tiny nodules by ultrasonography looking for possible growth(4).
The sensitivity and specificity of noninvasive criteria to be applied in patients at risk may reach 70% and near 100%, respectively(5,6). Biopsy has some limitations, one of them being a false-negative rate of near 30% in the first attempt of detecting such a small tumor; this makes it desirable to devise a tool that increases the sensitivity of noninvasive criteria while maintaining a very high specificity.
MRI with combined extracellular and hepatobiliary contrast agents has shown to increase sensitivity for the detection of HCCs < 2 cm, but the lack of data on specificity and the imaging overlap between small HCCs and dysplastic nodules makes it difficult to reach a confident diagnosis of malignancy based on imaging(7-10).
In summary, very small HCCs are often atypical on imaging and difficult to detect and diagnose. Care has to be taken to avoid overdiagnosis and overtreatment of small atypical nodules in pa-tients at risk of HCC that would potentially induce treatment-related morbidity without any outcome benefit.

References

1. Bruix J, Sherman M. Management of hepatocellular carcinoma: an update. Hepatology 2011;53:1020-22.
2. Forner A, Llovet JM, Bruix J. Hepatocellular carcinoma. Lancet 2012;379:1245-55.
3. Forner A, Vilana R, Bianchi L, et al. Lack of arterial hypervascularity at contrast-enhanced ultrasound should not define the priority for diagnostic work-up of nodules <2 cm. J Hepatol 2015;62:150-5.
4. Bruix J, Reig M, Rimola J, et al. Clinical decision making and research in hepatocellular carcinoma: pivotal role of imaging techniques. Hepatology 2011;54:2238-44.
5. Forner A, Vilana R, Ayuso C, et al. Diagnosis of hepatic nodules 20 mm or smaller in cirrhosis: Prospective validation of the noninvasive diagnostic criteria for hepatocellular carcinoma. Hepato-logy 2008;47:97-104.
6. Sangiovanni A, Manini MA, Iavarone M, et al. The diagnostic and economic impact of contrast imaging technique in the diagnosis of small hepatocellular carcinoma in cirrhosis. Gut 2010;59:638-44.
7. Bartolozzi C, Battaglia V, Bargellini I, et al. Contrast-enhanced magnetic resonance imaging of 102 nodules in cirrhosis: correlation with histological findings on explanted livers. Abdom Imaging 2013;38:290-6.
8. Yu MH, Kim JH, Yoon JH, et al. Small (≤1-cm) Hepatocellular carcinoma: diagnostic performance and imaging features at gadoxetic acid-enhanced MR imaging. Radiology 2014;271:748-60.
9. Granito A, Galassi M, Piscaglia F, et al. Impact of gadoxetic acid (Gd-EOB-DTPA)-enhanced magnetic resonance on the non-invasive diagnosis of small hepatocellular carcinoma: a prospective study. Aliment Pharmacol Ther 2013;37:355-63.
10. Golfieri R, Grazioli L, Orlando E, *et al.* Which is the best MRI marker of malignancy for atypical cirrhotic nodules: hypointensity in hepatobiliary phase alone or combined with other features? Classification after Gd-EOB-DTPA administration. J Magn Reson Imaging 2012;36:648-57.

103.2

Staging, patient selection and treatment algorithms

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Learning Objectives

1. To learn how to stage patients with HCC
2. To learn how to assess patient and tumour-related factors
3. To learn how to select patients for each treatment option

Hepatocellular carcinoma (HCC) represents the leading cause of death in patients with liver cirrhosis. Role of diagnostic and interventional radiology has been established for staging and treating patients with HCC. Multiple curative and palliative therapy options are now available for these patients, and the prognosis is mostly influenced by tumour stage and performance status and also by the degree of liver-function impairment. The Barcelona Clinic Liver Cancer (BCLC) classification has defined a subset of patients categorized as very early and early stage who can benefit from curative treatments. Patients with intermediate-stage HCC, who are considered ineligible for curative treatment (ablation, resection or transplantation), may benefit from transarterial treatments. However, the most important prognostic factors remain clinical symptoms, tumour burden and liver function. Discrepancies persist between different treatment algorithms, e.g. EASL-EORTC still recommends PEI for early-stage HCC nodules and only resection for very early-stage HCC, although meta-analyses have reported the superiority of thermal ablation over PEI for HCC <3cm in size, and similar results for ablation and surgery have been reported for HCC <2 cm in size. In other recommendations, image-guided thermal techniques with radiofrequency ablation (RFA) is recommended as the first-line treatment in early-stage HCC in patients with associated disease or even as the first-choice therapy in very early-stage HCC if the patient is not a candidate for transplantation. Strengths and weaknesses of international treatment algorithms will be reviewed.

103.3

Ablation: techniques and complications

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Learning Objectives

1. To learn how to use different techniques for image-guided ablation
2. To learn how to select patients for each ablation technique
3. To learn how to prevent and manage complications

No abstract available.

103.4

Outcomes of interventional treatments

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Learning Objectives

1. To learn how to interpret long-term results of image-guided ablation
2. To learn how to discuss ablation survival data in comparison with surgical survival data
3. To learn how to select patients with the best expected outcomes

Hepatocellular carcinoma (HCC) is the sixth most common cancer and the third leading cause of cancer-related death. Early diagnosis of HCC can be achieved by the surveillance of at-risk populations. However, a careful multidisciplinary assessment of tumor characteristics, liver function, and physical status is required for proper therapeutic management even in patients with early stage tumors. When surgical options are precluded, image-guided tumor ablation is recommended as the most appropriate therapeutic choice, and it is considered to be a potentially curative treatment in properly selected candidates.

In very early stage HCC, the presence of a solitary, small nodule with a diameter of <2 cm in Child-Pugh A patients AND the absence of microvascular invasion and dissemination offers the highest likelihood of cure. These patients can be offered surgical resection if they are noncirrhotic or if they have cirrhosis but still have well-preserved liver function and normal bilirubin as well as the absence of clinically significant portal hypertension. Despite recent refinements in surgical techniques that have resulted in the reduction of treatment-related mortality to 1%–3%, most groups restrict an indication for anatomical resection in patients with very early HCCs that are at a suitable location for resection to maximally preserve noncancerous, functional liver parenchyma. Nodules of <2 cm that are neither subcapsular nor perivascular are the ideal target for percutaneous RFA, which is considered as the standard technique for liver tumor ablation at most institutions. In patients with very early HCC, the complete response rate approaches 97%, with 5-year survival rates of 68%. Therefore, in these small, centrally located tumors, RFA seems to challenge the role of surgical resection, thereby allowing a long-term survival rate similar to that of resection along with the preservation of liver parenchyma. Therefore, in patients with very early HCC, RFA can be offered as the first-line treatment, considering that surgical approach when individual variables including tumor location would make RFA unfeasible or unsafe.

Early stage disease includes patients with preserved liver function (Child-Pugh A and B), with solitary HCC or up to three nodules with a size of <3 cm. These patients can be effectively treated by resection, liver transplantation, or percutaneous ablation with the possibility of long-term cure, with 5-year survival estimates ranging from 50% to 75%. Among different ablative techniques, RFA is currently considered as the best treatment options in patients with early stage HCC. Five randomized controlled trials (RCTs) have compared RFA versus PEI for the treatment of early stage HCC. These investigations consistently showed that RFA was more effective than PEI, which led to a better local control of the disease. The assessment of the impact of RFA on survival has been more controversial. While a survival benefit was identified in the three RCTs performed in Asia, the two European RCTs failed to show statistically significant differences in overall survival between patients who received RFA and those treated with PEI, despite the trend favoring RFA. Nevertheless, three independent meta-analyses including all RCTs have confirmed that treatment with RFA offers a survival benefit compared with PEI, particularly for tumors >2 cm, thereby establishing RFA as the standard percutaneous technique in these patients. Recent reports on long-term outcomes of RFA-treated patients have shown that in patients with Child-Pugh class A and early stage HCC, 5-year survival rates are as high as 51%–64%, and they may reach to 76% in patients who meet the BCLC criteria for surgical resection. Therefore, an open question is whether RFA can compete with surgical resection as the first-line treatment not only for patients with very early HCC but also for patients with small, solitary HCC of >2 cm. Results of RCTs on this topic remain controversial.

Large-scale, nation-wide surveys can provide evidence regarding the respective role of resection versus percutaneous ablation in clinical practice. In Japan, a prospective cohort analysis was conducted by Hasegawa *et al.* They compared the outcomes of liver resection (n = 5,361), RFA (n = 5,548), and ethanol injection (n = 2,059) in HCC patients in Child-Pugh class A or B and up to three lesions with a maximum diameter of ≤3 cm. Three-year and 5-year survival rates were 85.3% and 71.7%, respectively, in the liver resection group versus 81.0% and 61.1%, respectively, in the RFA group. A retrospective comparison of resection and RFA in the treatment of a large selected group of patients, i.e., single HCC of <3 cm in Child-Pugh class A cirrhosis was recently published. Hepatic resection and RFA were offered to patients in 15 Italian centers by following clinical practice protocols. Four-year overall survival rates were 74.4% in the resection group and 66.2% in the RFA group (p = 0.353). The results of this study seem to confirm that when ablation is performed in appropriate patients with compensated liver cirrhosis and small HCCs, this approach can be offered as the first-line treatment option.

Microwave ablation (MWA) is emerging as a valuable alternative to RFA for the thermal ablation of HCC. Main features of the MW technology when compared with existing thermoablative technologies include consistently higher intratumoral temperatures, larger tumor ablation volumes, faster ablation times, and improved convection profile. As a result, the advantage of MWA over RFA is that treatment outcome is less affected by vessels located in the proximity of the tumor. In addition, because MWA does not rely on an electrical circuit as does RFA, multiple applicators can be applied simultaneously. So far, only one RCT has compared the effectiveness of MWA with that of RFA. Although no statistically significant differences were observed with respect to the efficacy of the two procedures, a trend favoring RFA was recognized in that study with respect to local recurrences and complications rates. However, it has to be pointed out that the MWA technology has evolved significantly since the publication of this trial. Recent advances in MW engineering have allowed the design of new MW systems with the potential for larger, more controlled ablation zones. Despite the fact that MWA has entered clinical practice, results of RCTs or large cohort studies are still missing. Very large patient populations would be needed to demonstrate significant advantages in the survival of patients with very early HCC or early HCC treated with MWA with respect to those treated with RFA. It is therefore essential to perform multicenter clinical trials and to standardize as much treatment protocols as possible by considering the differences among different MW devices.

A new, nonchemical, nonthermal image-guided ablation technique that is currently undergoing clinical investigation in early stage HCC is irreversible electroporation (IRE). IRE is a method to induce the irreversible disruption of cell membrane integrity by changing the transmembrane potential, resulting in cell death without the need for additional pharmacological injury. IRE creates a sharp boundary between the treated and untreated areas *in vivo*. This would suggest that IRE has the ability to sharply delineate the treatment area from the untreated area, and that treatment planning can be precisely performed according to mathematical predictions. Moreover, because IRE is a nonthermal technique, there appears to be complete ablation to the margin of blood vessels without compromising the functionality of blood vessels. Therefore, issues associated with perfusion-mediated tissue cooling or heating (a significant challenge with thermal methods) are not relevant. In a recent report, the safety and short-term efficacy of IRE in tumors near hepatic veins and/or portal pedicles were examined. Another critical tumor location for thermal

treatments is represented by tumors adjacent to major bile ducts due to the risk of producing severe stenosis of biliary structures. Clinical experience regarding this matter has been published, and the results suggested that IRE may be a treatment option for centrally located liver tumors with margins adjacent to major bile ducts where thermal ablation techniques are contraindicated. However, so far, the published data of IRE technique concerning studies conducted in preclinical models and small case series and results of the ongoing prospective clinical trials are strongly demanded.

References

1. Bruix J, Sherman M, Llovet JM, et al. Clinical management of hepatocellular carcinoma. Conclusions of the Barcelona-2000 EASL conference. J Hepatol 2001;35(3):421-430.
2. Bruix J, Sherman M. Management of hepatocellular carcinoma. Hepatology 2005;42(5):1208-1236.
3. Brunello F, Veltri A, Carucci P, et al. Radiofrequency ablation versus ethanol injection for early hepatocellular carcinoma:a randomized controlled trial. Scand J Gastroenterol 2008;43(6):727-735.
4. Chen MS, Li JQ, Zheng Y, et al. A prospective randomized trial comparing percutaneous local ablative therapy and partial hepatectomy for small hepatocellular carcinoma. Ann Surg 2006;243(3):321-328.
5. Cho YK, Kim JK, Kim MY, Rhim H, Han JK. Systematic review of randomized trials for hepatocellular carcinoma treated with percutaneous ablation therapies. Hepatology 2009;49(2):453-459.
6. Choi D, Lim HK, Rhim H, et al. Percutaneous radiofrequency ablation for early-stage hepatocellular carcinoma as a first-line treatment: long-term results and prognostic factors in a large single-institution series. Eur Radiol 2007;17(3):684-692.
7. Crocetti L, de Baere T, Lencioni R. Quality improvement guidelines for radiofrequency ablation of liver tumours.Cardiovasc Intervent Radiol 2010;33(1):11-17.
8. Germani G, Pleguezuelo M, Gurusamy K, Meyer T, Isgrò G, Burroughs AK. Clinical outcomes of radiofrequency ablation, percutaneous alcohol and acetic acid injection for hepatocelullar carcinoma: A meta-analysis. J Hepatol 2010;52(3):380-388.
9. Feng K, Yan J, Li X, et al. A randomized controlled trial of radiofre-quency ablation and surgical resection in the treatment of small hepatocellular carcinoma. J Hepatol 2012;57(4):794-802.
10. Hasegawa K, Kokudo N, Makuuchi M, *et al.* Comparison of resection and ablation for hepatocellular carcinoma: a cohort study based on a Japanese nationwide survey. J Hepatol 2013;58(4):724-729.
11. Huang J, Yan L, Cheng Z, et al. A randomized trial comparing radiofrequency ablation and surgical resection for HCC conforming to the Milan criteria. Ann Surg. 2010;252(6):903-912.
12. Kingham TP, Karkar AM, D'Angelica MI, *et al.* Ablation of perivascular hepatic malignant tumors with irreversible electroporation. J Am Coll Surg 2012;215(3):379-387.
13. Lencioni R, Allgaier HP, Cioni D, *et al.* Small hepatocellular carcinoma in cirrhosis: randomized comparison of radiofrequency thermal ablation versus percutaneous ethanol injection. Radiology 2003;228(1):235-240.
14. Lencioni R, Cioni D, Crocetti L, *et al.* Early-stage hepatocellular carcinoma in cirrhosis: long-term results of percutaneous image-guided radiofrequency ablation. Radiology 2005;234(3):961-967.
15. Lencioni R, Cioni D, Della Pina MC, Crocetti L. New options forimage-guided ablation. J Hepatobiliary Pancreat Sci 2010;17(4):399-403.
16. Lencioni R, Crocetti L. Local-regional treatment of hepatocellular carcinoma. Radiology 2012;262(1):43-58.
17. Lin SM, Lin CJ, Lin CC, Hsu CW, Chen YC. Radiofrequency ablation improves prognosis compared with ethanol injection for hepato-cellular carcinoma < or = 4 cm. Gastroenterology 2004;127(6):1714-1723.
18. Lin SM, Lin CJ, Lin CC, Hsu CW, Chen YC. Randomised controlled trial comparing percutaneous radiofrequency thermal ablation, percutaneous ethanol injection, and percutaneous acetic acid injection to treat hepatocellular carcinoma of 3 cm or less. Gut 2005;54(8):1151-1156.
19. Livraghi T, Meloni F, Di Stasi M, *et al.* Sustained complete response and complications rates after radiofrequency ablation of very early hepatocellular carcinoma in cirrhosis: Is resection still the treatment of choice? Hepatology 2008;47(1):82-89.
20. N'Kontchou G, Mahamoudi A, Aout M, *et al.* Radiofrequency ablation of hepatocellular carcinoma: long-term results and prognostic factors in 235 Western patients with cirrhosis. Hepatology 2009;50(5):1475-1483.
21. Orlando A, Leandro G, Olivo M, Andriulli A, Cottone M. Radiofrequency thermal ablation vs. percutaneous ethanol injection for small hepatocellular carcinoma in cirrhosis: meta-analysis of randomized controlled trials. Am J Gastroenterol 2009;104(2):514-524.
22. Pompili M, Saviano A, de Matthaeis N, *et al.* Long-term effectiveness of resection and radiofrequency ablation for single hepatocellular carcinoma ≤3 cm. Results of a multicenter Italian survey. J Hepatol 2013;59(1):89-97.
23. Shibata T, Iimuro Y, Yamamoto Y, *et al.* Small hepatocellular carcinoma: comparison of radio-frequency ablation and percutaneous microwave coagulation therapy. Radiology 2002;223(2):331-337.
24. Simon CJ, Dupuy DE, Mayo-Smith WW. Microwave ablation: principles and applications. Radiographics 2005;25(Suppl 1):S69-83.
25. Shiina S, Teratani T, Obi S, *et al.* A randomized controlled trial of radiofrequency ablation versus ethanol injection for small hepatocellular carcinoma. Gastroenterology 2005;129(1):122-130.
26. Silk MT, Wimmer T, Lee KS, *et al.* Percutaneous ablation of peribiliary tumors with irreversible electroporation. J Vasc Interv Radiol 2014;25(1):112-118.
27. Tateishi R, Shiina S, Teratani T, *et al.* Percutaneous radiofrequency ablation for hepatocellular carcinoma. Cancer 2005;103(6):1201-1209.
28. Yu NC, Lu DS, Raman SS, *et al.* Hepatocellular carcinoma: microwave ablation with multiple straight and loop antenna clusters - pilot comparison with pathologic findings. Radiology 2006;239(1):269-275.

Fundamental Course
Basic principles of acute stroke intervention

104.1

Current evidence on acute stroke intervention

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Learning Objectives

1. To learn about completed stroke treatment studies/trials
2. To understand where we stand with previous trial results
3. To learn about the practical impacts of these studies in daily routine

Pathophysiological background

Brain tissue is extremely sensitive to hypoxia. With occlusion of a cerebral artery that has no collateral circulation, permanent ischemic lesion may occur after 5 minutes. In the core of the infraction, without collateral circulation, 2 million neurons/minute will die. In the surrounding area, called penumbra, the neurons will lose their functional activity, but may survive for a limited period, up to several hours, depending on the quality of the collateral circulation. Our goal is to reopen the occluded artery ASAP to diminish the size/effect of the ischemic lesion.

Historical steps
The first intraarterial thrombolysis in a cerebral artery was reported by Zeumer, 1983, injecting streptokinase through a microcatheter into the vertebral artery at the C1 level in 5 patients with basilar artery thrombosis, with 3 recanalizations and clinical improvement. Intravenous thrombolysis with rTPA was approved in 1995, first in Europe, then also in the US; and has since then been the first-line treatment and the "gold standard" in the management of acute ischemic stroke. Since the advent of the Guglielmi detachable coils for the endovascular treatment of cerebral aneurysms 1991, the increasing number of thromboembolic complications occurring in the early years has motivated the development of new devices for intraarterial thrombectomy. The first of them, the Merci, was introduced in 2001, the second, the Solitair, in 2006. With these devices, the ratio of recanalizations has significantly improved, from 25% with the first to 60% with the latter. During the following years, several mechanical devices have been introduced based on the same principle, i.e., to remove the clot with a stent-like retriever, hence the name "stentriever." The latest achievement in the technology is the ADAPT technique, employing aspiration to remove the clot from the vessel.
Current status
However, until this year, all the major studies – IMS III, MR RESCUE, SYNTHESIS Expansion – have failed to present firm evidence for the benefit of intraarterial thrombectomy. On the other hand, early this year, several new studies – MR CLEAN, ESCAPE, EXTEND-IA, and SWIFT PRIME – have been published, presenting level 1a evidence for the benefit of intraarterial thrombectomy for patients with stroke caused by large vessel occlusion. A short analysis of these studies, and probably even those appearing after the deadline of this abstract, will be presented at the next CIRSE meeting to support the use of this method in the everyday practice.

104.2

Imaging algorithms and patient selection for IA treatment

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Learning Objectives
1. To learn about studies on image-guided patient selection in acute stroke
2. To understand the recent imaging algorithms for stroke
3. To learn how to select patients with this algorithm

The management of acute ischemic stroke is rapidly developing. The current approach to patient selection for mechanical stroke reperfusion therapies is based on the time from stroke symptom onset and the imaging-derived existence of a major vessel occlusion such as the ICA, BA, and proximal MCA. This approach is reasonable in the first 6 h after stroke onset when substantial salvageable tissue probably exists in a majority of patients. However, it neglects the variable collateral physiology that exists between individual patients and probably plays a critical role beyond this time window. Recent data could prove that interventional stroke treatment provides superior clinical outcome than intravenous thrombolytic therapy only. Besides the neurological deficit (NIH stroke scale score of ≥10), brain imaging is of major importance. The goals of imaging evaluation for acute stroke are to establish a diagnosis as early as possible to obtain accurate information about intracranial (collateral) vasculature and brain perfusion to select the appropriate therapy. At least multimodal brain CT imaging, ideally MRI with perfusion and diffusion imaging and various types of cerebral angiography, should be available 24 h/7 days, with priority to stroke patients. Based on recent data, alternative approaches employing absolute lesion volumes of the core infarct and of the surrounding region of hypoperfusion appear promising but require further validation. This presentation will summarize the impact of recent studies on imaging-guided patient selection for mechanical treatment of acute stroke.

References
1. Berkhemer OA et al.; MR CLEAN Investigators. A randomized trial of intraarterial treatment for acute ischemic stroke. N Engl J Med. 2015 Jan 1;372(1):11-20.
2. Goyal M et al.; ESCAPE Trial Investigators. Randomized assessment of rapid endovascular treatment of ischemic stroke. N Engl J Med. 2015 Mar 12;372(11):1019-30.
3. Campbell BC et al.; EXTEND-IA Investigators. Endovascular therapy for ischemic stroke with perfusion-imaging selection. N Engl J Med. 2015 Mar 12;372(11):1009-18.

104.3

IA stroke intervention: technique

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Learning Objectives
1. To learn initial fast access techniques in acute stroke patients
2. To learn preferred revascularisation techniques
3. To obtain perprocedural tips for successful recanalisation

Stroke intervention is not yet a standardized technique; there are still many areas of controversy, but stent retrievers (SR) have recently obtained evidence of their effectiveness through positive RCT.
SR thrombectomy: proof of efficacy
Swift and Trevo II studies have demonstrated the technical superiority of SR (Solitaire FR, Trevo ProVue) over first-generation devices. During MR CLEAN, ESCAPE, EXTEND-IA, and SWIFT PRIME studies, SR were used in 81.5%, 86.1%, and 100% of the thrombectomy cases, respectively. Clinical benefit of SR thrombectomy is now clearly established with a number needed to treat to obtain an extra patient, with an independent outcome of 7 in MR CLEAN and 3.2 in EXTEND-IA.
Controversies
Domains of controversy encompass the following: access, thromboaspiration, balloon guide catheter, recanalization strategy, the number of attempts of SR, emergent carotid stenting, and dual antiplatelet therapy.
Anatomical hostile arch configuration have to be recognized prior to the angio room. Contrast-enhanced MRA and CTA can depict type II and bovine arches as well as atherosclerotic arch lesions.
Balloon guide catheter significantly reduces the incidence of distal and collateral (previously unaffected territories) clot embolization complication.
Distal aspiration (manual or through a pump) provides either the ability to recapture fragmented thrombus debris, owing to the hydrodynamic force driven by distal, large-bore, intermediate catheter or to grab the base of the thrombus into the distal end of the catheter and maintain it firmly attached due to negative static pressure, allowing complete clot removal in one path.
Emergent carotid stenting feasibility, safety, and effectiveness in patients with acute ischemic stroke due to severe internal carotid stenosis or occlusion remains controversial.
Beside organization network and patient selection, consolidation of revascularization techniques will play a major role in the development of neurointerventions in the care of stroke patients with a definite intracranial vessel occlusion.

104.4

Cerebral sinus thrombosis

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Learning Objectives

1. To learn how to diagnose cerebral sinus thrombosis
2. To learn preferred revascularisation techniques
3. To understand the treatment indications

Cerebral sinus thrombosis is an uncommon reason for stroke. The treatment regimen is usually noninvasive with systemic anticoagulation. Interventional therapy should be considered in cases with deterioration in the clinical course of the patient and in imaging studies, despite adequate medical therapy.

Sinus thrombosis can be diagnosed by computed tomography including venous angiography. MR with MR venography is the second diagnostic tool, achieving more detailed information about the thrombosis and the accompanying findings such as venous infarction.

Interventional therapy includes local thrombolysis and mechanical thrombectomy. Dedicated tools for sinus thrombectomy are not available. We present our experience in consecutive case series with mechanical thrombectomy using stent retrievers or alternative off-label devices.

Fundamental Course
Basic principles of haemodialysis access maintenance

201.1

Current evidence and indications for failing dialysis access management

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Learning Objectives

1. To learn about the clinical indications for intervention
2. To learn about the outcomes of managing failing dialysis grafts
3. To learn which management strategy provides the best results

A vascular access needs to be imaged under the following conditions:
*in the presence of vascular access clinical abnormalities directly impacting patient's health
*for the prevention of acute thrombosis

Clinical abnormalities

They include the following:
*cannulation difficulties
*inadequate access flow during dialysis
*high venous pressure
*prolonged bleeding from cannulation site after dialysis
*arm or facial edema
*cutaneous necrosis in needling areas
*distal ischemia
*inadequate measured access flow and inadequate dialysis

Thrombosis prevention

It was initially suggested that an access flow of less than 600 mL/min in grafts and somewhere between 350 ml/min and 500 ml/min in AVFs warranted some form of access imaging (1-2).

However, Tonelli wrote in 2008 that a subsequent systematic review of randomized trials concluded that vascular access surveillance did not reduce prosthetic graft thrombosis or improve survival, although trials of autogenous fistulas suggested a beneficial effect on thrombosis but no effect on survival (3).

Tonelli found in 2003 that a Qa of <500 ml/min seemed to be the most appropriate threshold for performing angiography in patients with native vessel AVF (4). It was therefore recommended that clinicians arranged angiography when Qa was <500 ml/min in AVF. However, Tessitore recently showed that elective repair of subclinical stenosis in AVFs with a Qa of >500 ml/min cost-effectively reduced the risk of thrombosis and access loss in comparison with the approach of Kidney Disease Outcomes Quality Initiative (KDOQI) guidelines, raising the question of whether the currently recommended criteria for assessing and treating stenosis should be reconsidered (5).

Which type of image modality?

In this day and age, there is no place for ordering relatively costly and invasive diagnostic fistulograms unless for the purpose of rightly and justifiably dilating an underlying tight stenosis already detected by either clinical examination or duplex ultrasonography.

Duplex ultrasonography is less costly and invasive and should be the first-line diagnostic imaging modality (6).

Computed tomography and magnetic resonance angiography have no place in the diagnosis of vascular access abnormalities as they do not provide a platform for concomitant therapeutic interventions to date (7-8). These two modalities are expensive and require venipuncture of upper extremity veins. There are definite hazards with gadolinium (nephrogenic systemic fibrosis). It is indeed alarming that in the era of rigorous vein preservation advocacy, the upper extremity venous capital should be unnecessarily compromised for the sake of finer but purely diagnostic imaging that can be effectively obtained by duplex ultrasonography.

References

1. National Kidney Foundation's KDOQI (2006) Vascular Access Guidelines. Am J Kidney Disease 48:S177-322.
2. Tessitore N, Mansucto G, Bedogna V et al (2003) A prospective controlled trial on effect of percutaneous transluminal angioplasty on functioning arteriovenous fistulae survival. J Am Soc Nephrol 14:1623-27.
3. Tonelli M, James M, Wiebe N, Jindal K, Hemmelgarn B; Alberta Kidney Disease Network (2008) Ultrasound monitoring to detect access stenosis in hemodialysis patients: a systematic review. Am J Kidney Dis 51:630-40.
4. Tonelli M, Jhangri G, Hirsch D, et al (2003) Best threshold for diagnosis of stenosis or thrombosis within six months of access flow measurement in arteriovenous fistulae. J Am Soc Nephrol 14:3264-9.
5. Tessitore N, Bedogna V, Poli A, et al (2014) Should current criteria for detecting and repairing arteriovenous fistula stenosis be reconsidered? Interim analysis of a randomized controlled trial. Nephrol Dial Transplant 29:179-87.
6. Franco G (2003) Technique and results of duplex-Doppler for non-stenosing complications of vascular access for chronic hemodialysis: ischemia, steal, high flow rate, aneurysm. J Mal Vasc 28:200-5.
7. Ko S, Huang C, Nq S, et al (2005) MDCT angiography for evaluation of the complete vascular tree of hemodialysis fistulas. Am J Radiol 185:1268-74.
8. Froger C, Duijm L, Liem Y, et al (2005) Stenosis detection with MR angiography and digital subtraction angiography in dysfunctional hemodialysis access fistulas and grafts. Radiology 234:284-91.

201.2

Thrombosed dialysis access

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Learning Objectives
1. To learn how to image and identify failing grafts
2. To learn how to access thrombosed dialysis grafts
3. To learn how to perform the various treatment options

The prevalence of end-stage renal disease (ESRD) is increasing, with haemodialysis being the main stay of renal replacement therapy. Vascular access creation and maintenance are high-volume procedures. In the United States, the economic burden of maintaining access patency is calculated to exceed $1 billion, with an annual increment of >6%.

Access thrombosis is a complication seen in both arteriovenous grafts (AVGs) (0.5–0.8 episodes/year) and arteriovenous fistulas (AVFs). Monitoring and surveillance are tools to identify failing accesses. Physical signs (monitoring) of absent or changed bruit or thrill, pulsatility, increased bleeding post-dialysis and failure to gain needle access are indicative of dysfunction. Surveillance refers to the periodic device-based evaluation of access flow (ultrasound dilution, differential conductivity and Doppler) and static venous pressure. Imaging using colour flow Doppler and grey scale provides non-invasive anatomic and flow information.

Declotting of the thrombosed access can be performed either surgically or by endovascular techniques. Knowing indications and contraindications to access declotting is paramount to avoid poor clinical outcome. Gaining needle access can be challenging as 'flash back' is absent. The use of real-time, ultrasound-guided needle tracking can overcome this problem.

The basic principle of access declotting is the removal of clot to uncover and then performing angioplasty of the underlying culprit stenosis.

Pharmaco-mechanical thrombolytic methods utilise lytic agents along with mechanical thrombus disruption (balloon maceration). The lytic agents used are urokinase and r-tPA. The delivery of lytic agent into the clot is either by pull-back lacing pulse spray using specially designed multi-sidehole catheters or by lyse and wait technique.

Pure mechanical thrombectomy includes the use of devices such as Arrow-Trerotola and Angiojet, suction thrombectomy with curved catheters and large sheaths and rotating pigtail catheter.

Arterial plug removal at the anastomosis using the Fogarty embolectomy balloon is well described.

Large thrombosed pseudoaneurysms in the course of the access are problematic as clearing thrombus of varying ages may not be successful. An elegant and effective method is the endovascular control of inflow and outflow tracks, with a small surgical cut down over the thrombosed aneurysm with the physical extraction of clot.

A thorough knowledge of complications and bail-out strategies is essential to achieve procedural success.

Finally, a review of data both global and in-house with regards to technical success, duration of patency and factors affecting access survival will put these demanding procedures in perspective in salvage of these 'life lines'.

References

1. Schwab SJ. Hemodialysis access: the Achilles heel remains. Kidney Int. 2007 Sep;72(6):665-6.
2. Dheeraj K Rajan. Essentials of percutaneous dialysis interventions. Springer 2011.
3. Bush RL, Lin PH, Lumsden AB. Management of thrombosed dialysis access: thrombectomy versus thrombolysis. Semin Vasc Surg. 2004 Mar;17(1):32-9.
4. Turmel-Rodrigues L, Pengloan J, Bourquelot P. Interventional radiology in hemodialysis fistulae and grafts: a multidisciplinary approach. Cardiovasc Intervent Radiol. 2002 Jan-Feb;25(1):3-16.
5. Schmitz-Rode T, Wildberger JE, Hübner D, Wein B, Schürmann K, Günther RW. Recanalization of thrombosed dialysis access with use of a rotating mini-pigtail catheter: follow-up study. J Vasc Interv Radiol. 2000 Jun;11(6):721-7.
6. Schon D, Mishler R. Pharmacomechanical thrombolysis of natural vein fistulas: reduced dose of TPA and long-term follow-up. Semin Dial. 2003 May-Jun;16(3):272-5.
7. Trerotola SO, Vesely TM, Lund GB, Soulen MC, Ehrman KO, Cardella JF. Treatment of thrombosed hemodialysis access grafts: Arrow-Trerotola percutaneous thrombolytic device versus pulse-spray thrombolysis. Arrow-Trerotola Percutaneous Thrombolytic Device Clinical Trial. Radiology. 1998 Feb;206(2):403-14.
8. Vogel PM, Bansal V, Marshall MW. Thrombosed hemodialysis grafts: lyse and wait with tissue plasminogen activator or urokinase compared to mechanical thrombolysis with the Arrow-Trerotola Percutaneous Thrombolytic Device. J Vasc Interv Radiol. 2001 Oct;12(10):1157-65.
9. Rajan DK, Clark TW, Simons ME, Kachura JR, Sniderman K. Procedural success and patency after percutaneous treatment of thrombosed autogenous arteriovenous dialysis fistulas. J Vasc Interv Radiol. 2002 Dec;13(12):1211-8.

201.3

Treatment of central vein occlusions

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Learning Objectives
1. To learn how to identify and image central vein occlusion
2. To learn how to recanalise central vein occlusions
3. To learn how to treat central vein occlusions

Central vein stenosis/occlusion (CVO) is common in hemodialysis patients and frequently associated with previous central venous catheters (CVC) and cardiac pacemakers.

CVO can not only result in venous hypertension but also in access dysfunction; nevertheless, CVO is rarely responsible for the thrombosis of the venous access because of the development of a rich collateral circulation that redirects blood to the right auricle.

Doppler US gives valuable anatomic and hemodynamic information noninvasively. Small footprint probes are useful to image behind the sternum, clavicles, and ribs, but central innominate veins and the superior vena cava are particularly difficult to visualize directly. Doppler analysis of the accessible inlet thoracic veins gives indirect signs of more central CVO. Bilateral examination is the rule and helps to identify the location of CVO.

CT or MR venography allows the direct visualization of all central veins but are seldom indicated, owing to the deleterious effects of iodinated and gadolinium-based contrast agents in these patients and the need for venipuncture of the upper extremity veins for contrast injection.

Angiography can clarify doubtful cases, but it should be reserved for those that need intervention and not for purely diagnostic purposes. Owing to the poor results of angioplasty and the benign course of asymptomatic central vein stenosis, these veins should only be dilated in cases of clinically impaired facial/upper limb edema or when there is a reflux at venography to cerebral veins.

Stents/stent-grafts do not seem to be of any benefit over PTA in mid-/long-term, and they should be reserved for the control of venous rupture when prolonged balloon inflation fails and for significant residual stenosis due to dissection or elastic recoil. Self-expanding types are primarily used. It is important not to compromise future

access sites or surgical alternatives by the unselective use of stents.
Thrombosis can be recanalized by pharmacomechanical or purely mechanical techniques and by PTA of the culprit lesion after successful declotting. The best access is antegrade, transbrachial, and preferably via a basilic approach. When this fails, the femoral approach should be attempted, with through-and-through access sometimes being helpful. Sharp recanalization techniques can be tried when conventional methods of traversing the occlusion are exhausted.
Besides underlying stenosis, other less frequent causes of CVO have to be considered and dealt with, namely hypotension, dehydration, hypercoagulability, and mechanical compression.
Surgery is an option after multiple failed endovascular attempts.

201.4

Non-maturated dialysis access

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Learning Objectives
1. To learn about the angiographic characteristics of immaturity
2. To learn how to gain access and treat in- and outflow stenoses
3. To learn which interventions are appropriate

Failure of maturation of AVF is a growing problem, particularly in the US where the strong push to increase the prevalence of fistulae ("Fistula First") has led to a philosophy of placing fistulae in as many patients as possible, even in those who may be poorly suited to receive a fistula. A large, prospective randomized trial in 2008 showed maturation failure in 60% of fistulae in both arms of the study and served as a wake-up call regarding the magnitude of this problem. Fortunately, using standard IR techniques, primarily PTA, failure of maturation can be readily addressed with excellent outcomes.
Nonetheless, there remains a controversy regarding a number of aspects of IR-assisted AVF maturation, and this session will focus on the standard techniques as well as dispelling misconceptions regarding ineffective or superfluous treatments, such as side branch embolization and "BAM" or serial balloon-assisted maturation. The presentation will focus on the available evidence and will concentrate on the role of venous as well as arterial PTA for AVF maturation assistance. The outcomes of these techniques will be discussed, and the technical aspects of these procedures will be presented.

References

1. Trerotola, SO. Accessory Veins: The Crisis Upon Us. J Vasc Access 2013; 14:S38.
2. Debate: Con: Transcatheter Embolotherapy of Collaterals in Immature AVFs. J Vasc Access 2007; 8:138-39.
3. Trerotola, SO, Fiction: There's no proof that accessory veins cause immaturity. J Vasc Access 2010; 11:218-9.
4. Liang H, Fu J, Wang P, et al, Endovascular salvage of immature autogenous hemodialysis fistulas. Cardiovas Intervet Radiol 5. 2014; 37:671-8.
5. Beathard GA, Settle SM, Shields MW. Salvage of the nonfunctioning arteriovenous fistula. Am J Kidney Dis 1999; 33:910-6.
6. Faiyaz R, Abreo K, Zaman F, Pervez A, Zibari G, Work J. Salvage of poorly developed arteriovenous fistulae with percutaneous ligation of accessory veins. Am J Kidney Dis 2002; 39:824-7.
7. Beathard GA, Arnold P, Jackson J, Litchfield T. Aggressive treatment of early fistula failure. Kidney Int 2003; 64:1487-94.
8. Turmel-Rodrigues L, Mouton A, Birmele B, *et al.* Salvage of immature forearm fistulas for haemodialysis by interventional radiology. Nephrol Dial Transplant 2001; 16:2365-71.
9. Shin SW, Do YS, Choo SW, Lieu WC, Choo IW. Salvage of immature arteriovenous fistulas with percutaneous transluminal angioplasty. Cardiovasc Intervent Radiol 2005; 28:434-8.
10. Clark TW, Cohen RA, Kwak A, *et al.* Salvage of nonmaturing native fistulas by using angioplasty. Radiology 2007; 242:286-92.
11. Nasser G, Nguyen B, Rhee E, Achkar K. Endovascular treatment of the "failing to mature" arteriovenous fistula. Clin J Am Soc Nephrol 2006; 1:275-80.
12. Dember LM, Beck GJ, Allon M, Delmez JA, *et al.* Effect of clopidogrel on early failure of arteriovenous fistulas for hemodialysis: a randomized controlled trial. JAMA. 2008; 299(18):2164-71.
13. Turmel-Rodrigues L, Boutin JM, Camiade C, Brillet G, Fodil-Chérif M, Mouton A. Percutaneous dilation of the radial artery in nonmaturing autogenous radial-cephalic fistulas for haemodialysis. Nephrol Dial Transplant. 2009; 24(12):3782-8.
14. Ahmed O, Patel M, Ginsburg M, Jilani D, Funaki B. Effectiveness of collateral vein embolization for salvage of immature native arteriovenous fistulas. J Vasc Interv Radiol. 2014; 25(12):1890-4.
15. Lee T, Ullah A, Allon M, Succop P, El-Khatib M, Munda R, Roy-Chaudhury P. Decreased cumulative access survival in arteriovenous fistulas requiring interventions to promote maturation. Clin J Am Soc Nephrol. 2011; 6(3):575-81.

Special Session
Management of intermediate-advanced hepatocellular carcinoma

203.1

Patient selection and treatment algorithms

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Learning Objectives
1. To learn how to classify patients with intermediate-advanced HCC
2. To learn how to idenfy patients with locally advanced disease
3. To learn how to implement treatment algorithms in clinical practice

Transcatheter arterial chemoembolization (TACE) is the most widely used treatment for hepatocellular carcinoma (HCC) patients unsuitable for radical therapies. The data collected in the GIDEON, the largest global observational study completed in the field of HCC clinical management so far, suggests that nearly half of all HCC patients receive TACE at some point in the course of the disease. Randomized controlled trials (RCTs) and meta-analyses have shown that TACE improves survival with respect to best supportive care, extending the median survival from 16 to 19-20 months. As a result, TACE has been recommended as the standard of care for the treatment of unresectable, large, or multinodular noninvasive tumors isolated to the liver in patients with compensated cirrhosis. However, all RCTs comparing TACE and best supportive care were performed more than a decade ago. Distinct technical advances in the performance of TACE and improved patient selection and management have taken place since the completion of these studies. Several recent investigations have suggested that proper patient selection and optimized treatment techniques and protocols may be associated with longer median survival. An open issue in the management of TACE-treated patients is the assessment of tumor response and the criteria for treatment discontinuation. Several recent investigations conducted in the United States, Europe, and Asia have shown that the assessment of tumor response by modified response evaluation criteria in solid tumors (mRECIST) criteria predicts overall survival in HCC patients treated by TACE. It has been suggested that TACE should be discontinued in patients in whom an objective response in the treated tumor has not been achieved after two treatment cycles. In addition, TACE should be discontinued in patients showing clinical progression to ECOG performance status >2 or evolution to sustained hepatic decompensation. Various strategies to improve

outcomes for this patient group have become the subject of much ongoing clinical research. Embolic, drug-eluting beads for transarterial administration have been shown to reduce liver toxicity and systemic drug exposure compared to standard TACE and are currently used as alternative TACE regimens, especially in Europe and in the US. Radioembolization with Y90 is challenging the current paradigm of HCC treatment. Multiple centers around the world have provided compelling data suggesting a clinical role in patients with portal vein thrombosis as well as in downstaging to transplantation or conversion of surgically inoperable patients (due to small liver remnant) to potential cure with resection. The next few years will yield important information as results from the on-going phase III RCTs further define the role of the novel transarterial treatments in HCC clinical management.

203.2

Conventional vs. drug-eluting bead embolisation

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Learning Objectives

1. To learn about conventional and drug-eluting bead embolisation
2. To learn how to discuss the advantages and disadvantages of each embolisation technique
3. To learn how to use embolisation techniques in different clinical scenarios

TACE is the standard of care for Intermediate HCC, due to positive results of two randomized trial using conventional TACE (c-TACE) with either doxorubicin or cisplatin. TACE has level 1 evidence and grade 1 recommendation for treatment of intermediate stage HCC with a Child-Pugh score up to B7 [1].

Lipiodol is used during c-TACE, and is emulsified with chemotherapeutic drug because Lipiodol demonstrated some specific property such as selectivity for tumor, pharmacokinetic benefit, unique tagging capacity of tumor for potential future targeting, and some degree of embolization of the arterial feeders as well as peritumor portal venules. The type of the emulsion, including the size of the internal phase droplets, and direction of the emulsion impact highly on pharmacokinetic benefit and tumor selectivity [2-4]. For these reason, a water-in-oil emulsion must be preferred to a oil-in-water emulsion. Increasing the volume of Lipiodol relative to the volume of drug will help to obtain a water-in-oil (drug in Lipiodol) emulsion. Reproducibility of these emulsions remains questionable due to tailored preparation technique without standardization. Animal experiments have demonstrated a high pharmacokinetic benefit for stable water in oil emulsions. Small size internal phase droplets are more stable [4] and this can be improved by the use of a stabilizer. Embolic effect of Lipiodol is not enough, and it should be combined with particles embolization, which have been demonstrated to increase rate of main tumor and satellite nodules necrosis [5], as well as overall survival [6]. Gelfoam is most commonly used due to its resorbabilty allowing for subsequent treatment. Degradable starch microspheres have been reported for embolization during c-TACE with the benefit of rapid recanalization allowing for subsequent therapy.

Drug-eluting beads (DEB) have demonstrated reproducible loading and eluting capacity in vitro with doxorubicin and irinotecan, with some concerns about the quantity of drug remaining trapped in the beads [7], especially for doxorubicin. Prolonged drug release and high tumor exposure have been demonstrated in an animal model, for both doxorubicin and irinotecan [8, 9]. Lower systemic passage of drug than c-TACE has been demonstrated in clinical studies with a non-optimized Lipiodol drug mixture [10, 11]. DEB improve reproducibility of compounds injected for TACE. DEB are available in various size ranging from 75 to 700 microns, with a tendency for smaller bead being used in clinical practice, even if study looking at size range are controversial for safety and efficacy results [10, 12]. DEB have demonstrated to improve time to progression when compared to bland embolization in the treatment of HCC [13].

For HCC treatment, two randomized trail compared c-TACE with DEB-TACE with either tumor response at 6 months [14] or 2-year survival [15] as primary endpoints. No significant superiority of DEB-TACE has been demonstrated for response rate or overall survival. Post hoc analysis in one study demonstrated some benefit in response rate for more advanced disease and fragile patients, which was not found in the other study. Toxicity and especially rate of alopecia was significantly lower for DEB-TACE in one study, while in the other study, post-TACE pain was more frequent and severe after c-TACE; but pain did not affect the length of hospital stay and patient acceptance of additional TACEs. It is noteworthy that these randomized studies do not use optimized Lipiodol/drug emulsion for the direction of the emulsion.

While rates of post-procedure pain and alopecia were reported to be lower with DEB-TACE than with c-TACE, image finding of liver-biliary necrosis have been reported to be significantly higher with DEB-TACE vs c-TACE [16]; this is probably explained by aggressive embolization linked with high drug concentration in some healthy liver close to the peri-biliary plexus. This liver biliary necrosis is more frequent in NET patients treated with DEB-TACE, and induced liver abscesses were responsible for discontinuation of a prospective study at interim analysis [17].

Future hopes are placed in standardization and stabilization of emulsion used for Lipiodol TACE; resorbable drug eluting microspheres may palliate incomplete drug release and permanent embolization; and use of more active compounds against HCC, including sorafenib [18] or sunitinib [19], are possible future developments.

While waiting for these new developments, when looking worldwide at the use of TACE, it appears that c-TACE is used in 74% of patients who will receive sorafenib at a later stage of the disease, while DEB-TACE is used in 16% [20].

References

1. Llovet J, Ducreux M, Lencioni R, *et al.* EASL-EORTC clinical practice guidelines: management of hepatocellular carcinoma. Eur J Cancer 2012; 48:599-641.
2. de Baere T, Dufaux J, Roche A, *et al.* Circulatory alterations induced by intra-arterial injection of iodized oil and emulsions of iodized oil and Doxorubicin : Experimental study. Radiology 1995; 194:165-70.
3. Raoul JL, Heresbach D, Bretagne JF, *et al.* Chemoembolization of hepatocellular carcinomas. A study of the biodistribution and pharmacokinetics of doxorubicin. Cancer 1992; 70:585-90.
4. Choi JW, Cho HJ, Park JH, *et al.* Comparison of drug release and pharmacokinetics after transarterial chemoembolization using diverse lipiodol emulsions and drug-eluting beads. PLoS One 2014; 9:e115898.
5. Takayasu K, Shima Y, Muramatsu Y, *et al.* Hepatocellular carcinoma : Treatment with intra arterial iodized oil with and without chemotherapeutic agents. Radiology 1987; 162:345-51.
6. Takayasu K, Arii S, Ikai I, *et al.* Overall survival after transarterial lipiodol infusion chemotherapy with or without embolization for unresectable hepatocellular carcinoma: propensity score analysis. AJR Am J Roentgenol 2010; 194:830-7.
7. Jordan O, Denys A, De Baere T, Boulens N, Doelker E. Comparative study of chemoembolization loadable beads: in vitro drug release and physical properties of DC bead and hepasphere loaded with doxorubicin and irinotecan. J Vasc Interv Radiol 2010; 21:1084-90.
8. Hong K, Khwaja A, Liapi E, Torbenson MS, Georgiades CS, Geschwind JF. New intra-arterial drug delivery system for the treatment of liver cancer: preclinical assessment in a rabbit model of liver cancer. Clin Cancer Res 2006; 12:2563-7.

9. Rao PP, Pascale F, Seck A, *et al.* Irinotecan loaded in eluting beads: preclinical assessment in a rabbit VX2 liver tumor model. Cardiovasc Intervent Radiol 2012; 35:1448-59.
10. Malagari K, Pomoni M, Moschouris H, *et al.* Chemoembolization of hepatocellular carcinoma with HepaSphere 30-60 mum. Safety and efficacy study. Cardiovasc Intervent Radiol 2014; 37:165-75.
11. Varela M, Real MI, Burrel M, *et al.* Chemoembolization of hepatocellular carcinoma with drug eluting beads: efficacy and doxorubicin pharmacokinetics. J Hepatol 2007; 46:474-81.
12. Deipolyi AR, Oklu R, Al-Ansari S, Zhu AX, Goyal L, Ganguli S. Safety and Efficacy of 70-150 mum and 100-300 mum Drug-Eluting Bead Transarterial Chemoembolization for Hepatocellular Carcinoma. J Vasc Interv Radiol 2015; 26:516-22.
13. Malagari K, Pomoni M, Kelekis A, *et al.* Prospective randomized comparison of chemoembolization with doxorubicin-eluting beads and bland embolization with BeadBlock for hepatocellular carcinoma. Cardiovasc Intervent Radiol 2010; 33:541-51.
14. Lammer J, Malagari K, Vogl T, *et al.* Prospective randomized study of doxorubicin-eluting-bead embolization in the treatment of hepatocellular carcinoma: results of the PRECISION V study. Cardiovasc Intervent Radiol 2010; 33:41-52.
15. Golfieri R, Giampalma E, Renzulli M, *et al.* Randomised controlled trial of doxorubicin-eluting beads vs conventional chemoembolisation for hepatocellular carcinoma. Br J Cancer 2014; 111:255-64.
16. Guiu B, Deschamps F, Aho S, *et al.* Liver/biliary injuries following chemoembolisation of endocrine tumours and hepatocellular carcinoma: lipiodol vs. drug-eluting beads. J Hepatol 2012; 56:609-17.
17. Bhagat N, Reyes DK, Lin M, *et al.* Phase II study of chemoembolization with drug-eluting beads in patients with hepatic neuroendocrine metastases: high incidence of biliary injury. Cardiovasc Intervent Radiol 2013; 36:449-59.
18. Chatziioannou AN, Siskos AP, Loxas D, *et al.* Transarterial embolization with sorafenib in animal livers: a pharmacokinetics study. J Vasc Interv Radiol 2013; 24:1657-63 e1.
19. Fuchs K, Bize PE, Denys A, Borchard G, Jordan O. Sunitinib-eluting beads for chemoembolization: Methods for in vitro evaluation of drug release. Int J Pharm 2015; 482:68-74.
20. Lencioni R, Kudo M, Ye SL, *et al.* GIDEON (Global Investigation of therapeutic DEcisions in hepatocellular carcinoma and Of its treatment with sorafeNib): second interim analysis. Int J Clin Pract 2014; 68:609-17.

203.3

Radioembolisation (TARE)

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Learning Objectives

1. To learn about the different techniques for radioembolisation
2. To learn how to discuss the advantages and disadvantages of radioembolisation
3. To learn how to use radioembolisation in different clinical scenarios

No abstract available.

203.4

Combined therapies in HCC: the evidence

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Learning Objectives

1. To learn about different combination therapies used in patients with HCC
2. To learn how to discuss the advantages and disadvantages of each combination therapy
3. To learn how to use combination therapies in different clinical scenarios

Until recently, there was no standard systemic therapy for unresectable hepatocellular carcinoma (HCC). The introduction of anti-angiogenic therapy, such as the multikinase inhibitor sorafenib, has changed the management algorithm of patients with advanced disease. As antiangiogenic drugs are generally cytostatic rather than cytotoxic, combinations involving conventional cytotoxic chemotherapies with anti-angiogenic drugs may be useful for maximizing therapeutic efficacy. Moreover, given that HCC presents as hypervascular tumor(s), combining therapies that inhibit angiogenesis on a molecular and mechanistic level seems particularly attractive. Finally, given the fact that TACE directly causes angiogenesis through activation of the hypoxia-mediated pathway (hypoxic changes in the tumor directly up-regulate angiogenesis via VEGF), thereby potentially limiting its efficacy, it was logical to combine TACE with agents that directly counteract this angiogenic activity.

One of the most critical and specific factors for blood vessel formation is vascular endothelial growth factor (VEGF). VEGF is an endothelial cell mitogen that regulates proliferation, permeability, and survival of endothelial cells through inhibition of apoptosis. HCC is one of the most vascular solid cancers, associated with a high propensity for vascular invasion and a high expression of VEGF. Upregulation of VEGF has been correlated with increased tumor invasion, intratumoral microvessel density, disease recurrence, and poor prognosis. Bevacizumab is a humanized monoclonal antibody that, through its binding to VEGF, prevents the interaction of VEGF with its receptors on the surface of endothelial cells. When unblocked, this interaction may lead to endothelial cell proliferation and new blood vessel formation. VEGF expression is known to play an important role in the development of HCC, and the degree of its expression is reported to be associated with tumor size and histologic grade. Several studies have explored the potential therapeutic role for bevacizumab in patients with HCC. The results of the first US phase II study combining anti-angiogenic therapy with TACE were recently presented. Tumor response and safety of concurrent bevacizumab and TACE were evaluated in 26 patients with unresectable HCC (ECOG status 0-2, Child-Pugh stage A-B, BCLC B-C). These patients received bevacizumab 10 mg/kg every 2 weeks, in addition to TACE, in a 6-week cycle (on average, 1-3 cycles). Primary endpoint was tumor response, assessed by MR imaging at baseline, and 3 weeks post-TACE, using size (RECIST) and contrast enhancement (EASL). Secondary endpoints included safety and survival. On follow-up imaging, index lesions had a mean decrease in size of 13% ($p < 0.0005$). Using RECIST, eight (35%) achieved partial response and fifteen (65%) had stable disease. Targeted tumors demonstrated mean decrease in contrast enhancement of 69% ($p < 0.0005$). By EASL criteria, fourteen (60%) patients had complete or partial response, and nine (39%) had stable disease. The disease control rate was 100% using either criteria while undergoing treatment. Median overall survival was 13.5 months, with 10 patients still alive. Fifteen (58%) patients experienced grade 3/4 toxicities possibly related to either therapy with most toxicities resolving within 2 months of therapy. Overall, the combination therapy of bevacizumab and TACE was reasonably well tolerated in unresectable HCC patients, with 100% disease control rate by imaging criteria and median overall survival of 13.5 months.

Sorafenib, a small-molecule tyrosine kinase inhibitor with strong anti-angiogenic properties, was approved by the FDA in 2008 for the treatment of HCC. Since then, there have been a number of clinical trials combining sorafenib with TACE. Our study published in JCO 2011 showed that the combination of sorafenib and DEB-TACE did not lead to an increase in toxicities and was generally well tolerated. This was true for both BCLC B and C patients. These results have been supported by the GIDEON study, a phase IV study designed to provide a snapshot of the usage of sorafenib in clinical medicine. The SPACE trial, a randomized phase II study of DEB-TACE with or without sorafenib that was recently presented, also confirmed the safety of the combination therapy and indicated that the combination arm was superior to DEB-TACE alone (HR =0.85). Other studies to date including the COTSUN and START trials have confirmed the safety of combining TACE and sorafenib but have not shown any survival benefit. However, emerging trends in published data have also indicated a possible benefit in patients with BCLC C with PVT. This was also an observation we made during the final analysis of our study that combined DEB-TACE and sorafenib. Patients with more advanced HCC and who are able to tolerate sorafenib for at least 6 months without significant side effects appear to benefit most for the combined approach. Hopefully, more trials will be designed that address this very issue.

The rationale for combining anti-angiogenic drugs with TACE is abundantly clear and could become common clinical practice. The safety profile of the combined approach has now been established for all methods: interrupted, sequential, and continuous. Although the data has so far been promising in some limited subsets of patients with HCC, a clear survival benefit has not yet been demonstrated.

Special Session
In-depth diagnostic and treatment concepts in acute stroke

204.1

Where do we stand with ''one-stop shop'' flat-panel angio-stroke imaging?

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Learning Objectives

1. To understand the ''one-stop shop'' concept
2. To learn about the technical background
3. To understand the impact of this concept to acute stroke treatment

Cone-beam CT angiography (Dyna-CT) enables sectional images of the brain based on image post-processing of multiple views of angiograms acquired during contrast media injection. When compared with multislice CT, image quality reduced concerning the soft tissue contrast. However, Dyna-CT might be able to differentiate the presence or absence of intracranial hemorrhage and could sufficiently detect relevant perfusion deficiencies in diagnosis of stroke. Data that have been published very recently demonstrated a dramatic improvement of the outcome of stroke patients with thrombosis of carotid artery or the proximal segment of the ACM if thrombectomy was performed.

While time to intervention is the most important factor that influences outcome after stroke, concepts that might enable a significant reduction of this factor should be carefully tested because of the immense benefit for stroke patients concerning life quality and costs. The scenario "one-stop-shot diagnosis and therapy of stroke patients" includes an immediate transportation of stroke patients into the angiography suite when a stroke is clinically suspected. Despite the fact that most of the patients will not be suitable for thrombectomy, reduction of door-to-needle time for those patients who will be treated should be the most important benefit of this procedure.

References

1. Patel AP, Gandhi D, Taylor RJ, Woodworth G. Use of Dyna CT in Evaluation and Treatment of Pseudoaneurysm Secondary to Craniofacial Tumor Resection: Case Report and Diagnostic Implications. Surg Neurol Int. 2014.
2. Ganguly A1, Fieselmann A, Boese J et al.: In vitro evaluation of the imaging accuracy of C-arm conebeam CT in cerebral perfusion imaging. Med Phys. 2012 Nov;39(11):6652-9.
3. van den Berg LA, Koelman DL, Berkhemer OA et al.: Type of Anesthesia and Differences in Clinical Outcome After Intra-Arterial Treatment for Ischemic Stroke. Stroke. 2015 Apr 7.
4. Borst J, Marquering HA, Beenen LFM et al.: Effect of Extended CT Perfusion Acquisition Time on Ischemic Core and Penumbra Volume Estimation in Patients with Acute Ischemic Stroke due to a Large Vessel Occlusion. PLoS ONE 2015; 10(3) e0119409.
5. Jovin TG, Chamorro A, Cobo E et al.: Thrombectomy within 8 Hours after Symptom Onset in Ischemic Stroke. N Engl J Med. 2015 Apr 17.
6. Berkhemer OA, Fransen PS, Beumer D et al.: A Randomized Trial of Intraarterial Treatment for Acute Ischemic Stroke. N Engl J Med. 2015 Jan 1;372(1):11-20.

204.2

Role of imaging in patient selection for IV or IA treatment: importance of imaging parameters

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Learning Objectives

1. To learn important imaging parameters
2. To learn about the impact of imaging parameters for patient selection
3. To understand patient selection in connection with imaging findings

After three neutral trials with respect to endovascular treatment of acute ischemic stroke (1-3), the MR CLEAN trial was the first prospective randomized trial showing a clear benefit of endovascular treatment over intravenous lysis alone (4). The results of this study were confirmed by the results of EXTEND-IA and ESCAPE trials, both of which are stopped early because of the statistically proven efficacy of the endovascular treatment (5,6).

Good clinical outcome after 3 months (i.e., mRS: 0–2) was achieved in 32.6% (MR CLEAN), 71% (EXTEND-IA), and 53% (ESCAPE) trial. Thus, a significant proportion of patients are still not benefited from the IA procedure depending on the study design and patient selection. In addition to the patient's history and clinical status, neurovascular imaging is one of the essential tools for proper patient selection.

It is well established that patients eligible for endovascular treatment should have a proximal occlusion of a major brain-supplying artery (internal carotid artery, proximal M1 segment, and basilar artery). An infarct involving more than one-third of the MCA territory in the anterior circulation is generally accepted as an exclusion criterion for endovascular as well as IV treatment. Consequently, patients who do not show an occlusion of the large vessel without a large infarct presenting within an appropriate time window (typically less than 4.5 hours after symptom onset) would be candidates for IV treatment alone if intracranial bleeding has been ruled out. In contrast, patients with a proven large vessel occlusion are eligible for endovascular treatment within a time window of 6 hours or even more depending on the individual situation as long as the infarct is still limited. However, in addition to these criteria, it is desirable to know how much salvageable brain is present before the procedure is started.

Ideally, patient selection for intra-arterial treatment should be based on this information, which would help to avoid futile recanalization procedures that might be risky for the patients.

Currently, techniques used for neurovascular imaging comprise non-enhanced computed tomography (NE-CT), CT-angiography (CTA), magnetic resonance imaging (MRI) including MR-angiography (MRA), and multimodal imaging such as CT perfusion and MR perfusion.

Both MRI and NE-CT are safe and robust for the exclusion of intracerebral hemorrhage (7). Similarly, MRA and CTA both are reliable and robust methods in the evaluation of the major brain-supplying arteries, although some authors showed some advantages of CTA over MRA (8).

According to the current evidence, the indication for endovascular treatment of acute ischemic stroke can be established on the results of NE-CT or MRI (exclusion of intracranial hemorrhage or exclusion of a large infarct) and CTA or MRA (confirmation of a large vessel occlusion) in conjunction with the history (time window) and clinical situation (NIH-score, stroke severity). However, the estimation of the potentially salvageable brain is only possible with multimodal imaging and/or a detailed interpretation of source images from CTA (9).

The basic principle of multimodal imaging is the definition of the infarct core (non-salvageable brain) and the penumbra (salvageable brain). The most reliable method to image an acute infarct core is MRI with diffusion-weighted imaging (DWI) (10). In the early stage of stroke evolution, DWI shows the areas of cytotoxic edema, which is consistent with the infarct core. Several authors suggest that patients who have a core infarct volume of 60–100 ml measured on DWI images are not likely to benefit from intra-arterial treatment. This volume approximately represents one-third of the middle cerebral artery. NE-CT also shows the infarct core if the vasogenic edema has caused enough hypodensity to be detected on NE-CT. However, this usually occurs 5–6 hours after stroke onset.

The core of the infarct is surrounded by the so-called penumbra, a region of reduced brain perfusion. In this area, the brain has an impaired function but is still alive and therefore potentially salvageable. Both MR perfusion and CT perfusion are capable of displaying this area of hypoperfusion. The difference of the infarct core and the penumbra theoretically corresponds to the salvageable brain (mismatch concept). Although this concept seems to be logical, there is no common agreement on the definition of the penumbra based on different perfusion parameters. MTT (mean transit time), TTP (time to peak), and Tmax (time to maximum contrast arrival) may be used as single parameters or in combination. Furthermore, no overall accepted threshold has been defined; to make things even more complex, due to the pathophysiological evolution of an acute ischemic infarct, pure perfusion imaging (i.e., CT perfusion) cannot display the infarct core. Although it has been described that areas of critically reduced CBV (cerebral blood volume) and/or CBF (cerebral blood flow) may correspond to the infarct core, this is not reliable (11). It has been shown that differences in the acquisition technique and also in the applied software can lead to a different display of the infarct core (12).

However, in the EXTEND-IA trial, patient selection for IA treatment was based on CT perfusion. Definition of the infarct core was defined by CBF (less than 30%), and definition of penumbra was based on Tmax (more than 6 seconds delay). Interestingly, this manner of patient selection resulted in good clinical outcome of 71% after 3 months, compared to only 32% and 54% in the two other recently published positive trials (MR CLEAN and ESCAPE).

In conclusion, according to the current evidence, patient selection for intravenous and/or intra-arterial stroke treatment is based on patient's history and clinical situation as well as on three main imaging parameters that are as follows:

- Exclusion of hemorrhage
- Exclusion of a large infarct core (i.e., more than one-third, if the MCA territory is approximately equivalent to a volume of 60–100 ml of brain tissue)
- Confirmation (or exclusion) of a proximal occlusion of a major brain-supplying artery

Multimodal imaging is used with increased frequency and promising results. However, there is no clear evidence at present that therapeutic decision making can be based on these sophisticated imaging tools. Nevertheless, it can be expected that more evidence regarding the applicability of these techniques will be available in the near future.

References

1. Ciccone A, Valvassori L, Nichelatti M, et al; SYNTHESIS Expansion Investigators. Endovascular treatment for acute ischemic stroke. N Engl J Med. 2013;368:904-13.
2. Broderick JP, Palesch YY, Demchuk AM, et al; Interventional Management of Stroke (IMS) III Investigators. Endovascular therapy after intravenous t-PA versus t-PA alone for stroke.N Engl J Med. 2013;368:893-903.
3. Kidwell CS, Jahan R, Gornbein J, et al; MR RESCUE Investigators. A trial of imaging selection and endovascular treatment for ischemic stroke. N Engl J Med. 2013;368:914-23.
4. Berkhemer OA, Fransen PS, Beumer D, et al; MR CLEAN Investigators. A randomized trial of intraarterial treatment for acute ischemic stroke. N Engl J Med. 2015;372:11-20.
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. Goyal M, Demchuk AM, Menon BK, et al. Randomized assessment of rapid endovascular treatment of ischemic stroke. N EnglJ Med. 2015;372:1019-30.
7. Kidwell CS, Chalela JA, Saver JL, et al. Comparison of MRI and CT for detection of acute intracerebral hemorrhage. JAMA. 2004;292:1823-30.
8. Bash S, Villablanca JP, Jahan R, et al. Intracranial vascular stenosis and occlusive disease: evaluation with CT angiography, MR angiography, and digital subtraction angiography. AJNR Am J Neuroradiol. 2005;26:1012-21.
9. Menon BK, d'Esterre CD, Qazi EM, et al. Multiphase CT angiography: a new tool for the imaging triage of patients with acute ischemic stroke. Radiology. 2015;29 pub ahead of print.
10. Fiebach JB, Schellinger PD, Jansen O, *et al.* CT and diffusion-weighted MR imaging in randomized order: diffusion-weighted imaging results in higher accuracy and lower interrater variability in the diagnosis of hyperacute ischemic stroke. Stroke. 2002;33:2206-10.
11. Schaefer PW, Souza L, Kamalian S, *et al.* Limited reliability of computed tomographic perfusion acute infarct volume measurements compared with diffusion-weighted imaging in anterior circulation stroke. Stroke. 2015;46:419-24.
12. Borst J, Marquering HA, Beenen LF, et al; MR CLEAN investigators.Effect of extended CT perfusion acquisition time on ischemic core and penumbra volume estimation in patients with acute ischemic stroke due to a large vessel occlusion. PLoS One. 2015;10:e0119409.

204.3

Direct recanalisation with or without stent retrievers

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Learning Objectives
1. To understand the technical differences of clot retrieval with and without stent retrievers
2. To learn about direct thromboaspiration without a stent retriever
3. To learn about clot removal with stent retrievers

No abstract available.

204.4

Current status of IA acute stroke treatment in light of the MR CLEAN trial: the neurologist's view

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Learning Objectives
1. To learn about the results of the MR CLEAN trial
2. To understand the importance of these results compared to previous trials
3. To learn about the impact of this trial on stroke practice

No abstract available.

Special Session
Evidence Forum: Peripheral angioplasty

205.1

Should balloon angioplasty be the first-line treatment for aorto-iliac occlusive disease?

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Learning Objectives
1. Know the different technologies available
2. Learn about the role of these for treatment of stenosis and occlusive disease
3. To learn about the anatomical considerations

Know the different technologies available

Aorto-iliac occlusive disease (AIOD) is common and can present anywhere from the distal aorta to the common femoral arteries. One of the main contributing factors for AIOD is age, leading to an anticipated increase in prevalence with increase of average age of the population. The aorto-iliac region is affected in about one third of patients with peripheral artery disease, and morphology varies from localized stenosis to complete aorto-iliac occlusion (Leriche syndrome). Due to a strong correlation between AIOD and coronary artery disease (CAD), all patients with AIOD should be assessed for CAD and vice versa. AIOD causes a spectrum of symptoms from intermittent claudication to critical limp ischemia. Symptomatic AIOD requires treatment, but asymptomatic patients might also be treated in order to facilitate access for other endovascular procedures like transcatheter aortic valve repair (TAVR) or before renal transplant implantation. Lifestyle changes and risk factor modification, mainly consisting of smoking cessation, blood pressure control, and statin therapy, should be part of the disease management for all patients with AIOD. The role of exercise therapy for mild claudication is controversial due to limited collateral growth potential in this territory. Invasive treatment options include percutaneous transluminal angioplasty (PTA) with or without stent placement or surgical therapy with anatomical or extra-anatomical bypass grafting. Endarterectomy is performed mainly in combination with bypass surgery or in hybrid procedures.

Learn about the role of these for treatment of stenosis and occlusive disease

The primary goal in the treatment of AIOD is to relieve symptoms and to improve patient's quality of life and functional status. Surgical therapy is effective in achieving these goals with high long-term patency rates. However, open surgery has significant perioperative mortality and morbidity due to wound and graft infection, hernia, and other complications. Endovascular therapy offers adequate hemodynamic results and at the same time lower morbidity and mortality, shorter hospital stays, and lower expected costs than does open surgery. Ongoing development in devices and increased experience with endografts in aortic repair have made angioplasty and stenting the treatment of choice for more and more challenging AIOD pathology, unless open revascularization is required for other reasons. In experienced hands, endovascular treatment for Trans-Atlantic Inter-Society Consensus (TASC) C and D lesions is safe and effective with low complication and high technical success rates.

Restenosis or occlusion after endovascular treatment is the main problem. It is caused by residual plaque, constrictive remodeling, or intimal hyperplasia. Primary patency further depends on the status of the run-off vessels, which have to be kept in mind when comparing patency rates, especially in small studies. Recurrent AIOD can almost always be managed effectively with a percutaneous approach achieving secondary patency rates and limp salvage rates of endovascular therapy comparable to surgical therapy. However, optimal primary clinical results at lowest costs are desired. In a review of angioplasty for focal AIOD, mean technical success rate of 95% and 5-year patency of 80-90% are reported. The only randomized controlled trial comparing angioplasty to surgical therapy shows no difference in 3-year patency between both groups. Direct and late success of angioplasty, however, is limited by recoil stenosis and late re-stenosis. Little disagreement exists about stenting as a secondary procedure after failed angioplasty with residual systolic pressure gradient > 10 mmHg or residual stenosis > 30% or in order to treat flow-limiting dissections and ulcerative plaques. Predilatation may be performed in order to facilitate stent placement.

One area of continuous debate is the role of direct (primary) versus selective (after failure of PTA) stenting. Advocates for direct stenting maintain that there is less intimal hyperplasia after stenting. In irregular and calcified lesions, direct hemodynamic results may be better with stenting due to smoothing of the surface and leaving fewer irregularities and less dissection flaps. Especially after recanalization of occlusions, direct stenting potentially causes decreased risk for peripheral embolization as the thrombus and plaque are trapped between the mesh of the stent and the arterial wall. The Dutch iliac trial provides a randomized comparison of direct stent placement compared to primary angioplasty followed by selective stent placement in case of a residual gradient > 10 mmHg after PTA. In this study, 279 patients with mainly short iliac stenosis and few occlusions were included, and those with complex lesions were excluded. No significant differences in technical success, short-term and 5-year patency, and quality of life were found between groups. By applying the selective stenting strategy, stent placement was avoided in 60% of the cases. The STAG trial compared primary stenting with angioplasty in iliac artery occlusions shorter than 8 cm in length; 112 patients were randomly assigned to each group, and technical success of the procedures, distal embolization complications, and patency were assessed. No differences in primary and secondary patency after 1 and 2 years were observed, but initial technical success rates were significantly higher and embolization complications

lower in the direct stenting group. Direct stenting for aorto-iliac lesions has become common practice and is advocated by many studies. Reported technical success and clinical success are excellent, but late failure due to in-stent restenosis do occur, which often requires more advanced devices in re-treatment. In a retrospective review of 151 patients with AIOD who underwent either direct stenting or PTA with selective stenting, the authors found 100% clinical success rates for TASC A and B lesions in both groups. Short- and long-term patency were significantly higher for the direct stenting group in TASC C and D lesions, and overall perioperative complication rate was lower for direct stenting than for angioplasty and selective stenting (3% versus 24%). Currently, level 1b evidence data support that in AIOC, angioplasty can be an acceptable first-line treatment for focal, concentric, non-calcified, non-ostial stenosis. Aorto-iliac occlusions and complex lesions can be treated safely with primary stenting.

To learn about the anatomical considerations

In patients with concurrent stenosis of the common femoral artery, a hybrid procedure of iliac artery angioplasty with or without stent placement in combination with endarterectomy (with or without profundoplasty) is appropriate. Current evidence for device choice and procedure planning for specific AIOD pathology (e.g., in-stent restenosis), anatomical location (e.g., complete aorto-iliac occlusion), and AIOD morphology (e.g., common iliac artery versus external iliac artery) will be discussed during the session.

205.2

Should balloon angioplasty be the first-line treatment for femoropopliteal disease?

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Learning Objectives

1. Know the different technologies available
2. Learn about the role of these for treatment of stenosis and occlusive disease
3. To learn about the anatomical considerations

With respect to our patients we diagnose and treat during daily work, this question does not allow a clear "YES" or "NO" answer. The adequate manner to answer might be "YES, BUT...."

An attempt to clarify this "YES, BUT..." will be made during the evidence forum lecture. Please find below some strategies of interpreting what "YES, BUT..." means.

An interventional procedure consists of four elementary interventional treatment steps followed by an adequate follow-up of the patient: 1. lesion access, 2. lesion crossing, 3. lesion treatment, and 4. vascular closure. Once a lesion, either a stenosis or an occlusion, is crossed successfully with a guide wire, different endovascular treatment algorithms are possible like PTA, BMS, DEB, and DES, as well as others like laser and atherectomy. For the moment, it is appropriate to start treatment of an old lesion with PTA or plain old balloon angioplasty (POBA), regardless of the lesion length. Just PTA means look and see what happens to the index lesion. Just PTA means to choose a balloon size appropriate in terms of diameter and length to cover the lesion on an intention-to-treat basis. The time of balloon inflation and the applied inflation pressure will influence the immediate outcome during a first angiographic control (1). Often, one wonders about the result. It will have different faces; one might look like an undiseased vessel without any signs of remaining stenosis, recoil, and dissection. It is still appropriate to stay with this result, advising the patient for the right medication and follow-up care. To stay with PTA as the first-line and single-line treatment seems justified. A recent Cochrane analysis demonstrated that there was a short-term gain in primary patency and no sustained benefit from primary stenting of lesions of the superficial femoral artery in addition to angioplasty (2). If one wants to go ahead with a DCB, a BMS, or a DCS, PTA still remains the first-line treatment. At the moment, valuable study data indicate that we do not harm the patient with an additional implant made of Nitinol or additional drug like paclitaxel. Data indicate enhanced primary patency rates and reduces TLR rates under ideal and selected trial conditions. In real world conditions, meaning during daily practice, the difference in terms of reported outcome might be lower. PTA is still the first-line treatment, and it might be enriched by an additional DCB as indicated in promising trial data (3). An implant like BS or DES should limited to PTA failure.

References

1. Zorger N et al. J Vasc Interv Radiol. 2002;13(4):355-9.
2. Choowdhury MM et al. Angioplasty Versus Bare Metal Stenting for Superficial Femoral Artery Lesions. Cochrane Database Syst Rev. 2014;24:6.
3. Tepe G, et al. 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;131(5):495-502.

205.3

Should balloon angioplasty be the first-line treatment for infrapopliteal disease?

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Learning Objectives

1. Know the different technologies available
2. Learn about the role of these for treatment of stenosis and occlusive disease
3. To learn about the anatomical considerations

Multiple trials have investigated endovascular treatment options in infrapopliteal lesions and stents vs. PTA, which has always been the classic question in studies. However, regarding infrapopliteal lesions, some special criteria have to be considered for discussion.

As a general rule, particularly for infrapopliteal lesions, efficient treatment is based on the biological behavior of the underlying disease and on the appropriateness of methods and techniques.

Biological background:

For infrapopliteal lesions, the biological background of infrapopliteal lesions is crucial. Particularly patients with diabetes mellitus, who are frequently associated with small vessel disease below the knee present with long diffuse arteriosclerotic disease. Highly calcified and rigid stenosis as well as long occlusion exist, and more than 80% of lesions are more than 10 cm in length.

Endovascular options:

Regarding endovascular options, the treatment of infrapopliteal lesions has been started with plain old balloon angioplasty (POBA) approximately two decades ago, with the use of low-profile balloons that came from coronary interventions. Treatment options were later enlarged by the use of stents, which showed to have some advances in short, rigid stenosis. Drug-coated stents even overcame these results in some special indications. In the PTA section, further improvement was achieved by the development of long, flexible balloons. Latest radical improvements and innovations were added by the development of drug-eluting balloons (DEBs), which in the meantime were successfully used in infrapopliteal lesions.

The basic idea for the use of DEBs is to improve the outcome of PTA by using paclitaxel as an antiproliferative agent to reduce restenosis and to avoid the negative influence of the remaining stent material, similar to the use in drug-eluting stents (DES).

Until now, several studies have shown the successful use of DEBs in BTK lesions, particularly the statistically demonstrated superiority of DEB over plain balloon angioplasty for restenosis and target lesion

revascularization. Moreover, in several current investigations, study questions and endpoints changed from the evaluation of numeric results such as restenosis and freedom of reintervention to clinical aspects such as improvement of clinical results or freedom from amputation.

Technical considerations and development of PTA techniques:

Dedicated devices for PTA for infrapopliteal use in longer lesions have been developed. Low-profile balloons with a length of up to 20 cm contribute substantially to the successful treatment of long BTK lesions. Currently, dedicated guidewires for long chronic total occlusions (CTO wires) have been developed, and they can successfully be used in infrapopliteal arteries. CTO wires start at a diameter of 0.014 inch and have a range of tip loads from 3 to 25 g. These wires are designed to cross lesions within the lumen. Basically, although a true lumen approach will mostly be considered as the first-line technique for longer lesions, it is acceptable if not beneficial to carry out angioplasty for longer segments from the subintimal tract using a hydrophilic guidewire.

By using micropunctures of pedal arteries, infrapopliteal arteries can be achieved in the retrograde technique, and/or an antegrade-retrograde access can be created resulting in pedal plantar loop techniques or subintimal flossing, which was first described as the SAFARI technique. Pedal plantar loop techniques can create a guidewire loop from the anterior tibial artery to the posterior tibial artery through the pedal arch. Such techniques facilitate the recanalization of long segments of infrapopliteal pedal and plantar arteries.

Studies:

Multiple studies have been conformed with the goal to evaluate individual results of POBA, DEBs, bare stents, and DES in infrapopliteal lesions and to compare results. (1-7)

Recent publications presented results from the meta-analysis of DEBs and DES placement where DEB angioplasty and DES demonstrated superior outcomes compared with PTA and BMS, with no difference in amputation or mortality. (1)

When comparing PCB vs. DES in long infrapopliteal lesions, a recently published prospective randomized controlled trial demonstrated that DES were related with significantly lower residual immediate postprocedure stenosis, and they have shown significantly reduced vessel restenosis at 6 months. However, PCB might produce positive vessel remodeling. (4) Other studies underline the meaning of DEB in infrapopliteal lesions. For the DEBATE study, DEBs compared with PTA strikingly reduced 1-year restenosis, target lesion revascularization, and target vessel occlusion in the treatment of below-the-knee lesions in diabetic patients with critical limb ischemia (CLI). (8) Other authors considered DEB as the leading approach in below-the-knee disease. (6)

General considerations:

Due to the background and nature of BTK lesions, it is essential to treat this special kind of lesions with dedicated tools and concepts as simply and effectively as possible.

Starting with the biological background of BTK lesions, PTA is most effective, and it easily and quickly treats long lesions.

This biological background of infrapopliteal arterial disease might have influenced an obvious change in paradigms in the treatment of long infrapopliteal lesions. Consequently, the revised TASC-II guidelines stated an "increasing evidence to support a recommendation for angioplasty in patients with CLI and infrapopliteal artery occlusion;'' lesion length is no longer used to determine a recommendation for treatment.

As a further and an effective development in PTA, drug-coated balloons have recently been started to be used, and they are a strong and new tool for treating long segmental lesions and have shown very promising results.

However, with regard to stents, treatment options seem to cover more focal and short segments or bail-out procedures.

The use of stents in BTK lesions have proved to be sufficient for bail-out strategies; however, they have not been used in long tibial arterial disease systematically.

Conclusion:

Regarding angioplasty of infrapopliteal lesions, excellent clinical results can be achieved with the proper use of dedicated techniques and devices. With the current development based on the biological background of lesions and under the premise of fast, effective treatments, PTA as the first-line approach even more proves to be the right tool.

References

1. Baerlocher MO, Kennedy SA, Rajebi MR, Baerlocher FJ, Misra S, Liu D, Nikolic B. Meta-analysis of drug-eluting balloon angioplasty and drug-eluting stent placement for infrainguinal peripheral arterial disease. J Vasc Interv Radiol. 2015 Apr;26(4):459-73.
2. Laird JR, Armstrong EJ. Drug-coated balloons for infrapopliteal disease: digging deep to understand the impact of a negative trial. J Am Coll Cardiol. 2014 Oct;64(15):1577-9.
3. Zeller T, Baumgartner I, Scheinert D, Brodmann M, Bosiers M, Micari A, Peeters P, Vermassen F, Landini M, Snead DB, Kent KC, Rocha-Singh KJ; IN.PACT DEEP Trial Investigators. Drug-eluting balloon versus standard balloon angioplasty for infrapopliteal arterial revascularization in critical limb ischemia: 12-month results from the IN.PACT DEEP randomized trial. J Am Coll Cardiol. 2014 Oct;64(15):1568-76.
4. Siablis D, Kitrou PM, Spiliopoulos S, Katsanos K, Karnabatidis D. Paclitaxel-coated balloon angioplasty versus drug-eluting stenting for the treatment of infrapopliteal long-segment arterial occlusive disease: the IDEAS randomized controlled trial. JACC Cardiovasc Interv. 2014 Sep;7(9):1048-56.
5. Canaud L, Ozdemir BA, Belli AM, Loftus IM, Thompson MM, Hinchliffe RJ. Infrainguinal angioplasty with drug-eluting stents and balloons. J Vasc Surg. 2014 Jun;59(6):1721-36.
6. Fanelli F, Cannavale A. Endovascular treatment of infrapopliteal arteries: angioplasty vs stent in the drug-eluting era. Eur Radiol. 2014 Apr;24(4):793-8.
7. Fanelli F, Cannavale A. Drug-coated balloons and drug-eluting stents: clinical effectiveness revisited. J Cardiovasc Surg (Torino). 2014 Oct;55(5):625-30.
8. Liistro F, Porto I, Angioli P, Grotti S, Ricci L, Ducci K, Falsini G, Ventoruzzo G, Turini F, Bellandi G, Bolognese L. Drug-eluting balloon in peripheral intervention for below the knee angioplasty evaluation (DEBATE-BTK): a randomized trial in diabetic patients with critical limb ischemia. Circulation. 2013 Aug;128(6):615-21.
9. Iida O, Soga Y, Yamauchi Y, Hirano K, Kawasaki D, Yamaoka T, Takahara M, Uematsu M. Clinical efficacy of endovascular therapy for patients with critical limb ischemia attributable to pure isolated infrapopliteal lesions. J Vasc Surg. 2013 Apr;57(4):974-81.

205.4

Should balloon angioplasty be the first-line treatment for visceral artery occlusive disease?

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Learning Objectives

1. Know the different technologies available
2. Learn about the role of these for treatment of stenosis and occlusive disease
3. To learn about the anatomical considerations

No abstract available.

Special Session Controversy
Controversies in venous disease treatment

301.1

Pre-emptive dilation of stenoses in dialysis access: pro

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Surveillance of haemodialysis access is advocated by the current KDOQI guidelines. The guidelines indicate that a single abnormal monitoring value should not be used in isolation. The recommendation is for a combination of clinical factors and surveillance parameters to be monitored, and prospective trend analysis of these parameters is more valuable in deciding which patient requires further imaging and intervention.

Among the threshold values recommended for further assessment are access flow rate less than 600 mL/min in grafts and less than 400–500 mL/min in fistulae, venous segment static pressure (mean pressures) ratios greater than 0.5 in grafts or fistulae, and arterial segment static pressure ratio greater than 0.75 in grafts.

However, much of the recommended guidelines have been based on observational studies with historical control groups, and there is an ongoing debate as to whether the use of surveillance with pre-emptive intervention improves long-term access survival.

There has been a dearth of randomized controlled trials addressing this issue, and many of the studies have included a relatively small number of patients.

In analysing the strategy of pre-emptive dilation of stenosis in dialysis access, it is perhaps better to consider grafts and fistulae separately. For grafts, while initial observational studies suggested a reduction in thrombosis with surveillance programmes, this has not been subsequently supported by evidence from randomized control trials. This is also the conclusion of a systematic review published in 2008.

However, the data for pre-emptive intervention in fistulae suggests that surveillance can be of benefit. The same review showed that there was reduced risk of fistula thrombosis in the surveillance groups. Despite this, there was no reduction in the risk of fistula loss. A more recent single-centre randomized controlled trial showed significant benefit of an active surveillance programme in decreasing fistula thrombosis and loss. Using parameters that are more aggressive than the KDOQI guidelines, i.e. a combination of positive physical examination, access flow of 500–900 mL/min and/or elevated venous pressure measurements, patients were enrolled to either a control group or to an early pre-emptive intervention group. The early pre-emptive intervention group led to a relative risk of 0.47 [95% confidence interval (CI): 0.17–1.15] for access failure (P=0.090), 0.37 [95% CI: 0.12–0.97] for thrombosis (P=0.033) and 0.36 [95% CI: 0.09–0.99] for access loss (P=0.041).

The results of this trial are promising and suggest that the strategy of pre-emptive intervention has a distinct part to play in the management of haemodialysis access. There is clearly a need for larger multicentre randomized trials to confirm this.

References

1. National Kidney Foundation: KDOQI clinical practice guidelines for vascular access 2006. Am J Kidney Dis 2006; 48 (Suppl S1): S176-S273.
2. Tonelli M, James M, Wiebe N, Jindal K, Hemmelgarn B; Alberta Kidney Disease Network. Ultrasound monitoring to detect access stenosis in hemodialysis patients: a systematic review. Am J Kidney Dis 2008; 51: 630-40. doi: 10.1053/j.ajkd.2007.11.025. Epub 2008 Mar 6.
3. Shetty A, Whittier WL. Does regular surveillance improve the long-term survival of arteriovenous fistulas? Int J Nephrol 2012; 2012: 539608. doi: 10.1155/2012/539608. Epub 2011 Dec 1.
4. Tessitore N, Bedogna V, Poli A, Lipari G, Pertile P, Baggio E, Contro A, Criscenti P, Mansueto G, Lupo A. Should current criteria for detecting and repairing arteriovenous fistula stenosis be reconsidered? Interim analysis of a randomized controlled trial. Nephrol Dial Transplant 2014; 29(1): 179-87. doi: 10.1093/ndt/gft421. Epub 2013 Oct 28.

301.2

Pre-emptive dilation of stenoses in dialysis access: con

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AV access failure most often results from multiple factors culminating in neointimal hyperplasia, vessel stenosis, and eventually thrombosis. These events predominate in the juxta-anastomotic segment in AV fistulae (AVF) and at the venous anastomosis in AV grafts (AVG). Certain factors such as surgical anastomotic configuration and wall shear stress (WSS)[1] have been shown to cause endothelial dysfunction, leading to activation and intimal migration of fibroblasts, vascular smooth muscle cells, and proliferation of microvessels[2]. Other implicated causes include chronic kidney disease-mediated vasculopathy[3], inadequate outward remodelling and compliance mismatch due to vessel wall stiffness in synthetic AV grafts, and increased arterial stiffness in diabetes mellitus.

On a molecular level, vascular smooth muscle cell proliferation may be initiated by growth factors (PDGF-BB), hormones, or other stimuli such as uremia, oxidative stress, tissue injury, inflammation, cytokines, and certain drugs. Via various pathways, they influence production of transcription factors (non-coding microRNAs [miRs]) that direct gene activity. These miRs help downregulate gene expression through translational repression or degradation of target mRNA (autophagy), causing phenotype switching of vascular smooth muscle cells from contractile to synthetic. This results in increased proliferation, migration, matrix secretion, and microvessel proliferation. Although our knowledge of the molecular processes driving neointimal hyperplasia is rapidly expanding, many questions remain to be answered with respect to mechanisms of action, particularly in veins.

AVFs have a much higher reported primary failure rate than AVGs due to non-maturation[4]. Once mature, AVFs require fewer interventions than AVGs to maintain similar cumulative patency. Early surgical or endovascular intervention may result in salvage of immature AVFs with acceptable post-intervention primary patency (PIPP) and access circuit primary patency (ACPP). However, there is a paucity of published level I data on cumulative patency following pre-emptive dilatation.

In a non-randomized study, Timmy Lee *et al.* reported cumulative AVF survival of 68% vs.78% vs. 92%, respectively, at 1 year following 2 vs.1 vs. 0 interventions prior to achieving maturation. At 2 years, AVF survival was 57% vs.71% vs.85%, respectively, and at 3 years, AVF survival was 42% vs. 57% vs. 75%, respectively. Frequency of intervention to maintain patency after maturation was 3.51 ± 2.2 vs.1.37 ± 0.31 vs.0.76 ± 0.10, respectively, per year. They concluded that AVFs requiring intervention to maintain patency had decreased cumulative survival compared with those that spontaneously matured[5].

The rationale for pre-emptive dilatation of stenoses in dialysis access follows KDOQI surveillance guidelines[6]. AVFs with access dysfunction and/or access blood flow (Qa) < 400–500 ml/min and AVGs with either Qa ≤ 600 ml/min or Qa < 1000 ml/min with a decrease of >25% should be referred for stenosis imaging and treatment.

In a randomized trial, Tessitore *et al.* reported that elective stenosis revision in functional AVFs with Qa > 350 ml/min resulted in a four-fold reduction in risk of access loss compared with intervention in dysfunctional AVFs[7].

Vascular access screening also detects subclinical and significant stenoses (>50%) in properly functioning AVFs with Qa ≥ 500 ml/min. These AVFs can deliver adequate dialysis with a low risk of failure[8]. No

intervention is warranted in such cases since the stenosis is not hemodynamically significant (i.e., poor clearance, prolonged bleeding, difficult cannulation, and >50% stenosis, with a trending change in access flow or pressure). Treatment may be harmful since unnecessary angioplasty (PTA) for stable or slow-growing stenoses may impair access survival by prompting aggressive restenosis due to accelerated neointimal hyperplasia[9].

AV access surveillance and pre-emptive treatment of severe stenosis have been reported to reduce the incidence of thrombosis. However, randomized controlled trials failed to confirm improved long-term AV access survival. In a systematic review and analysis, Tonelli *et al.*[10] reported no conclusive evidence that screening with access flow measurements prevented access loss in fistulas or grafts nor did pre-emptive angioplasty result in improved quality of life or conserved resources. Moreover, randomized controlled trials did not demonstrate benefit of surveillance in grafts.

In a randomized trial to test the hypothesis that pre-emptive treatment of AVGs reduces thrombosis rates and increases access survival compared with treatment only at time of dysfunction or thrombosis, Dember *et al.*[11] randomized 64 patients to 2 study arms (observation and pre-emptive treatment). Monthly static venous pressure/systolic pressure ratios (SVPR) were obtained. Values ≥ 0.4 triggered pre-emptive intervention in the treatment group, whereas patients in the observation group only underwent study and treatment for access dysfunction or thrombosis. During the 3.5-year study period, the proportion of patients with a thrombotic event was significantly greater in the observation group. However, both groups showed similar thrombosis rates, identical access abandonment (14 patients/group), and no statistical difference in time to access abandonment.

In a sequential observational trial, Shahin *et al.*[12] compared historical controls (physical exam) with physical exam plus monthly access flow monitoring (ultrasound dilution technique). The addition of access flow monitoring resulted in a sevenfold increase in angioplasty procedures (0.67 vs. 0.09 per access-year). Angioplasty effectively restored flow to original baseline, with no improvement in thrombosis rate or cumulative patency. Primary assisted patency decreased due to the increased rate of angioplasty.

In their report on interim analysis of a randomized controlled trial, Tessitore *et al.* confirmed that treating asymptomatic stenoses could trigger aggressive stenosis, leading to thrombosis[13]. Another potential concern was the generation of high Qa (>2000 ml/min) leading to high-output heart failure[14].

Paclitaxel-coated balloons employed after successful conventional or high-pressure angioplasty retard neointimal hyperplasia and stenosis in AVFs and possibly in AVGs. Their mechanism of action involves stabilization of nuclear microtubules causing tubular overload of cells and arrest of cell division at the G2/M checkpoint, thus preventing cytokinesis.

Three significantly flawed trials reported results with paclitaxel-coated balloons in treating AVF and AVG stenosis in 51 patients[15,16,17]. Six-month primary patency ranged from 70% to 92.3%. Two of the studies reported 12-month patency of 90.9% and 20%[16,17]. One study reported 24-month patency of 57.8%[16]. These results suggest a short-term advantage of paclitaxel-coated balloons over conventional balloons in retarding neointimal hyperplasia. Patane *et al.*'s unusually good long-term results were outliers without a control group for comparison.

Perhaps most importantly, the concept of pre-emptive treatment of AV access stenosis is misguided, based on the idea that repeatedly dilating a stenosis with a balloon will somehow correct abnormalities of wall shear stress, vascular remodeling, compliance mismatch, and suboptimal anastomotic angles/configuration to favorably improve long-term access viability. Instead, we must recognize that stenosis is the macro-manifestation of molecular response to vessel injury and endothelial dysfunction. The ultimate solution will reside in our understanding of vessel wall molecular biology and our use of genetic tools to influence or control the factors that upregulate and downregulate the genetic response to injury.

References

1. Rajabi-Jagahrgh E, Krishnamoorthy MK, Wang Y, Choe A, Roy-Chaudhury P, Banerjee RK. Influence of temporal variation in wall shear stress on intima-media thickening in arteriovenous fistulae. *Seminars in dialysis.* 2013;26(4):511-519.
2. Fitts MK, Pike DB, Anderson K, Shiu YT. Hemodynamic Shear Stress and Endothelial Dysfunction in Hemodialysis Access. *The open urology & nephrology journal.* 2014;7(Suppl 1 M5):33-44.
3. Rothuizen TC, Wong C, Quax PHA, van Zonneveld AJ, Rabelink TJ, Rotmans JI. Arteriovenous access failure: more than just intimal hyperplasia? *Nephrology Dialysis Transplantation.* 2013;28(5): 1085-1092.
4. Lok CE, Sontrop JM, Tomlinson G, *et al.* Cumulative patency of contemporary fistulas versus grafts (2000–2010). *Clinical Journal of the American Society of Nephrology.* 2013;8(5):810-818.
5. Timmy Lee caAU, Michael Allon, Paul Succop, Mahmoud El-Khatib, Rino Munda, Prabir Roy-Chaudhury. Decreased cumulative access survival in arteriovenous fistulas requiring Interventions to promote maturation. *Clinical Journal of the American Society of Nephrology.* 2011;6(3):575-581.
6. Workgroup VA. Clinical practice guidelines for vascular access. *American journal of kidney diseases : the official journal of the National Kidney Foundation.* 2006;48 Suppl 1:S176-247.
7. Tessitore N, Lipari G, Poli A, *et al.* Can blood flow surveillance and pre-emptive repair of subclinical stenosis prolong the useful life of arteriovenous fistulae? A randomized controlled study. *Nephrology Dialysis Transplantation.* 2004;19(9):2325-2333.
8. Sivanesan S, How TV, Bakran A. Sites of stenosis in AV fistulae for haemodialysis access. *Nephrology Dialysis Transplantation.* 1999;14(1):118-120.
9. Paulson WD, Moist L, Lok CE. Vascular access surveillance: an ongoing controversy. *Kidney International.* 2012;81(2):132-142.
10. Tonelli M, James M, Wiebe N, Jindal K, Hemmelgarn B. Ultrasound Monitoring to Detect Access Stenosis in Hemodialysis Patients: A Systematic Review. *American Journal of Kidney Diseases.* 2008;51(4):630-640.
11. Dember LM, Holmberg EF, Kaufman JS. Randomized controlled trial of prophylactic repair of hemodialysis arteriovenous graft stenosis. *Kidney International.* 2004;66(1):390-398.
12. Shahin H, Reddy G, Sharafuddin M, Katz D, Franzwa BS, Dixon BS. Monthly access flow monitoring with increased prophylactic angioplasty did not improve fistula patency. *Kidney International.* 2005;68(5):2352-2361.
13. Tessitore N, Bedogna V, Poli A, *et al.* Should current criteria for detecting and repairing arteriovenous fistula stenosis be reconsidered? Interim analysis of a randomized controlled trial. *Nephrology Dialysis Transplantation.* 2014;29(1):179-187.
14. Basile C, Lomonte C, Vernaglione L, Casucci F, Antonelli M, Losurdo N. The relationship between the flow of arteriovenous fistula and cardiac output in haemodialysis patients. *Nephrology Dialysis Transplantation.* 2008;23(1):282-287.
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. *Journal of Endovascular Therapy.*2012;19(2):263-272.
16. Patane D, Giuffrida S, Morale W, *et al.* Drug-eluting balloon for the treatment of failing hemodialytic radiocephalic arteriovenous fistulas: our experience in the treatment of juxta-anastomotic stenoses. *The Journal of Vascular Access.* 2014;15(5):338-343.
17. Lai C-C, Fang H-C, Tseng C-J, Liu C-P, Mar G-Y. Percutaneous Angioplasty Using a Paclitaxel-Coated Balloon Improves Target Lesion Restenosis on Inflow Lesions of Autogenous Radiocephalic Fistulas: A Pilot Study. *Journal of Vascular and Interventional Radiology.* 2014;25(4):535-541.

301.3

Permanent filters are obsolete: pro

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No abstract available.

301.4

Permanent filters are obsolete: con

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301.5

Surgery for Paget-Schroetter syndrome is mandatory: pro

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Paget-Schroetter syndrome is the phenomenon of upper limb deep vein thrombosis stimulated by repetitive endothelial damage to subclavian and axillary veins, resulting in thrombosis.
It is well recognised that anatomical factors, which allow for repetitive trauma during the course of exercise (or effort), facilitate and perpetuate this trauma. (1, 2)
The anatomical abnormalities that allow the thoracic outlet to be restricted are formed primarily by the first rib, clavicle and scalenus anterior muscle, with contribution from other abnormalities such as the presence of the cervical rib and congenital bands and hypertrophy of scalenus tendons and abnormal insertion of the costoclavicular ligament.
The role of other factors, such as haematological abnormalities, while undoubtedly being part of the process, is less well established. (3)
Established practice, as with lower limb DVT, has viewed anti-coagulation alone as the gold-standard treatment for DVT of both the upper and lower limb. With advancements, in particular of catheter-directed lysis techniques, it is now increasingly apparent that long-term consequences of conservative management in a young patient population are unacceptable. (2, 4-7)
The premise is accepted that intervention confers better results; ultimately, this is predicated on restoring normal venous outflow from the upper limb.
Therefore, there are two options for treatment:
Venous lysis without surgery (lysis, venoplasty ± stent)
Venous lysis plus surgery (±venoplasty ± stent)
The first non-surgical strategy ignores the contribution made by anatomical factors.
Published results of the first strategy suggest that good results may be achieved in up to 75% of patients, with the rest requiring surgery at a delayed interval due to residual symptoms, principally recurrent thrombosis and the development of post-thrombotic syndrome. A strategy of selective surgical intervention after lysis, while in principal sensible to avoid the risks of surgical intervention, is only possible with a robust pathway for identifying which of the patients would require surgery. However, no such pathway exists. (8)
In addition, venoplasty and stenting without rib resection has extremely poor outcome due to stent fracture and re-occlusion. (2, 8-10)
It therefore remains, with current evidence, that best results for the treatment of Paget-Schroetter syndrome are achieved by the policy of catheter-directed lysis and by the correction of anatomical abnormality (first rib resection) in all patients who are suitable for intervention.

References

1. Zell L, Kindermann W, Marschall F, et al. Paget-Schroetter syndrome in sports activities--case study and literature review. Angiology. 2001;52:337–42. [PubMed].
2. Urschel HC, Jr, Patel AN. Surgery remains the most effective treatment for Paget-Schroetter syndrome: 50 years' experience. Ann Thorac Surg. 2008;86:254–60. [PubMed].
3. Heron E, Lozinguez O, Alhenc-Gelas M, *et al.* Hypercoagulable states in primary upper extremity deep vein thrombosis. Arch Intern Med. 2000;160:382–6. [PubMed].
4. Donayre CE, White GH, Mehringer SM, *et al.* Pathogenesis determines late morbidity of axillosubclavian vein thrombosis. Am J Surg. 1986;152:179–84. [PubMed].
5. AbuRahma AF, Robinson PA. Effort subclavian vein thrombosis: evolution of management. J Endovasc Ther. 2000;7:302–8. [PubMed].
6. Urschel HC, Razzuk MA. Paget - Schroetter syndrome: What is the best management? Ann Thorac Surg. 2000;69:1663–9. [PubMed].
7. Grunwald MR, Hofmann LV. Comparison of urokinase, alteplase, and reteplase for catheter-directed thrombolysis of deep venous thrombosis. J Vasc Interv Radiol. 2004;15:347–52. [PubMed].
8. Lee JT, Karwowski JK, Harris EJ, *et al.* Long-term thrombotic recurrence after nonoperative management of Paget-Schroetter syndrome. J Vasc Surg. 2006;43:1236–43. [PubMed].
9. Molina JE, Hunter DW, Dietz CA. Protocols for Paget-Schroetter syndrome and late treatment of chronic subclavian vein obstruction. Ann Thorac Surg. 2009;87:416–22. [PubMed].
10. Urschel HC, Jr, Patel AN. Paget Schroetter syndrome therapy: failure of intravenous stents. Ann Thorac Surg. 2003;75:1693–6.

301.6

Surgery for Paget-Schroetter syndrome is mandatory: con

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The problem with Paget-Schroetter/venous thoracic outlet syndrome (VTOS) is that it is not the name of a single entity, but rather it is a catch-all term for a wide variety of conditions, the causes of which are attributed to the compression of neurovascular structures as they cross the thoracic outlet.
As with most conditions in which the diagnosis is clinically difficult, treatments vary amongst different doctors. Most of us tend to see things in a way in which we can treat the patient. It is human nature to attempt to "do something." This is particularly so amongst a group of interventionalists.
The title of this debate is whether surgical reconstruction is mandatory in Paget-Schroetter syndrome. To interventional radiologists, "surgery" would clearly represent some form of open operation, whereas "surgery" to the general public would be considered to include any form of intervention including venography, wire passage, thrombolysis, and stent placement.
So a better title of this debate might be as follows:
"Paget-Schroetter syndrome is better managed by conservative therapy rather than any form of operative or interventional therapy"
For acute axillo-subclavian venous thrombosis, treatment needs to address three problems: thrombus, extrinsic compression, and intrinsic damage to the vein. Thrombolysis is the most commonly recommended treatment, with continued anticoagulation for several months. Surgery is needed to decompress the area between the back of the first rib and the front of the clavicle. The timing of this is under debate.
For chronic obstruction, differentiation between venous-related symptoms and neurological symptoms is much more difficult, and it is here that the real problems lie.

References
1. H. Machleder, "A brief history of the thoracic outlet compression syndromes," in Thoracic Outlet Syndrome, K. A. Illig, R. W. Thompson, J. A. Freischlag, D. M. Donahue, S. E. Jordan, and P. I. Edgelow, Eds., pp. 3–9, Springer, New York, NY, USA, 2013.
2. R. S. Tubbs and M. M. Shoja, "Embryology of the thoracic outlet," in Thoracic Outlet Syndrome, K. A. Illig, R. W. Thompson, J. A. Freischlag, D. M. Donahue, S. E. Jordan, and P. I. Edgelow, Eds., Springer, New York, NY, USA, 2013.
3. R. J. Sanders, "Anatomy and pathophysiology of ATOS," in Thoracic Outlet Syndrome, K. A. Illig, R. W. Thomson, J. A. Freischlag, D. M. Donahue, S. E. Jordan, and P. I. Edgelow, Eds., Springer, London, UK, 2013.
4. R. L. Feinberg, "Clinical presentation and patient evaluation in VTOS," in Thoracic Outlet Syndrome, K. A. Illig, R. W. Thompson, J. A. Freischlag, D. M. Donahue, S. E. Jordan, and P. I. Edgelow, Eds., pp. 345–353, Springer, London, UK, 2013.
5. A. J. Doyle and D. L. Gillespie, "VTOS for the primary care team: when to consider the diagnosis," in Thoracic Outlet Syndrome, K. A. Illig, R. W. Thompson, J. A. Freischlag, D. M. Donahue, S. E. Jordan, and P. I. Edgelow, Eds., Springer, London, UK, 2013.
6. A. Azizzadeh and R. W. Thompson, "Clinical presentation and patient evaluation in ATOS," in Thoracic Outlet Syndrome, pp. 551–556, Springer, London, UK, 2013.
7. A. E. Weber and E. Criado, "Relevance of bone anomalies in patients with thoracic outlet syndrome," Annals of Vascular Surgery, vol. 28, no. 4, pp. 924–932, 2014.
8. W. Brandon and J. A. Freischlag, "Thoracic outlet syndromes," in Current Surgical Therapy, J. L. Cameron and A. M. Cameron, Eds., Elsevier, New York, NY, USA, 11th edition, 2013.
9. B. S. Brooke and J. A. Freischlag, "Contemporary management of thoracic outlet syndrome," Current Opinion in Cardiology, vol. 25, no. 6, pp. 535–540, 2010.
10. Y. W. Lum, B. S. Brooke, K. Likes *et al.*, "Impact of anterior scalene lidocaine blocks on predicting surgical success in older patients with neurogenic thoracic outlet syndrome," Journal of Vascular Surgery, vol. 55, no. 5, pp. 1370–1375, 2012.

Special Session
Genitourinary embolisation

302.1

Uncontrolled post-partum haemorrhage

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Learning Objectives
1. To learn how to select the appropriate patient
2. To learn how to perform embolisation
3. To learn about the outcomes including future fertility

Obstetric haemorrhage remains one of the major causes of maternal death in both developed and developing countries. Primary post-partum haemorrhage (PPH) is the most common form of major obstetric haemorrhage. In the 2003–2005 report of the UK Confidential Enquiries into Maternal Deaths, haemorrhage was the third highest direct cause of maternal death (6.6 deaths/million maternities).

The traditional definition of primary PPH is the loss of 500 ml or more of blood from the genital tract within 24 hours of delivery. Secondary or late PPH occurs after 24 hours but less than 6–12 weeks after delivery. Primary PPH involving an estimated blood loss of 500–1000 ml (and in the absence of clinical signs of shock) should prompt basic measures (close monitoring, intravenous access, full blood count, group and save) to facilitate resuscitation should it become necessary. If a woman with primary PPH is continuing to bleed after an estimated blood loss of 1000 ml (or has clinical signs of shock or tachycardia associated with a smaller estimated loss), this should prompt a full protocol of measures to achieve resuscitation and haemostasis.

The main causes of primary PPH are uterine atony (80% of PPH) and trauma or laceration of the lower portion of the genital tract. Other causes include caesarean section, invasive placentation, congenital or acquired coagulation disorders, uterine rupture or inversion, bladder flap haematoma, retention of blood clots or placental fragments and fibroids. The main causes of secondary PPH are retained placenta, abnormal placentation, uterine subinvolution, coagulopathies and ruptured pseudoaneurysm (PSA).

Transcatheter arterial embolisation (TAE) of the pelvic arteries for control of persistent PPH was first described in 1979. A 2002 review summarised case series totalling 100 women and reported 97% success with selective arterial embolisation for obstetric haemorrhage. Interventional radiology should be considered in all cases with persistent haemorrhage despite appropriate medical and obstetric treatment. Where there is uterine rupture or bladder injuries are suspected, surgery is preferred. In PPH after caesarean section and vaginal birth, in secondary PPH or in case of coagulopathies, TAE should be the preferred option. TAE must be performed rapidly and should be considered as soon as blood transfusion has started in order to avoid delays which allow severe coagulation abnormalities with disseminated intravascular coagulation (DIC) and associated increased morbidity.

Embolisation Technique

The technique is similar to that carried out for uterine artery embolisation. We perform bilateral common femoral arterial punctures usually under ultrasound guidance, and 6-French sheaths are inserted. Bilateral 4-French RIM catheters are used to selectively catheterise the uterine arteries. Very rarely, in cases with small or tortuous uterine arteries, or arteries that appear prone to spasm, we would use a microcatheter. Embolisation is carried out using slurry of gelfoam created by mixing small cubes of gelfoam cut out of a sheet of gelfoam sponge with contrast and saline using a three-way stopcock and two syringes. Unless a specific, focal bleeding point is identified and embolised, embolisation must be bilateral due to presence of anastomosis between the uterine arteries, which may therefore result in rebleeding when only one uterine artery is embolised. Following embolisation, if there are no contraindications, a closure device is used to seal the puncture site.

Minor complications which may arise from embolisation include puncture site haematoma, uterine artery dissection, transient sciatic nerve paresis, infection and post-embolisation syndrome. Major complications are rare and include non-target embolisation causing bladder necrosis, embolic material migrating down the external iliac artery and causing acute limb ischaemia and uterine necrosis requiring hysterectomy.

Frequently, no focal bleeding point is identified from a flush aortogram or even on selective catheterisation of the uterine arteries. If the patient is not critically unstable and catheterisation is not too difficult, we advocate performing bilateral selective embolisation of the uterine arteries. Where time is of the essence due to haemodynamic instability and catheterisation of the uterine artery is not proving straightforward, embolisation of the anterior division of the internal iliac artery can be carried out. In cases of secondary PPH, a focal bleeding point is sometimes seen due to the delayed rupture of a PSA. Following caesarean sections, the PSAs are usually of the uterine arteries, whereas following traumatic vaginal deliveries, they are usually of the internal pudendal or vaginal arteries. If a PSA is identified, more selective embolisation can be carried out using coils.

In patients with morbidly adherent placentas, prophylactic occlusion of the internal iliac arteries prior to a planned, elective caesarean section enables a controlled approach to delivery in this high-risk group. Should there be uncontrollable haemorrhage in these cases, embolisation can be performed immediately as there is already access into the internal iliac arteries.

Outcome
Failed TAE is noted in cases with DIC, major transfusion (more than 5 to 10 red blood cell packs transfused), blood loss of greater than 1.5 l, morbidly adherent placenta and severe arterial spasm at the time of initial embolisation. This is seen in 5–10% of cases. Where there is continued or repeat bleeding after an apparently successful TAE, a repeat TAE should be considered.
Repeat procedure may demonstrate reopening of a previously occluded uterine artery, which can then be re-embolised. An aortogram should be performed with the tip of the pigtail catheter at the level of the renal arteries to look for significant uterine blood supply from the ovarian arteries, as well as collateral supply which can arise from the inferior mesenteric artery, iliolumbar, lumbar, middle rectal and other arteries.
Fertility
In spite of the presence of transient ovarian failure, no adverse effect on fertility is seen in 91–100% of cases of patients undergoing TAE. Regular menstruation has been reported in recent studies with rates of 97–100% in almost 290 patients. Follow-up studies of smaller groups of women who had undergone arterial embolisation for control of PPH also suggest that the intervention does not impair subsequent menstruation and fertility.
Conclusion
Treatment of PPH requires a multi-disciplinary approach with close involvement of obstetricians, interventional radiologists and anaesthetists. It is important that arterial embolisation is considered early in the treatment algorithm to avoid failure due to the development of severe clotting abnormalities.
References

1. Confidential Enquiry into Maternal and Child Health. Saving Mothers Lives 2003–2005. Seventh Report on Confidential Enquiries into Maternal Deaths in the United Kingdom. London: CEMACH (2006).
2. Mousa HA, Alfirevic Z. Treatment for primary postpartum haemorrhage. Cochrane Database Syst Rev (2007).
3. Prevention and Management of Postpartum Haemorrhage. RCOG Green-top guideline No.52. May 2009. Minor revisions November 2009 and April 2011.
4. Heaston DK, Mineau DE, Brown BJ, *et al.* (1979) Transcatheter arterial embolization for control of persistent massive puerperal hemorrhage after bilateral surgical hypogastric artery ligation. Am J Roentgenol 133:152-4.
5. Dildy GA 3rd. (2002) Postpartum haemorrhage: new management options. Clin Obstet Gynecol 45:330-44.
6. Salomon LJ, deTayrac R, Castaigne-Meary, *et al.* (2003) Fertility and pregnancy outcome following pelvic arterial embolization for severe post-partum haemorrhage. A cohort study. Hum Reprod 18:849-52.
7. Descargues G, Mauger Tinlot F, et al. (2004) Menses, fertility and pregnancy after arterial embolization for the control of postpartum haemorrhage. Hum Reprod 19:339-43.
8. Gayat E, Resche-Rigon M, Morel O, *et al.* (2011) Predictive factors of advanced interventional procedures in a multicentre severe postpartum haemorrhage study. Intensive Care Med 37:1816-25.
9. Khan KS, Wojdyla D, Say L, *et al.* (2006) WHO analysis of causes of maternal death: a systematic review. Lancet 367:1066-74.
10. Lee HY, Shin JH, Kim J, *et al.* (2012) Primary postpartum hemoarrhage: outcome of pelvic arterial embolization in 251 patients at a single institution. Radiology 264:903-9.
11. Amato P, Robers AC. (2001) Transient ovarian failure: a complication of uterine artery embolization. Fertil Steril 75:438-9.
12. Kirby JM, Kachura JR, Rajan DK, *et al.* (2009) Arterial embolization for primary postpartum haemorrhage. J Vasc Interv Radiol 20:1036-45.
13. Pelage JP, le Dref O, Mateo J, *et al.* (1998) Life-threatening primary postpartum hemorrhage: treatment with emergency selective arterial embolization. Radiology 208:359-62.
14. Pelage JP, Le Dref O, Jacob D, *et al.* (2000) Uterine artery embolization: anatomical and technical considerations, indications, results, and complications. J Radiol 81:1863-72.
15. Amato P, Roberts AC. (2001) Transient ovarian failure: a complication of uterine artery embolization. Fertil Steril 75:438-9.
16. Soyer P, Dohan A, Dautry R, *et al.* (2015) Transcatheter arterial embolization for postpartum hemorrhage: indications, technique, results, and complications. Cardiovasc Intervent Radiol Feb 13. [Epub ahead of print].

302.2

Pelvic congestion

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Learning Objectives
1. To learn how to select the appropriate patient
2. To learn how to perform embolisation
3. To learn about the clinical outcomes

Approximately 10% of outpatient gynecologic visits are secondary to chronic pelvic pain; among the varied causes, pelvic congestion syndrome (PCS) is second only to endometriosis in frequency. Symptoms are varied, and classically, dyspareunia or menstrual disorder is observed more often in multigravidae. Correlation of imaging findings with clinical history and physical examination lead to correct diagnosis with high sensitivity (94%) and specificity (77%), especially when other significant gynecological or pelvic pathologies are excluded (1). Therefore, gonadal venography through femoral or jugular access still remains the definitive imaging modality to diagnose patients with PCS. If reflux is present, then selective catheterization and embolization can be performed.
Interventional radiological embolization is curative in up to 83% of cases (2). Sclerosing agents alone or in combination with coils or plugs are commonly used. The most accepted embolization technique for PCS consists of bilateral ovarian vein embolization if the right ovarian vein is refluxing; in cases in which symptoms persist for a period of 3–6 months, the embolization of internal iliac veins is performed. Here is an increasing population of patients with refluxing pelvic veins associated with leg varicosities for whom the primary embolization of four pelvic veins (both ovarian and internal iliac veins) has been successfully performed (3,4).
References

1. Nicholson T, Basile A. Pelvic congestion syndrome, who should we treat and how? Tech Vasc Interv Radiol. 2006 Mar;9(1):19-23.
2. Meissner M, Gibson K. Clinical outcome after treatment of pelvic congestion syndrome: Sense and nonsense. Phlebology. 2015 Mar;30(1 suppl):73-80.
3. Laborda A, Medrano J, de Blas I, Urtiaga I, Carnevale FC, de Gregorio MA. Endovascular treatment of pelvic congestion syndrome: visual analog scale (VAS) long-term follow-up clinical evaluation in 202 patients. Cardiovasc Intervent Radiol. 2013 Aug;36(4):1006-14.
4. Koo S, Fan CM. Pelvic congestion syndrome and pelvic varicosities. Tech Vasc Interv Radiol. 2014 Jun;17(2):90-5.

302.3

Testicular varicocele

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Learning Objectives
1. To learn how to select the appropriate patient
2. To learn how to perform embolisation
3. To learn about the outcomes including future fertility

A varicocele is defined as an abnormally dilated vein within the spermatic cord caused mainly by retrograde blood flow through the internal spermatic vein. Varicocele is detected in 9–20% of the general male population and observed in about 40% of subfertile/infertile adult males. In many cases, varicocele is asymptomatic; but according to many authors, it is the most common correctable cause of male infertility. Among many non-specific symptoms, effort-associated pain and cosmetic defects usually cause serious discomfort to patients.

There are many theories explaining formation of varicocele: congenital absence or malfunction of valves and a specific shape and course of the left spermatic vein are the most popular ones. Compression of the left renal vein between the aorta and the superior mesenteric artery (nutcracker syndrome) or post-thrombotic complications are less common. More than 90% of varicocele cases are left-sided. Bilateral varicocele and isolated right-sided involvement are very rare.

Endovascular embolisation of varicocele was described for the first time by Iaccarino in 1977, and in following years, various embolisation techniques (different embolising agents) have been successively described. Nowadays, the most frequent technique used is a combination of coils and sclerosing agents, which is simple, effective and economic. Our preferred method is the 'sandwich technique', which means distal coiling/sclerosant in a foam shape/proximal coiling. We found it very effective for testicular vein obliteration to keep foam sclerosant between coils and also with fewer complications, when sclerosant is not migrating to the scrotum.

Endovascular treatment of varicocele has some well-known advantages: it is a minimally invasive procedure performed under local anaesthesia and causes much less patient anxiety than conventional surgical operations. The modern percutaneous transcatheter procedures have comparable, or even lower, recurrence/persistence rates compared to microsurgical and laparoscopic methods. Nevertheless, some authors argue that surgery is still the first choice of treatment.

Till the mid-1980s, many clinical studies on varicocele treatment have shown variable effects on postoperative sperm parameters and pregnancy rates. A number of conflicting results in this subject come from many different clinical approaches, variable repair techniques and problematic controls, especially when associated with other reproductive technologies. Despite that, varicocele repair (embolisation) is nowadays considered as the primary treatment option when a couple with documented infertility involves a male with a clinical varicocele and suboptimal semen quality.

References

1. Robinson SP, Hampton LJ, Koo HP. Treatment strategy for the adolescent varicocele. Urol Clin North Am. 2011; 37(2): 269-278.
2. Iaccarino V, Venetucci P. Interventional radiology of male varicocele: current status. Cardiovasc Intervent Radiol. 2012; 35(6): 1262-1280.
3. Bittles MA, Hoffer EK. Gonadal vein embolization: treatment of varicocele and pelvic congestion syndrome. Semin Intervent Radiol. 2008; 25(3): 261-270.
4. Jargiello T, Drelich-Zbroja A, Falkowski A, et al. Endovascular transcatheter embolization of recurrent postsurgical varicocele: anatomic reasons for surgical failure. Acta Radiol. 2015; 56(1): 63-69.
5. Will MA, Swain J, Fode M, et al. The great debate: varicocele treatment and impact on fertility. Fertil Steril. 2011; 95(3): 841-852.

302.4

Prostate and bladder haemorrhage

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Learning Objectives
1. To learn how to select the appropriate patient
2. To learn how to perform embolisation
3. To learn about the outcomes including complications

Life-threatening haematuria is a severe problem that usually demands urgent medical or surgical treatment. Surgical treatment is often not indicated due to advanced age or poor conditions of the patient. First references to prostate or bladder artery embolisation in medical literature to treat haematuria date back to the year 1979[1].

There are several aetiologies, which can cause severe haematuria with difficult medical or surgical control. When ureteral or renal causes are ruled out, the most important causes are bladder, prostate and urethral tumours and transurethral resection of the prostate (TURP), prostatic biopsy and radiation or cyclophosphamide-induced cystitis. In some patients with this pathology, haematuria can be life threatening. When conservative treatment fails, surgery is not always possible because of high-operative risk. In these cases, endovascular embolisation can be a safe and effective method to control bladder or prostatic bleeding[2].

For endovascular embolisation, the biggest disadvantage is the correct anatomical identification of arteries supplying different organs of the pelvis. When it is technically possible, clinical success is achieved in over 90% of the cases[3-6].

The vascular anatomy of the pelvis is difficult and variable as there are multiple collateral arteries that hinder its recognition. Several authors have tried to systematise vascular maps through schemes and studies with CT, angiography and even cadaver studies[7].

It is utterly important to check for the following in CT images of the patient before embolisation: organs involved, affected arteries, etc. Various C-arm angulations or even the use of cone-beam CT can help identify the diseased arteries[3].

The embolisation technique requires a thorough previous workup, appropriate for an elderly patient with foreseeable comorbidities and severe haematuria[8,9].

A unilateral or bilateral femoral access is recommended under local anaesthesia or mild sedation. The hypogastric artery may be catheterised with a single or double curve catheter (such as Cobra 2, vertebral and MPA), and a 30–50° angulation of the C-arm may be useful to better identify bleeding arteries. Once the bleeding arteries have been identified, coaxial microcatheterisation is then required. The small size of some of the arteries (such as prostatic and vesical) requires calibres between 1.8 and 3 French. Initially, distal embolisation is recommended, and the most used embolisation agents are polyvinyl alcohol (PVA) or trisacryl gelatine microspheres (300–500 microns).

Larger particles (500–700 microns) may be of use when reflux is achieved. Other embolisation agents such as n-butyl-2-cyanoacrylate and ethylene vinyl alcohol (Onyx) can be used with similar results. Its use requires expertise in the management of these substances and a special microcatheter. Once one side is embolised, it is necessary to repeat this same process on the contralateral side either by the same route or through a contralateral access[3,9].

If distal catheterisation of vesical or prostatic arteries is not possible for some reason, the entrance to these arteries can be occluded with 0.018-inch microcoils. Sometimes, it is even impossible to safely access the anterior trunk of the hypogastric artery. In this case, it can be occluded by larger size macrocoils released at its ostium or by embolisation with temporary materials such as gelfoam. Ligouri G *et al.*[8] have published excellent results with complete internal iliac artery embolisation, with permanent and non-permanent agents safeguarding the superior gluteal artery. Other authors have used non-permanent agents and coils with similar results[10,11].

When a detailed examination of the affected organ vascularisation shows no signs of bleeding, it is mandatory to investigate for other arterial origins supplying organs such as the inferior mesenteric artery[12].
There are potential complications, although rare, due to rich and abundant collaterals existing in pelvic organs. Post-embolisation syndrome and gluteal and perineal pain have been described after any pelvic artery embolisation. Other rare complications include bladder necrosis with possible fistula to other organs, skin necrosis, gluteal nerve paresis and even neurological impairment due to the involvement of the anterior sacral artery[3].
It is essential to have a thorough knowledge of the angiographic anatomy of pelvic organs to be able to recognise them in each specific case using C-arm angulation or cone-beam CT. The use of microcatheters below 2.3 French allows safe supraselective embolisation of small prostate or bladder arteries.
Conclusion: Embolisation of arteries supplying the pelvic organs is feasible, safe and effective in controlling haematuria when conservative medical or surgical treatment has failed or is not indicated. Whenever possible, embolisation should be bilateral, and the use of microcatheters is advisable to allow supraselective embolisation and to conduct a thorough technique to prevent the embolisation of other areas.

References

1. Giuliani L, Carmignani G, Belgrano E, Puppo P. Gelatin foam and isobutyl-2-cyanoacrylate in the treatment of life-threatening bladder haemorrhage by selective transcatheter embolisation of the internal iliac arteries. Br J Urol. 1979;51:125-128.
2. Giuliani L, Carmignani G, Belgrano E, Puppo P. Transcatheter arterial embolization in urological tumors: the use of isobutyl-2-cyanoacrylate. J Urol. 1979;121:630-634.
3. Loffroy R, Pottecher P, Cherblanc V, Favelier S, Estivalet L, Koutlidis N, *et al.* Current role of transcatheter arterial embolization for bladder and prostate hemorrhage. Diagn Interv Imaging. 2014;95:1027-1034.
4. Kobayashi T, Kusano S, Matsubayashi T, Uchida T. Selective embolization of the vesical artery in the management of massive bladder hemorrhage. Radiology. 1980;136:345-348.
5. Amis ES Jr, Pfister RC, Yoder IC. Interventional radiology of the adult bladder and urethra. Semin Roentgenol. 1983;18:322-330.
6. Barbieri A, Simonazzi M, Marcato C, Larini P, Barbagallo M, Frattini A, *et al.* Massive hematuria after transurethral resection of the prostate: management by intra-arterial embolization. Urol Int. 2002;69:318-320.
7. Garcia-Monaco R, Garategui L, Kizilevsky N, Peralta O, Rodriguez P, Palacios-Jaraquemada J. Human cadaveric specimen study of the prostatic arterial anatomy: implications for arterial embolization. J Vasc Interv Radiol. 2014;25:315-322.
8. Liguori G, Amodeo A, Mucelli FP, Patel H, Marco D, Belgrano E, *et al.* Intractable haematuria: long-term results after selective embolization of the internal iliac arteries. BJU Int. 2010;106:500-503.
9. Delgal A, Cercueil JP, Koutlidis N, Michel F, Kermarrec I, Mourey E, *et al.* Outcome of transcatheter arterial embolization for bladder and prostate hemorrhage. J Urol. 2010;183:1947-1953.
10. Rodríguez-Patrón Rodríguez R, Sanz Mayayo E, Gómez García I, Blazquez Sanchez J, Sanchez Corral J, Briones Mardones G, *et al.* Hypogastric artery embolization as a palliative treatment for bleeding secondary to intractable bladder or prostate disease. Arch Esp Urol. 2003;56:111-118.
11. Nabi G, Sheikh N, Greene D, Marsh R. Therapeutic transcatheter arterial embolization in the management of intractable haemorrhage from pelvic urological malignancies: preliminary experience and long-term follow-up. BJU Int. 2003;92:245-247.
12. Hama Y, Iwasaky Y, Kaji T. Selective CT angiography and embolization of the inferior mesenteric artery for massive bladder hemorrhage secondary to locally advanced prostate cancer. Cardiovasc Intervent Radiol. 2010;33:874-876.

Special Session
Management of colorectal liver metastases

303.1

Treating colorectal liver metastases with liver-directed therapies: the medical oncologist's point of view

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Learning Objectives

1. To learn how to classify patients with colorectal liver metastases
2. To learn how to implement liver-directed therapies in the treatment of colorectal liver metastases
3. To learn how to discuss the data on liver-directed therapies

No abstract available.

303.2

Ablation in the modern oncological setting: when and how

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Learning Objectives

1. To learn how to select patients for image-guided ablation
2. To learn how to select the most appropriate ablation technique
3. To learn how to combine ablation with systemic therapy

When resection, when chemotherapy, when ablation, when and which combination?

Treatment choices depend on liver tumour number, size, distribution, the presence of extra-hepatic disease, potential for radical therapy to extra-hepatic sites of disease, disease-free interval between the primary resection and the diagnosis of liver metastases, stage of the primary tumour, success of the primary treatment, patient comorbidity and response to chemotherapy. Definitions of resectability and ablatability vary between centres due in part to local resources and expertise.
Optimal thermal ablation requires a minimum of 1-cm ablative margins, which in turn requires due consideration of tumour size, number, location, ablation technology, imaging guidance and intra-procedural imaging assessment. Analysis of local recurrence rates and survival shows an advantage for small tumours with consistently lower tumour progression reported with reducing tumour size. The most common cut-off point is 3 cm. However, tumours up to 5 cm can be completely ablated and permanently eradicated depending on their anatomic position and the treatment protocol used. Recurrence rates for >5-cm tumours ranges from 27% to 45%, so thermal ablation with curative intent is not generally recommended for metastases >5 cm. Most centres will accept patients with up to 5 tumours. Some centres treat up to 9 tumours, if the maximum diameter is <4cm, and usually at 2 treatment sessions. As in the resection literature, the best results are achieved in solitary tumours; I have previously reported 3-year survival in excess of 80% in patients with small, <4-cm solitary tumours, and Kim et al reported 5-year survival of 51% in solitary tumours.
Accepted applications for thermal ablation in colorectal liver metastases include patients with inoperable disease due to extent/distribution of disease, lack of adequate liver reserve or patient co-morbidity, and as part of the test-of-time approach and patient choice. Future applications may include resectable disease, e.g. for small solitary tumours.

Resectable disease

For some years, all patients received neoadjuvant chemotherapy followed by resection in those who respond. Chemotherapy was

used as a triage mechanism, with many centres not advocating radical therapy in non-responders. Chemotherapy response rates have greatly improved in the last 15 years from <30% to >75%, so although the majority did not respond, some degree of chemotherapy response is now expected. A more recent trend is to offer resection de novo in those who are resectable, followed by adjuvant chemotherapy with neoadjuvant chemotherapy being reserved for those who are not readily resectable at presentation. Oncologists argue about the benefit of adjuvant chemotherapy; there are reported significant differences in progression free survival but less evidence for an improvement in overall survival.

Unresectable but ablatable disease

Several ablation groups have published RFA survival data in unresectable patients of 50% at 3 years and 30% at 5 years. Although most centres agree that ablation adds a survival advantage to systemic chemotherapy in inoperable patients, this is still not universal. Randomised controlled trials have struggled to accrue, and the one RCT that did get started closed early and was insufficiently powered. Inevitably, there was some cross-over between treatment groups with 8.5% of the chemotherapy-only arm undergoing liver resection and the chemotherapy arm also received significantly more salvage chemotherapy. However, this RCT (CLOCC) showed a significant difference in progression free survival between the 2 groups at 3 years (27.6% for the ablation group vs. 10.6% for the chemotherapy group; p = 0.025). The overall survival at 30 months was not significantly different, but the survival curves continued to separate on long-term follow-up; 47% vs. 36% at 4 years and 40% vs. 30% at 5 years.

I would advocate ablation with adjuvant chemotherapy in patients who are ablatable de novo and neoadjuvant chemotherapy in non-ablatable patients with the hope that downsizing will allow a definitive treatment with ablation and or resection. As ablation is minimally invasive with a low morbidity, the interval between chemotherapy and ablation can be as little as 2 weeks.

Resectable with adjunctive measures but also ablatable – which route is better?

Five-year survival following resection with adjunctive measures such as portal vein embolisation is 25%. Some but not all of these patients will have denovo ablatable disease with comparable survival, and 40% of patients fail to complete their planned resection programme after portal vein embolisation, due to either inadequate liver hypertrophy or tumour progression. There is some evidence that portal vein embolisation stimulates tumour growth in the contralateral lobe. Ablation could be a better, far less traumatic, less complex treatment journey with a greater chance of treatment completion. In patients with normal volume liver and normal background liver parenchyma, it is possible, with appropriate access to anaesthesia, guidance techniques and ablation technology, to ablate up to 9 liver metastases at 2 treatment sessions 4 weeks apart.

As with patients who require portal vein embolisation, staged resection is associated with poorer overall survival and many patients fail to complete the treatment programme due to complications or disease progression. For those with ablatable disease de novo, ablation should seriously be considered as these patients are more likely to complete radical treatment to all sites of disease.

Resectable and ablatable

There is sufficient retrospective data showing comparable survival results in appropriate patients, that an RCT should be considered. Percutaneous ablation is much less invasive with minimal mortality and a much lower major morbidity. Serious complication rates of <2.5% have been published by several high volume centres. Ablation also preserves normal liver parenchyma. Given that most patients have multiple metastatic episodes, maximising the volume of normal liver also maximises the therapeutic options at each stage of the disease. Local recurrence rates post ablation can be as good as post resection if due regard is given to patient selection, imaging guidance, anaesthesia and ablation technique.

Conclusion

The role of ablation is becoming much more widely accepted by our clinical colleagues. Emphasis now should be on minimising local recurrence rates after ablation. This will result in an increased survival benefit and wider acceptance of ablation as an alternative to surgery in appropriate patients.

References

1. Abdalla EK, Vauthey JN, Ellis LM, Ellis V, Pollock R, Broglio KR, Hess K, Curley SA. Recurrence and outcomes following hepatic resection, radiofrequency ablation, and combined resection/ablation for colorectal liver metastases. Ann Surg. 2004;818-25.
2. Agcaoglu O, Aliyev S, Karabulut K, El Gazzaz G, Aucejo F, Pelley R, Siperstein AE, Berber E. Complementary use of resection and radiofrequency ablation for the treatment of colorectal liver metastases: an analysis of 395 patients. World J Surg. 2013;1333-9.
3. Bale R, Widmann G, Schullian P, Haidu M, Pall G, Klaus A, Weiss H, Biebl M, Margreiter R. Percutaneous stereotactic radiofrequency ablation of colorectal liver metastases. Eur Radiol. 2012;930-7.
4. Gillams AR, Lees WR. Five-year survival in 309 patients with colorectal liver metastases treated with radiofrequency ablation. Eur Radiol. 2009;1206-13.
5. Hamada A, Yamakado K, Nakatsuka A, Uraki J, Kashima M, Takaki H, Yamanaka T, Inoue Y, Kusunoki M, Takeda K. Radiofrequency ablation for colorectal liver metastases: prognostic factors in non-surgical candidates. Jpn J Radiol. 2012;567-74.
6. Hammill CW, Billingsley KG, Cassera MA, Wolf RF, Ujiki MB, Hansen PD. Outcome after laparoscopic radiofrequency ablation of technically resectable colorectal liver metastases. Ann Surg Oncol. 2011;1947-54.
7. Jakobs TF, Hoffmann RT, Trumm C, Reiser MF, Helmberger TK. Radiofrequency ablation of colorectal liver metastases: mid-term results in 68 patients. Anticancer Res. 2006;671-80.
8. Kim KH, Yoon YS, Yu CS, Kim TW, Kim HJ, Kim PN, Ha HK, Kim JC. Comparative analysis of radiofrequency ablation and surgical resection for colorectal liver metastases. J Korean Surg Soc. 2011;25-34.
9. Machi J, Oishi AJ, Sumida K, Sakamoto K, Furumoto NL, Oishi RH, Kylstra JW. Long-term outcome of radiofrequency ablation for unresectable liver metastases from colorectal cancer: evaluation of prognostic factors and effectiveness in first- and second-line management. Cancer J. 2006;318-26.
10. Reuter NP, Woodall CE, Scoggins CR, McMasters KM, Martin RC. Radiofrequency ablation vs. resection for hepatic colorectal metastasis: therapeutically equivalent? J Gastrointest Surg. 2009;486-91.
11. Sofocleous CT, Petre EN, Gonen M, Brown KT, Solomon SB, Covey AM, Alago W, Brody LA, Thornton RH, D'Angelica M, Fong Y, Kemeny NE. CT-guided radiofrequency ablation as a salvage treatment of colorectal cancer hepatic metastases developing after hepatectomy. J Vasc Interv Radiol. 2011;755-61.
12. Solbiati L, Ahmed M, Cova L, Ierace T, Brioschi M, Goldberg SN. Small liver colorectal metastases treated with percutaneous radiofrequency ablation: local response rate and long-term survival with up to 10-year follow-up. Radiology. 2012;958-68.
13. Sorensen SM, Mortensen FV, Nielsen DT. Radiofrequency ablation of colorectal liver metastases: long-term survival. Acta Radiol. 2007;253-8.
14. van Tilborg AA, Meijerink MR, Sietses C, van Waesberghe JH, Mackintosh MO, Meijer S, Van Kuijk C, van den TP. Long-term results of radiofrequency ablation for unresectable colorectal liver metastases: a potentially curative intervention. Br J Radiol. 2011;556-65.
15. Veltri A, Sacchetto P, Tosetti I, Pagano E, Fava C, Gandini G. Radiofrequency ablation of colorectal liver metastases: small size favorably predicts technique effectiveness and survival. Cardiovasc Intervent Radiol. 2008;948-56.

303.3

HAIC, TACE, or TARE?

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Learning Objectives
1. To learn how to select patients for HAIC, TACE, and TARE
2. To learn how to select the most appropriate technique
3. To learn how to combine HAIC, TACE and TARE with systemic therapy

There is no clear evidence that hepatic arterial infusion chemotherapy (HAIC) via ports or isolated hepatic perfusion (IHP), transarterial chemoembolization (TACE), and transarterial radioembolization (TARE) will improve overall survival (OS) and progression-free survival (PFS), respectively, in comparison with systemic treatment (ST) or best supportive care. However, local response and conversion to resectability due to these treatments have been shown, and this will probably provide benefit for salvage patients.

In 2007, a systematic review including 10 RCTs concluded that HAIC does not provide survival benefit in comparison with ST (1). However, subsequent trials showed that HAIC combined with ST after the failure of first-line therapy may improve PFS to 4–7 months (2-4). Conversion to resectability was achieved in 35%–47% (3,5).

IHP may improve local response in very selected patients progressive after ST. Response rates up to 60%–68%, with PFS up to 12 months may be possible (6,7).

Since 1998, several trials evaluated conventional TACE in patients with metastases refractory to ST. Objective response rates of 2%–63%, PFS of 3–8 months, and OS of 8.6–14.3 months showed highly variable results (8-12).

TACE using drug-eluting microparticles (DE-TACE) with irinotecan loaded into several types of microparticles had been evaluated in six retrospective studies and in one RCT comprising 215 patients (13-19). If patients had pretreatment with ST, local tumor control (no progression) was 40%–86%, PFS was 4–8.1 months, and OS was 5.4–13.3 months after first DE-TACE.

TARE was evaluated in seven trials comprising 1174 patients, with data of 606 patients from a multicenter trial (20-26). Most patients had ST prior to TARE. Local tumor control ranged between 29% and 73% depending on time interval and tumor volume, and OS was 6.2–11.6 months.

HAIC, IHP, TACE, DE-TACE, and TARE are treatment options for patients with failure of one or more lines of standard palliative ST. Clinical results of these treatments are similar and offer a chance of PFS between 4 and 8 months depending on tumor load, performance status, and extrahepatic tumor spread. Advantages of DE-TACE are a high level of standardization and a low grade of complexity.

References

1. Mocellin *et al.* J Clin Oncol 2007;25:5649-54.
2. Boige *et al.* Ann Surg Oncol 2008;15:219-26.
3. Samaras *et al.* Ann Surg Oncol 2011;18:1924-31.
4. Tsimberidou *et al.* Hepatogastroenterol 2013;60:1611-23.
5. D`Angelica *et al.* Ann Surg 2015;261:353-60.
6. Reddy *et al.* Ther Adv Med Oncol 2014;6:180-94.
7. Magge *et al.* Ann Surg 2014;259:953-9.
8. Tellez *et al.* Cancer 1998;82:1250-9.
9. Leichman *et al.* Cancer 1999;86:775-81.
10. Hong *et al.* J Vasc Interv Radiol 2009;20:360-7.
11. Vogl *et al.* Radiology 2009;250:281-9.
12. Albert *et al.* Cancer 2011;117:343-52.
13. Fiorentini *et al.* In vivo 2007;21:1085-92.
14. Martin *et al.* Ann Surg Oncol 2011;18:192-8.
15. Fiorentini *et al.* Anticancer Res 2012;32:3-11.
16. Narayanan *et al.* Anticancer Res 2013;33:2077-83.
17. Huppert *et al.* Cardiovasc Intervent Radiol 2014;37:154-64.
18. Stutz *et al.* Gastroenterol Res Pract 2015;715102.
19. Iezzi *et al.* Cardiovasc Intervent Radiol 2015;Mar 24 epub.
20. Cosimelli *et al.* Br J Cancer 2010;103:324-31.
21. Kalva *et al.* Am J Clin Oncol 2014 epub.
22. Golfieri *et al.* Radiol Med 2015 epub.
23. Kennedy *et al.* J Gastrointest Oncol 2015;6:134-42.
24. Abbott *et al.* Clin Colorectal Cancer 2015;Feb 16 epub.
25. Sabet *et al.* Eur J Nucl Med Mol Imaging 2015;42:370-6.
26. Saxena *et al.* Ann Surg Oncol 2015;22:794-802.

303.4

Patient follow-up and when to re-intervene

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Learning Objectives
1. To learn how to develop follow-up protocols for patients with colorectal liver metastases
2. To learn how to diagnose recurrent disease
3. To learn how to select patients for repeat interventional treament

No abstract available.

Special Session Controversy Controversies in radiation safety

304.1

Dose optimization is easy and improves image quality: pro

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Please refer to abstract 304.2 for the collective abstract of Dr. Vano and Dr. Bartal:
Dose optimization is easy and improves image quality: pro & con

304.2

Dose optimization is easy and improves image quality: con

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Collective abstract of Dr. Vano and Dr. Bartal:
Dose optimization is easy and improves image quality: pro & con

This topic is one of the main issues while considering potential controversies in radiation safety and image quality. We will address several hard-hitting questions that are important for our daily routine and safe practice:

- Are we properly and responsibly managing patient and staff radiation doses as we perform and document image-guided (mainly fluoroscopy) interventions?
- Are we asking for "excellent image quality" instead of diagnostic image quality, which is really required to be maintained according to the highest international standards?

We present the points of view of two experienced professionals: interventional radiologist (IR) and medical physicist (MP). The main task of an IR is to perform a safe and successful procedure. Safety for the IR is **zero** procedure-related complications, while radiation safety usually plays a secondary role, if any. The MP is an important team member who should be there in order to make sure that the

staff follows safety standards using passive and active radiation protection tools and methods, thereby contributing useful information and helping in the optimization of procedures.
Following topics will be addressed in this session:
1. Clear definition and meaning of optimization when ionizing radiation is used in interventional procedures (1, 2).
a. The MP highlights that the optimization of interventional procedures is not always equivalent to patient and personnel radiation dose reduction during the entire clinical procedure.
b. In some instances, the level of radiation dose needs to be increased when the required image quality has to be high.
2. The IR requires more information on image quality and on its reliability in clinical practice (3).
3. Are there any standards (3, 4)?
4. Can a phantom evaluation/simulation guarantee acceptable diagnostic image quality in a real case (2)?
5. Should a certain level of radiation dose be considered as the limit for certain complex procedures (1, 2)?
Real-time image quality evaluation (the really needed diagnostic information) is a challenging task in clinical practice, and it should be utilized in any quality assurance and optimization program (1, 4).
The MP claims that it is simple to suggest actions to improve image quality, but IRs not only need to have "adequate image quality" but also "adequate diagnostic information." The diagnostic information is a combination of several images, sometimes obtained using various acquisition techniques and/or modalities (fluoroscopy, cine, DSA, and cone-beam CT) and different post-processing and numerical reconstructions. The striking difference between diagnostic and interventional radiology is that IRs need an intraprocedural real-time imaging (4, 5, 6). Clearly, the decisions are often made based on the preacquired images displayed on monitors in the cath. lab together with real-time imaging, mainly fluoroscopy.
IR is a practicing clinician who is able to recognize "low image quality" as well as the advantages of different imaging modalities, but is not usually aware of the "cost" of radiation dose for patient and staff when shifting from fluoroscopy to DSA runs or when using several cone-beam CT acquisitions during the interventional procedure. IRs request "clear information" on radiation doses involved in different imaging modes to decide on when and how to implement each of them.
One of the problems is that IRs usually lack the knowledge on how to evaluate quality of dynamic imaging, impact of geometry parameters (e.g., angulation and distances), and thickness of patients on radiation dose.
There are other collateral but relevant aspects in optimization having an impact on patient and staff doses that are discussed and argued between the MP and IR.
The MP suggests to consider specific training and to implement diagnostic reference levels (DRLs) and planning to record and process patient doses and periodically compare the obtained median values with the existing DRLs reported in the literature. Also, he suggests to conduct a program to detect high doses in patients to decide the clinical follow-up of potential skin radiation injuries and to include this risk in the informed consent for patients (7).
The IR points out the still existing practical difficulties for patient dose registries, and the lack of support (sometimes) from the MP in imaging departments, but agrees on the need to bring these issues to quality assurance committees and to promote actions to improve radiation safety culture (4).
Optimization requires close cooperation of the whole imaging team, including the radiographer, as well as proper, continuous training to gain from the advantages of the new technology in X-ray and imaging systems.
The MP suggests the convenience to work in close cooperation with the IR and the radiographer and to understand the requirements in the image quality of different parts of clinical procedures. Moreover, we have to register patient doses and compare them with DRLs in order to detect potential high doses that might induce skin radiation injuries in patients. The IR questions the necessity and reliability of DRLs. The physicist also highlights the need to audit staff doses and specially lens doses by considering the new limit for occupational exposures (2, 4, 6). All these aspects should be a part of clinical sessions and radiation safety culture.
The IR points out that the final balance between the benefit (success of the clinical procedure) and the risk (radiation doses for patient as well as renal risk from contrast media and anesthesia) should be considered for each procedure, especially in pediatric and elderly patients. Optimization actions should be finally decided by a team headed by an experienced IR, with special training in dose management and radiation protection (4, 5, 6).

References

1. European 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. Off J Eur Commun. L13;57:1–73 (2014).
2. ICRP Publication 105. Radiological protection in medicine. Ann ICRP. 37:1–63 (2007).
3. ICRP Publication 85. International Commission on Radiological Protection. Avoidance of radiation injuries from medical interventional procedures. Ann ICRP. 30:7–67 (2000).
4. Bartal G, Vano E, Paulo G, Miller DL. Management of patient and staff radiation dose in interventional radiology: current concepts. Cardiovasc Intervent Radiol. 37:289–98 (2014).
5. Stecker MS, Balter S, Towbin RB, Miller DL, Vano E, Bartal G, Angle JF, Chao CP, Cohen AM, Dixon RG, Gross K, Hartnell GG, Schueler B, Statler JD, de Bae`re T, Cardella JF, SIR Safety and Health Committee, CIRSE Standards of Practice Committee. Guidelines for patient radiation dose management. J Vasc Interv Radiol. 20:S263–73 (2009).
6. Miller DL, Vano E, Bartal G, Balter S, Dixon R, Padovani R, Schueler B, Cardella JF, de Baère T, Cardiovascular and Interventional Radiology Society of Europe, Society of Interventional Radiology. Occupational radiation protection in interventional radiology: a joint guideline of the Cardiovascular and Interventional Radiology Society of Europe and the Society of Interventional Radiology. Cardiovasc Intervent Radiol. 33:230–9 (2010).
7. Vano E. Reduction of exposure of patients and staff to radiation during fluoroscopically guided interventional procedures. Curr Radiol Rep. 1:11–2 (2013).

304.3

Real-time dose monitoring of staff makes sense: pro

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Please refer to abstract 304.4 for the collective abstract of Prof. Jaschke and Dr. Efstathopoulos:
Real-time dose monitoring of staff makes sense: pro & con

304.4

Real-time dose monitoring of staff makes sense: con

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Collective abstract of Prof. Jaschke and Dr. Efstathopoulos for:
Real-time does monitoring of staff makes sense: pro & con
Intro-Background
Occupational exposures in interventional radiology are of high concern. The current gold standard for radiation monitoring is personal dosimetry with the use of passive personal dosimeters that are checked after a period of time. Due to the advances in imaging and the increased complexity in interventional techniques, staff may be exposed to high dose levels; therefore, real-time dose monitoring continues to gain ground. Active badges measure radiation dose in real-time, giving radiology personnel immediate feedback regarding their exposure. There are several studies supporting that real-time feedback of radiation doses decreases staff exposure [1, 2]. Some of the advantages and disadvantages of real-time dose monitoring are listed below.
Advantages
- Real-time dose monitoring gives you the information you need to manage your own X-ray dose exposure.
- You learn how to avoid being unnecessarily exposed to radiation.
- It Increases awareness of lowering the personal dose: the staff can be more aware of what areas in the room have high dose rates and can therefore avoid these "hot spots" or try to spend as little time as possible in those areas.
- It Increases staff compliance with use of radiation protection equipment and dose reduction techniques.
- Application of the radiation protection principles: radiation protection culture is fostered.

o In the case of integrated real-time dosimetry solutions:
- There are a lot of available recorded data for post-processing that could help in improving radiation safety.
- Real-time dosimetry helps to identify optimal equipment settings. The operator gets a real-time feedback regarding dose and image quality.
- Changes in equipment settings that may occur accidentally during software updates can cause an unnecessary high radiation exposure to the staff. Real-time dose monitoring helps to identify the reason for an increased dose during identical procedures prior and after a software update of the angiographic equipment.

Disadvantages/Challenges
- Use of multiple sensors is cumbersome or impossible.
- Inconvenience to the staff: change in the routine/habits and additional parameters to think (i.e., placement of extra dosimeters).
- Staff may forget to check the dosimeter (or the base station) during a complicated PCI; dosimeters will thus only be useful during "standard procedures" when the staff have more "free time" during the procedure.

o In the case of integrated real-time dosimetry solutions:
- It can be difficult to remember what happened during a procedure if data are not analyzed immediately after the procedure. It may be good if a physicist or someone having good knowledge of radiation protection could give the staff feedback and help them interpret their dose graphs.
- One potential risk of having this kind of system for a longer time is that one might stop looking at the base station.
- Base station may not always be seen when sitting for example.
- The efficacy of real-time monitoring devices has not been established yet.
- The cost is high.

Conclusion
One important thing to remember is that real-time monitoring systems do not replace the TLD or other legal dosimeters, and they should be more considered as a tool for improving the staff's awareness so that they easier can take action and optimize their radiation environment.
References
1. Christopoulos G, Papayannis AC, Alomar M, Kotsia A, Michael TT, Rangan BV, et al. Effect of a real-time radiation monitoring device on operator radiation exposure during cardiac catheterization: the radiation reduction during cardiac catheterization using real-time monitoring study. Circulation cardiovascular interventions. 2014;7:744-50.
2. Racadio J, Nachabe R, Carelsen B, Racadio J, Hilvert N, Johnson N, et al. Effect of real-time radiation dose feedback on pediatric interventional radiology staff radiation exposure. Journal of vascular and interventional radiology. 2014;25:119-26.

304.5

Patient dose monitoring and recording is essential: pro

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Collective abstract of Dr. Paulo and Prof. Loose for:
Patient dose monitoring and recording is essential: pro & con
In recent years, health professionals have provided assistance to unprecedented actions of several international organizations [such as International Atomic Energy Agency-IAEA (1–3), World Health Organization-WHO, European Commission-EC (4–6), and International Commission of Radiological Protection-ICRP (7,8)] regarding radiation protection in medicine. Those actions have been carefully followed and counted with the active collaboration of the European Societies representing the health professionals directly involved in the medical procedures using ionizing radiation.
One of the most significant topics is the importance of the development and implementation of an effective patient dose monitoring and recording system, allowing to track patient dose during his/her lifetime, independently of where the exposure took place and in what modality. The development of such a system will benefit several stakeholders:
- the society in general, by contributing to the increase of "health literacy";
- the health authorities, by providing relevant information for planning and development of medical imaging departments;
- the regulators and health authorities, by facilitating the process of determination of population dose exposure due to medical exposure;
- the hospital managers, by assisting in the justification process and in the clinical decision support;
- the medical imaging departments, by providing support in the development of an optimization process and benchmark tools;
- the patient, by allowing a real-time dose exposure tracking, and therefore keeping it below the levels defined by the international organizations; and
- the research community, by creating patient dose exposure data centers, with relevant information, for the development of a harmonized metric system for patient exposure.

These are some of the aspects that, combined with the engagement of the medical imaging equipment manufacturers, will contribute for the implementation of a real patient safety (8–11) culture, the main reason why dose monitoring and recording is essential.
However, the risk of ionizing radiation is one of the many risks of patients in medicine but by far not the highest. Following the arguments of the previous pro speaker, it seems that patient dose

monitoring and recording is essential. Generally spoken, this statement is true but … :

- We invest a lot of time and money into the process of monitoring, recording, and tracking of patient doses, especially in radiography where the risk of an exposed patient is comparable to the natural background radiation. The dose of many radiological procedures is in the range of, or below the "noise" of, risks of daily life like smoking a few cigarettes, driving a car, performing various sports activities, and others. We record, store, and monitor the dose of a single PA chest radiography, which is equivalent to 3 days of natural background radiation without being worried about the other 120 annual "natural chest exams." On the other hand, dose recording of modalities with higher patient exposure like CT or angiography is essential for examinations with deterministic risks, in children and young adults, and in women with unknown pregnancy.
- Following the ALARA principle, the dose of a justified examination must be optimized and not minimized. Reporting of doses to patients and referrers involves the risk of unwanted side effects. Assuming that neither patients nor referrers have sufficient knowledge about the link between dose, image quality, and diagnostic information, reporting of doses may be used for unintended benchmarking, e.g., "which radiologist performs my examination with the lowest dose?"
- A lifelong dose tracking of patients is a challenge with questionable benefit. Assuming an acute disease in a patient, in which a radiological procedure is justified, the first question should be "do we have reports or images of prior examinations?" and not "do we know the dose history?" To simplify, justification of medical exposure means to do more good than harm in an individual situation. Dose history should have only a limited impact on this decision and cannot be used to reject a justified procedure.
- Without any doubt, as laid down in the new Directive 2013/59/Euratom (12), we have to fulfil the requirements of our competent authorities to record medical exposures for an estimate of the medical population exposure and to derive diagnostic reference levels (13–15). All additional efforts in dose recording, storage, tracking, and processing should be limited to procedures with high doses, such as CT or interventional procedures with deterministic risks (16–18).

In summary, patient dose monitoring and recording should help to minimize the risk of ionizing radiation in medicine. As long as other risks to patients such as surgery, chemotherapy, anesthesia, and cancer by far exceed the risk of medical exposure, radiation protection is not a primary concern.

References

1. International Atomic Energy Agency. Dosimetry in Diagnostic Radiology: An International Code of Practice. IAEA series. Vienna: IAEA; 2007.
2. International Atomic Energy Agency. Avoidance of Unnecessary Dose to Patients While Transitioning from Analogue to Digital Radiology. IAEA-TECDO. Vienna: IAEA; 2011.
3. International Atomic Energy Agency. IAEA Human of Diagnostic Radiology Practices: A Tool for Quality Improvement. IAEA Human. Vienna: IAEA; 2010.
4. European Commission. RP Nº 180, part 1. Medical Radiation Exposure of the European Population. Luxembourg; 2014.
5. European Commission. RP Nº 154. European Guidance on Estimating Population Doses from Medical X-Ray Procedures. Luxembourg; 2008.
6. European Commission. RP Nº 159. European Commission Guidelines on Clinical Audit for Medical Radiological Practices. Luxembourg; 2009.
7. International Commission on Radiological Protection. ICRP Publication 73. Radiological Protection and Safety in Medicine. Ann ICRP. 1996.
8. International Commission on Radiological Protection. Managing patient dose in digital radiology. A report of the International Commission on Radiological Protection. Ann ICRP. 2004;34(1):1–73.
9. Frush D, Denham C, Goske M, Brink J, Morin R, Mills T, *et al.* Radiation Protection and Dose Monitoring In Medical Imaging: A Journey from Awareness, Through Accountability, Ability and Action…But What is the Destination? J Patient Saf. 2012;8.
10. Vaño E, Fernandez Soto J. Patient dose management in digital radiography. Biomed Imaging Interv J. 2007;3:e26.
11. Bartal G, Vano E, Paulo G, Miller DL. Management of Patient and Staff Radiation Dose in Interventional Radiology: Current Concepts. Cardiovasc Intervent Radiol. Epub 2013 Jul 16.
12. European Commission. Council Directive 2013/59/EURATOM, Laying Down Basic Safety Standards for Protection against the Dangers Arising from Exposure to Ionising Radiation. Official Journal of the European Union 2013;1–73.
13. Vassileva J, Rehani M. Diagnostic Reference Levels. Am J Roentgenol. 2015;34:1–6.
14. European Commission. RP Nº 109. Guidance on Diagnostic Reference Levels (DRLs) for Medical Exposures. Luxembourg; 1999.
15. European Commission. RP Nº 180, part 2. Diagnostic Reference Levels in Thirty-six European Countries. Luxembourg; 2014.
16. Holmberg O, Malone J, Rehani M, McLean D, Czarwinski R. Current Issues and Actions in Radiation Protection of Patients. Eur J Radiol. 2010;76:15–9.
17. Krille L, Zeeb H, Jahnen A, Mildenberger P, Seidenbusch M, Schneider K, *et al.* Computed Tomographies and Cancer Risk in Children: A Literature Overview of CT Practices, Risk Estimations and an Epidemiologic Cohort Study Proposal. Radiat Environ Biophys. 2012;103–11.
18. Pearce MS, Salotti JA, Little MP, McHugh K, Lee C, Kim KP, *et al.* Radiation exposure from CT scans in childhood and subsequent risk of leukaemia and brain tumours: a retrospective cohort study. Lancet. 2012;380(9840):499–505.

304.6

Patient dose monitoring and recording is essential: con

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Please refer to abstract 304.5 for the collective abstract of Dr. Paulo and Prof. Loose:

Patient dose monitoring and recording is essential: pro & con

Fundamental Course
Basic principles of biliary intervention

901.1

Biliary interventions for stone disease

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Learning Objectives

1. To learn imaging strategies for diagnosing biliary strictures/stones
2. To learn about different treatment strategies for anastomotic or iatrogenic biliary strictures
3. To learn about treatment strategies when dealing with intrahepatic and common bile duct stones

Benign biliary strictures are less frequent than malignant stenoses. The commonest causes are as follows:

Postoperative injury after cholecystectomy, gastrectomy, or hepatectomy.
Liver transplantation: anastomotic strictures, intrahepatic, or diffuse (ischemic cholangiopathy).
Blunt or penetrating trauma.
Lithiasis, pancreatitis, primary sclerosing cholangitis.
Abdominal ultrasonography, computed tomography, and MRI are highly sensitive for depicting the dilatation of the bile ducts and the location and cause of the obstruction.
MR cholangiopancreatography is ideal for depicting the anatomy of the bile ducts, the site of the stenosis, and its cause.
Benign biliary strictures can be treated by surgery or interventional radiology (IR).
The indications for IR treatment include high surgical risk, surgery failure, purulent cholangitis, and patient's preference.
Contraindications include uncorrectable coagulopathy and ascites.
The intervention begins with percutaneous transhepatic cholangiography (PTC). The stricture is located, crossed by a guide wire, and dilated with an angioplasty balloon. Because recurrence of the stricture occurs in 30%-60% of the patients, a plastic catheter or stent is left in place for a period of 2-6 months.
Because of the high recurrence rate, stents and stent grafts have been tried with moderate results. Some authors have reported on retrievable stents; however, the main problem is the inflammatory process, which may be triggered by the foreign body presence and may result in recurrent stenosis.
Major complications include septic shock (1%), septicemia (5%), and hemorrhage (4%).
Biliary stones
Percutaneous treatment of biliary stones concerns three patients groups:
1. Patients with symptomatic gallstones, very high risk for cholecystectomy.
2. Patients with bile duct stones, who have failed or deemed not suitable for endoscopic management.
3. Patients with intrahepatic bile duct stones.
For group 1 patients, the intervention starts with percutaneous cholecystostomy. For group 2 and group 3 patients, the intervention starts with PTC and placement of a biliary drainage catheter.
A combination of angioplasty balloons and baskets is usually used to fragment the stones, which are subsequently extracted through the percutaneous tract or pushed through the ampulla into the duodenum. In many cases, the use of lithotripters (ultrasonic or laser) is required to fragment the stones. These devices can be combined with the use of a flexible choledochoscope.
IR treatment results in complete gallstone removal in 90% of patients with a 6% major complication rate.
Similarly, 90% success rate has been reported for bile duct and intrahepatic bile duct stone removal, with a 10% complication rate.

References

1. Akhan O, Akinci D, Ozmen MN. Percutaneous cholecystectomy. Eur J Radiol 2002; 43: 229-236.
2. Burhenne HJ. Dilatation of biliary tract strictures: a new roentgenologic technique. Radiol Clin (Basel) 1975; 44: 153-159.
3. Bower BL, Picus D, Hicks ME, et al. Choledochospcopic stone removal through a T-tube tract: experience in 75 consecutive patients. J Vasc Interv Radiol 1990; 1: 107-112.
4. Garcia-Garcia L, Lanciego C. Percutaneous treatment of biliary stones: sphingteroplasty and transpapillary elimination of bile duct stones: 10 years' experience. AJR 2000; 182: 1451-1458.

901.2

Biliary interventions in bile duct malignancy

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Learning Objectives

1. To learn imaging strategies for diagnosing malignant biliary obstruction
2. To learn about different treatment strategies for malignant biliary strictures
3. To learn about follow-up and re-intervention strategies in patients with malignant biliary obstruction

The cornerstones to safe and successful percutaneous biliary intervention are preparation and close collaboration with the interventional endoscopists.
Adequate pre-procedure imaging with ultrasound and CT is essential, and MRCP helps planning difficult cases.
The puncture site should be chosen to allow drainage of at least 4 of the liver segments. Unless the prognosis is poor, multiple punctures should be considered in case of complex hilar strictures, but over-ambitious procedures may result in permanent external drainage.
Patients must be well resuscitated, particularly in cases of sepsis. Intravenous fluids and antibiotics must be administered aggressively, and the team needs to be prepared for sepsis precipitated by increase in biliary pressure during the procedure. In case of suspected infection, the procedure should be staged and minimally invasive external drainage performed at the first attendance only. Where internal/external drainage is appropriate, this is preferable in order to conserve bile and limit fluid loss. Vascular access sheaths allow multiple exchanges, reduce trauma to the track and biliary leakage, allow contrast injection with a catheter or stent in situ, and facilitate track embolisation on removal.
Designs of self-expanding metal stents and their characteristics vary considerably. It is essential that interventionists understand the differences and use them to their advantage. Covered stents are preferable to achieve long-term patency, but must not be so placed that they occlude side branches or the cystic duct. Where possible, stents should be placed with the lower end across the papilla to optimise biliary drainage. The role of fenestrated stents or stents with a "large cell" design allowing bilateral stenting from a single puncture and the role of stents with anti-reflux valves still need to be established.
Currently, the greatest challenge is the increasing survival of palliative patients, requiring increasing numbers of repeat procedures. Consideration must be given not only to the current procedure but also to "the next time" when the stent has failed.
The presentation will illustrate basic principles of biliary access; the differences between laser-cut, braided, and knitted stents; and additional measures to optimise outcomes such as intra-ductal biopsy, intraluminal radiofrequency ablation, and transhepatic track embolisation.

References

1. Kozarek R, Baron T, Song HY (eds.) Self-expandable stents in the GI-tract. Springer Verlag, Arlington, 2012. ISBN 978-1-4614-3745-1
2. www.springer.com/gp/book/9781461437451.
3. British Society of Interventional Radiology. Biliary Drainage and Stent Audit Report. Dendrite Clinical Systems, Henley-on-Thames, 2009.
4. www.e-dendrite.com/files/13/file/Pages%20from%20BDSR%202009.pdf.
5. Cassani L, Lee JH. Management of malignant distal biliary obstruction. Gastrointest Interv 2015 (in press), DOI: 10.1016/j.gii.2015.02.001.
6. Jang SI, Lee DK. Stents with specialized functions: drug-eluting stents and stents with anti-reflux devices. Gastrointest Interv 2015 (in press),
7. DOI: 10.1016/j.gii.2015.03.004.

901.3

Biliary leak and iatrogenic bile duct injury management

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Learning Objectives

1. To learn imaging strategies for diagnosing biliary leak and iatrogenic bile duct injury
2. To learn about different treatment strategies for biliary leak after lap chole
3. To learn about appropriate strategies for definitive treatment of patients with iatrogenic bile duct injury

PTBD plays a vital role in the treatment of biliary leak and iatrogenic bile duct injury. Biliary leak may occur as the result of a variety of operations such as laparoscopic cholecystectomy, bilioenteric anastomosis for malignant or benign conditions and bile duct injury during non-biliary operations. PTBD can diagnose the exact location and the extent of biliary injury, including anatomic variations, which may be difficult to clarify with MRCP in patients with leakage and non-dilated bile ducts. It can be used as the sole treatment in conjunction with ERCP as a rendezvous procedure or as a measure to prepare the patient for reconstructive bile duct surgery. The presence of one or more biliary drainage catheters may also guide surgeons during complex operations while creating bilioenteric anastomosis. PTBD catheters may not only drain the bile ducts themselves but can also be positioned through the site of the bile leak into the peritoneal cavity, thereby draining the biloma very close to the hilum of the liver.

PTBD also plays an increasing role in the treatment of leakage of the duodenum or proximal jejunum, which can be very difficult to treat surgically.

In addition to this, the presence of transhepatic biliary access may be used to serve as the route for a feeding tube into the jejunum, which can be used for feeding and/or for restoring bile flow into the gut.

PTBD in these often sick patients in whom there usually is no dilatation of bile ducts can be very challenging, and a proper technique is required using ultrasound guidance and thin needles for obtaining bile duct access. Deep procedural sedation with the help of anaesthesiology nurses can greatly facilitate these difficult procedures. Complications include sepsis, arterial or portal venous bleeding and drainage catheter dislocation, with subsequent intra-abdominal bile leakage. Interventional radiologists should not only perform the PTBD procedure but should also be continuously involved in catheter management as these patients will require numerous tube changes and repeat imaging to assess the progress of the treatment of the leakage.

901.4

Biliary interventions in liver transplant patients

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Learning Objectives

1. To learn imaging strategies for diagnosing biliary complications in liver transplant patients
2. To learn about different treatment strategies for biliary complications in liver transplant patients
3. To learn how to diagnose and manage other associated complications

Biliary complications (biliary strictures and/or leak) are considered 'Achilles heel' of orthotopic liver transplantation (OLT) because of their high frequency, need for long-term repeated treatment and potential detrimental effects on graft and patient survival. Recent improvement in surgical techniques, immunosuppression and organ preservation have reduced their incidence from originally 30%–50% to 10%–20% at present (1, 2, 3, 4, 5, 6).

Biliary strictures:

- Anastomotic stenosis (incidence, 5%–25%; higher in grafts from living donors): they differ according to type of anastomosis. Choledochocholedochoanastomosis (CCA) is most commonly used, while choledochojejunoanastomosis (CJA) is usually used in patients with bile duct stenosis or other pathology, graft reduction, re-transplantation and PSC or after biliary surgery. They usually occur within the first year after transplantation (7, 8).
- Non-anastomotic stenosis (incidence, 0%–25%): They are most often caused by ischaemic fibrotic scarring caused by hepatic artery stenosis/thrombosis (9, 10). Hepatic artery revascularisation (usually PTA/stenting) increases the patency rate after dilatation up to 70%–90% (11).

The diagnosis is in recent years made by MRCP. Original surgical therapy is currently replaced by endoscopic or percutaneous techniques. The method of choice is ERCP with repeated stenting (using plastic stents) with or without balloon dilatation. Percutaneous approach is reserved for patients for whom endoscopy has failed or is not feasible (usually in patients with CJA), although it may be technically challenging as bile ducts are usually not dilated because transplantation impairs biliary innervations (12). Balloon dilatation (often repeated) is employed followed by long-lasting external-internal drainage (9). In patients with CJA with short hepatic duct, a kissing balloon technique can be used (balloons introduced from both left and right bile ducts).

Biliary leakage:

The incidence of biliary leakage is 6%–10%; it usually occurs within the first months after OLT. There are three different entities in biliary leakage: leakage from anastomosis, leakage from the cut surface of the partial graft and leakage after (T) drain removal. A majority of leakages can be managed by prolonged abdominal drainage or endoscopic or percutaneous drainage. The strategy and technique of the therapy is similar to the stricture treatment. If the leak is combined with biliary obstruction, the treatment of obstruction is essential for leakage management (13).

References

1. Calne RY (1976) A new technique for biliary drainage in orthotopic liver transplantation utilizing the gall bladder as a pedicle graft conduit between the donor and recipient common bile ducts. Ann Surg 184:605.
2. Williams ED, Draganov PV (2009) Endoscopic management of biliary strictures after liver transplantation. World J Gastroenterol 15:3725.
3. Thuluvath PJ, Pfau PR, Kimmey MB, Ginsberg GG (2005) Biliary complications after liver transplantation: the role of endoscopy. Endoscopy 37:587.
4. Pascher A, Neuhaus P (2006) Biliary complications after deceased-donor orthotopic liver transplantation. J Hepatobiliary Pancreat Surg 13:487.
5. Wojcicki M, Milkiewicz P, Silva M (2008) Biliary tract complications after liver transplantation: a review. Dig Surg 25:245.
6. Duailibi DF, Ribeiro Jr MAF (2010) Biliary complications following deceased and living donor liver transplantation: a review. Transplant Proc 42:517.
7. Graziadei IW, Schwaighofer H, Koch R et al (2006) Long-term outcome of endoscopic treatment of biliary strictures after liver transplantation. Liver Transpl 12:718.
8. Park JS, Kim MH, Lee SK et al (2003) Efficacy of endoscopic and percutaneous treatments for biliary complications after cadaveric and living donor liver transplantation. Gastrointest Endosc 57:78.
9. Tung BY, Kimmey MB (2002) Biliary strictures after liver transplantation. Techniques in Gastrointestinal Endoscopy 3:140.

10. Sanchez-Urdazpal L, Gores GJ, Ward EM et al (1993) Clinical outcome of ischemic-type biliary complications after liver transplantaion. Transpl Proc 25:1107.
11. Laštovičková J, Peregrin J (2012) Biliary strictures after orthotopic liver transplantation: long-term results of percutaneous treatment in patients with nonfeasible endoscopic therapy. Transplant Proc 44:1379.
12. Hung H, Chen TS, Tseng HS et al (2009) Percutaneous transhepatic cholangiography and drainage is an effective rescue therapy for biliary complications in liver transplant recipients who fail endoscopic retrograde cholangiopancreatography. J Clin Med Assoc 72:395.
13. Akamatsu N, Sugawara Y, Hashimoto D (2010) Biliary reconstruction, its complications and management of biliary complications after adult liver transplantation: a systematic review of the incidence, risk factors and outcome. Transpl Int 24:379.

Special Session
How to improve acute stroke management: new horizons

902.1

How can imaging improve patient selection for mechanical thrombectomy or IV thrombolysis?

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Learning Objectives
1. To learn about the importance of imaging in patient selection for acute stroke treatment
2. To learn about new imaging parameters in patient selection
3. To understand how these new parameters could improve the right patient selection

No abstract available.

902.2

New generation stent retrievers

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Learning Objectives
1. To learn about new generation stent retrievers
2. To understand the technical differences of new retrievers
3. To learn what improved about new generation stent retrievers

Approximately 5 years since the more or less incidental finding that the detachable Solitaire® stent could be used to remove intracranial thromboemboli, there has been a steady development of "stent retrievers" or "stentrievers." At present, many alternatives such as Solitaire®, Trevo®, and Revive® are available in the market, most of them with similar basic construction. They all depend on the radial force to make the stent partially penetrate the thrombus and then to snare and hold it within the mesh, which has different configuration in various devices. The newly developed Embotrap® is different in a way that it instead traps and captures the thromboembolus and has an inner flow channel aimed at instant reperfusion plus breaking of the blood stream pressure gradient acting on the clot.

The stent retrievers are preferably used in conjunction with a balloon guide catheter placed in the proximal internal carotid artery with or without a so-called intermediate catheter positioned as close as possible to the thromboemboli. The latter technique is particularly useful in patients with carotid stenosis or even occlusion caused by atherosclerosis or acute dissection.

In the recently published randomized controlled studies on intravenous thrombolysis followed by thrombectomy against thrombectomy alone (MR CLEAN, ESCAPE, and EXTEND-IA), stent retrievers were consistently utilized with preponderance for Solitaire FR®. In addition, in the presented but not yet published SWIFT PRIME study, Solitaire FR® was used exclusively. In conclusion, all these studies showed superiority of stroke patient outcome by adding endovascular treatment with stent retrievers in the treatment of large vessel occlusions.

In this presentation, modern stent retrievers will be discussed with a focus on studies, technique, and future development.

References

1. MR CLEAN: Berkhemer OA et al, N Engl J Med, 1;372, 2015.
2. ESCAPE: Goyal M et al, N Engl J Med, 12;372, 2015.
3. EXTEND-IA: Campbell BCV et al, N Engl J Med, 12;372, 2015.

902.3

MR guidance in endovascular acute stroke intervention with new magnetically-assisted, remote-controlled catheters

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Learning Objectives
1. To learn the basic principles of MR guidance in acute stroke treatment
2. To learn how the technique could be applied with remotely controlled catheters
3. To understand the future of this approach with increased computational power

Magnetic resonance (MR) imaging guidance of endovascular interventions affords a wealth of physiological and structural information, and it can be used for the delivery of local therapy without the use of ionizing radiation. The promise of endovascular MR-guided procedures remains unrealized in part because of the lack of MR-compatible catheters and guidewires that the user can safely navigate and track efficiently in real time. Maneuverability and steering performance of an endovascular catheter from a remote access site to pathologic targets is of paramount importance because it affects procedural time and efficiency.

We have used an electromagnetic microcoil on the microcatheter tip to deflect the catheter and assist endovascular navigation. When energized inside the MR imaging unit bore, the magnetic moment created by the microcoil will align itself with the direction on B0, causing the catheter tip to deflect. By controlling the direction of the current, the interventionalist can control the direction of deflection thus allowing the catheter tip to be more easily steered into the desired vessel branch. The operating system, deflection capability, and safety with the use of several generations of prototypes in vitro and in vivo will be described.

Translation of endovascular catheter and guidewire technologies to allow real-time MR guidance of endovascular therapy for acute ischemic stroke would enable intraprocedural, repeated evaluation of the viability of the brain parenchyma through the use of diffusion-weighted imaging. Having such gold-standard physiological data available at any point during ischemic stroke interventions would permit the optimal selection of therapy by directing the physician to open occluded arteries supplying the viable brain, while leaving arteries to the dead brain closed thus lowering the risk of reperfusion hemorrhage. Imaging and catheter-based tools that enable MR-guided acute stroke interventions are now undergoing a revolution based on improved computing power and manufacturing techniques; these technologies are on the cusp of clinical translation.

References

1. Bock M, Wacker FK. MR-guided intravascular interventions: techniques and applications. J Magn Reson Imaging 2008;27:326–338.

2. Saeed M, Hetts SW, English J, Wilson M. MR fluoroscopy in vascular and cardiac interventions (review). Int J Cardiovasc Imaging 2012;28:117–137.
3. Kos S, Huegli R, Bongartz GM, Jacob AL, Bilecen D. MR-guided endovascular interventions: a comprehensive review on techniques and applications. Eur Radiol 2008;18:645–657.
4. Ratnayaka K, Faranesh AZ, Guttman MA, Kocaturk O, Saikus CE, Lederman RJ. Interventional cardiovascular magnetic resonance: still tantalizing. J Cardiovasc Magn Reson 2008;10:62.
5. Henk CB, Higgins CB, Saeed M. Endovascular interventional MRI. J Magn Reson Imaging 2005;22:451–460.
6. Fu Y, Liu H, Huang W, Wang S, Liang Z. Steerable catheters in minimally invasive vascular surgery. Int J Med Robot 2009;5:381–391.
7. Muller L, Saeed M, Wilson MW, Hetts SW. Remote control catheter navigation: options for guidance under MRI. J Cardiovasc Magn Reson 2012;14:33.
8. Bell JA, Saikus CE, Ratnayaka K, et al. A deflectable guiding catheter for real-time MRI-guided interventions. J Magn Reson Imaging 2012;35:908–915.
9. Gudino N, Heilman JA, Derakhshan JJ, Sunshine JL, Duerk JL, Griswold MA. Control of intravascular catheters using an array of active steering coils. Med Phys 2011;38:4215–4224.
10. Karmarkar PV, Kraitchman DL, Izbudak I, et al. MR-trackable intramyocardial injection catheter. Magn Reson Med 2004;51:1163–1172.
11. Gosselin FP, Lalande V, Martel S. Characterization of the deflections of a catheter steered using a magnetic resonance imaging system. Med Phys 2011;38:4994–5002.
12. Zhang K, Krafft AJ, Umathum R, Maier F, Semmler W, Bock M. Real-time MR navigation and localization of an intravascular catheter with ferromagnetic components. MAGMA 2010;23:153–163.
13. Roberts TP, Hassenzahl WV, Hetts SW, Arenson RL. Remote control of catheter tip deflection: an opportunity for interventional MRI. Magn Reson Med 2002;48(6):1091–1095.
14. Hetts SW, Saeed M, Martin AJ, et al. Endovascular catheter for magnetic navigation under MR imaging guidance: evaluation of safety in vivo at 1.5T. AJNR Am J Neuroradiol 2013;34:2083–2091.
15. Settecase F, Sussman MS, Wilson MW, et al. Magnetically-assisted remote control (MARC) steering of endovascular catheters for interventional MRI: a model for deflection and design implications. Med Phys 2007;34(8):3135–3142.
16. Wilson MW, Martin AB, Lillaney P, et al. Magnetic catheter manipulation in the interventional MR imaging environment. J Vasc Interv Radiol 2013;24:885–891.
17. Hetts SW, Saeed M, Martin A, et al. Magnetically-assisted remote controlled microcatheter tip deflection under magnetic resonance imaging. J Vis Exp 2013;74:e50299.
18. Settecase F, Hetts SW, Martin AJ, et al. RF heating of MRI-assisted catheter steering coils for interventional MRI. Acad Radiol 2011;18:277–285.
19. Bernhardt A, Wilson MW, Settecase F, et al. Steerable catheter microcoils for interventional MRI reducing resistive heating. Acad Radiol 2011;18:270–276.
20. Saeed M, Lee R, Martin A, et al. Transendocardial delivery of extracellular myocardial markers by using combination x-ray/MR fluoroscopic guidance: feasibility study in dogs. Radiology 2004;231:689–696.
21. Surry KJ, Austin HJ, Fenster A, Peters TM. Poly(vinyl alcohol) cryogel phantoms for use in ultrasound and MR imaging. Phys Med Biol 2004;49:5529–5546.
22. Schiemann M, Killmann R, Kleen M, Abolmaali N, Finney J, Vogl TJ. Vascular guide wire navigation with a magnetic guidance system: experimental results in a phantom. Radiology 2004;232:475–481.
23. Lillaney P, Malba V, Evans L, et al. Catheters for interventional MR: LaserLathe fabrication of micro-coils for remote catheter tip deflection. [abstr]. In: Proceedings of the Twenty-First Meeting of the International Society for Magnetic Resonance in Medicine. Berkeley, Calif: International Society for Magnetic Resonance in Medicine, 2013;0472.
24. Losey AD, Lillaney P, Martin AJ, et al. Magnetically assisted remote-controlled endovascular catheter for interventional MR imaging: in vitro navigation at 1.5 T versus X-ray fluoroscopy. Radiology 2014;271:862–869.
25. Losey AD, Lillaney P, Martin AJ, et al. Safety of retained microcatheters: an evaluation of radiofrequency heating in endovascular microcatheters with nitinol, tungsten, and polyetheretherketone braiding at 1.5 T and 3 T. J Neurointerv Surg 2013;6:314–319.
26. Moftakhar P, Lillaney P, Losey AD, et al. New generation laser lithographed dual axis magnetically-assisted remote controlled endovascular catheter for interventional MR imaging: in vitro multiplanar navigation at 1.5T and 3T versus X-ray fluoroscopy. Radiology (in press for 2015).

902.4

IA stem cell therapy in stroke patients

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Learning Objectives

1. To briefly learn the background of stem cell treatment
2. To understand how stem cell treatment could be applied in acute stroke patients
3. To learn about the initial results of this treatment

Stem cell therapy is an emerging therapeutic modality in the treatment of stroke. Its basis stems from the observation that certain parts of the adult brain are capable of regeneration. While the regenerative capacity of certain parts of the brain has been demonstrated, it is clear that this endogenous repair process is unable to overcome the devastating damage to the brain tissue that occurs after acute, severe stroke.

Cell-based therapies have the potential to open up new avenues of treatment in this arena. Targets for stem cell therapy include neuroprotective approaches, which are aimed at protecting the at-risk tissue during the acute phase of stroke, as well as neuroreparative approaches, which may involve direct replacement of damaged brain tissue or, alternatively, promote endogenous repair processes of the brain.

Broadly speaking, clinical approaches to stem cell therapy can be divided into 'endogenous' and 'exogenous' approaches:

The endogenous approach aims to stimulate the mobilisation of stem cells, which are already present within the individual.

The exogenous approach involves transplantation of a patient with stem cells delivered locally (e.g. direct intracerebral implantation) or systemically (e.g. intravenous or intra-arterial), and it may involve in vitro culture of cells for the expansion of cell numbers prior to administration. There is a large body of pre-clinical data and data from the current clinical trials that have utilised exogenous approaches to stem cell therapy for stroke.

In this lecture, I will discuss the latest evidence for stem cell therapy in ischaemic stroke focusing on exogenous delivery methods, in particular intra-arterial delivery.

Special Session
Embolic agents for microcatheters

903.1

Microcoils

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Learning Objectives
1. To learn about the types and specific properties of micro coils
2. To learn about specific indications for the use of micro coils
3. To learn tips and tricks for deploying micro coils, as well as pitfalls

No abstract available.

903.2

Microparticles

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Learning Objectives
1. To learn about the types and specific properties of microparticles
2. To learn about specific indications for the use of microparticles
3. To learn tips and tricks for deploying microparticles, as well as pitfalls

Overview
Particle embolization has been widely applied for various indications such as tumor devascularization and tumor-related symptom control, including hemorrhagic conditions. Because of significant progress in microcatheter technology, selective embolization has become the standard practice in any organ or location. The choice of embolic agents is essential according to individual pathology, anatomy, and flow dynamics; a variety of microparticles, either spherical or nonspherical, are currently available.
Since the 1970, gelatin sponge (GS) and polyvinyl alcohol (PVA) particles have been widely used as conventional particulate agents. However, the occlusion level of these conventional materials is unpredictable because of their irregular shape and size variability. In general, they tend to aggregate in vessels more proximally than intended, but their tiny fragments can also migrate into the capillary beds. Therefore, it is difficult to achieve the target embolization of intratumoral vessels by using these agents.
Since the 1990, spherical embolic agents or microspheres have been developed to improve the limitations of conventional embolic agents. Because they are spherical and homogeneously calibrated in size, microspheres tend to occlude more distal vessels, and the occlusion level is predictable by selected particles size. Furthermore, drug-eluting beads (DEB) have been introduced for transarterial chemoembolization (TACE) to treat primary and secondary liver tumors. DEB can achieve controlled, sustained drug release from microspheres and enrich the indication of oncological embolization.
Nonspherical particles
PVA particles have been the most popular conventional agents. Their size ranges from 50 to 1200 μm, and the particle suspension is prepared by mixing with diluted contrast media. Although PVA particles are usually calibrated in approximately 200-μm increments, the occlusion level is not correlated with the given particle size because they tend to aggregate in proximal vessels due to their irregular shape. PVA particles can even aggregate inside the microcatheter and may occlude it, especially when dense suspension is rapidly injected. In embolized vessels, PVA particles create the intravascular lattice, and vessel occlusion is completed with platelet aggregation and thrombus formation among the particles. Therefore, recanalization can occur through the organized thrombus, although PVA is regarded as a permanent embolic agent. PVA was first used to treat uterine cancer and vascular tumors of the liver and the head and neck in the 1970, it has since been widely used for various tumors and hemorrhages, such as gastrointestinal bleeding and hemoptysis, for long years.
GS has been the other most popular conventional agent. Small cubes or pledgets are made by hand cutting of sheets, and their sizes are operator dependent. Smaller slurry can also be prepared by pumping syringes to crush the pledgets. Since 2006, porous gelatin particles (Gelpart®; Nippon Kayaku) have been available in Japan as a ready-to-use product. Porous gelatin particles have 1-mm and 2-mm labeled sizes, although their actual sizes are inhomogeneous, especially after microcatheter passage. As gelatin is biodegradable, GS is regarded as absorbable or as a temporary embolic agent. In animal studies, GS is typically absorbed within a few weeks. Thus, GS has been preferred for organ traumas and postpartum hemorrhage and in combination with a mixture of lipiodol and chemotherapeutic agents for liver tumors because preservation of arterial patency and organ function is considered. However, GS can also induce permanent vessel occlusion by residual organized thrombi or fibrotic change of the vessel as well as by chemical damage caused by toxic drugs in chemoembolization.
Spherical particles or microspheres
Microspheres are made of inert elastic polymer with a smooth surface, and the spherical shape allows narrow calibration of the particle size. Microspheres can be easily injected through a microcatheter, and they travel distally to vessels corresponding to the particle size. In histology, a single particle tends to occupy entirely a vessel lumen, and the diameter of embolized vessel and the particle size are well correlated. However, the final location of microspheres does not only depend on the particle size but is also influenced by each mechanical property, injection techniques, and blood flow volumes. For example, softer microspheres with less elastic recovery are more deformable, and they may migrate distally from vessels corresponding to the original particle size. Another concern is particle redistribution that can occur after the injection of a dense suspension of microspheres. Here, numerous microspheres may once aggregate at the vessel bifurcation, but soon or later, they scatter distally and the blood flow resumes. To avoid such a false angiographic endpoint, it is essential to dilute the microsphere suspension adequately to inject it very slowly under free-flow condition and to wait for 5–10 minutes after stop injection to confirm the intended angiographic endpoint.
Trisacryl gelatin microsphere (TGMS) (Embosphere®; Merit Medical) is the first commercial bland microsphere with the following size ranges: 40–120, 100–300, 300–500, 500–700, 700–900, and 900–1200 μm. TGMS was first used for head and neck tumors and AVMs in the 1990. Since the US-FDA approval in 2000–2002, TGMS has been widely used for liver tumor embolization and uterine fibroid embolization. In liver tumor bland embolization, the main goal is "targeted embolization" using smaller microspheres of 40–120 μm and 100–300 μm to achieve intratumoral vessel occlusion until near stasis of the parent artery. In uterine fibroid embolization, the concept of "limited embolization" has been proposed to target perifibroid plexus using larger particles ranging from 500 to 900 μm in size and to minimize the ischemic damage of the normal myometrium. Recently, TGMS has been additionally approved for prostatic embolization to relieve lower urinary tract symptoms associated with benign prostatic hyperplasia. Following the wide acceptance of TGMS, PVA-based microspheres (Contour SE®; Boston Scientific and Bead Block®; Biocompatibles) were introduced in 2003–2004. They have size ranges similar to those of TGMS, which are as follows: 100–300, 300–500, 500–700, 700–900, and 900–1200 μm. In histology, PVA microspheres travelled more distally than TGMS of comparable

size range because they are softer and more deformable than TGMS. Therefore, operators should consider choosing a larger particle size for PVA microsphere than that for TGMS. In 2007, polyphosphazene-coated polymethylmethacrylate microsphere (Embozene®; CeloNova) was introduced. Embozene® microspheres are more precisely calibrated in narrower size range than others: 40, 75, 100, 250, 400, 500, 700, 900, 1100, and 1300 µm. The coating of polyphosphazene (Polyzene-F®) is expected to act as an antithrombogenic and anti-inflammatory material. Such a property might be an advantage when particles persist for a long period in patients with a benign conditions such as uterine fibroid or meningioma.

Finally, the recent drug-delivery technology has introduced drug-eluting microspheres or DEBs. Besides being calibrated microspheres for targeted embolization, DEB can load a specific drug and release the drug locally within the target tissue over a prolonged period. Three commercial products have been approved to treat liver cancers: PVA-based microspheres (DC-Bead®; Biocompatibles), superabsorbent polymer (SAP) microspheres (HepaSphere®; Merit Medical), and (Oncozene®; CeloNova). In these DEBs, microspheres can load a positively charged drug, such as doxorubicin and irinotecan, by ion exchange mechanism. Exceptionally, HepaSphere® microspheres can also load noncharged drugs, such as cisplatin, by the reservoir effect. The goal of TACE using DEB is to deliver a high concentration of chemotherapy to the entire liver tumor with the embolization of intratumoral to peritumoral vessels. To consider the deeper penetration of the particles, each DEB product offers smaller size ranges: DC-Bead M1®, 70–150 µm; HepaSphere®, 30–60 µm; and Oncozene®, 40±10, 75±15, and 100±25 µm. Compared with lipiodol, in conventional TACE, intravascular behavior of DEBs is less visible on fluoroscopy monitoring. To avoid nontarget embolization by reflux as well as the proximal aggregation of DEBs in the feeding artery, the suspension of DEBs should be adequately diluted in half-diluted contrast media, and injection must be very slow (e.g., 1 cc/min).

Future direction

There is growing interest to improve the visualization of microspheres to monitor the behavior of microspheres during injection and to evaluate the intralesional deposit of microspheres after the procedure. Investigation of radiopaque or MR-detectable microspheres is underway. Permanence of embolic effect by nonresorbable microspheres has also become controversial because it may prolong organ ischemia beyond necessity. Thus, the development of resorbable microspheres has been initiated. Ideal characteristics of resorbable microspheres remain unclear, and investigations are underway to optimize chemical components, mechanical properties, biocompatibility, drug chargeability, and resorption time as well as the degree of vessel recanalization. In DEBs, a combination of microspheres with molecular targeting or antiangiogenic agents has been investigated.

References

1. Bédouet L, Verret V, Louguet S, et al. Anti-angiogenic drug delivery from hydrophilic resorbable embolization microspheres: an in vitro study with sunitinib and bevacizumab. Int J Pharm 2015;484:218-227.
2. Erinjeri JP, Salhab HM, Covey AM, et al. Arterial patency after repeated hepatic artery bland particle embolization. J Vasc Interv Radiol 2010;21:522-526.
3. Jordan O, Denys A, De Baere T, et al. Comparative study of chemoembolization loadable beads: in vitro drug release and physical properties of DC bead and hepasphere loaded with doxorubicin and irinotecan. J Vasc Interv Radiol 2010;21:1084-1090.
4. Katsumori T, Kasahara T. The size of gelatin sponge particles: differences with preparation method. Cardiovasc Intervent Radiol 2006;29:1077-1083
5. Khankan AA, Osuga K, Hori S, et al. Embolic effects of superabsorbent polymer microspheres in rabbit renal model:comparison with tris-acryl gelatin microspheres and polyvinyl alcohol. Radiat Med 2004;22:384-390.
6. Laurent A. Microspheres and nonspherical particles for embolization. Tech Vasc Interv Radiol 2007;10:248-256.
7. Laurent A, Wassef M, Namur J, et al. Arterial distribution of calibrated tris-acryl gelatin and polyvinyl alcohol embolization microspheres in sheep uterus. Cardiovasc Intervent Radiol 2010;33:995-1000.
8. Lewis AL, Gonzalez MV, Lloyd AW, et al. DC bead: in vitro characterization of a drug-delivery device for transarterial chemoembolization. J Vasc Interv Radiol 2006;17:335-342.
9. Liapi E, Lee KH, Georgiades CC, et al. Drug-eluting particles for interventional pharmacology. Tech Vasc Interv Radiol 2007;10:261-269.
10. Maeda N, Osuga K, Higashihara H, et al. In vitro characterization of cisplatin-loaded superabsorbent polymer microspheres designed for chemoembolization. J Vasc Interv Radiol 2010;21:877-881.
11. Namur J, Wassef M, Millot JM, et al. Drug-eluting beads for liver embolization: concentration of doxorubicin in tissue and in beads in a pig model. J Vasc Interv Radiol 2010;2:259-267.
12. Osuga K, Anai H, Takahashi M, et al. Porous gelatin particles for hepatic arterial embolization; investigation of the size distribution and fragmentation before and after microcatheter passage. Gan To Kagaku Ryoho 2009;36:437-442.
13. Pelage JP, LeDref O, Beregi JP, et al. Limited uterine artery embolization with tris-acryl gelatin microspheres for uterine fibroids. J Vasc Interv Radiol 2003;14:15-20.
14. Stampfl S, Stampfl U, Bellemann N, et al. Biocompatibility and recanalization characteristics of hydrogel microspheres with polyzene-F as polymer coating. Cardiovasc Intervent Radiol 2008;31:799-806.
15. Tanaka T, Nishiofuku H, Hukuoka Y, et al. Pharmacokinetics and antitumor efficacy of chemoembolization using 40 µm iinotecan-loaded microspheres in a rabbit liver tumor model. J Vasc Interv Radiol 2014;25:1037-1044.

903.3

Ethylene vinyl alcohol

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Learning Objectives

1. To learn about specific properties of ethylene vinyl alcohol
2. To learn about specific indications for the use of ethylene vinyl alcohol
3. To learn tips and tricks for using ethylene vinyl alcohol, as well as pitfalls

Main indication for liquid agents is their ability to deeply penetrate into the vasculature, leading to a complete, permanent occlusion. At present, three agents are commonly used: liquid ethanol, histoacryl (n-butyl cyanoacrylate; NBCA), and Onyx (ethylene-vinyl alcohol copolymer).

Onyx is a liquid embolic agent consisting of ethylene-vinyl alcohol copolymer dissolved in various concentrations of dimethylsulfoxide (DMSO). Onyx is opacified with micronized tantalum powder, which is very radiopaque. The physicochemical characteristics permit a very controlled application. The simultaneous performance of control angiographies during Onyx application proves to be beneficial, while embolizing large lesions due to embolization-induced changes in flow characteristics. Using the "plug-and-push" technique, it is possible to apply Onyx against the direction of blood flow. Disadvantages are high costs. Furthermore, the solvent DMSO requires special catheter material, is toxic to the endothelium, and causes pain during Onyx application.

Currently, Onyx is mainly used for embolotherapy of endoleaks after endovascular aortic aneurysm repair in the treatment of acute arterial bleeding and arterio-venous malformations.

903.4

Acrylic glue

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Learning Objectives
1. To learn about specific properties of acrylic glue
2. To learn about specific indications for the use of acrylic glue
3. To learn tips and tricks for using acrylic glue, as well as pitfalls

No abstract available.

Special Session
Venous Forum II: Deep vein thrombosis

904.1

Trials update and current evidence

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Learning Objectives
1. To present DVT trial results
2. To comment on the various DVT trials
3. To recommend treatment strategies based on trial results

Anticoagulation prevents PE, fatal PE, and clot extension. Recurrent ipsilateral DVT increases PTS risk, and non-therapeutic INR increases PTS risk. –Prandoni P *et al.* Ann Intern Med 1996; 125:1-7. –Prandoni P *et al.* Ann Intern Med 2004; 141:249-256. –Van Dongen *et al.* J Throm Haemost 2005; 3:939-942. New oral anticoagulants are equally effective (PTS unknown), at least as safe, and more convenient. Pros: 1-2x daily oral; no INR, interactions, diet Cons: no antidote, renal failure, missed dose Dabigatran, trade name Pradaxa, target factor II, half-life 12-14 hours, renal clearance 80%, administered twice daily, use heparin first: Yes Rivaroxaban, trade name Xarelto, target factor Xa, half-life 9-13 hours, renal clearance 66%, administered once daily, use heparin first: No Apixaban, trade name Eliquis, target factor Xa, half-life 8-15 hours, renal clearance 25%, administered twice daily, use heparin first: No Edoxaban, trade name Savaysa, target factor Xa, half-life 8-10 hours, renal clearance 35%, administered once daily, use heparin first: Yes CAVENT: CDT prevents PTS? Major bleeds: N = 209, CDT arm = 3.2%, control arm = 0, NS PTS (Villalta): N = 189, CDT arm = 41.1%, control arm = 55.6%, p = 0.047 VTE over 2 years: N = 189, CDT arm = 11%, control arm = 18%, NS Bleeds: no ICH-death, one surgery, one transfusion –Enden T *et al.* Lancet 2012; 379:31-38 CAVENT: QOL Minimally significant –Enden T *et al.* BMJ Open 2013; e002984 Bernutiful Study: ultrasound-assisted CDT (EKOS) Thrombus reduction: ultrasound = 55%, no ultrasound = 54%, NS Need for PTA/stent: ultrasound = 80%, no ultrasound = 83%, NS Complications: ultrasound = 12%, no ultrasound = 8%, NS Patency: ultrasound= 100%, no ultrasound = 96%, NS Villalta PTS: ultrasound = 3.0, no ultrasound = 1.9, NS 48 patients had CDT with 20-mg t-PA over 15 hours with EkoWave, randomized 1:1 to have US turned on –Engelberger RP *et al.* Circ Cardiovasc Interv 2015 ATTRACT study 692 subjects fully enrolled as of 12/2014. Patients had proximal DVT; prior to randomization, had initiation of anticoagulation. Randomized 1:1 to control arm, heparin to warfarin, and PCDT arm. In the PCDT arm, they underwent pharmacomechanical thrombolysis using t-PA and devices, Angiojet, and Trellis. All patients on warfarin for 3 months and ECS. Endpoint is assessment of PTS at 24 months. Study is fully enrolled, but not all subjects have completed 24 months yet. Real-world use of CDT National inpatient sample 2005-2010 (n= 90,618) Propensity-matched patient subsets (n= 7,188) Death: CDT 1.2%, no CDT 0.9%, NS Intracranial bleed: CDT 0.9%, no CDT 0.3%, p = 0.03 Blood transfusion: CDT 11.1%, no CDT 6.5%, p < 0.001 PE: CDT 17.9%, no CDT 11.4%, p < 0.001 LOS: CDT 7.2 days, no CDT 5.0 days, p < 0.001 Charges: CDT $ 85,094, no CDT $ 28,164, p < 0.001 –Bashir R *et al.* JAMA 2014; 174(9):1494-1501. What is the state of aggressive DVT treatment in 2015? In cases of increased clinical severity, CDT is recommended. In cases of extensive anatomic disease and iliofemoral involvement, CDT is recommended. If symptoms have persisted despite anticoagulation for >28 days, CDT is recommended. Take care in patients with increased bleeding risk, and not-recommended for chronically non-ambulatory patients.

References

1. Decousus H et al. NEJM 1998; 338(7):409-415.
2. PREPIC Study Group. Circulation 2005; 112:416-22.
3. Enden T et al. Lancet 2012; 379:31-38.
4. Enden T et al. BMJ Open 2013; e002984.
5. Engelberger RP et al. Circ Cardiovasc Interv 2015.
6. Bashir R et al. JAMA 2014; 174(9):1494-1501.

904.2

Patient selection and treatment: upper limb DVT

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Learning Objectives
1. To describe the entity of Paget-Schroetter syndrome
2. To describe the technique of endovascular therapy
3. To describe results of thrombectomy and thrombolysis

Introduction and background

Upper extremity deep venous thrombosis has an incidence of 2%–10% of all deep venous thromboses. Primary upper extremity deep vein thrombosis (UEDVT) is defined as spontaneously developed thrombosis without any clinically apparent risk factors or after strenuous exercise (effort thrombosis). Screening for occult cancer should be performed in idiopathic thrombosis, while effort thrombosis (Paget-Schrötter syndrome; PSS) typically occurs in young and physically active patients due to repetitive injury to the vein due to the tight thoracic outlet and the frequently repetitive use of arms above the shoulder level. Secondary UEDVT is far more common than the primary form, it develops in the setting of central venous catheter, pregnancy, malignancy, recent surgery, or recent trauma. The incidence of UEDVT is increasing, partly due to an exponential growth in the use of central venous catheters and the increasing placement of permanent cardiac pacemaker or defibrillator devices. Risk factors for catheter-related thrombosis include malignancy, chemotherapy, increased age, diabetes, obesity, and thrombophilia.

Paget-Schrötter syndrome

PSS, first described in 1875, is the venous component of thoracic outlet syndrome, with only 4% of all thoracic outlet syndrome cases. Usually, the dominant arm is affected. Its annual incidence is two cases per 100,000 persons. The subclavian vein can be compressed when the arm is externally rotated or abducted at extreme degrees. Differential diagnosis includes arterial and neurogenic TOS, rotator cuff disorders, Pancoast tumor, vasculitis, infections, and inherited or acquired thrombophilias.

The most common signs and syndromes include unilateral arm swelling, heaviness of the affected upper limb, erythema, discomfort, dilated superficial veins, low-grade fever, dyspnea, and superior vena cava syndrome. Recent studies showed that D-dimer has a negative predictive value of 98% and 93% for upper extremity deep thrombosis and superficial venous thrombosis, respectively.

The main complication of effort UEDVT thrombosis is the post-thrombotic syndrome (venous distension, swelling of the arm, blue discoloration, and pain with exercise). UEDVT thrombosis, especially the secondary form carries a substantial risk of pulmonary embolism

(3%–12%). Symptomatic PE with lower limb DVT was three times more frequent compared with UEDVT in the RIETE registry (29% vs. 9%); however, 3-month mortality rate was higher in the UEDVT group (11% vs. 7%). Recurrence rate is smaller in UEDVT than lower limb DVT.

Imaging

Plain radiography

This may be useful in identifying cervicothoracic osseous abnormalities (e.g., abnormal first rib).

Ultrasound

On B-mode imaging, echogenicity may vary in acute thrombosis. As usual, noncompressibility defines the presence of DVT. Obviously, this evaluation technique cannot be used either for the centrally situated veins (i.e., brachiocephalic veins and superior vena cava) or for the medial segment of subclavian veins near the clavicle. Absence of flow and the normal biphasic pattern on pulsed wave Doppler can also suggest DVT (75% sensitivity; 100% specificity). A recent guideline suggests the use of compressions and Doppler US ("Combined modality US") as the initial diagnostic test.

Contrast venography (CV)

Earlier, it has been the reference standard for suspected lower limb DVT. Contrast medium is injected into the distal vein of the upper extremity. Thrombus is identified as a filling defect present in more than one view. However, interobserver agreement on venogram interpretation in suspected DVT is only 70%–80%. This technique is reserved when initial noninvasive imaging is insufficient for a conclusive diagnosis or is negative in case of high-clinical suspicion of DVT. CV visualizes veins at the thoracic outlet. However, it requires radiation exposure and intravenous contrast, and is technically demanding. CO_2 venography has been used in small studies with acceptable results (97% sensitivity and 85% specificity against standard contrast venography).

Computed tomography venography (CTV)

Pooled sensitivity of 96% and specificity of 95% was found in a recent study against US or CV in lower limb studies; upper extremity investigations were scarce. Obvious disadvantages of CTV include ionizing radiation and risk associated with intravenous iodinated contrast medium.

Magnetic resonance venography (MRV)

There are very few studies on MR diagnosis of UEDVT; most of our current experience is from publications investigating lower extremity. Pooled sensitivity and specificity of CE-MRV was 91% and 95%, respectively, against CV as the reference standard in lower limb veins. TOF-MRV is also promising. Magnetic resonance direct thrombus imaging (MRDTI) can distinguish recent from chronic thrombus in case of recurrent DVT in the lower extremity.

Treatment possibilities

Anticoagulation

The mainstay therapy is therapeutically dosed parenteral anticoagulant bridged to an oral anticoagulant. INR should reach 2.0 or higher in two measurements with a difference in time of at least 24 hours. Acute phase therapy is for 3 months. Complication rate of anticoagulation therapy includes 2%–4% of major bleeding. A retrospective analysis reported increased symptomatic resolution (48% vs. 70%). Indications of anticoagulation therapy beyond 3 months are uncertain; provoked situations (e.g., cancer and central venous catheter) or UEDVT with tight thoracic outlet (not corrected surgically) may justify long-term anticoagulation treatment. In case of PSS, if compressive forces are not eliminated, then benefits of anticoagulation may be limited.

Endovascular therapies

Thrombolysis and thrombectomy

Systemic thrombolysis has been largely replaced by catheter-directed thrombolysis in the lower limb DVT due to the smaller number of bleeding complications and better rates of valvular competence. Catheter-directed thrombolysis (CDT) uses a multiport catheter placed directly into the thrombus using image guidance. The risk of bleeding is directly proportional to the volume and duration of CDT. For lower limb treatment, typical regimen consists of continuous high-volume drip regimen with dilute thrombolytics and concomitant unfractionated heparin. Clearance rates are 70%–90%. Clots older than 2 weeks are generally less susceptible for thrombolysis. Most common complications are typically access site bleeding (major bleeding rate is approximately 10%). Appropriate case selection is challenging. Thrombolysis can be followed by elective thoracic outlet decompression procedure. There are only scarce data on percutaneous mechanical thrombectomy for the upper limb DVT.

Angioplasty and stenting

Limited data are available in the literature. Stent placement for central and peripheral limb obstruction in 65 patients showed a clinical success rate of 75% and 42% at 12 and 24 months, respectively, with a high rate of reintervention. A smaller study (22 patients) reported occlusion of stents in all patients with Paget-Schrötter syndrome. Angioplasty has higher failure rate if attempted before decompression. Indications for these interventions are uncertain, and long-term data are lacking. Unless contraindicated, anticoagulation should follow all interventional treatments.

Superior vena cava filter

A recent systematic review analysis on 209 SVC filter placements showed a complication rate of 3.8% (mainly filter strut perforation causing cardiac tamponade, pneumothorax, and aortic perforation). The benefit is yet uncertain. Currently, SCV filter has little role in the management of UEDVT.

Conclusions

The combination of clinical decision score, D-dimer testing, and ultrasonography can safely and effectively exclude UEDVT. The cornerstone of UEDVT treatment is anticoagulation. Angioplasty has higher failure rates if attempted before decompression; stenting may be indicated if PTA fails and decompressive forces are eliminated. The long-term benefit of thrombolysis and thrombectomy is currently unclear; selective patients with acute thrombosis having severe syndromes and low-bleeding risk may be considered. Placement of superior vena cava filter may only be considered in patients with contraindications for anticoagulation therapy and pulmonary embolism. Clear indications for endovascular therapies warrant data from larger-scale studies or randomized trials.

References

1. Bates SM, et al. Diagnosis of DVT: antithrombotic therapy and prevention of thrombosis, 9th ed: American College of Chest Physicians Evidence-Based Clinical Practice Guidelines. Chest 2012;141:e351S-418S.
2. Czihal M, Hoffmann U. Upper extremity deep venous thrombosis. Vasc Med. 2011;16:191-202.
3. Grant JD, et al. Diagnosis and management of upper extremity deep-vein thrombosis in adults. Thromb Haemost. 2012;108:1097-108.
4. Heye S, Maleux G, Marchal GJ. Upper-extremity venography: CO_2 versus iodinated contrast material. Radiology 2006;241:291-297.
5. Kearon C, et al. Antithrombotic therapy for VTE disease: antithrombotic therapy and prevention of thrombosis, 9th ed: American College of Chest Physicians Evidence-Based Clinical Practice Guidelines. Chest 2012;141:e419S-494S.
6. Kleinjan A, et al. Safety and feasibility of a diagnostic algorithm combining clinical probability, d-dimer testing, and ultrasonography for suspected upper extremity deep venous thrombosis: a prospective management study. Ann Intern Med. 2014;160:451-457.
7. Leung A1, Heal C, Perera M, Pretorius C. A systematic review of patient-related risk factors for catheter-related thrombosis. J Thromb Thrombolysis 2015 Feb 14. [Epub ahead of print].
8. Merminod T, Pellicciotta S, Bounameaux H. Limited usefulness of D-dimer in suspected deep vein thrombosis of the upper extremities. Blood Coagul Fibrinolysis 2006;17:225-226. [Epub ahead of print].

9. Munoz FJ, et al. Clinical outcome of patients with upper-extremity deep vein thrombosis: results from the RIETE Registry. Chest 2008;133:143-148.
10. Naeem M, Soares G, Ahn S, Murphy T. Paget-Schroetter syndrome: A review and Algorithm (WASPS-IR). Paget-Schroetter syndrome: A review and Algorithm (WASPS-IR). Phlebology 2015 Feb 11. [Epub ahead of print].
11. Oderich GS, Treiman GS, Schneider P, Bhirangi K. Stent placement for treatment of central and peripheral venous obstruction: a long-term multi-institutional experience. J Vasc Surg. 2000;32:760-769.
12. Owens CA, Bui JT, Knuttinen MG, Gaba RC, Carrillo TC. Pulmonary embolism from upper extremity deep vein thrombosisand the role of superior vena cava filters: a review of the literature. J Vasc Interv Radiol. 2010;21:779-787.
13. Patel MC, Berman LH, Moss HA, McPherson SJ. Subclavian and internal jugular veins at Doppler US: abnormal cardiac pulsatility and respiratory phasicity as a predictor of complete central occlusion. Radiology 1999;211:579-583.
14. Ponec D, et al. Recombinant tissue plasminogen activator (alteplase) for restoration of flow in occluded central venous access devices: a double-blind placebo-controlled trial—the Cardiovascular Thrombolytic to Open Occluded Lines (COOL) efficacy trial. J Vasc Interv Radiol. 2001;12:951-955.
15. Sajid MS, Ahmed N, Desai M, Baker D, Hamilton G. Upper limb deep vein thrombosis: a literature review to streamline the protocol for management. Acta Haematol. 2007;118:10-18.
16. Sartori M, et al. D-dimer for the diagnosis of upper extremity deep and superficial venous thrombosis. Thromb Res. 2015;135:673-678.
17. Schneider DB, et al. Combination treatment of venous thoracic outlet syndrome: open surgical decompression and intraoperative angioplasty. J Vasc Surg. 2004;40:599-603.
18. Thomas SM, Goodacre SW, Sampson FC, van Beek EJ. Diagnostic value of CT for deep vein thrombosis: results of a systematic review and meta-analysis. Clin Radiol. 2008;63:299-304.
19. Urschel HC Jr., Patel AN. Paget-Schroetter syndrome therapy: failure of intravenous stents. Ann Thorac Surg. 2003;75:1693-1696.

904.3

Patient selection and treatment: lower limb DVT

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Learning Objectives

1. To review the indications, pre-procedural imaging and clinical evaluation
2. To describe the technique of endovascular therapy
3. To compare the results of various therapeutic approaches: medicamentous, endovascular, and surgical therapy

Acute deep vein thrombosis (DVT) in the region between the popliteal vein termination and the confluence of the common iliac veins is usually treated by anticoagulation (AC) with bed rest and compression stockings [1]. However, almost 90% of patients with DVT will have relevant symptoms; and despite AC, 15% of these will develop stasis ulcers due to venous hypertension that results from residual venous obstruction and valve incompetence [2]. This chronic venous insufficiency, most commonly manifesting as postthrombotic syndrome (PTS), occurs in up to 75% of patients with proximal DVT [3] and is more severe in those with iliofemoral DVT. These late postthrombotic complications of DVT are common but often unrecognized by those responsible for the initial management.

Iliac vein occlusion (IVO) rarely recanalizes, resulting in persistent iliac obstruction and increased ambulatory venous pressures. In contrast to femoropopliteal occlusion by DVT, which can access alternative venous channels, sudden venous outflow obstruction of IVO may cause both ''white'' and ''blue'' phlegmasia. It is important to differentiate, that phlegmasia alba dolens, or white, painful thrombosis, is not due to arterial obstruction, as the color suggests, but rather to arterial spasm in response to the marked increase in outflow obstruction caused by the venous thrombosis [1]. Thus, in the acute setting of suprapopliteal DVT, a threatened limb (phlegmasia) requires aggressive and urgent intervention to avoid limb loss.

Long-term AC is an essential treatment component to prevent propagation of any persisting clot, helps to relieve symptoms, and prevents pulmonary embolism, although if used alone it yields just 6% complete DVT lysis at 10 days [4].

Surgical thrombectomy with calf massage and intravenous heparin is a method to remove bulk thrombus. Including a temporary surgical arteriovenous fistula formation has been successfully performed in order to preserve valve function and reduced the rate of PTS [5]. Although surgical thrombectomy is more effective than AC alone, it is rarely performed, in part because of the relatively high recurrence rates as compared to catheter-directed thrombolysis (CDT). Furthermore, the indication for operative thrombectomy during acute DVT in the absence of phlegmasia cerulean dolens is still not well defined [6].

As early as 1933, Tillett and Garner reported successful fibrinolysis using streptokinase [7]. However, the risk of allergy and high incidence of antibody formation reduced its effectiveness, thus other direct tissue plasminogen activators, including alteplase, increased the effectiveness and specificity of thrombolysis. So far, systemic thrombolysis results in three times better lysis compared to AC alone but four times the increased risk of major bleeding [8].

As a result of complications related to systemic thrombolysis and the limited results of surgical thrombectomy in DVT, localized treatment techniques using catheter-based (pharmaco)mechanical-assisted thrombectomy devices were developed to treat acute and early iliofemoral DVT [2, 3, 8-32].

Interventional techniques

Most promising techniques of thrombus removal include CDT, pulse-spray technique, and mechanical devices (table 1). CDT uses a thrombolytic infusion through an end-hole catheter into the thrombus, usually followed by aspirating the loosened fragments of clots. The pulse-spray technique increases penetration of the thrombus by a lytic agent using a multiple side-holed catheter placed through the thrombus. Then the lytic drug is intermittently sprayed over several hours until adequate results are shown by repeat venography. Mechanical devices aim to macerate clots either by a spinning metallic helix or by a rotating wire between the balloons and to aspirate fragmented thrombus from the vein. These systems may use burst-sprayed saline with or without thrombolytic to further macerate thrombus. In particular in patients who have relative contraindications to thrombolysis, these maceration/aspiration systems may be considered [23].

Table 1. Devices for catheter-directed (pharmaco)mechanical thrombolysis

Mechanical devices:

Aspiration thrombectomy: large bore aspiration catheter (7F or larger) and negative syringe pressure for mechanical clot removal.

AngioVac (Angio Dynamics, Latham, NY): removal of soft, fresh thrombi or emboli utilizing extracorporeal bypass.

Arrow Trerotola PTD (Arrow, Reading, PA, USA): macerates clot with a spinning metallic helix and aspirates it from the vein.

Aspirex S Catheter (Straub Medical, Wangs, Switzerland): macerates clot with a spinning metallic helix and aspirates it from the vein.

Clot Buster Amplatz Thrombectomy (ATD, Minneapolis, MN): macerates clot with rotating helix device.

Pharmacomechanical devices:
AngioJet (Possis, Minneapolis, MN): burst-sprayed power pulse thombolysis + thrombectomy by Venturi effect.
Ekos EndoWave system (Ekos, Bothell, WA): ultrasound-assisted thrombolysis to exposes additional plasminogen receptor sites to the thrombolytic agent.
Trellis (Bacchus Vascular, Santa Clara, CA): thrombus fragmentation by rotating sinusoidal wire + local thrombolysis + aspiration with embolic protection by two inflated balloons.
Evidence for interventional therapy
There is level III intervention evidence that earlier, more complete removal of thrombus will result in reduced DVT recurrence and its subsequent complications, including PTS, and will improve the quality of life [2, 23]. Despite interesting case series and small single-center studies, there is still a lack of prospective, randomized data regarding the safety, efficacy, and cost of thrombolytics versus anticoagulants (including the acute procedure, ongoing treatments, and management of complications). Clinical benefit end points in several series are also poorly defined, which makes direct comparison difficult [33].
CDT with local delivery of thrombolytic to the thrombus produces more favorable results than systemic thrombolysis, with almost double the venous patency rate at 1 year and an approximately 80% overall success rate [8]. Manual aspiration thrombectomy [20] coupled with inferior vena cava (IVC) filter insertion and optional basket clot fragmentation provided successful clot lysis in nearly 90% of patients; however, in cases when the aspiration technique was inadequate or failed, CDT was included.
Using the Clot Buster Amplatz Thrombectomy Device (ATD, Minneapolis, MN) complete lysis in 44% of patients was achieved as early as in 2001 [9]; however, patients experienced transient arterial desaturation which might be caused by micropulmonary emboli induced by the device. The incidence of PE in these cases seems to be similar to the significant incidence of PE as reported with the pulse-spray technique, evident in 18% of patients who underwent treatment for thrombosed dialysis grafts using plasminogen activator but increasing to 64% when heparin alone was used [1]. This data indicates that the incidence of PE is reduced by adding a plasminogen activator. One approach is to speed drug dispersion within the thrombus by loosening fibrin strands. However, as shown in the Bernutiful trial, the addition of the EKOS system during CDT did not facilitate thrombus resolution [31].
Another approach is the pharmacomechanical thrombolysis using thrombolytic agents and mechanical maceration or disruption of clot, that offers easier and more complete thrombus aspiration [11, 14, 16, 19]. Using the AngioJet system episodic reports of hemolysis, resulting in decreased white blood cell and platelet counts in porcine models indicate the need of a carefully and cautious application of this system [18]. Nevertheless, a major advantage of pharmacomechanical thrombolysis vs. the original CDT technique is the shorter duration (26h vs. 48h), a lower amount of lytic agent used (2.6 vs. 5.6 mU), the higher lysis rate (>90% vs 73%) and the lower costs, whereas no difference in major complication was observed [1, 16, 34, 35]. Recently, routine venous stenting after CDT has been associated with patency rates >90% and a low rate of PTS [23, 24, 36, 37].
Patient selection
Considering the current evidence, the most favorable outcome is achieved by selecting patients with large suprapopliteal clot burden, younger age, iliac vein compression syndrome, a low risk of bleeding, < 2 weeks from onset of symptoms, an acceptable life expectancy (all evidence 2A), and limb-threatening venous ischemia (phlegmasia) due to iliofemoral DVT (evidence 1A), [1]. Immediate thrombus removal should be attempted since this population has the highest risk to develop PTS [8]. Nevertheless, after acute AC long-term heparin, or warfarin (international normalized ratio 2–3) for at least 3-6 months up to 2 years is still recommended thereafter, and patients should wear long leg compression stockings for 6 months [1, 38, 39].
Acute DVT induced by the formation of venous spurs and synechiae due to a typically left-sided compressed proximal left common iliac vein (May-Thurner syndrome) is a rewarding indication for thrombectomy, thrombolysis, and subsequent stent placement, since recurrence of untreated acute left iliofemoral DVT is as high as 73% [40].
Routine IVC filter insertion may be unwarranted and necessary only in particular cases such as reduced cardiopulmonary reserve or free-floating thrombus [1].
However, in patients with recent internal bleeding, severe hypertension, or recent cardiovascular accident, thrombolysis of the suprapopliteal DVT is contraindicated and should only applied after careful consideration of the overall benefit-to-risk profile [1, 2].
Proximal lower extremity DVT
A proximal lower extremity DVT (pDVD) is defined as a constant and incompressible intraluminal deep venous defect at or above the popliteal vein. When thrombus extends above the popliteal vein, it may involve the iliac veins or the inferior vena cava and potentially fatal pulmonary embolism will develop in 10% of these patients [23]. However, isolated femoropopliteal DVT is treated by conventional AC therapy since data does not support early thrombus removal (evidence 1C) [41].
Deep calf vein thrombosis
Controversy still persists as today whether deep calf vein thrombosis (cDVT) should be treated with AC or observed with duplex surveillance. In a systematic review of the literature Masuda et al assessed whether data could support either approach [28]. So far, data shows that cDVT will propagate in 8-15% into the popliteal vein or higher. In two studies of moderately strong methodology, AC reduced the propagation of cDVT into higher veins. Recent surgery, trauma, and malignancy was associated with an increased risk of propagation and advocates AC for this high-risk group. Pulmonary emboli (PE) with unassigned treatment were strikingly lower than the historical reports. It seems that recurrence of cDVT is lower than in thigh DVT, and data suggest that in low-risk groups with transient risk factors, 6 weeks of AC may be sufficient. Studies of PTS reported that patients with cDVT had fewer symptoms than their thigh DVT counterparts. The authors concluded that no study of strong methodology was found to resolve the controversy of optimal treatment of cDVT. Further, no data supports the use of thrombolytic drugs in localized infrapopliteal venous thrombosis [1].
Conclusion
In patients with iliofemoral DVT, early thrombus removal can be safely and effectively performed as a first-line therapy by percutaneous catheter-based techniques (2C). Pharmacomechanical thrombolysis may be considered over catheter-directed pharmacologic thrombolysis (2C) alone if expertise and resources are available [41]. There is increasing evidence that this preserves venous valve function [42], reduces longer-term venous hypertension, and lowers the incidence of PTS.
Solitary minor pDVT, or cDVT, can be safely treated with compression stockings and AC without the need for urgent intervention, such as CDT or mechanical thrombectomy, given the associated low morbidity and mortality [1, 28, 43].
Open surgical thrombectomy may be suitable in selected patients who are candidates for AC but in whom thrombolytic therapy is contraindicated (2C).

References

1. Pianta, M.J. and K.R. Thomson, Catheter-directed thrombolysis of lower limb thrombosis. Cardiovasc Intervent Radiol, 2011. 34(1): p. 25-36.
2. Hood, D.B. and J.Q. Alexander, Endovascular management of iliofemoral venous occlusive disease. Surg Clin North Am, 2004. 84(5): p. 1381-96, viii.
3. Kwon, S.H., et al., Percutaneous aspiration thrombectomy for the treatment of acute lower extremity deep vein thrombosis: is thrombolysis needed? Clin Radiol, 2009. 64(5): p. 484-90.

4. Alonso, A., et al., In vivo clot lysis of human thrombus with intravenous abciximab immunobubbles and ultrasound. Thromb Res, 2009. 124(1): p. 70-4.
5. Plate, G., et al., Venous thrombectomy for iliofemoral vein thrombosis--10-year results of a prospective randomised study. Eur J Vasc Endovasc Surg, 1997. 14(5): p. 367-74.
6. Greenfield, L.J. and E.L. Alexander, Current status of surgical therapy for deep vein thrombosis. Am J Surg, 1985. 150(4A): p. 64-70.
7. Tillett, W.S. and R.L. Garner, The Fibrinolytic Activity of Hemolytic Streptococci. J Exp Med, 1933. 58(4): p. 485-502.
8. Comerota, A.J. and D. Paolini, Treatment of acute iliofemoral deep venous thrombosis: a strategy of thrombus removal. Eur J Vasc Endovasc Surg, 2007. 33(3): p. 351-60; discussion 361-2.
9. Delomez, M., et al., Mechanical thrombectomy in patients with deep venous thrombosis. Cardiovasc Intervent Radiol, 2001. 24(1): p. 42-8.
10. Vedantham, S., et al., Society of Interventional Radiology position statement: treatment of acute iliofemoral deep vein thrombosis with use of adjunctive catheter-directed intrathrombus thrombolysis. J Vasc Interv Radiol, 2006. 17(4): p. 613-6.
11. Cynamon, J., et al., A new method for aggressive management of deep vein thrombosis: retrospective study of the power pulse technique. J Vasc Interv Radiol, 2006. 17(6): p. 1043-9.
12. Brightwell, R.E. and I.S. Osman, Iliofemoral deep vein thrombosis in childhood; developing a management protocol. Eur J Vasc Endovasc Surg, 2006. 31(6): p. 667-78.
13. Protack, C.D., et al., Long-term outcomes of catheter directed thrombolysis for lower extremity deep venous thrombosis without prophylactic inferior vena cava filter placement. J Vasc Surg, 2007. 45(5): p. 992-7; discussion 997.
14. O'Sullivan, G.J., et al., Pharmacomechanical thrombectomy of acute deep vein thrombosis with the Trellis-8 isolated thrombolysis catheter. J Vasc Interv Radiol, 2007. 18(6): p. 715-24.
15. Oguzkurt, L., et al., Iliac vein compression syndrome: outcome of endovascular treatment with long-term follow-up. Eur J Radiol, 2008. 68(3): p. 487-92.
16. Martinez Trabal, J.L., et al., The quantitative benefit of isolated, segmental, pharmacomechanical thrombolysis (ISPMT) for iliofemoral venous thrombosis. J Vasc Surg, 2008. 48(6): p. 1532-7.
17. Parikh, S., et al., Ultrasound-accelerated thrombolysis for the treatment of deep vein thrombosis: initial clinical experience. J Vasc Interv Radiol, 2008. 19(4): p. 521-8.
18. Lang, E.V., et al., Hemolysis comparison between the OmniSonics OmniWave Endovascular System and the Possis AngioJet in a porcine model. J Vasc Interv Radiol, 2008. 19(8): p. 1215-21.
19. Hilleman, D.E. and M.K. Razavi, Clinical and economic evaluation of the Trellis-8 infusion catheter for deep vein thrombosis. J Vasc Interv Radiol, 2008. 19(3): p. 377-83.
20. Shi, H.J., et al., Percutaneous mechanical thrombectomy combined with catheter-directed thrombolysis in the treatment of symptomatic lower extremity deep venous thrombosis. Eur J Radiol, 2009. 71(2): p. 350-5.
21. Nazir, S.A., et al., Endovascular treatment options in the management of lower limb deep venous thrombosis. Cardiovasc Intervent Radiol, 2009. 32(5): p. 861-76.
22. Comerota, A.J., Randomized trial evidence supporting a strategy of thrombus removal for acute DVT. Semin Vasc Surg, 2010. 23(3): p. 192-8.
23. Karnabatidis, D., et al., Quality improvement guidelines for percutaneous catheter-directed intra-arterial thrombolysis and mechanical thrombectomy for acute lower-limb ischemia. Cardiovasc Intervent Radiol, 2011. 34(6): p. 1123-36.
24. O'Sullivan, G.J., The role of interventional radiology in the management of deep venous thrombosis: advanced therapy. Cardiovasc Intervent Radiol, 2011. 34(3): p. 445-61.
25. Liu, F., P. Lu, and B. Jin, Catheter-directed thrombolysis for acute iliofemoral deep venous thrombosis. Ann Vasc Surg, 2011. 25(5): p. 707-15.
26. Jenkins, J.S., Endovascular therapies to treat iliofemoral deep venous thrombosis. Prog Cardiovasc Dis, 2011. 54(1): p. 70-6.
27. Vedantham, S., Endovascular procedures in the management of DVT. Hematology Am Soc Hematol Educ Program, 2011. 2011: p. 156-61.
28. Masuda, E.M., et al., The controversy of managing calf vein thrombosis. J Vasc Surg, 2012. 55(2): p. 550-61.
29. Fahrni, J., et al., Catheter-based treatment of ilio-femoral deep vein thrombosis - an update on current evidence. Vasa, 2013. 42(3): p. 161-7.
30. Willenberg, T., et al., [Acute interventional therapy of deep venous thrombosis]. Dtsch Med Wochenschr, 2014. 139(6): p. 231-3.
31. Engelberger, R.P., et al., 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(6): p. 1153-60.
32. O'Sullivan, G.J., et al., Thrombolysis and iliofemoral vein stent placement in cancer patients with lower extremity swelling attributed to lymphedema. J Vasc Interv Radiol, 2015. 26(1): p. 39-45.
33. Kettenbach, J. and R. Aujesky, There is enough evidence to justify lysis/thrombectomy for acute iliofemoral DVT: Con. 2013, CIRSE. p. 200.
34. Kim, H.S., et al., Catheter-directed thrombolysis with percutaneous rheolytic thrombectomy versus thrombolysis alone in upper and lower extremity deep vein thrombosis. Cardiovasc Intervent Radiol, 2006. 29(6): p. 1003-7.
35. Lin, P.H., et al., Catheter-direct thrombolysis versus pharmacomechanical thrombectomy for treatment of symptomatic lower extremity deep venous thrombosis. Am J Surg, 2006. 192(6): p. 782-8.
36. Oguzkurt, L., F. Tercan, and U. Ozkan, Manual aspiration thrombectomy with stent placement: rapid and effective treatment for phlegmasia cerulea dolens with impending venous gangrene. Cardiovasc Intervent Radiol, 2008. 31(1): p. 205-8.
37. Engelberger, R.P., et al., Ultrasound-assisted versus conventional catheter-directed thrombolysis for acute iliofemoral deep vein thrombosis. Circ Cardiovasc Interv, 2015. 8(1).
38. Snow, V., et al., Management of venous thromboembolism: a clinical practice guideline from the American College of Physicians and the American Academy of Family Physicians. Ann Fam Med, 2007. 5(1): p. 74-80.
39. Galanis, T., G. Keiffer, and G. Merli, The new oral anticoagulants for the treatment of venous thromboembolism: a new paradigm shift in antithrombotic therapy. Curr Ther Res Clin Exp, 2014. 76: p. 76-83.
40. Oguzkurt, L., et al., Compression of the left common iliac vein in asymptomatic subjects and patients with left iliofemoral deep vein thrombosis. J Vasc Interv Radiol, 2008. 19(3): p. 366-70; quiz 371.
41. Meissner, M.H., et al., Early thrombus removal strategies for acute deep venous thrombosis: clinical practice guidelines of the Society for Vascular Surgery and the American Venous Forum. J Vasc Surg, 2012. 55(5): p. 1449-62.
42. Vogel, D., et al., Comparison of vein valve function following pharmacomechanical thrombolysis versus simple catheter-directed thrombolysis for iliofemoral deep vein thrombosis. J Vasc Surg, 2012. 56(5): p. 1351-4.
43. Watson, L.I. and M.P. Armon, Thrombolysis for acute deep vein thrombosis. Cochrane Database Syst Rev, 2004(4): p. CD002783.

904.4

Chronic iliac vein and caval occlusion

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Learning Objectives

1. To review the indications, pre-procedural imaging and clinical evaluation
2. To describe the technique of endovascular therapy
3. To compare the results of various therapeutic approaches: medicamentous, endovascular, and surgical therapy

The incidence of deep venous thrombosis (DVT) in the literature is about 3/1000 per year in the adult population. In the two years following DVT, between 30% and 60% develop a post-thrombotic syndrome (PTS), with 10% developing severe PTS, resulting in disability and a severe impact on the quality of life. Moreover, the socioeconomic impact is significant. In the vast majority, PTS is caused by chronic iliofemoral obstructive venous disease due to suboptimal recanalization after conservative anticoagulative therapy. Treatment for chronic deep venous disease has also been characterized by the sole use of conservative modalities. Open surgical or endovascular approaches were only reserved for the most severe cases. In recent years, however, the treatment options in chronic deep venous obstructive disease have changed dramatically. Endovascular treatment, by use of percutaneous transluminal angioplasty (PTA) and stenting, has become the standard of care in a great number of specialized centers worldwide. Due to low morbidity, absence of mortality, and excellent short- and long-term results, worldwide interest in this type of treatment is quickly increasing and more and more centers are starting to offer this treatment. Technical success rates of endovascular venous recanalization described in the literature are well above 90%, generally approaching 100% depending on studies and patient population. Secondary patency rates are high and generally exceed 90% after 5 years. Clinical outcome is also encouraging with pain relief, reduction in leg swelling, and ulcer healing in the vast majority of cases.

We identify three groups of indications for deep venous stenting. First, venous compression syndromes seem to be best treated by stenting. May-Thurner syndrome, in the most classic form, is caused by compression of the left iliac vein by the right common iliac artery. The pelvic anatomy harbors multiple potential compression sites, however, and several locations have been identified in iliac veins bilaterally. Malignancy comprises another category of compression syndromes, with superior vena cava syndrome as the most devastating. Second, DVT-related venous obstructions are nowadays generally accepted as a good indication for stenting. In the acute phase, however, stenting has no place. Awaiting the results of randomized controlled trials (ATTRACT, CAVA), the primary treatment for DVT seems to move towards endovascular thrombus removal. It becomes more evident, however, that in a majority of cases, a cause for DVT can be found in the underlying compression of the iliac vein, which should be stented to prevent recurrent DVT. Chronic vein obstructions caused by unsuccessful recanalization after conventional measures should be treated primarily by stenting. Over the last two decades, iliofemoral stenting proved feasible with very high patency rates. This does not mean, however, that all obstructed venous segments can be readily stented. Stenting unilateral iliac vein obstructions show the highest patency and usually succeed without complications. Bilateral iliocaval chronic occlusions show lower success rates and long-term patency. Even worse outcome is seen when stents are positioned below the inguinal ligament, more specifically below the femoral vein confluence, and should therefore be avoided. Third, congenital disorders, mostly located at the level of the inferior vena cava (IVC), can result in venous flow obstruction. Subsequently, patients might suffer from venous hypertension or secondary DVT caused by a sudden decompensation in blood outflow patterns. After successful thrombolysis, recanalization and stenting of the IVC should be performed to relieve complaints and reduce the risk of recurrent DVT.

The recanalization procedure is performed under local analgesia in some cases of sole external vein compression (i.e., MTS) or general anesthesia in most cases of post-thrombotic disease. In contrast to arterial obstructions, PTA alone is never enough to recanalize the vein completely; stenting with self-expandable stents is always necessary to permanently push away the fibrotic trabeculations and webs. Principally, stenting should be performed from healthy to healthy, i.e., all diseases venous segments have to be covered by stents. In cases of extensive obstruction in the common femoral vein (CFV), insufficient inflow into iliac segments can be expected; in these cases, it is advised to perform an endophlebectomy (surgical desobstruction) of the CFV with or without an AV fistula to improve patency during follow-up. The stenting procedure itself encompasses access to the femoral vein under ultrasound guidance. A 5-10-F sheath is then introduced, and angiography is performed to assess the extent and localization of the venous obstruction. In total iliac occlusive disease, it is important to visualize collateral pathways, which helps to determine the anatomical route for recanalization. Therefore, angiography in multiple projections is helpful. By use of hydrophilic guidewires, the obstruction can be passed in most cases. In difficult cases of extensive post-thrombotic disease, CTO wires and catheters might be used to optimize technical success. Following the crossing of the obstruction, the affected vein segments are pre-dilated with non-compliant balloons. Over-dilating the obstructed veins facilitate complete stent deployment since significant recoil is seen after initial PTA. The risk of vein rupture and subsequent bleeding is very small, and pre-dilation till 16-14 mm can safely be performed in the iliac veins down to the level of the inguinal ligament. Stent sizing is fairly standard in occlusive disease, with 14-mm stents in the iliac veins and 12-mm stents over the inguinal ligament into the CFV. Stent migration in this entity is non-existent. However, the risk of stent migration increases in compressive disease since the vein wall is still smooth in most cases and does not have enough hold on the stent. Oversizing the stent is therefore advised. In most cases, 16-mm stents will suffice; however, specific patients with particularly large veins sometimes need diameters up to 18-20 mm. Following stent placement, the treated segments are dilated again for optimal deployment and wall apposition. Completion angiography is then performed to evaluate flow through the stented segments and the absence of collaterals. Stagnant flow within the stents should further be evaluated, and residual stent compression has to be excluded. However, an indication of significant flow obstruction on anteroposterior projection might be nothing more than a minimal line of contrast on lateral projection and therefore needs no further action. In the situation of significant flow obstruction without stent compression, the degree of inflow might be the prominent limiting factor. Principally, the femoral vein and the deep femoral (profunda) vein are the prominent outflow veins of the leg and are significant for long-term patency of the stented iliac veins. When post-thrombotic disease is limited to the CFV, an exclusive endovascular approach is possible because stents can be extended down to the femoral vein confluence. However, when trabeculations extent into one or both femoral veins, inflow into the stents is hampered and might be worsened by placing stents distal to the femoral confluence. The better alternative is considered to be surgical desobstruction of the femoral outflow vein orifices and adding an AV fistula to further increase flow. The fistula can be electively closed after 6-8 weeks to prevent focal restenosis. Another factor that might limit patency can be found in stents and stent design. For a long time, veins were treated with stents designed for arterial disease. Stent specifications were determined based upon the nature of the disease, i.e., atherosclerotic. High radial force or crush resistance has never

been the predominant feature of vascular stents before. However, in external compressive and post-thrombotic disease, higher hoop strength is necessary to maintain sufficient stent lumen. Moreover, stents placed into the iliac veins are continuously forced into multiple curves and should therefore be flexible. Rigid stents have a tendency to straighten and might change venous anatomy and hamper the integrity of the vein. The awareness of this philosophy continues to increase among venous specialists, and currently there is shift towards dedicated venous stent design. First experience with dedicated venous stents indicates that stent-related complications decrease and patency rates improve.
If venous flow is uncompromised and optimal stent configuration is confirmed, the most important factor for short-term patency is coagulability. After PTA and stent placement, a clear hypercoagulability state exists. Therefore, it is advised that patients are anticoagulated post-operatively for at least 5 days with LMWHs, during which anticoagulation with vitamin K antagonist is started. This is continued for at least 6 months, aiming at an INR of 2.5-3.5. Recently, new oral anticoagulants, i.e., rivaroxaban and dabigatran, have been suggested as alternatives to coumarins in some patients. Patients are generally discharged within 24 hours after endovascular intervention and 48 hours after hybrid intervention when duplex evaluation does not show any complications. The first visit to the outpatient clinic should be planned no later than 2 weeks after the interventions, since cases of early re-thrombosis are clearly better treatable within this timeframe.
In conclusion, endovascular treatment of iliocaval obstructions is generally accepted and technically feasible in virtually all cases and shows very high patency rates. Dedicated venous materials and availability of flow-increasing techniques further optimize long-term results.

Fundamental Course
Basic principles of biopsy and drainage procedures

1001.1

Percutaneous biopsy of easy and difficult lesions in the lungs and mediastinum

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Learning Objectives
1. To learn about the indications and contraindications for lung and mediastinal biopsy
2. To learn about techniques including new tools for image guidance for lung and mediastinal biopsy
3. To learn about results and complications of lung and mediastinal biopsy, including their treatment

The decision to biopsy a lesion should be taken after careful analysis of the clinical history and images following a discussion about the indication with our clinical partner in order to avoid unnecessary procedures and/or "pseudolesions."
Considering an effectiveness/accuracy ratio, CT remains probably the best cross-section multi-plane imaging method to guide a biopsy.
Regarding specifically the thorax, CT still is the only method that allows a fast, accurate, and safe positioning of a biopsy needle.
Whenever possible, the shortest distance to the lesion should be selected, avoiding as many pleural structures (surface/fissures) as possible that have to be traversed during breathhold.
Prone position should be preferred, and strict horizontal or perpendicular path allows an easier targeting of the lesion, diminishing the number of passes and avoiding vessels, bubbles and bullae.
Whenever possible, the use of a tru-cut 20G needle is advised in order to obtain a sample for histology.
Ensure that the needle enters the lesion before triggering the device. This avoids pushing forwards or laterally the lesion namely encapsulated ones and not getting the sample.
Cavitated lesions should be punctured peripherally targeting its wall.
If it is predictable the necessity of multiple passes (small lesion), then should be considered the use of a coaxial cannula or the tandem technique.
Puncturing the mediastinum requires a careful planning and demands some skill even more if a small lesion is the case.
Anatomical structures are placed very closed. Guided injected saline creates an "effusion" separating the limits of the organs.
The use of the tandem technique is strongly advised, advancing the needles in a "step-by-step" way.
CT fluoroscopy may be helpful if one has to choose an oblique pathway.
After a biopsy, the patient should always be placed laying in lateral position, the punctured side facing downwards (approx. for 60 minutes).
The most frequent complication is the pneumothorax often due to emphysematous lung and/or lack of cooperation by the patient.
A hypertensive or a major one has to be drained with simple aspiration (with an 8-Fr pigtail drain) or with the placement of a chest tube.
Haemoptysis due to parenchymal hemorrhage or bronchial effusion along the needle path can also occur and should not be of concern.
The patient must be kept calm, positioned correctly, and some oxygen should be applied.
Pulmonary blood flow is of low pressure and coagulation occurs usually in a few minutes.

References

1. Gupta S et al: Quality improvement guidelines for percutaneous needle biopsy. J Vasc Interv Radiol. 21(7):969-75, 2010.
2. Arellano RS et al: The difficult biopsy: let's make it easier. Curr Probl Diagn Radiol. 32(1):3-10, 2003.
3. Dicato M, Freilinger J, Dondelinger RF, Kurdziel JC (1990) Economic considerations. In: Dondelinger RF, Rossi P,Kurdziel JC, Wallace S (eds) Interventional Radiology, Thieme, Stuugart, pp 142-155.
4. Dondelinger RF (1991) Interventional Radiology of the Chest: Percutaneous Procedures. In: Imaging of the Chest (Syllabus). European Congress of Radiology (ECR), Vienna. Springer, Heidelberg, pp 165-175.
5. Gazelle GS, Haaga JR, Rowland DY. Effect of needle gauge, level of anticoagulation, and trget organ on bleeding associatedwith aspiration biopsy. Radiology 183:509-513, 1992.
6. Sonderstrom M (1966) Fine Needle Aspiration Biopsy. Almqvist & Wiksell, Stockholm.

1001.2

Percutaneous treatment of empyema, lung abscess and mediastinal abscess

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Learning Objectives
1. To learn about clinical management and indications for IR treatments of empyema, lung abscess and mediastinal abscess
2. To learn about techniques for puncture and drainage of empyema, lung abscess and mediastinal abscess
3. To learn about results and complications of IR treatments for empyema, lung abscess and mediastinal abscess, including how they are treated

No abstract available.

1001.3

Percutaneous biopsy of easy and difficult lesions in the abdomen and pelvis

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Learning Objectives
1. To learn about the indications and contraindications for abdominal and pelvic biopsy
2. To learn about techniques including new tools for image guidance for abdominal and pelvic biopsy
3. To learn about results and complications of abdominal and pelvic biopsy, including how they are treated

Image-guided percutaneous biopsy, which is the most commonly performed procedure, has already become an integral part of daily work in interventional radiology units. According to the indications, we can perform either "fine-needle aspiration biopsy" or "core biopsy." Complications during or after biopsy are very rare. Although percutaneous biopsy of most of the abdominal masses are easily and safely performed under the guidance of ultrasonography (US) and/or computerized tomography (CT), biopsies of some lesions might be technically difficult due to several reasons such as small lesion size, risky locations including lesions next to the main vessels, organ motion, intervening structures, and hardly visible lesions by imaging modalities. We use different techniques to perform biopsy procedures, which are accepted as "technically difficult biopsy." The difficulties may be overcome by several techniques such as real-time guidance by US or CT fluoroscopy, changing patient position, transorgan punctures, organ displacement techniques, breath-hold of patients, and image fusion technologies. High rate of success for the biopsy of difficult abdominal masses is closely related to the experience of interventional radiologists who are familiar with problem-solving techniques.

References

1. McDermott S, Levis DA, Arellano RS. Approaches to the difficult drainage and biopsy. Semin Intervent Radiol 2012;29:256-263.
2. Sainani NI, Arellano RS, Shyn PB, Gervais DA, Mueller PR, Silverman SG. The challenging image-guided abdominal mass biopsy: established and emerging techniques "if you can see it, you can biopsy it". Abdom Imaging 2013;38:672-696.
3. Khati NJ, Gorodenker J, Hill MC. Ultrasound-guided biopsies of the abdomen. Ultrasound Q 2011;27:255-268.

1001.4

Percutaneous management of abdominal and pelvic fluid collections

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Learning Objectives
1. To learn about clinical management and indications for IR treatments of abdominal and pelvic abscess
2. To learn about techniques for puncture and drainage of abdominal and pelvic abscess
3. To learn about results and complications of IR treatments for abdominal and pelvic abscess, including how they are treated

No abstract available.

Special Session
State-of-the-art vascular malformation management

1003.1

Diagnosis and treatment: low-flow malformations

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Learning Objectives
1. To review the best imaging techniques to characterise low-flow AVMs
2. To learn about embolisation techniques and the results of embolisation in low-flow AVMs
3. To review the results and complications of embolisation in low-flow AVMs and how to minimise them

Vascular malformations (VMs) are now described according to the widely accepted guidelines, and the principle of proper treatment is becoming clear. An appropriate classification scheme for vascular anomalies and definite indications for treatment are important for an overall successful treatment. Findings from noninvasive imaging (mostly Doppler ultrasound with magnetic resonance imaging (MRI) and CT for high-flow malformations) in association with clinical findings are critical for establishing the diagnosis, evaluating the extent of malformation, and planning appropriate treatment.

In most cases, conservative treatment is recommended; however, when a patient suffers clinical complications (e.g., ulceration, pain, hemorrhage, cardiac failure, organ dysfunction, and unacceptable cosmetic consequences), the nidus sclerotherapy/embolotherapy becomes mandatory. A multidisciplinary approach is needed in the treatment of any VM, and a dedicated team approach is necessary for appropriate management in most cases.

Surgical excision, which includes excision of lesions, offers an attractive solution in theory. However, the infiltrating nature of VMs increases the possibility of recurrence and complications. Embolization and sclerotherapy procedures as percutaneous management techniques offer a superior alternative and/or complimentary treatment choices with increasingly recognized safety and efficacy. Embolization is the intentional occlusion of the nidus and feeder vessels of a VM via a foreign material (e.g., n-butyl cyanoacrylate (NBCA) or ethylene-vinyl alcohol copolymer derivatives), whereas sclerotherapy is the obliteration of a VM via an aggressive sclerosing agent (e.g., alcohol, polydocanol, and bleomycin). Utility of embolization technique in low-flow VM is generally reserved for cases that are to be surgically resected not only to achieve better hemostasis during surgery but also to serve as a roadmap for the surgeon to better delineate the extent of VM filled with embolic agent inside. The combination of embolization and sclerotherapy can potentially serve as a treatment method in cases with relatively large VM to obtain a curative result at the end with surgical resection. All of these embolization and sclerotherapy procedures can be performed under ultrasound and/or fluoroscopy guidance in an interventional radiology unit. General anesthesia may be needed in cases of alcohol sclerotherapy or for any treatment in the pediatric population.

Currently, there is no consensus on the selection of an appropriate agent for percutaneous treatment options. Lymphatic or venous nature of the lesion, location (deep vs. superficial), operator experience, presence of an adjunct surgery plan, patient expectations, cost, and availability are the main factors that influence agent selection. For the percutaneous technique in the treatment of low-flow VM following the appropriate sterile preparation and draping of the puncture site, again a 19–23-G butterfly needle(s) or 21-G micropuncture needle(s) may be placed into the VM (mostly under US

guidance), and diluted contrast was injected into the VM to depict the vascularity and venous drainage of the VM. Only after that, the chosen embolization or sclerotherapy agents were injected under the guidance of fluoroscopy/US. Additional punctures may be performed when needed during the therapy. In both techniques (embolotherapy/sclerotherapy), complete obliteration of the VM is the goal; for diffuse, large VMs, additional treatment sessions are to be scheduled at 4–6 week intervals. While dose limitations are one important reason for doing session by session treatment for select agents (such as alcohol, lipiodol, and polidocanol), staying in the safe side with more limited sclerotherapy is another vital reason to do so for large lesions to avoid potential complications. Periodic (1–3 months) follow-up evaluations were performed based on physical examination, using gray scale and/or color Doppler US and MRI, as needed.

In general, low-flow VM lesions are rare and present challenges in both diagnosis and management. Percutaneous management with sclerotherapy can be effectively used alone or with surgery for the treatment of PVM lesions, provided that the lesion is correctly classified and an appropriate agent is selected. To achieve better outcomes for these potentially complex lesions, interventional radiologists and plastic surgeons must work together beginning with the diagnosis and continuing throughout treatments so that these lesions can be treated aggressively and patiently, yielding excellent outcomes with an acceptable rate of complications. Choice of the embolization/sclerotherapy route and embolic agent plays an important role in the management of these lesions and requires significant experience and expertise in all kinds of imaging-guided embolizations.

References

1. Cil BE, Vargel I, Geyik S, Peynircioglu B, Cavusoglu T. Venous vascular malformations of the craniofacial region: pre-operative embolisation with direct percutaneous puncture and n-butyl cyanoacrylate. Br J Radiol. 2008 Dec;81(972):935-9. Epub 2008 Sep 29.
2. Turkbey B, Peynircioglu B, Arat A, Canyigit M, Ozer C, Vargel I, Balkanci F, Cil B. Percutaneous management of peripheral vascular malformations: a single center experience. Diagn Interv Radiol. 2011 Dec;17(4):363-7. Epub 2011 Jan 4.

1003.2

Diagnosis and treatment: high-flow malformations

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Learning Objectives

1. To review the best imaging techniques to characterise high-flow AVMs
2. To learn about embolisation techniques and the results of embolisation in high-flow AVMs
3. To review the results and complications of embolisation in high-flow AVMs and how to minimise them

Peripheral vascular malformations are true structural anomalies resulting from errors in vascular morphogenesis, and they are present at birth and grow commensurately with the child.

Vascular malformations are categorized into low-flow malformations (venous, capillary, lymphatic, and mixed) and high-flow malformations (AV malformations, congenital AV fistulae, acquired AV fistulae, and mixed).

From the treatment point of view, exact differentiation according to predominant vascular structures is not essential, but differentiation according to flow characteristics into low-flow and high-flow lesions is necessary. From imaging methods, it is expected to distinguish between low-flow and high-flow lesions, localization, volume and range of lesion, and relationship to the surrounding tissues and organs. Magnetic resonance (MR) offers a good differentiation between high-flow and low-flow lesions, good evaluation of the volume and extent of lesion, and good interpretation of anatomical relationship to the surrounding tissues and organs. Angiography is part of the therapeutic procedure only.

Endothelial cells in the AVM retain the embryonic growth potential. Sclerotherapy, which leads to the destruction of endothelial cells and subsequent thrombosis and fibrosis, has the potential for complete cure of AVM. Permanent (curative) effect of sclerotherapy by ethanol is given by complete damage of endothelial cells. Incomplete endothelial damage after the treatment by other embolic material or procedure is responsible for angiogenesis, neovascularization, and recanalization, and it has palliative effect only. Technique and tactics of sclerotherapy varies by the type of AVM.

The results are classified into four stages: cure, partial remission, no remission, and aggravation. Cure and partial remission are considered to be successful therapeutic outcomes, and this result can be expected in 70–89%. The best therapeutic outcome is for type II AVMs.

Complications of sclerotherapy of AVM by ethanol can be observed in 10–30%.

Minor complications are blister, skin necrosis, and temporary nerve injury. Major complications include necrosis of surrounding organs, permanent nerve injury, PE, stroke, hemoglobinuria, and circulatory collapse.

1003.3

Diagnosis and treatment: large visceral vascular malformations

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Learning Objectives

1. To learn about proper imaging technique in order to achieve the best pre-treatment evaluation
2. To describe different methods of treatment, and where and how to use the different types of embolic material available
3. To review problems and challenges encountered when treating large AVMs

Vascular malformations are inborn errors of vasculogenesis of unknown aetiology, although familial forms are recognised in which a genetic defect has been localised. They are frequently incorrectly named 'haemangiomas', a source of considerable confusion when reviewing the literature; for this reason, it is important that the term haemangioma is used only for the acquired tumours of infancy, lesions that differ considerably in their histology and natural history.

All vascular malformations are rare, particularly those involving the viscera. Many of these visceral lesions are only picked up as an incidental finding during the investigation of unrelated symptoms, and they remain quiescent throughout life; others, however, may present with life-threatening complications, particularly haemorrhage. Cardiac failure, an oft-quoted complication of high-flow arteriovenous malformations (AVMs), is remarkably rare, but it is most commonly seen when there is diffuse involvement of the liver, usually associated with the autosomal dominant condition hereditary haemorrhagic telangiectasia (HHT). Although pulmonary AVMs, which are associated with HHT in more than 90% of individuals, are also classified as visceral AVMs, they will not be discussed in this presentation as their management differs from that of the systemic AVMs, which are the subject of this session.

Low-flow visceral vascular malformations

The most common of these are focal hepatic and splenic malformations, commonly and incorrectly termed haemangiomas; these rarely require treatment. Massive hepatic low-flow lesions may be associated with pain, and they are best managed by surgical resection as they respond poorly to embolisation. Gastrointestinal tract

low-flow lesions are very common in HHT, and if the cause of transfusion-dependent anaemia, may require management by repeated endoscopic ablation. The radiologist's role in their diagnosis and management is small.

High-flow visceral vascular malformations

The most common sites of visceral involvement by AVMs that require radiological treatment within the abdomen are the kidney and gastrointestinal tract. Although hepatic AVMs are common, they rarely require treatment and, even when the cause of cardiac failure, respond poorly to embolisation. As is the case with high-flow malformations involving other body parts, the most important aspect of embolisation of visceral AVMs is an understanding of the anatomy of the vascular communications within them as these have a bearing both upon the method of vascular occlusion and upon the final result. Regardless of their anatomy, however, the general principle is that occlusion is performed at the site of the abnormal arteriovenous shunts and not in the vessel proximal to this point. The embolisation of arterial feeding vessels, which was performed for many years with metallic coils or particulate matter such as absorbable gelatin sponge, is akin to proximal surgical ligation and must be avoided. It has little effect upon symptoms in most individuals and renders subsequent treatment more difficult because the arterial inflow vessels have been occluded. If, however, the embolisation is directed at the arteriovenous communications themselves from an arterial approach, via a direct percutaneous puncture or retrogradely from the venous side, and these are totally obliterated, often with a liquid embolic agent, then a long-term improvement in symptoms can be achieved. This presentation will concentrate on the radiological management of these high-flow lesions.

The cure of a high-flow vascular anomaly is uncommon, although there is no doubt that radiological and clinical obliteration of more malformations has come with a better understanding of their radiological anatomy and with the use of agents that are directed at arteriovenous shunts rather than at proximal feeding vessels.

References

1. A proposed angiographic classification of intracranial arteriovenous fistulae and malformations. Houdart E, Gobin YP, Casasco A, Aymard A, Herbreteau D, Merland JJ. Neuroradiology. 1993;35(5):381-5.
2. Treatment of high-flow vascular malformations by venous embolization aided by flow occlusion techniques. Jackson JE, Mansfield AO, Allison DJ. Cardiovasc Intervent Radiol. 1996;19(5):323-8.
3. Arteriovenous malformations of the body and extremities: analysis of therapeutic outcomes and approaches according to a modified angiographic classification. Cho SK, Do YS, Shin SW, Kim DI, Kim YW, Park KB, Kim EJ, Ahn HJ, Choo SW, Choo IW. J Endovasc Ther. 2006;13(4):527-38.

1003.4

Diagnosis and treatment: paediatric vascular malformations

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Learning Objectives

1. To review the clinical and anatomical features specific to paediatric vascular malformations
2. To review the indications and techniques for embolisation of paediatric vascular malformations
3. To review the results, complications and follow-up strategy post-embolisation of paediatric vascular malformations

The general principles of sclerotherapy and embolisation apply to childhood lesions as much as they do to adult lesions, but there are a few important factors to consider in paediatrics including complexities of imaging young children, careful case selection tailored towards symptom control and not expectations, sclerosant dose limits and radiation dose reduction principles. In addition, there are some conditions that present in childhood, but are very rarely encountered in adult populations and complex syndromes that require intensive multi-disciplinary input in childhood to ensure that the physical and psychological development of the child is as normal as possible.

Most radiologists would consider MRI to be the imaging modality of choice for all but the simplest of malformations. In small children, cross-sectional imaging usually necessitates sedation or general anaesthesia; therefore, ultrasound plays a more central role, certainly, in the initial triaging of lesions and in post-treatment follow-up. It is important that the sonographer is both skilled in scanning children and experienced in diagnosing vascular anomalies so that as much information as possible is gathered in a short span of time. In skilled hands, it is possible to get detailed information even from hard-to-reach areas, such as the orbit, without upsetting the child. A majority of vascular malformations are superficial, and childhood body habitus tends to mean ultrasound is easier compared with large adults. It is important to remember that these are often children who will need repeat imaging and interventions over many years; therefore, scans should only be undertaken if really necessary and only by experienced operators. An experienced multi-disciplinary team is invaluable for deciding imaging strategies for complex cases.

Multi-disciplinary teams play a key role not only in the diagnostic work-up of complex cases but also in terms of deciding when and how to treat children and for managing the long-term sequelae of their condition. Paediatric cases often bring associated complexities, such as parental anxiety and high expectations, genetic implications (including genetic counselling for subsequent pregnancies), effects on skeletal development, psychological consequences of disfigurement or just 'being different', effects on schooling and sports and the development of independence. Perhaps far more than in an adult setting, the inclusion of geneticists, psychologists and physiotherapists in the multi-disciplinary team is essential.

The choice of sclerosing agents for slow-flow malformations in children is not different to that in adults. For venous malformations, a dose limit of 0.5 ml/kg of sodium tetradecyl sulfate (STS; 3%) applies, but the dose limit in young children should probably be kept lower than this. Young patients are likely to be dehydrated due to pre-anaesthesia starvation regimes, and operators should consider active rehydration pre- and/or intra-operatively to avoid renal toxicity if high doses of STS are used. Doxycycline is often used as the first-line agent for lymphatic malformations. It is usually diluted to 10 mg/ml with saline and/or a water-soluble contrast agent. Most operators use a maximum single-session dose of 1 g, but they are cautious when using above 500 mg of doxycycline per session in infants. Doxycycline can cause hypoglycaemia, and some centres advocate post-operative blood glucose monitoring for small children. Tetracyclines are associated with (usually reversible) staining or discolouration of adult dentition and are not recommended in children under 8 years of age. Doxycycline instilled into a lymphatic cyst is unlikely to result in high serum levels of the drug, but some operators have concerns about effects on dentition and therefore include this risk in the consent process. Commonly, bleomycin is increasingly used for slow-flow malformations, and it appears to have better outcomes for microcystic lymphatic malformations than other agents. It is an attractive agent to consider in areas where swelling, skin breakdown or nerve injury risks are high such as the orbit and the tongue. Dose limits are not well documented, but most centres advocate a maximum of 15,000 IU per session, with a total cumulative dose of 20,000–30,000 IU/kg in children (note that 1 USP = 1,000 IU). Documented side effects of bleomycin sclerotherapy include skin, nail and hair changes and lung fibrosis. The risk of systemic effects is probably higher when the agent is used to treat venous malformations. Careful intra-operative precautions are

recommended including the avoidance of high inspired oxygen levels during general anaesthesia and the avoidance of any drapes or monitoring equipment being stuck to the skin. Pre- and post-exposure respiratory surveillance should be considered.

A significant proportion of children present with a constellation of lesions labelled as a syndrome. This aspect of the study of vascular malformations is rapidly evolving, and the genetic basis of many syndromes is now far better understood. Clinicians need to move away from many of the older names for syndromes, which are poorly defined and often no longer relevant. Families often find syndrome labels helpful but are then exposed to incorrect information from websites, outdated literature and ill-informed clinicians, with the potential for ineffective or damaging intervention. Detailed discussion of most syndromes is beyond the scope of this lecture, but some aspects of treatment for patients with limb overgrowth and vascular malformation merit attention. Klippel-Trenaunay syndrome (KTS) is one of the names used most commonly and often inappropriately to label patients with limb overgrowth and an associated slow-flow malformation. Patients may have one or more of the following: capillary or port-wine stain of the skin, fatty overgrowth of parts of the limb, lymphatic malformation and/or anomalous, dysplastic venous drainage of the limb. This last feature usually comprises a variant of the embryonic or the lateral/marginal vein. Patients with this constellation of features can lie anywhere on a wide spectrum of disease, and symptoms vary from minimal leg length discrepancy to very disabling overgrowth, bleeding and infection. The malformation often extends into the pelvis. Some children present with haematuria or bleeding per rectum. Gastrointestinal involvement usually requires a surgical approach, but lymphatic malformations of the bladder can be sclerosed very effectively under cystoscopic control. Thromboembolism is well recognised in association with this condition, and sudden death from pulmonary emboli is reported. There is much debate on whether caval filters are merited for these patients. Recently, a few centres have reported endovenous laser ablation of the lateral marginal vein as a means of controlling proliferation/dilatation of dysplastic veins, ablating anomalous drainage to the IVC and encouraging normal development of the deep venous system; very early intervention may be advantageous.

Finally, it is worth mentioning fibro-adipose vascular anomaly (FAVA), a previously unrecognised condition recently described by Alomari *et al.* It appears to present 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 phlebectsia, 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, although recurrence rates are as yet unknown.

References

1. The use of endovenous laser treatment in toddlers. King K, Landrigan-Ossar M, Clemens R, Chaudry G, Alomari AI. J Vasc Interv Radiol. 2013 Jun;24(6):855-8.
2. Fibro-adipose vascular anomaly: clinical-radiologic-pathologic features of a newly delineated disorder of the extremity. Alomari AI, Spencer SA, Arnold RW, Chaudry G, Kasser JR, Burrows PE, Govender P, Padua HM, Dillon B, Upton J, Taghinia AH, Fishman SJ, Mulliken JB, Fevurly RD, Greene AK, Landrigan-Ossar M, Paltiel HJ, Trenor CC 3rd, Kozakewich HP. J Pediatr Orthop. 2014 Jan;34(1):109-17.

Special Session Controversy
Controversies in arterial intervention

1004.1

Renal denervation is dead: pro

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Several unblinded studies and small RCTs have suggested that catheter-based renal artery denervation reduces blood pressure in patients with resistant hypertension. However, it has been known from older pharmacological studies regarding the treatment of hypertension that external circumstances can have a substantial influence on treatment results. Not only the so-called "white coat" hypertension but also other external factors can influence treatment results. Hypertension treatment is sensitive to placebo. The only way to deal with this problem is to perform a prospective, single-blind, randomized sham-controlled trial. The SYMPLICITY HTN-3 trial randomized 535 patients in a 2:1 ratio. This blinded trial did not show a significant reduction of systolic blood pressure in patients with resistant hypertension 6 months after renal artery denervation as compared with the sham control.

The only conclusion is that with the current technology, renal denervation is not useful as a treatment option for patients with treatment-resistant hypertension.

1004.2

Renal denervation is dead: con

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The history of interventional radiology is full of inventions that created a lot of enthusiasm in the beginning and underwent a very hectic development before being finally accepted.

We are facing the same "ups and downs" with renal denervation but with a much higher magnitude. Because hypertension is the number one "silent killer," the opportunity to treat patients with catheter-based technology has created an enormous hope in the medical community after the publication of the first-in-man results in 2009 (1,2). Immediately after the publication of the first RCT in the Lancet, Medtronic acquired the company in late 2010 (3).

From 2010 to late 2013, some countries in Europe became "RDN addict" and behaved as if they had found the golden egg, treating thousands of patients outside the appropriate research context. A press release from the American Heart Association even touted renal denervation as a potential "cure" for mild hypertension (4).

In the meantime, the community of hypertension specialists raised concern about the unknown efficacy of the technique and the inappropriate design of ongoing and previously published trials (5). The initially positive trials overstated the efficacy of the technology because of poor design and multiple methodological limitations: lack of ABPM measurements and lack of control of medical treatment were the 2 most powerful mistaken approaches. In an effort to control the widespread misuse of the technology, several countries created transdisciplinary group to define the appropriate guidelines (6,7). Other major industrial players and a few start-ups developed alternative catheters based either on RF ablation or focused ultrasound, while Medtronic improved its Symplicity to Symplicity Flex and now to Symplicity Spyral.

In order to obtain FDA clearance and reimbursement for RDN in the US, Medtronic sponsored a large RCT including a sham arm, so-called HNT 3, that turned out to be a dramatic failure for several

reasons (see below). Consequently, in January 2014, a huge disappointment transpierced the whole community of stakeholders of RDN, including interventionalists, industry, and investors.

In a few months, all efforts of clinical research were stopped in several countries, mostly under the influence of Medtronic that was forced to abruptly revise its internal strategy; some companies (Cordis, Covidien) even completely stopped their program. Only a few teams recognized that the disappointment should not stop all research efforts and should only stress the need for appropriate clinical research (8).

Today, it is reasonable to recognize that RDN is not dead but needs more efforts to become an accepted technique.

1. Why can an inappropriate trial design or inappropriate technique mask the actual potential of RDN?

The negative results of HTN 3 can lead to an understanding of why the trial was negative.

Many explanations have been proposed regarding the design of the study and the technique of denervation. Regarding the trial design, lack of a defined protocol to exclude patients with secondary HTN and lack of precise medical treatment control were the most important. Among the technical questions, it should be noted that the experience of the interventionalist with RDN was very limited, and this was not compensated for by the presence of well-trained field specialists for each case. The number of ablation points was likely too small, on an average, resulting in less-than-optimal nerve ablation.

2. How can appropriate clinical trial design unveil the real efficacy of the technology?

We and other teams have underlined since the beginning that the design of the trials are of primary importance to demonstrate the real effect of antihypertensive treatment (5). Validating a device is just like validating a new antihypertensive drug.

The next step in recent months has been publication of several negative trials even in randomized design with or without sham control.

Only a single trial, which we designed, was able to counter-balance this negative wave by actually demonstrating better results for RDN compared to medical therapy for resistant hypertension for the first time.

The Renal Denervation for Hypertension (DENERHTN) trial was a prospective, open-label, randomized controlled trial with blinded endpoint evaluation in patients with resistant hypertension. Eligible patients aged 18–75 years received indapamide (1.5 mg), ramipril (10 mg) or irbesartan (300 mg), and amlodipine (10 mg) daily for 4 weeks to confirm treatment resistance by ambulatory blood pressure monitoring before randomization. Patients were then randomly assigned (1:1) to receive either renal denervation plus SSAHT regimen (renal denervation group) or SSAHT alone (control group). For SSAHT, after randomization, a predefined escalation protocol to control blood pressure by adding on the top of each other various classes of drugs, from months 2 to 5 in both groups if home blood pressure was ≥135/85 mmHg; 106 patients were randomly assigned to treatment (53 patients in each group, intention-to-treat population), and 101 were analyzed.

The mean change in daytime ambulatory systolic blood pressure at 6 months was −15.8 mmHg (95% CI, −19.7 to −11.9) in the renal denervation group and −9.9 mmHg (−13.6 to −6.2) in the SSAHT-alone group, with a baseline-adjusted difference of −5.9 mmHg (p=.033) (9).

3. What are the next hurdles?

First of all, there are a lot of remaining technical questions and a lot of progress that can be made in the RDN technology. Several authors underlined the fact that the Simplicity catheter is not the optimal tool; a recent case report mentioned post-mortem control of a patient who underwent RDN and in whom pathological evidence showed that the sympathetic nerves had not been adequately destroyed (10). The current RF-based catheters share some similar limitations: inability to reach the deepest layers of the peri-adventitial space where most of the nerves are, limitation in energy delivery because of the need to preserve the arterial wall, absence of feedback on the actual denervation (has the intervention been technically successful?), duration of intervention, very large catheters that prevent using radial approach or doing procedures as a day case. It is of interest to note that various companies are exploring alternative technology among which is ultrasound-based ablation by external or internal endovascular approach, while some other researchers are exploring the feasibility and efficacy of percutaneous perirenal delivery of alcohol. Among them, the most advanced technology is probably

the Radiance catheter (ReCor Medical) that has the advantage of addressing some of these limitations and allowing complete denervation while preserving the arterial wall. Unfortunately, there is not enough clinical data to support its use; an FDA-controlled trial will need to be performed.

The next step will be to better understand the best ablation target, be it the renal artery branches, ostium, or whole arterial length. Some authors recently showed that ablating into the branches would result in better efficacy, at least with the Simplicity catheter (11).

In terms of clinical trial design, we are now at a very important turn, a period of "restart." All companies have conducted extensive discussions with the FDA to find a common ground for the appropriate clinical trial design. There is no doubt that they will all come to a common or neighboring position in randomized trials versus sham in various level of hypertension.

Research is ongoing, both in the academic setting, in the ENCOReD consortium, and industry sponsored, and the next 2 or 3 years will be a great period of clinical research; all stakeholders have finally understood that the field is complex and needs a lot of effort, but has potential for rewarding results. An interventional radiologist should participate in multidisciplinary research efforts. Should these trials yield positive results, the field of RDN will again become a major part of our future clinical activity.

As declared by Messerli, "the time has come to turn the page on renal denervation for hypertension, but by all means, let's not close the book." (12).

References

1. Krum H, Schlaich M, Whitbourn R et al. Catheter-based renal sympathetic denervation for resistant hypertension: a multicentre safety and proof-of-principle cohort study. Lancet 2009; 373: 1275–1281.
2. Schlaich MP, Sobotka PA, Krum H, Lambert E, Esler MD. Renal sympathetic-nerve ablation for uncontrolled hypertension. N Engl J Med 2009; 361: 932–934.
3. Esler MD, Krum H, Sobotka PA, Schlaich MP, Schmieder RE, Böhm M. Renal sympathetic denervation in patients with treatment-resistant hypertension (the SYMPLICITY HTN-2 Trial): a randomised controlled trial. Lancet 2010; 376: 1903–1909.
4. Radio-waves to kidneys lower persistent high blood pressure. Press release of the American Heart Association, Dallas, December 17, 2012.
5. Persu A, Renkin J, Thijs L, Staessen JA. Renal denervation: ultima ratio or standard in treatment-resistant hypertension. Hypertension 2012; 60: 596–606.
6. Pathak A, Girerd X, Azizi M et al. Expert consensus: Renal denervation for the treatment of hypertension Diagnostic and Interventional Imaging 2012 ; 93: 386–394.
7. Mahfoud F, Luscher TF, Andersson B et al . Expert consensus document from the European Society of Cardiology on catheter-based renal denervation. European Heart Journal 2013; 34: 2149–2157.
8. Sapoval M Azizi M. Renal artery denervation for the treatment of resistant hypertension. Update after Medtronic announcement that its Symplicity HTN3 study failed to meet its primary efficacy end point. Diagn Intervent Imaging 2014; 95: 353–354.

9. Azizi M, Sapoval M, Gosse P et al. Optimum and stepped care standardised antihypertensive treatment with or without renal denervation for resistant hypertension (DENERHTN): a multicenter, openlabel, randomised controlled trial. Lancet 2015; 385: 1957–1965.
10. Vink EE , Goldschmeding R, Vink A et al. Limited destruction of renal nerves after catheter-based renal denervation: results of a human case study Nephrol Dial Transplant 2014; 0: 1–3.
11. Henegar JR, Zhang Y, Hata C, Narciso I, Hall ME, Hall JE. Catheter-based radiofrequency renal denervation location effects on renal norepinephrine? Am J Hypertension 2015 Jan 8. [Epub ahead of print].
12. Messerli FH, Bangalore S. Renal denervation for resistant hypertension? N Engl J Med 2014; 370: 1454–1457.

1004.3

Popliteal stents are effective: pro

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Reports of isolated popliteal artery (PA) angioplasties are scarce. Technical success rates (residual stenosis of <30%) are as low as 71% [1], and 12-month primary patency rates are as low as 30% for PA occlusion [2].

Stent implantation after angioplasty or primary stent implantation has two goals; first, to achieve technical success (to enable healing in critical limb ischemia patients) and second, to prolong or improve patency rates (for an economic and potentially cost-effective treatment approach in patients with claudication). Unfortunately, the PA is considered an even more hostile vascular territory for stents than the superficial femoral artery (SFA). Limitations of PA stent placement are largely due to conformational changes of the PA. The PA shortens during the flexion of the knee, with fixation points at the adductor hiatus and anterior tibial artery at the interosseus membrane pass-through [3]. When a longitudinal rigid stent is implanted in the PA, the unstented PA has to undergo an even greater flexion to compensate for the stented portion leading to intimal hyperplasia. However, there is still a relevant mechanical load on the stent, which potentially leads to stent fracture. Depending on the stented length and the rigidity of stents used, the more pronounced is the effect [4-10].

Until 2013, the lack of positive trials with clinical success of PA stent placement could have been considered as the lack of proof or success in this field.

Studies including the treatment of shorter lesions and the use of new-generation, more flexible nitinol stents have addressed the issue of stent fracture; good, long-term primary patency rates were reported in two trials [11-14].

Published in 2013 [13], a single-center registry data proved that PA obstructions could be treated with similar clinical and angiographic success to those associated with SFA. Between January 2008 and April 2010 in a single-center registry study, 125 implantations were performed in the PA with the Supera stent (Abbott), a closed-end, braided, self-expanding stent made of interwoven nitinol (nickel-titanium alloy) wire material. The mean stent length was 84.4 ± 45.1 mm, and the mean lesion length was 58.5 ± 34.2 mm. Procedural success defined as 30% residual stenosis was 98%. Twelve-month follow-up demonstrated 87.7% ± 3.7% of primary patency. The stent fracture rate (51 patients were available at mean follow-up of 15.2 months) was 0%. Twenty-four-month patency rates were still comparable to the SFA with approximately 70% of primary patency [14]. The results for the Supera stent were corroborated by Leon *et al.* [15] in a series with 34 patients and a stented length of >100 mm in the PA. Twelve-month primary and secondary patency rates were 79.2% and 93%, respectively.

Published in 2013 [12], the ETAP trial was a prospective, randomized multicenter trial (RCT) that compared primary nitinol stent placement with angioplasty in patients with de novo lesion in the PA in 246 patients. The studied stent was the Lifestent (CR Bard), a flexible, tubular, nitinol mesh prosthesis with a helical design. The mean target lesion length was 42.3 mm. Angioplasty was considered successful when it resulted in residual stenosis of <30% of vascular lumen diameter by visual estimation. If residual stenosis of >30% or flow-limiting dissection occurred, patients underwent an additional, 5-minute PTA. If these conditions persisted after prolonged and repeated PTA, patients underwent selective stenting. Twenty-five percent of patients in the angioplasty group needed provisional stenting to achieve a similar 100% procedural success rate to that of patients in the primary stent group. Twelve-month primary patency rates were 67.4% for the primary stent group and 65.7% for the angioplasty with selective stenting group (P = 0.92). Twenty-four-month patency rates were 64.2% for the primary stenting group vs. 56.1% for the angioplasty with selective stenting group (P = 0.44) [11]. Target lesion length of >60 mm was an independent predictor of restenosis (OR, 1.77). Seven stents (4.6%) demonstrated fractures; two (2.6%) were classified as type III and IV fractures, respectively. No correlation could be found between stent fracture incidence and either restenosis or target lesion revascularization.

In the MISAGO registry, the Misago stent (Terumo), a flexible, spineless nitinol stent, was used to treat femoral and popliteal obstructions. In a subgroup analysis, 57 PA lesions were treated. The average lesion length was 54 mm, and 49.1% of the treated lesions were occlusions. No primary patency rates were obtained, but the 12-month TLR rate was only 9.4% [16].

There are no available data (RCTs or larger registry studies) to evaluate the performance of stent grafts in the treatment of isolated PA obstructive disease.

In summary, it seems that the PA is not a hostile location for stent placement, but lesion selection and the use of new-generation nitinol stents results in good procedural success and high patency rates in the PA.

References

1. Semaan E, Hamburg N, Nasr W, et al. (2010) Endovascular management of the popliteal artery: comparison of atherectomy and angioplasty. Vasc Endovascular Surg, 44(1):25-31. doi: 10.1177/1538574409345028.
2. Steinkamp HJ, Rademaker J, Wissgott C, et al. (2002) Percutaneous transluminal laser angioplasty versus balloon dilation for treatment of popliteal artery occlusions. J Endovasc Ther, 9(6):882-888. doi: 10.1583/1545-1550(2002)009<0882:PTLAVB>2.0.CO;2.
3. Vernon P, Delattre JF, Johnson EJ, Palot JP, Clement C. (1987) Dynamic modifications of the popliteal arterial axis in the sagittal plane during flexion of the knee. Surg Radiol Anat, 9(1):37-41.
4. Tsuji Y, Kitano I, Iida O, Kajita S, Sawada K, Nanto S. (2011) Popliteal pseudoaneurysm caused by stent fracture. Ann Vasc Surg, 25(6):840 e845-848. doi: 10.1016/j.avsg.2010.12.039.
5. Tamashiro GA, Tamashiro A, Villegas MO, et al. (2011) Flexions of the popliteal artery: technical considerations of femoropopliteal stenting. J Invasive Cardiol, 23(10):431-433.
6. Goltz JP, Ritter CO, Petritsch B, Kellersmann R, Hahn D, Kickuth R. (2010) Endovascular treatment of acute limb ischemia secondary to fracture of a popliteal artery stent. J Vasc Interv Radiol, 21(11):1739-1745. doi: 10.1016/j.jvir.2010.07.024.
7. Furuichi S, Sangiorgi GM, Colombo A. (2007) Early occlusive restenosis due to self-expandable stent squeeze in the popliteal artery. J Invasive Cardiol, 19(10):E300-302.
8. Arena FJ. (2005) Arterial kink and damage in normal segments of the superficial femoral and popliteal arteries abutting nitinol stents--a common cause of late occlusion and restenosis? A single-center experience. J Invasive Cardiol, 17(9):482-486.

9. Babalik E, Gulbaran M, Gurmen T, Ozturk S. (2003) Fracture of popliteal artery stents. Circ J, 67(7):643-645.
10. Solis J, Allaqaband S, Bajwa T. (2006) A case of popliteal stent fracture with pseudoaneurysm formation. Catheter Cardiovasc Interv, 67(2):319-322. doi: 10.1002/ccd.20600.
11. Rastan A, Krankenberg H, Baumgartner I, et al. (2015) Stent placement vs. balloon angioplasty for popliteal artery treatment: two-year results of a prospective, multicenter, randomized trial. J Endovasc Ther, 22(1):22-27. doi: 10.1177/1526602814564386.
12. Rastan A, Krankenberg H, Baumgartner I, et al. (2013) Stent placement versus balloon angioplasty for the treatment of obstructive lesions of the popliteal artery: a prospective, multicenter, randomized trial. Circulation, 127(25):2535-2541. doi: 10.1161/CIRCULATIONAHA.113.001849.
13. Scheinert D, Werner M, Scheinert S, et al. (2013) Treatment of complex atherosclerotic popliteal artery disease with a new self-expanding interwoven nitinol stent: 12-month results of the Leipzig SUPERA popliteal artery stent registry. JACC Cardiovasc Interv, 6(1):65-71. doi: 10.1016/j.jcin.2012.09.011.
14. Werner M, Paetzold A, Banning-Eichenseer U, et al. (2014) Treatment of complex atherosclerotic femoropopliteal artery disease with a self-expanding interwoven nitinol stent: midterm results from the Leipzig SUPERA 500 registry. EuroIntervention, 10(7):861-868. doi: 10.4244/EIJV10I7A147.
15. Leon LR, Jr., Dieter RS, Gadd CL, et al. (2013) Preliminary results of the initial United States experience with the Supera woven nitinol stent in the popliteal artery. J Vasc Surg, 57(4):1014-1022. doi: 10.1016/j.jvs.2012.10.093.
16. Schulte KL, Kralj I, Gissler HM, et al. (2012) MISAGO 2: one-year outcomes after implantation of the Misago self-expanding nitinol stent in the superficial femoral and popliteal arteries of 744 patients. J Endovasc Ther, 19(6):774-784. doi: 10.1583/JEVT-12-3861MR.1.

1004.4

Popliteal stents are effective: con

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Anatomy and specificity:

Each part of the femoro-popliteal artery presents its own challenges. The popliteal artery is short but is located in a highly flexible segment at the knee joint.

The popliteal artery is divided into 3 segments:

- Segment P1: from the adductor canal to the superior aspect of the patella.
- Segment P2: between the superior aspect of the patella and the knee joint.
- Segment P3: from the knee joint to the origin of the anterior tibial artery.

The popliteal artery gives origin to the important perigeniculate collaterals. These are typically numerous and can be responsible for maintaining a limb that may have extensive proximal or distal occlusions.

The popliteal artery conformation is dynamic and responds to flexion/extension at the knee joint with length changes averaging of 32mm, twisting of 61°, and the formation of more than 2 flexion points of 15° or more.

Anomalous tibial artery origin is present in less than 5% of the population; the anterior tibial or posterior tibial artery arises from the retrogeniculate popliteal artery.

Popliteal artery disease may be focal, involving one segment or several segments of the popliteal artery. Popliteal disease may also be diffuse and may be combined with contiguous superficial femoral artery disease or tibial artery disease, or both.

When popliteal arteries were evaluated at 90° flexion of the knee and hip, stented popliteal arteries demonstrated 11% longitudinal compression, versus 14% for native-non-stented popliteal arteries. This suggests that stent placement diminishes the capacity of the popliteal artery to respond to changes in leg position that are associated with common behavior. The artery is somewhat fixed proximally, due to the adductor canal, and in its mid-segment, due to the perigeniculate collaterals. Stents fractures in the femoral-popliteal arteries have been associated with positioning in the adductor canal and the popliteal artery. For this reason, the popliteal artery is considered hostile to stents.

There is an implication in the TASC II guidelines that a popliteal artery lesion substantially increases the challenge of repair. The presence of popliteal artery stenosis, length not specified, automatically qualifies as TASC B and D if lesions include popliteal artery occlusion that extends to tibial vessels and also if SFA lesion is >20cm and extends into the popliteal artery.

Studies

The ETAP Trial evaluated PTA (with bailout stent) versus primary stent for popliteal artery lesions using the LifeStent (Bard). P1 and P2 segments were involved in 47% of patients, P2 and P3 in 47%, and only 7% had involvement of P1, P2, and P3. The patency rate at 12 months was 67.4% for primary stent placement and 44.9% for PTA. Freedom from TLR, amputation, death, and MI was significantly better in the primary stent group than in the PTA group ($p<0.0001$); but when primary stent was compared with PTA/selective stent (as treated), there was no significant difference. This concludes that routine stent placement confers no significant advantage over selective stent placement.

Another results of an alternative new stent design, the Supera stent and the publication of the Popliteal Registry stenting using this stent without a control group and no randomization. The lesion length described in this registry was 58mm and stented length 84mm. Primary patency at 12 months was 87.7%.

Conclusion

PTA and selective stent is a viable option for isolated popliteal artery lesions and for lesions associated with SFA or tibial disease. If SFA disease is being treated, whatever stent is required for the SFA disease can be extended into the popliteal artery. Avoiding a stent when possible leaves all treatment options preserved for later usage, if needed. Modified balloons (drug-coated balloons) or dedicated stents (Supera stent) in the future may change the options for popliteal revascularization.

References

1. Stent placement vs. balloon angioplasty for popliteal artery treatment: two-year results of a prospective, multicenter, randomized trial. Rastan A, Krankenberg H, Baumgartner I, Blessing E, Müller-Hülsbeck S, Pilger E, Scheinert D, Lammer J, Beschorner U, Noory E, Neumann FJ, Zeller T. J Endovasc Ther. 2015 Feb;22(1):22-7.
2. Stent placement versus balloon angioplasty for the treatment of obstructive lesions of the popliteal artery: a prospective, multicenter, randomized trial. Rastan A, Krankenberg H, Baumgartner I, Blessing E, Müller-Hülsbeck S, Pilger E, Scheinert D, Lammer J, Gibler M, Noory E, Neumann FJ, Zeller. T. Circulation. 2013 Jun;127(25):2535-41.
3. Clinical outcomes using aggressive approach to anatomic screening and endovascular revascularization in a veterans affairs population with critical limb ischemia. Shah AP, Klein AJ, Sterrett A, Messenger JC, Albert S, Nehler MR, Hiatt WR, Casserly IP. Catheter Cardiovasc Interv. 2009 Jul;74(1):11-9.
4. Assessment of self-expanding nitinol stent deformation after chronic implantation into the femoropopliteal arteries. Nikanorov A, Schillinger M, Zhao H, Minar E, Schwartz LB. EuroIntervention. 2013 Oct;9(6):730-7.
5. Fracture of self-expanding nitinol stents stressed in vitro under simulated intravascular conditions. Nikanorov A, Smouse HB, Osman K, Bialas M, Shrivastava S, Schwartz LB. J Vasc Surg. 2008 Aug;48(2):435-40.

1004.5

ICSS long-term data will lead to resurgence of CAS: pro

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Atherosclerosis is a systemic disease that commonly affects carotid arteries. There are roughly 1,000,000 stroke-related events per year in the US alone. Subsequent stroke is a leading cause of death and long-term morbidity. Approximately 10%–15% of all strokes are due to atherosclerotic stenosis of the internal carotid artery. Carotid endarterectomy is a long known standard of reference for lowering the risk of stroke in patients with symptomatic carotid artery stenosis. Over the last decades, carotid artery stenting evolved as a treatment alternative without the discomfort of anesthesia and neck incision. Endovascular treatment is also known to reduce the risk of myocardial infarction, cranial nerve injury, and neck hematoma.

However, several studies raised safety issues with carotid artery stenting as there was an increased rate of stroke after carotid artery stenting. In 2010, meta-analyses of three trials [EVA-3S, SPACE, and Internal Carotid Stenting Study (ICSS)] comparing endarterectomy versus angioplasty in patients with symptomatic carotid stenosis confirmed higher periprocedural risk of stroke and death after carotid artery stenting than endarterectomy (8.9% vs. 5.8%) [1]. However, there was significant heterogeneity between different age groups, with a significant difference in early strokes or death recorded between carotid artery stenting and carotid endarterectomy in patients older than 70 years (12.0% vs. 5.9%; p=0.0053), whereas this difference could not be proven in patients younger than 70 years (5.1% vs. 4.5%; p=n.s.). Although this trend was present in all studies, the wide 95% confidence interval did not exclude a difference in either direction [1,2].

These data were based on the interim analysis of the ICSS. Only recently, long-term outcomes of the trial were published, thereby revealing an interesting development over time [3]. The risk of disabling stroke or death decreased from the interim analysis at 120 days after randomization (4.0% vs. 3.2%; HR, 1.28; p=0.34) [4] to the long-term analysis at 5 years after randomization (6.4% vs. 6.5%; HR, 1.06; p=0.77) [3]. Most importantly, the initial significantly higher all-cause death rate after carotid artery stenting (2.3% vs. 0.8%; HR, 2.76; p=0.017) [4] showed a catch up for the carotid endarterectomy group, and the long-term data failed to confirm a significant difference (17.4% vs. 17.2%; HR, 1.17; p=0.19) [3]. However, there is still a significant higher risk for any stroke after carotid artery stenting, which is mostly attributed to a higher risk of contralateral and vertebrobasilar events. Considering these potentially unrelated locations, there might be a chance effect as even the authors of the study feel unable to explain this particular finding [3].

A more detailed analysis of the ICSS data confirms the previous findings that an excess in procedural stroke is limited to patients older than 70 years. Moreover, center and an interventionalist's experience appear to play a major role. Correspondingly, results in centers including 50 or more patients had better outcomes than smaller centers. Most interestingly, the preprocedural presence of white matter lesions played a major role in the risk of stroke after stenting, while there was no such association after endarterectomy [5].

Considering these facts, stenting may re-emerge for a well-selected group of patients younger than 70 years, with limited age-related white matter lesions and treated in high-volume centers. While we are not yet there, long-term data from the ICSS study show a way towards the resurgence of carotid artery stenting.

References

1. Carotid Stenting Trialists' Collaboration; Bonati LH, Dobson J, Algra A, Branchereau A, Chatellier G, Fraedrich G, Mali WP, Zeumer H, Brown MM, Mas JL, Ringleb PA. Short-term outcome after stenting versus endarterectomy for symptomatic carotid stenosis: a preplanned meta-analysis of individual patient data. Lancet. 2010 Sep 25;376(9746):1062-73.
2. Bonati LH, Fraedrich G; Carotid Stenting Trialists' Collaboration. Age modifies the relative risk of stenting versus endarterectomy for symptomatic carotid stenosis--a pooled analysis of EVA-3S, SPACE and ICSS. Eur J Vasc Endovasc Surg. 2011 Feb;41(2):153-8.
3. Bonati LH, Dobson J, Featherstone RL, Ederle J, van der Worp HB, de Borst GJ, Mali WP, Beard JD, Cleveland T, Engelter ST, Lyrer PA, Ford GA, Dorman PJ, Brown MM; International Carotid Stenting Study investigators. Long-term outcomes after stenting versus endarterectomy for treatment of symptomatic carotid stenosis: the International Carotid Stenting Study (ICSS) randomised trial. Lancet. 2015 Feb;385(9967):529-38.
4. International Carotid Stenting Study investigators; Ederle J, Dobson J, Featherstone RL, Bonati LH, van der Worp HB, de Borst GJ, Lo TH, Gaines P, Dorman PJ, Macdonald S, Lyrer PA, Hendriks JM, McCollum C, Nederkoorn PJ, Brown MM. Carotid artery stenting compared with endarterectomy in patients with symptomatic carotid stenosis (International Carotid Stenting Study): an interim analysis of a randomised controlled trial. Lancet. 2010 Mar;375(9719):985-97.
5. Ederle J, Davagnanam I, van der Worp HB, Venables GS, Lyrer PA, Featherstone RL, Brown MM, Jäger HR; ICSS investigators. Effect of white-matter lesions on the risk of periprocedural stroke after carotid artery stenting versus endarterectomy in the International Carotid Stenting Study (ICSS): a prespecified analysis of data from a randomised trial. Lancet Neurol. 2013 Sep;12(9):866-72.

1004.6

ICSS long-term data will lead to resurgence of CAS: con

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There will not be a resurgence of carotid stenting as a result of the long-term outcomes of the International Carotid Stenting Study (ICCS) for a number of reasons. While this is a landmark study, which is prospective and randomized, the authors' conclusions (that carotid stenting and carotid endarterectomy were equivalent because long-term disabling stroke and functional outcomes were similar and not statistically different) are marred by the higher incidence of minor strokes, similar to what was identified in the CREST trial earlier. It does appear that both procedures provide equal protection against major strokes in the long term, a finding that has been shown repetitively in various clinical trials. While this data certainly supports the use of carotid stenting in symptomatic patients, resurgence implies growth in volume and mainstream acceptance. The ICCS does not provide separation in quality between procedures but claims equivalence. Given the involvement of multiple disciplines, the presence of political turf, and procedural competition, resurgence will require more than equivalence. There are multiple other barriers and factors that will prevent the resurgence of carotid stenting; these will be presented and used to support this position against the proposition.

Special Session
Palliation in cancer: alleviation strategies

1005.1

Plexus block for pain management

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Learning Objectives
1. To learn about patient selection
2. To learn about the principles of plexus blocks
3. To learn specifically about celiac block

An interventional radiologist can propose several interventions to manage pain related to cancer. Besides thermal ablation, cementoplasty and embolisation, percutaneous nerve blocking is probably one of the most efficient procedures to alleviate pain due to advanced cancers.

Technique

Nerve blocks were initially performed under fluoroscopic guidance, but the incidence of complication was quite high mostly because of the wrong position of the needle. CT guidance (and more recently MRI) offers a higher precision, thereby increasing the efficacy and safety of the procedure.

The injection of a neurolytic agent is the cheapest and most widespread technique to perform nerve blocks. Typically, a 22- or 20-G needle is advanced close to the sympathetic chain, and after verification of the proper position of the needle with injection of the contrast medium, 5–15 ml of a neurolytic agent is injected. Ethanol and phenol are both neurolytic agents, with ethanol reported to be more efficient but more painful. The interventional radiologist should pay attention to the proper repartition of alcohol in order to avoid complications.

Another way to perform neurolysis is to use radiofrequency ablation (RFA), with the same machine as that for facet joint denervation. RFA produces a small and predictable ablation, thereby avoiding untargeted ablation that may occur with alcohol injection. However, RFA has higher cost and requires a very close contact with the sympathetic chain to be efficient. It is therefore not always easy to perform as sympathetic nerves are punctured based on anatomical landmarks because they are not visible with current imaging.

Recently, cryoablation has also been proposed for the same purpose. Main advantage of cryoablation is the clear visualisation of the zone of ablation, owing to the monitoring of the iceball with imaging. Cryoablation is also less painful than RFA, although both techniques are feasible under local anaesthesia. Major drawback of cryotherapy is the high cost of the procedure.

Indications

Nerve blocks can be proposed in a palliative setting to patients who present intense ill-defined deep pain related to locally advanced cancers. The procedure should be proposed if pain is refractory to level 3 analgesics or if the dose of analgesics cannot be increased because of side effects. Informed consent about the goal and risks of the procedure is mandatory.

The site of nerve blocking depends on the location of the cancer:
- The stellate ganglion block is indicated when a cancer invades the stellate ganglion with upper arm pain and Horner's syndrome. The target point is the stellate ganglion, which is located in front of the neck of the 1st rib and transverse process of C7 just behind the origin of the vertebral artery.
- The upper thoracic chain block is indicated for neoplasms which are invading the paravertebral gutter. The target point is the thoracic chain, which is located laterally to the middle part of the vertebral body.
- The coeliac plexus block is discussed in the next paragraph.
- The lumbar ganglia block is indicated for retroperitoneal tumours invading paravertebral gutters. The target point is the lumbar ganglia located in the prevertebral space from L1 to L3.
- The hypogastric plexus block for rectal, left colon, bladder, prostate and gynaecological cancers. Approach to the plexus may be anterior or posterior.
- The impar ganglion block for cancers of the anus, distal urethra, vulva and distal third of the vagina. The neurolysis should be performed in front of the sacrococcygeal joint.

Coeliac block

Most frequent indication of coeliac nerve block is the management of pain secondary to advanced pancreatic cancer. Patients usually present with a transfixing epigastric pain resistant to opioid analgesics. Several approaches have been described in literature: coeliac block with an anterior approach, coeliac block with a posterior approach, splanchnic nerve block requiring a posterior bilateral approach, and combination of the two latter approaches. Splanchnic neurolysis seems to be more effective than other coeliac nerve blocks. Coeliac nerve blocking is very effective but is associated with some frequent adverse effects such as diarrhoea and orthostatic hypotension.

In conclusion, the interventional radiologist involved in oncological treatments should be able to perform nerve blocks, especially the coeliac block that is the most effective block that helps to alleviate pain related to advanced pancreatic cancers. The interventional radiologist can propose several interventions to manage pain related to cancer. Besides thermal ablation, cementoplasty and embolisation, percutaneous nerve blocking is probably one of the most efficient procedures to alleviate pain due to advanced cancers.

1005.2

GI obstruction

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Learning Objectives
1. To learn about technique
2. To learn about the role of endoscopy
3. To learn about patient selection

No abstract available.

1005.3

Long-term drainage of malignant pleural effusion and ascites

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Learning Objectives
1. To learn about tunneled catheter and ports
2. To learn about technical tricks
3. To learn about patient selection

No abstract available.

1005.4

Lymphatic leaks

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Learning Objectives

1. To learn about non invasive measures: e.g. parenteral nutrition
2. To learn about the technique
3. To learn about patient selection

Chylous leakage from the lymphatic system is a complex problem that usually results from inflammation, injury, or abnormalities of the lymphatic system. Loss of chyle can be life threatening due to the significant loss of fluid, plasma protein, fats, and immunoregulatory lymphocytes, and manifests clinically as severe malnutrition, hypoalbuminemia, acidosis, hypokalemia, and susceptibility to infection. Leakage of lymph from the lymphatic ducts causes chylothorax or chylous ascites. A particular form of chyle leakage is chyluria.

Primary leakage can be found in specific hereditary lymphatic anomalies like fetal chylothorax, Noonan syndrome, and Costello syndrome.

Chylothorax is usually caused by pathology or damage of the thoracic duct. Non-traumatic causes of thoracic chyle effusion are very rarely seen in hepatic cirrhosis, lymphomas, or lymphangioleiomyomatosis. Thoracic duct trauma is regularly seen after head and neck surgery (radical neck dissections), thoracic surgery (lobectomies), or esophageal/gastric surgery. Post-operative chylus leak ranges from 0.5% to 5%.

In most cases, clinical presentation of non-traumatic chylothoraces is comparable with other types of pleural effusion. It presents with dyspnea due to intra-pleural space-occupying chyle, thereby leading to incomplete compliance of the affected lung.

After surgery, the most common presentation of a chylothorax is chyle leakage (milky substance) in the thoracic drains without other physical complaints. Diagnosis is performed by conventional X-ray of the thorax and microbiologic analysis of the pleural effusion. To prevent pulmonary distress, initial treatment with drainage of the pleural effusion is always indicated. Thoracic drainage of chyle will lead to loss of protein, fat, and lymphoid cells.

Primary chylous ascites is very uncommon and is closely correlated to lymphatic-lymphonodal dysplasia that does not involve a single visceral district alone. Secondary chylous ascites is usually caused by neoplasia (NHL), trauma, inflammation, and abdominal surgery (aortic surgery, pancreaticoduodenectomy, nephroureterectomy, and retroperitoneal lymph node dissections) and usually occurs as a result of operative trauma to the thoracic duct, cisterna chyli, or its tributaries. Post-operative incidence varies from 0.03% to 11%. Chylous ascites usually presents with abdominal distension. US-guided punction reveals a milky fluid. True chylous ascites is defined as the presence of ascitic fluid with high fat (triglyceride) content, usually higher than 110 mg/dL, and cholesterol higher than 200 mg/dL. Drainage of the fluid may be necessary, but then loss of protein, fat, and lymphoid cells introduce new risks and require careful replacement.

Treatment of choice is conservative: low-fat diets with MCT and parenteral nutrition decrease fluid production while allowing adequate nutritional input. If lymph leakage does not stop, secretion inhibitors like somatostatin or octreotide are prescribed, although there is only weak evidence of their benefits. The loss of this protein-rich, calorie-rich fluid can cause serious complications including dehydration, malnutrition, and immunosuppression. Nutritional support is vital and leads to spontaneous leak closure in many cases. Nutritional management options include total bowel rest with parenteral nutrition, enteral feeding with specialized formula, and oral diet with supplementation. At present, there is no consensus regarding which approach is superior. In reality, most patients with chyle leaks are managed with a combination of oral and enteral feeding. Treatment success is assessed by monitoring of drain production (chylothorax) or monitoring of bowel distension and US of the abdomen to evaluate ascites.

When conservative treatment fails, treatment options are surgical or radiological intervention. The sequence is then first to visualize the leak by lymphography.

The number of conventional lymphographies has declined markedly since the introduction of cross-sectional imaging techniques. Nevertheless, lymphography has a high potential as a reliable method to visualize and directly occlude lymphatic leaks, which other imaging modalities, such as lymphoscintigraphy or MR lymphography, cannot do.

The mechanism remains unclear. The suggestion is that Lipiodol has an inflammatory and granulomatous reaction during extravasation. When used as a distinct radiological procedure with the intention to treat, this application can be described as therapeutic lymphography. In case of persisting chylothorax, and thus failure of conservative treatment, thoracic duct embolization (TDE) through the cisterna chyli by transabdominal approach is nowadays the first alternative. TDE is not applicable in case of chyloascites.

Surgical treatment is considered in resistant cases, for instance, paracentesis with a continuous low-pressure drainage system in cases of chyle leakage or clipping of the thoracic duct in case of chylothorax.

In this lecture, clinical presentation, diagnostics, decisive algorithm, and treatment options will be discussed.

References

1. Lymphangiography in the diagnosis and localization of various chyle leaks. Deso S, Ludwig B, Kabutey NK, Kim D, Guermazi A. Cardiovasc Intervent Radiol. 2012 Feb;35(1):117-26.
2. Genetics of lymphatic anomalies. Brouillard P, Boon L, Vikkula M. J Clin Invest. 2014 Mar;124(3):898-904.
3. Successful management of chylous ascites with total parenteral nutrition and octreotide in children. Yang C, Zhang J, Wang S, Li CC1, Kong XR, Zhao Z. Nutr Hosp. 2013 Nov;28(6):2124-7.
4. Diagnosis and localization of laceration of the thoracic duct: usefulness of lymphangiography and CT. Sachs PB, Zelch MG, Rice TW, Geisinger MA, Risius B, Lammert GK. AJR Am J Roentgenol. 1991 Oct;157(4):703-5.
5. Diagnosis and management of primary chylous ascites. Campisi C, Bellini C, Eretta C, Zilli A, da Rin E, Davini D, Bonioli E, Boccardo F. J Vasc Surg. 2006 Jun;43(6):1244-8.
6. Lymphangiography with sclerotherapy: a novel therapy for refractory chylous ascites. Mullins JK, Pierorazio PM, Hyams ES, Mitchell SE, Allaf ME. Can J Urol. 2012 Jun;19(3):6250-4.
7. Nutritional management in chyle leaks and chylous effusions. Bibby AC, Maskell NA. Br J Community Nurs. 2014 Oct;Suppl Nutrition:S6-8.
8. Chylothorax and chylous ascites: management and pitfalls. Lopez-Gutierrez JC, Tovar JA. Semin Pediatr Surg. 2014 Oct;23(5):298-302.
9. Therapeutic effectiveness of diagnostic lymphangiography for refractory postoperative chylothorax and chylous ascites: correlation with radiologic findings and preceding medical treatment. Kawasaki R, Sugimoto K, Fujii M, Miyamoto N, Okada T, Yamaguchi M, Sugimura K. AJR Am J Roentgenol. 2013 Sep;201(3):659-66.
10. Chylous ascites: a rare complication of thoracic duct embolization for chylothorax. Gaba RC, Owens CA, Bui JT, Carrillo TC, Knuttinen MG. Cardiovasc Intervent Radiol. 2011 Feb;34 Suppl 2:S245-9.
11. Percutaneous treatment of thoracic duct injuries. Marcon F1, Irani K, Aquino T, Saunders JK, Gouge TH, Melis M. Surg Endosc. 2011 Sep;25(9):2844-8.

Honorary Lecture
Andreas Gruentzig Lecture

1301.1

Advanced image modelling of abdominal aortic aneurysm: impact on EVAR management

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Aneurysm maximal diameter (Dmax) and growth rate are the most important predictive factors for AAA rupture. The indications for a procedure are Dmax ≥5.5cm (men) and ≥5cm (women), AAA growth ≥ 7mm in 6 months or 1cm in 1 year, and symptomatic AAA. Standardization and automation of Dmax measurement and growth over time still needs to be implemented in our clinical routine.

AAA segmentation is the first step before AAA modeling. CT scanner is the modality of choice for AAA evaluation before and after endovascular repair (EVAR). AAA lumen segmentation is easily performed after contrast injection, but thrombus segmentation is more challenging. Computer modeling has raised the possibility of patient-specific risk prediction based on AAA geometry. Advanced AA metrics such as detection of focal growth, bulge location, computational flow dynamics, or finite element analysis have been proposed. However, addition of these new indices in a predictive model has not been yet clinically validated on a large scale. The evaluation of AAA wall inflammation with PET-CT is under investigation, and preliminary results are still controversial.

AAA modeling is a necessary step for EVAR planning and stent selection. This AAA model can be registered with fluoroscopy to improve guidance during EVAR procedure and minimize fluoroscopy time and contrast injection. This 2D/3D roadmap is more valuable for advanced EVAR procedures (fenestrated, branched stent-grafts). To increase the accuracy of image fusion, new approaches of elastic registration are under development to correct the vessel deformation induced by endovascular devices. In the near future, modeling of AAA will be combined with finite element analysis to enable EVAR rehearsal.

Regarding EVAR follow-up, considering the incidence of renal failure in this population, follow-up with unenhanced CT is a good alternative. AAA segmentation on unenhanced CT can now be achieved with a high reproducibility. This opens the door to patient follow-up with low-dose unenhanced CT to evaluate Dmax or AAA volume progression over time.

Ultrasound (US) follow-up is more used for EVAR follow-up, but its sensitivity for endoleak detection is still suboptimal and Dmax measurement less reproducible compared to CT. Contrast-enhanced US improves endoleak detection but is difficult to integrate to our clinical routine. We are currently evaluating the potential of US elastography to detect endoleak and characterize thrombus organization. Detection of organized (fibrous) versus soft (liquid) thrombus could be a useful information to assess AAA healing after EVAR and rule out endotension.

Hot Topic Symposium
Aortic intervention – quo vadis?

1302.1

Thoracic aortic trauma

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Thoracic aortic injury (TAI) is, after brain injury, the second most common cause of death in blunt trauma patients. With improved rescue processes and rapid detection of TAI, patients who initially survive are more likely to undergo successful repair.

Rapid deceleration results in torsion and shearing forces at relatively immobile portions of the aorta, such as the aortic isthmus, in up to 90% of cases. Computed tomography is quick and reproducible, with sensitivity and specificity close to 100% for TAI. A classification scheme for TAI has been proposed: Type I (intimal tear), Type II (IMH), Type III (pseudoaneurysm), and Type IV (rupture).

The appropriate timing of treatment in patients with TAI is still controversial. Patients with free aortic rupture or large periaortic haematoma should be treated as emergency cases. For all other conditions, the intervention may be delayed for up to 24 hours to allow for patient stabilization and the best possible conditions for the aortic intervention. An initial conservative management, with serial imaging, has been proposed for patients with minimal aortic injuries (intimal tear/Type I lesions), as most lesions remain stable or resolve.

As a whole, available data indicate that TEVAR, in suitable anatomies, should be the preferred treatment option in TAI. A recently published review, including 7768 patients enrolled for TAI, found a significantly reduced mortality for TEVAR when compared with OR (9% vs 19%; $p < 0.01$). In the same study, no significant difference in event rate across the two groups was noted for stroke, whilst the risk of spinal cord ischaemia (SCI) and end-stage renal disease (ESRD) were higher in OR (9% vs 3%; $p = 0.01$ for SCI and 8% vs 5%; $p = 0.01$ for ESRD). OR was also associated with an increased risk of graft and systemic infection, whilst endovascular repair was associated with an increased need for secondary procedures (5.4%; $p = 0.07$), mostly due to endoleak (60%), followed by stent collapse (11%).

Long-term surveillance by CT is currently considered the standard imaging modality for follow-up; however, given the frequent young age of patients with TAI, concerns arise with regard to cumulative exposure to radiation and iodinated contrast medium. For these reasons, MRI is the best alternative for surveillance when magnetic resonance-compatible stent grafts are employed.

References

1. Neschis DG, Scalea TM, Flinn WR, Griffith BP. Blunt aortic injury. N Engl J Med 2008;359:1708-16.
2. Murad MH, Rizvi AZ, Malgor R, Carey J, Alkatib AA, Erwin PJ, Lee WA, Fairman RM. Comparative effectiveness of the treatments for thoracic aortic transection. J Vasc Surg 2011;53:193-199 e1-21.
3. Jonker FH, Verhagen HJ, Lin PH, Heijmen RH, Trimarchi S, Lee WA, Moll FL, Atamneh H, Rampoldi V, Muhs BE. Open surgery versus endovascular repair of ruptured thoracic aortic aneurysms. J Vasc Surg 2011;53:1210-6.
4. Lee WA, Matsumura JS, Mitchell RS, Farber MA, Greenberg RK, Azizzadeh A, Murad MH, Fairman RM. Endovascular repair of traumatic thoracic aortic injury: clinical practice guidelines of the Society for Vascular Surgery. J Vasc Surg 2011;53:187-92.
5. Azizzadeh A, Charlton-Ouw KM, Chen Z, Rahbar MH, Estrera AL, Amer H, Coogan SM, Safi HJ. An outcome analysis of endovascular versus open repair of blunt traumatic aortic injuries. J Vasc Surg 2013;57:108-14.

1302.2

Complicated acute type B dissection

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No abstract available.

1302.3

Malperfusion syndromes in acute aortic dissection

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State of the art. Patients with aortic dissection (AoD) do not die from the presence of an intimal tear and two channels into the aorta; they die because of two complications: rupture and malperfusion syndromes. Principles of the management are to detect and to treat these complications before it becomes too late. If rupture of the aorta is relatively easy to diagnose in the acute phase (< 2 weeks from initial onset of symptoms), malperfusion syndromes are relatively new entities.

Definition. Malperfusion syndrome is a complication of AoD, encountered in 25% to 50% of patients, defined as end-organ ischemia caused by branch-vessel involvement and resulting in clinical symptoms and functional impairment in a wide range of arterial beds that spans a spectrum between mid-dysfunction to tissue necrosis, resulting in organ damage. Symptoms related to the heart (coronaries, myocardial infarct), brain (supra-aortic vessel, stroke), spine (paraplegia), bowel (ischemia, necrosis, death), kidneys (renal failure, anuria, refractory hypertension), and lower limbs (ischemia, claudication) are some of the possible symptoms of the malperfusion syndromes.

How to detect malperfusion? Because of improvements in technology, a complete thoraco-abdomino-pelvic CT scan of the aorta is now mandatory. Aorta should be considered as an organ, and limited thoracic analysis should be avoided (analysis of only 50% of the organ), leading to insufficient information and mistreatment algorithm. Detection of AoD is not sufficient, and radiologists have to describe the location of AoD on the aorta and its branches, entry tears, possible ruptures, organ ischemia, mechanism of the malperfusion, thrombi, ….

Impact on treatment. Diagnosis of malperfusion syndrome evidenced the remaining mortality after classical AoD management. Because complications were observed and because of improvements of endovascular tools (fenestration, TEVAR, peripheral stents) to repair the arteries, patients could be suitable for an alternative strategy compared to the classical medical or surgical approach.

Classification for management. If De Backey or Stanford classification is well known, AoD management should be performed depending of the presence or absence of complications. If a complication is present, it should be treated first before performing the preventive treatment, regardless of the location of AoD on the aorta.

And now? The main challenge remains to understand the mechanism of the malperfusion and to adapt the best treatment. Questions of when and how to treat patients depend on CT scan analysis, which in turn depends on the quality of the acquisition protocol and the experience of the radiologist.

References

1. Willoteaux S, Lions C, Gaxotte V, Negaiwi Z, Beregi JP. Imaging of aortic dissection by helical computed tomography (CT). Eur Radiol. 2004;14:1999-2008.
2. Midulla M, Fattori R, Beregi JP, Dake M, Rousseau H. Aortic dissection and malperfusion syndrome : a when, what and how-to guide. Radiol Med. 2012;118:74-88.
3. Midulla M, Renaud A, Martinelli T, Koussa M, Mounier-Vehier C, Prat A, Beregi JP. Endovascular fenestration in aortic dissection with acute malperfusion syndrome: immediate and late follow-up. J Thorac Cardiovasc Surg. 2011;142:66-72.
4. Beregi JP, Mounier-Vehier C, Koussa M, Goyault G, Prat A, Martinelli T, Midulla M. Chronic aortic syndrome: how to follow patients, which complications and when to treat? Presse Med. 2011;40:88-93.
5. Kaya A, Heijmen RH, Rousseau H, Nienaber CA, Ehrlich M, Amabile P, Beregi JP, Fattori R. Emergency treatment of the thoracic aorta: results in 113 consecutive acute patients (the Talent Thoracic Retrospective Registry). Eur J Cardiothorac Surg. 2009;35:276-81.
6. Gaxotte V, Thony F, Rousseau H, Lions C, Otal P, Willoteaux S, Rodiere M, Negaiwi Z, Joffre F, Beregi JP. Midterm results of aortic diameter outcomes after thoracic stent-graft implantation for aortic dissection: a multicenter study. J Endovasc Ther. 2006;13:127-38.
7. Gaxotte V, Cocheteux B, Haulon S, Vincentelli A, Lions C, Koussa M, Willoteaux S, Asseman P, Prat A, Beregi JP. Relationship of intimal flap position to endovascular treatment of malperfusion syndromes in aortic dissection. J Endovasc Ther. 2003;10:719-27.
8. Beregi JP, Haulon S, Otal P, Thony F, Bartoli JM, Crochet D, Lacombe P, Bonneville JF, Besse F, Douek P, Heautot JF, Rousseau H; Societé Fraçaise d'Imagerie Cardio-Vasculaire (SFICV) Research Group on Aortic Dissection. Endovascular treatment of acute complications associated with aortic dissection: midterm results from a multicenter study. J Endovasc Ther. 2003;10:486-93.
9. Beregi JP, Prat A, Gaxotte V, Delomez M, McFadden EP. Endovascular treatment for dissection of the descending aorta. Lancet. 2000;356:482-3.

1302.4

Ruptured abdominal aortic aneurysm

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Ruptured abdominal aortic aneurysms (RAAAs) are a catastrophic condition with high morbidity and 30-day mortality when treated by open surgical repair (OSR) procedures. The introduction of endovascular graft repair (EVAR), first performed in 1994, combined with other endovascular adjuncts, offered the possibility of better outcomes.

Numerous single-center reports, population-based studies, and the collected world experience with the use of EVAR for RAAAs demonstrated better early outcomes after EVAR than after OSR. Some of these reports emphasized the importance of several strategies and adjuncts in achieving these better outcomes. These included having a protocol or system for managing RAAAs, fluid restriction or hypotensive hemostasis prior to and during repair, properly performed use of supraceliac aortic balloon control for hemodynamic collapse, and open abdomen treatment for abdominal compartment syndrome when detected (1).

However, the superiority of EVAR over OSR for the treatment of RAAAs remains controversial. This controversy is sustained by several reports of controlled studies showing no better outcomes for EVAR than for OSR with RAAAs and the claim that reports of better outcomes for EVAR were based on case selection with patients treated by EVAR having more favorable anatomy, being more hemodynamically stable, and less risky.

Recently, 3 randomized controlled trials comparing EVAR and OSR for the treatment of RAAAs have been published or presented. These are the AJAX, EVAR, and IMPROVE trials, all of which demonstrated no better 30-day mortality with EVAR than with OSR. All

these trials have serious flaws that render them misleading (2). In addition, one report has demonstrated the ability to treat all RAAAs seen at 2 centers with EVAR, provided some adjuncts like chimney grafts are employed (3). A low 30-day mortality (24%) and turn-down rate (4%) were observed. It can therefore be concluded that EVAR is better than OSR for the treatment of RAAAs, provided EVAR capability exists in an institution and an EVAR procedure can be performed.

References

1. Veith FJ, et al. Collected world and single center experience with endovascular treatment of ruptured abdominal aortic aneurysms. Ann Surg 2009;250:818-824.
2. Veith FJ, Rockman CB. The recent randomized trials of EVAR versus open repair for ruptured abdominal aortic aneurysms are misleading. Vascular 2015;23:217-219.
3. Mayer D, et al. Complete replacement of open repair for ruptured abdominal aortic aneurysms by endovascular aneurysm repair: a two-center 14-year experience. Ann Surg 2012;256:688-696.

Fundamental Course
Basic principles of transcatheter embolisation in the trauma patient

1701.1

Treatment of extremity trauma

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Learning Objectives

1. To understand the relevant anatomy and types, causes and symptoms of injury
2. To describe remodeling and embolisation principles of treatment
3. To review potential failure and complications

No abstract available.

1701.2

Treatment of parenchymatous bleeding in abdominal cavity

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Learning Objectives

1. To review the indications and results of embolisation in splenic trauma
2. To review the indications and results of embolisation in liver trauma
3. To review the indications and results of embolisation in renal trauma

Trauma is the leading source of death under 45 years in developed countries. When a trauma patient arrives into the emergency room, during the initial resuscitation procedures, a first diagnostic survey must be done with total body CT whenever possible to identify those major injuries. Abdominal haemorrhage due to blunt trauma is life-threatening. Key signs to recognise are the presence of blood/haematoma in the abdomen, sentinel clot or active contrast extravasation from solid organs. It is crucial to decide whether the optimal therapy is surgery or IR. The decision should be based on which treatment is able to control haemorrhage most rapidly with minimum sequelae. IR has a role in many cases, particularly if there is arterial bleeding. For the subgroup of patients who are haemodynamically stable without signs of peritonitis, embolisation is currently considered a first line of treatment by the American Association for the Surgery of Trauma (AAST). When the indication is appropriate, embolisation is associated with a lower rate of complications, earlier discharge and lower cost. Although any solid intra-abdominal organ can be injured after an abdominal trauma, spleen is the most commonly involved, followed by liver and kidney.

To treat splenic trauma, there are two options: proximal and distal embolisation. In terms of effectiveness in bleeding control, the difference between these techniques has not been demonstrated. When a focal bleeding is identified, distal embolisation is recommended; and for patients with multiple bleeding sites or challenging anatomy, proximal embolisation may be the best option. When proximal embolisation is chosen, it should be done distal to the origin of the pancreatic branches.

In liver trauma when there is a massive portal bleeding, surgery is mandatory. When the source of bleeding is arterial, embolisation is an appropriate treatment. Unlike in spleen, a proximal embolisation is not indicated in the liver. A superselective embolisation should be done limited to the devascularised area.

Embolisation is a nephron-sparing technique for renal trauma. Expanding perirenal haematoma and corticomedullary laceration are indications for superselective microcatheter embolisation. Patients with avulsion of the renal pelvis, injuries in the vascular pedicle and life-threatening haemodynamic instability need surgery.

References

1. Chakraverty S, Flood K, Kessel D, McPherson S, Nicholson T, Ray CE Jr, Robertson I, van Delden OM. CIRSE guidelines: quality improvement guidelines for endovascular treatment of traumatic hemorrhage. Cardiovasc Intervent Radiol. 2012; 35:472-82.

1701.3

Treatment of pelvic haemorrhage

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Learning Objectives

1. To discuss suitable candidates
2. To understand the relevant anatomy and examine embolisation techniques
3. To review potential failure and complications of embolisation

Traumatic pelvic fractures can result in significant haemorrhage that can be associated with significant morbidity and mortality. Patients with pelvic fractures that cause hemodynamic instability have a mortality rate that exceeds 50% in several series. Thus, hemodynamic instability indicates a poor prognosis, especially if it persists for a longer time period. Bleeding from pelvic fractures can be generated from several sources, including arterial and venous injury and bleeding from fractured cancellous bone within the pelvis. Bleeding from fractured bone within the pelvis can be controlled with prompt stabilization of the fracture, which also can tamponade and control venous bleeding. However, arterial bleeding cannot be controlled using these measures. Although the risk of significant arterial haemorrhage after pelvic fracture is clear, the incidence and predictors for needing therapeutic arterial embolization remain in debate. Criteria exist for obtaining pelvic arterial angiography in patients with severe pelvic fracture based on the presence of hemodynamic instability or the need for ongoing blood transfusion. However, early therapy, avoiding massive transfusions, prolonged hemodynamic instability, and abdominal compartment syndrome, would be desirable. Contrast-enhanced MSCT during the arterial and venous phase provides important information allowing early indication for treatment. Predictors for massive arterial bleedings are as follows: instable pelvic fracture with pelvic hematoma; contrast extravasation during MSCT in the arterial phase; drop of blood pressure; and hemodynamic instability. Arterial embolization is indicated if arterial contrast extravasation caused by fractured bone is demonstrated on

CT. In hemodynamically unstable patients, treatment has to be performed on an emergency basis. Transarterial embolization (TAE) is highly effective (85-100%); repeat embolization to control haemorrhage has to be performed in less than 10%. The complication rate is low (4-8%). Stent grafts are very rarely indicated to control bleeding since most bleedings sites are located in the internal iliac territory. The common and external iliac arteries are very rarely involved in pelvic trauma. If one of these arteries is lacerated, rapid control of bleeding by balloon tamponade and secondary repair (stentgraft or surgery) is frequently indicated.

References

1. Arterial embolization for pelvic fractures after blunt trauma: are we all talk? Costantini TW, Bosarge PL, Fortlage D, Bansal V, Coimbra R. Am J Surg. 2010 Dec;200(6):752-7; discussion 757-8.
2. The role of arterial embolization in controlling pelvic fracture haemorrhage: A systematic review of the literature. Papakostidis C, Kanakaris N, Dimitriou R, Giannoudis PV.Eur JRadiol. 2011 Mar 24. [Epub ahead of print].
3. Early embolization without external fixation in pelvic trauma. Tanizaki S, Maeda S, Hayashi H, Matano H, Ishida H, Yoshikawa J, Yamamoto T. Am J Emerg Med. 2012 Feb;30(2):342-6.
4. Efficacy of plain radiography and computer tomography in localizing the site of pelvic arterial bleeding in trauma patients. Dormagen JB, Tötterman A, Røise O, Sandvik L, Kløw NE. Acta Radiol. 2010 Feb;51(1):107-16.
5. Transcatheter embolization in the treatment of hemorrhage in pelvic trauma. Hoffer EK. Semin Intervent Radiol. 2008 Sep;25(3):281-92.

1701.4

Role of stent grafts in large vessel trauma

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Learning Objectives

1. To discuss when to embolise and when to use a stentgraft
2. To examine suitable stent grafts and techniques for implantation
3. To review potential failure and complications of stent graft insertion and embolisation

Especially in patients after a high-speed trauma, a ruptured/dissected thoracic or abdominal aorta is relatively common.

The presentation will start with imaging prerequisites in order to diagnose a traumatic aortic pathology in the right way. Moreover, radiologists have to decide according to the images if an interventional treatment is possible. If a treatment is indicated and technically possible, intervention and material selection has to be planned. A precise treatment planning is crucial in order to ensure successful and fast treatment.

The following part of the presentation will deal with the different ways to treat aortic traumatic pathologies – when, where, how, and which device should be implanted.

The last part of the presentation will present the literature data about the outcome of endovascular treatment possibilities of traumatic aortic pathologies.

Special Session
Venous Forum III: Pulmonary embolism and IVC filters

1702.1

PE: patient assessment and selection for treatment

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Learning Objectives

1. To learn about the pulmonary embolism severity index (PESI)
2. To learn about the imaging criteria, including normal heart function
3. To learn about important lab findings

Acute pulmonary embolism (PE) is a common and potentially fatal disease. With an incidence rate of 1–1.5 per thousand, PE is implicated in over 300,000 deaths annually in Europe (1). Contemporary diagnostic and therapeutic armamentarium, including IR procedures, contribute to the increased detection of PE as well as to decreased mortality. In general, when left untreated, PE is associated with an overall mortality of up to 30%, compared with that of 2%–11% in those treated with anticoagulation (2,3).

Following an acute PE episode, the resolution of pulmonary thrombi is frequently incomplete, as shown in lung perfusion scintigraphy, despite marked improvement of pulmonary vascularization (4). After PE treatment, the incidence of chronic thromboembolic pulmonary hypertension (CTEPH) is about 1.5% (5).

PE usually presents with symptoms of dyspnoea at rest or exertion, pleuritic pain, cough, orthopnea, DVT symptoms, wheezing, and hemoptysis. On clinical examination, prominent signs may include tachypnea, tachycardia, rales, decreased breath sounds, jugular vein distention, and fever, which mimic pneumonia. In central (saddle or main branches) PE, chest pain may have a typical angina character. Indeed, massive PE may lead to RV failure as a consequence of PE-induced vasoconstriction and anatomical obstruction, which increase pulmonary vascular resistance. Mechanical and neurohumoral sequences result in desynchronization of cardiac ventricles, leftward bowing of the interventricular septum, right bundle branch block, impedance of LV, and reduction of cardiac output. Finally, systemic hypotension and hemodynamic instability occur.

Patients with suspected acute PE should therefore be assessed as hemodynamically unstable or hemodynamically stable. Hypoxemia is considered a typical PE finding, but up to 40% of the patients have normal O_2 saturation at presentation. CXR, ECG (S1Q3T3 pattern, RBBB), BNP, and troponin levels may be useful, but they are of limited diagnostic value unless used in combination with clinical suspicion. D-dimer testing has a high-negative but low-positive predictive value.

Assessment of clinical probability is based on a combination of findings, clinical judgement, and prediction rules. Both Geneva and Wells score tables are of value.

Diagnostic strategy then starts after the evaluation of patients with suspected PE as being hemodynamically unstable or not. For those who were hemodynamically unstable, initial support should focus upon restoring perfusion with IV fluids (500–1000 ml of N/S), vasopressors, and oxygenation with possible intubation while awaiting imaging (CTPA). If CTPA is not readily available, echocardiography could check for RV overload.

Catheter-directed procedures are reserved for CTA positive with RV overload patients. Tables 2 and 3 indicate the proposed diagnostic algorithms by European Society of Cardiology guidelines. In case of uncertainties, additional testing such as V/Q scan may be useful.

Prognostic assessment of patients with confirmed PE is equally important as several parameters are associated with high risk of early death or with an unfavorable short-term prognosis. Acute RV

failure, arterial hypotension, syncope, and tachycardia as well as pre-existing comorbidities should be evaluated in order to categorize patients for further monitoring and treatment options.
PE severity index (PESI) and its simplified version, sPESI, are the most validated scoring systems to date. Some authors propose a combination of sPESI with troponin or BNP l levels.
PESI affects therapeutic strategy as patients of intermediate-high risk should be closely monitored and considered as potential candidates for rescue reperfusion, while those with intermediate-low risk could stay hospitalized on anticoagulation.

References

1. Cohen AT, Agnelli G et al. Venous thromboembolism (VTE) in Europe. The number of VTE events and associated morbidity and mortality. Thromb Haemost 2007; 98:756-764.
2. Soloff LA, Rodman T. Acute pulmonary embolism. II. Clinical. Am Heart J 1967; 74:829-847.
3. Laporte S, Mismetti P et al. Clinical predictors for fatal pulmonary embolism in 15,520 patients with venous thromboembolism: findings from the Registro Informatizado de la Enfermedad TromboEmbolica venosa (RIETE) Registry. Circulation 2008; 117:1711-1716.
4. Miniaty M, Monti S et al. Survival and restoration of pulmonary perfusion in a long term follow-up of patients after acute pulmonary embolism. Medicine (Baltimore) 2006; 85:253-262.
5. 2014 ESC Guidelines on the diagnosis and management of acute pulmonary embolism. www.escardio.org/guidelines.
6. Stein PD, Beemath A et al. Clinical characteristics of patients with acute pulmonary embolism: data from PIOPED II. Am J Med 2007; 120:871-879.
7. Spirk D, Aujesky D et al. Cardiac troponin testing and the simplified pulmonary embolization severity index. Thromb Haemost 2011; 106:978-984.
8. Jimenez D, Kopecna D et al. Derivation and validation of multimarker prognostication for normotensive patients with acute symptomatic pulmonary embolism. Am J Respir Crit Care Med 2014; 189:718-726.

1702.2

Treatment options for pulmonary embolism

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Learning Objectives

1. To learn about the different endovascular treatment options
2. To learn about the outcomes of different treatment options
3. To learn about different strategies (uni- vs. bilateral, etc.)

No abstract available.

1702.3

Current evidence on IVC filter placement

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Learning Objectives

1. To learn about the absolute and relative IVC filter indication
2. To learn about IVC filter complications
3. To learn about the differences between permanent and optional filters

In general, the indications for IVC filter placement are to provide an alternative to anticoagulation because of anticoagulation failure, complications, or non-compliance. It can also be considered as a stand-alone or adjunctive treatment in severe thromboembolic disease or in a prophylactic setting.

The benefit of an IVC filter placement always has to be weighed against the risks, as this procedure is not without complications. The complications can be divided into immediate and delayed. Immediate complications at placement include technical problems such as access site failure and thrombosis, anatomical issues, clot dislodgment, as well as filter non-deployment, misplacement, migration, and tilting. Delayed complications include filter migration, thrombosis, tilting, perforation, exhaustion, and infection, as well as recurrent embolism.
We now have the choice between permanent and optional filters, which have similar indications and complications. However, the optional filters require a slightly different though process when it comes to deciding on the indication, as there will be a possibility of filter removal. Nevertheless, these optional filters also show a different palette of complications, such as impossibility of filter removal and increased fracture rate.

References

1. Caplin D et al. Quality Improvement Guidelines ofr the Performance of Inferior Vena Cava Filter Placement for the Prevention of Pulmonary Embolism. JVIR 2011; 22:1499-1506.
2. Kaufman J et al. Guidelines for the Use of Retrievable and Convertible Vena Cava Filters: Report from the Society of Interventional Radiology Multidisciplinary Consensus Conference. JVIR 2006; 17:449-459.
3. Grassi C et al. Quality Improvement Guidelines for Percutaneous Permanent Inferior Vena Cava Filter Placement for the Prevention of Pulmonary Embolism. JVIR 2003; 14:S271-S275.
4. Harvey JJ et al. Inferior vena cava filters: What radiologists need to know. Clin Radiol 2013; 68:721-732.
5. Uberoi R et al. British Society od Interventional Radiology (BSIR) Inferior Vena Cava (IVC) Filter Registry. Cardiovasc Intervent Radiol 2013; 36:1548-1561.
6. Kaufman J. Guidelines for the Use of Retrievable Vena Cava Filters. Interventional Cardiology 2007.

1702.4

Challenging placements and retrievals

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Learning Objectives

1. To learn about access site selection
2. To learn about different retrieval techniques
3. To learn when to stop a retrieval

In general, IVC filter placements and retrievals are quite straightforward. However, in certain circumstances, there can be some challenges, which will be discussed in the lecture. The importance of a correct indication for IVC filter placement as well as retrieval should be emphasized.
Challenging access:
With the wide availability of ultrasound guidance and the smaller profiles of IVC filter delivery systems, the complication rates at the venous access site have dropped markedly. While for most IVC filters, a femoral or a jugular delivery system is available, only one approach for retrieval is generally possible. Therefore, the appropriate type of filter should be chosen if either the femoral or the jugular route is not available for retrieval. Most filters are removed from a jugular approach. The Optease filter is the most suitable choice for a femoral retrieval.
Location of placement:
The most common implantation site for IVC filters is the infrarenal IVC with the idea that in case of a thrombosed filter the outflow of the renal veins is not impaired. However, a suprarenal position can be chosen without any major drawbacks in case of a challenge in the infrarenal location. There are different situations to consider:

- If there is thrombus extending into the IVC, the filter has to be positioned above any thrombus, because if a filter is placed into thrombus there is a chance of incomplete opening, insufficient filtration, and also migration.
- If there is a narrowing or a tortuosity of the infrarenal IVC, a filter placement in that area could be less than optimal because of incomplete expansion or tilting. In such a circumstance implantation in a straight non-obstructed area is preferable.
- If there is an anatomical variant, for example a duplicated IVC, either one filter can be placed in the suprarenal position or one filter can be placed in either IVC. The latter possibility is more expensive due to two devices needed.

Another consideration is the size of the IVC. Because most filters depend on oversizing, the size of the IVC should be less than described by the IFU of a given filter. The maximum diameter is commonly 28mm or 30mm. For larger IVC's a smaller area could be chosen such as the intrahepatic IVC or two filters can be placed into the common iliac veins. Alternatively, a Bird's Nest filter which is approved for IVC's up to 40mm can be placed. Unfortunately, the Bird's Nest filter is not as easy to place as the current devices and it is a permanent device.

Challenging retrievals

Arguably, the biggest challenge is to make sure patients are followed and are evaluated for possible retrieval. A retrieval should be attempted when the initial indication is no longer present and when the patient is likely to benefit from the retrieval: long enough life expectancy (at least > 1 year) and a low chance of a repeated risk for a pulmonary embolism which would require another IVC filter.

In addition, a filter should not be retrieved if there is more than just a little thrombus in the filter. There is no standardized imaging workup. Some perform an ultrasound, others a CT and others move directly to a venogram if there is no clinical suspicion. In any case, if there is a substantial amount of clot in the filter, the retrieval should be postponed and anticoagulation continued for 1-3 months. In case of massive thrombus extending beyond the filter a second filter above the first one can be necessary. One factor however should be considered when postponing retrieval: the maximum possible dwell time which varies among different filter designs. As a rule of thumb: the larger the contact areas of the filter to the IVC wall, the shorter is the time till a filter cannot be safely removed.

The most common technical problem is a tilted filter with the filter tip against the IVC wall. In such cases, the standard retrieval techniques often do not work anymore. Before doing anything else the indication for retrieval should be critically reassessed again because all current retrievable filters are so called "optional" filters meaning they could stay in permanently if needed. The risk for any retrieval should be lower than the risk of a filter complication in case the filter is left in place.

In the literature, many different ways to overcome a tilted filter are described, including use of deflecting wires to center the tip, angioplasty balloons from different access points to push the tip away from the wall, different loop-snares formed around the tip of the filter to pull the filter away from the wall, forceps to free-up the tip, and laser technology to remove tissue around the tip. The latter is especially helpful if the tip is not just tilted but also grown into the caval wall. A thorough knowledge of the different devices is important to not run into problems during these off-label retrieval maneuvers.

In summary, a thorough planning and careful placement can minimize the need for challenging retrievals. During any time of a retrieval procedure, the option of leaving the filter in place should be kept in mind, especially when off-label techniques are used.

Special Session
State-of-the-art SFA interventions

1703.1

Trials update

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Learning Objectives

1. To learn about onging trials on SFA interventions
2. To learn how to make decisions on when to stent and when not
3. To learn about the outcome analysis of trials

An interventional procedure consists of four elementary interventional treatment steps followed by an adequate follow-up of the patient: 1. lesion access, 2. lesion crossing, 3. lesion treatment, and 4. vascular closure. Once a lesion, either a stenosis or an occlusion, is crossed successfully with a guide wire, different endovascular treatment algorithms are possible such as PTA, BMS, DEB, DES, and others like laser and atherectomy. A recent Cochrane analysis could demonstrate that there was a short-term gain in primary patency and there was no sustained benefit from primary stenting of lesions of the superficial femoral artery in addition to angioplasty (1). In addition, it is reported that quality of life showed no significant difference between participants treated with PTA alone or PTA with stent insertion at any time interval (1). In this context, latest trial data will be presented, mostly focusing on in PubMed published data. From current perspective, these indicate enhanced primary patency rates and reduced TLR rates under ideal and selected trial conditions for DCB technology (2), BMS (3), combination of BMS and DCB (4), and DES (5). Latest data will be presented during the meeting.

References

1. Choowdhury MM et al. Angioplasty versus bare metal stenting for superficial femoral artery lesions. Cochrane Database Syst Rev. 2014 Jun 24;6.
2. Tepe G et al. 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;131(5):495-502.
3. Gray WA et al. S.M.A.R.T. self-expanding nitinol stent for the treatment of atherosclerotic lesions in the superficial femoral artery (STROLL): 1-year outcomes. J Vasc Interv Radiol. 2015 Jan;26(1):21-8.
4. Listro F et al. Drug-eluting balloon in peripheral intervention for the superficial femoral artery: the DEBATE-SFA randomized trial (drug eluting balloon in peripheral intervention for the superficial femoral artery). JACC Cardiovasc Interv. 2013 Dec;6(12):1295-302.
5. Dake M et al. Sustained safety and effectiveness of paclitaxel-eluting stents for femoropopliteal lesions: 2-year follow-up from the Zilver PTX randomized and single-arm clinical studies. J Am Coll Cardiol. 2013 Jun 18;61(24):2417-27.

1703.2

Techniques and complication management

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Learning Objectives

1. To learn about the indications for recanalisation
2. To learn about different materials and techniques available for recanalisation
3. To learn about the outcomes of recanalisation

Lower limb peripheral artery disease (PAD) is a common manifestation of systemic atherosclerosis. The superficial femoral artery (SFA) is often involved in atherosclerotic lesions occurring as a site of single stenosis, segmental obstruction, or diffuse condition involving multiple arterial segments.

Single stenosis alone generally causes limited impairment of lower limb and intermittent claudication, while a more diffuse condition also involving other arterial vessels can lead to severe clinical impairment such as critical limb ischemia (rest pain, ulcer, gangrene, and necrosis).

Surgery represents the gold standard for complete SFA obstruction or concomitant involvement of common and profunda femoral arteries, but endovascular techniques for occlusive SFA disease in the last decades had become a reliable alternative treatment to open surgery. Most recent guidelines in literature recommended endovascular techniques as a safe approach in highly symptomatic patients (Rutherford 4 to 6) with complex femoropopliteal lesions (TASC C and D) (1).

Potential advantages of this continuously evolving treatment are short hospitalization, ability to perform procedures under local anesthesia, and low perioperative morbidity rates.

Endovascular revascularization of SFA is particularly challenging as manifestations of the disease can differ from short, focal stenosis to long, diffuse obstruction.

Several endovascular techniques have been proven to be effective in the treatment of SFA lesions:

intraluminal angioplasty (by balloon catheter, cutting balloon, scoring balloon, and drug-coated balloon)

subintimal angioplasty

debulking techniques (such as atherectomy and cryoplasty)

stenting (using bare metal stent, covered stent, drug-eluted stent, and absorbable stent).

After assessment of the arterial occlusive disease, an endovascular specialist can decide on the type of endovascular revascularization.

Percutaneous transluminal angioplasty (PTA) with balloon catheter is the gold standard among percutaneous techniques in the treatment of PAD. It can be used alone or in association with other endovascular procedures (stent, stent-graft, and debulking techniques).

An important issue in endovascular revascularization is the selection of an appropriate vascular access by means of a direct puncture (according to Seldinger technique) or surgical vessel exposure (graft in the puncture site, obesity, and hybrid procedure). For SFA revascularization, the endovascular approach to the artery can be antegrade or retrograde; standard access is common femoral artery approached retrograde (in case of proximal contralateral SFA disease) or antegrade (in case of ipsilateral distal SFA lesion). In this latter case, common femoral artery puncture may be performed below the groin crease because of the lower risk of retroperitoneal hemorrhage caused by external iliac artery puncture. Other alternatives are the retrograde approach using direct puncture of popliteal or pedal arteries (2) and the combined antegrade and retrograde approach ("Safari" technique) (3), particularly in case of the inability to cross the SFA occlusion.

After arterial access and positioning of the sheath, intra-arterial heparin is given as a matter of routine between 2500 and 5000 IU, and the diagnostic arteriogram is performed. The angiography provides the basis for selecting guidewire and balloon catheters and for defining the PTA technique. This involves the use of a balloon catheter to dilate the arterial segment affected by the obstructive disease. Balloon width should be selected equal to the caliber of a normal vessel adjacent to the arterial lesion in order to avoid overdilatation of the artery, with risk of arterial rupture and flow-limiting dissection. PTA is an effective technique in the treatment of SFA stenosis of a noncalcified plaque or short occlusion, but it can have a poor effect in arterial long occlusion or in the arterial stenosis of calcified plaque. In the latter case, the critical point is to pass the arterial lesion with the guidewire. Arterial revascularization may be affected by intraluminal or intentional subintimal technique.

In the first case, the guidewire is advanced into the initial segment of the occlusion until resistance is encountered. The degree of resistance is an indication of the severity of the disease. If the resistance is high, it could sometimes be necessary to use a straight catheter to give further support to the guidewire. The injection of a small amount of contrast medium should be ensured in the lumen of the vessel and not in the subintimal space. After the occluded segment is passed, a balloon catheter can be positioned over the guidewire and inflated. To reduce the risk of complications (arterial rupture and peripheral embolism), a predilation with balloon catheter of a small diameter can be performed. Since the intraluminal PTA with bare balloon catheter is characterized by a high rate of restenosis, the use of drug-eluted balloon has been recently proposed. These balloon catheters have shown a significant reduction in late lumen loss and target lesion revascularization (4).

In case of intentional subintimal angioplasty, the goal is to intentionally go into the subintimal space at the origin of the occlusion. The presence of a disease-free segment distal to artery occlusion allows intraluminal return of the guidewire. Extensively diseased distal segments beyond the occlusion represent a contraindication for this technique. Through an angulated catheter, a hydrophilic guidewire is directed towards the wall of the artery at the level of the occlusion. The guidewire is manipulated into a loop, which is then used to dissect the entire length of the occlusion. The catheter is then advanced into the arterial wall. Distal re-entry of the guidewire in the arterial lumen is the most critical and difficult part of this technique. Once re-entry has been achieved, the catheter is substituted for a balloon catheter and the dissection is dilated (5). When performing PTA, there is no absolute standard for inflation time or the number of repetitions. During inflations, patients may experience pain. Pain that persists after deflation is a warning of possible arterial rupture.

Technical success of PTA is defined as the achievement of a residual diameter stenosis of <30% at the end of the procedure. If the residual stenosis is of >30% or if it appears to be a flow-limiting dissection, it is necessary to repeat inflation or to consider stent implantation (secondary stenting). Stent can fixate the residual defect against the arterial wall and prevent elastic recoil and postprocedural arterial restenosis. The stent more commonly used in SFA are nitinol self-expandable stent, which have great longitudinal flexibility into tortuous vessels and recover from deformation secondary to flexion and extension.

In addition to bare stent, the industries are proposing bioabsorbable (6) and drug-eluted stents (7). The rationale for the use of these stents is to reduce the long-term stimulus for neointimal hyperplasia and to decrease in-stent restenosis. Polytetrafluoroethylene (PTFE)-covered stents are now used to treat long-segment occlusive disease aiming at decreasing in-stent restenosis and improving vessel patency (8). Compared with conventional stents, stent-grafts may combine the radial resistance of the stent with a mechanical barrier to prevent restenosis.

A debulking strategy prior to balloon angioplasty is warranted in many cases. Removal of obstructive material can facilitate the crossing of total occlusions, thereby transforming an occlusion into a more easily balloonable stenosis.

Several techniques have been developed to remove the endoluminal occlusive material such as laser ablation and atherectomy devices (rotational atherectomy, orbital atherectomy, and excisional atherectomy). All seem to work, but their superiority over PTA is still under debate (9). Nevertheless, these techniques have a reported 0.8% risk of perforation (10). Under these conditions, as in all cases of arterial-contained rupture or rupture after endovascular revascularization, covered stent can be deployed to exclude the lesion.
Acute in situ thrombosis and distal embolization during SFA revascularization can occur. Their incidence and outcomes have not been well defined in the literature (11).
In the first condition, pharmacological therapy can be utilized in an effort to reopen the lumen. Tissue-type plasminogen activator (tPA) can be infused according to different protocols (bolus infusion on the table, placement of an infusion catheter across the lesion, infusion for 12–24 hours, and use of a rheolytic catheter with or without subsequent infusion of tPA for 12–24 hours) with or without subsequent PTA and/or stenting.
In case of distal embolization, open embolectomy through femoral, popliteal, and tibial approaches can be performed, but several endovascular techniques have been proposed for the restoration of outflow vessels such as wire passage, bolus tPA injection, balloon angioplasty, atherectomy, and aspiration catheter.

References

1. Grenville JI, Tan KT, Moshonov H, Rajan DK. Endovascular first strategy for de novo TransAtlantic Inter-Society Consensus C and D femoro-popliteal disease: mid-term outcomes from a single tertiary referral center. Vascular 2015;23: 31-40.
2. Fanelli F, Cannavale A. Retrograde recanalization of complex SFA lesions indications and techniques. J Cardiovasc Surg 2014;55: 456-471.
3. Gandini R, Pipitone V, Stefanini M. The "Safari" technique to perform difficult subintimal infragenicular vessels. Cardiovasc Intervent Radiol 2007;30: 469-473.
4. Zeller T, Rastan A, Macharzina R, Beschorner U, Noory E. Drug-coated balloon: how should we incorporate into our practice in treating superficial femoral artery lesions? Curr Treat Options cardiovasc Med 2015;17: 380.
5. Bolia A, Bell PR. Femoropopliteal and crural artery recanalization using subintimal angioplasty. Semin Vasc Surg 1995;8: 253-264.
6. Katzen BT. A great start, but the promise of biodegradable stents remains to be proven. JACC Cardiovasc Interv 2014;7: 313-314.
7. Zeller T, Rastan A, Macharzina R, Tepe G, Kaspar M, Chavarria J et al. Drug-coated balloons vs. drug-eluting stents for treatment of long femoropopliteal lesions. J Endovasc Ther 2014;21: 359-368.
8. Zeller T, Peeters P, Bosiers M, Lammer J, Brechtel K, Scheinert D et al. Heparin-bonded stent-graft for the treatment of TASC II C and D femoropopliteal lesions: the Viabahn-25 cm trial. J Endovasc Ther 2014;21: 765-774.
9. Akkus NI, Abdulbaki A, Jimenez E, Tandon N. Atherectomy devices: technology update. Med Devices 2014;17: 1-10.
10. Clegg S, Aghel A, Rogers RK. Late presenting, contained rupture of the superficial femoral artery following atherectomy and stenting: case report and literature review. Cathet Cardiovasc Interv 2014;84: 257-261.
11. Lam RC, Shah S, Faries PL, McKinsey JF, Kent KC, Morrisey NJ. Incidence and clinical significance of distal embolization during percutaneous interventions involving the superficial femoral artery. J Vasc Surg 2007;46: 1155-1159.

1703.3

Are stent grafts the best option?

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Learning Objectives

1. To learn about the different materials for SFA treatment
2. To learn about stent grafts and how to use them
3. To learn about available outcome data on stent grafts

No abstract available.

1703.4

Treatment options and cost effectiveness

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Learning Objectives

1. To learn about the cost associated with peripheral artery disease
2. To learn about the standard treatment options: medical - intervention - surgery
3. To learn about the quality of life associated with SFA treatment

Do we know the cost associated with peripheral artery disease?

Several cost analyses for lower extremity peripheral arterial disease (PAD) are available. PAD is associated with high rates of myocardial infarction, stroke, amputation, and death. PAD-related treatment costs were calculated in the elderly, non-disabled US Medicare population. The cost analysis relied on the 5% control population for the linked SEER-Medicare data and on Medicare claims for the calendar year 2001 identifying PAD cases based on diagnosis and procedure codes. Costs were aggregated separately for inpatient and outpatient treatments and estimates were adjusted to reflect the Medicare population. A total of $4.37 billion was spent on PAD-related treatment, and 88% of expenditures were for inpatient care. Medicare program outlays totaled $3.87 billion, while enrollees (or their supplemental insurance) spent the remaining $500 million. In total, 6.8% of the elderly Medicare population received treatment for PAD. Treatment increased with age at rates of 4.5%, 7.5%, and 11.8% for individuals aged 65–74, 75–84, and >85 years, respectively. PAD-related costs accounted for approximately 13% of all Medicare Part A and B expenditures for the PAD-treated cohort and 2.3% of the total Medicare Part A and B expenditures. In conclusion, the US national PAD-related costs are high, which are associated with inpatient care and increase with age. PAD is treated at rates lower than those of the known PAD prevalence as only approximately one-third of the population with known PAD had detectable PAD-related healthcare costs in our analysis. The potential impact of earlier PAD detection and the use of outpatient preventive strategies on total national PAD healthcare costs are unknown (http://www.ncbi.nlm.nih.gov/pubmed/18687757; accessed on April 4, 2015).
Within the international prospective REACH Registry [REduction of Atherothrombosis for Continued Health (REACH) Registry], patients at risk of atherothrombosis caused by established arterial disease or with the presence of ≥3 atherothrombotic risk factors were followed. Two-year rates of vascular-related hospitalizations and associated costs in US patients with established PAD across patient subgroups were compared. One- and cumulative 2-year follow-up data were available for 2137 (82%) and 1677 (64%) US REACH patients, respectively, with either symptomatic or asymptomatic PAD. At 2 years, mean cumulative hospitalization costs per patient were $7445, $7000, $10430, and $11693 for patients with asymptomatic PAD, those with a history of claudication, those with lower-limb amputation, and those who underwent revascularization, respectively

(p=0.007). A history of peripheral intervention (lower limb revascularization or amputation) was associated with higher rates of subsequent procedures at both 1 and 2 years.

Stable patients with asymptomatic PAD have high annual costs, largely because of high rates of cardiovascular events and hospitalizations; costs escalate in the more symptomatic PAD categories because of high rates of leg revascularization and other vascular-related procedures and hospitalizations. High rates of recurring rehospitalizations and repeat revascularization procedures during the 2 years after peripheral revascularization suggest that neither patients and physicians nor healthcare systems should assume that a first admission for lower extremity PAD procedure serves as the permanent resolution of the underlying condition. Prospective studies of the effectiveness and cost effectiveness of secondary prevention strategies aimed specifically at reducing PAD-related events seem to be warranted because effective interventions may curb the otherwise impending clinical and economic burden of PAD in the aging US population (http://circoutcomes.ahajournals.org/content/3/6/642.full; accessed on April 4, 2015).

Within a consulting company report, it was described that PAD costs more than other major chronic diseases, including diabetes and coronary disease. The bill for PAD is two to three times the dollar amount spent on all cancers in the US. Cardiovascular events, such as heart attacks and strokes, and related treatments account for over 40% costs adding significantly to the total. Hidden cost factors, with ischemic diabetic foot ulcers (DFU) and functional decline being major factors, increase the total so that the real economic burden of PAD is actually even higher than $164–$290 billion in the US. PAD remains underestimated, underdiagnosed, undertreated, and under-researched. This highly prevalent, costly, and deadly disease continues to be largely ignored, resulting in unnecessary mortality, morbidity, and amputations. Early diagnosis is believed to be a key factor in reducing costs of PAD. If diagnosed in the early stages, PAD patients can be treated with appropriate lifestyle modifications and drug therapies to reduce risks of heart attack and stroke or with exercise therapy to reduce the pain of claudication or with minimally invasive revascularization technologies if blockages are more severe. However, if the disease is not diagnosed until critical ischemia (CLI) occurs, interventional therapy is more costly. If gangrene is so severe that the limb cannot be salvaged, the patient must undergo amputation, which is the most costly procedure (http://www.businesswire.com/news/home/20140908006428/en/Recognition-National-Peripheral-Artery-Disease-PAD-Awareness#.VR_mT2bO_7c; accessed on April 4, 2015).

What is the spectrum of treatment options?

Treatments for peripheral arterial disease include lifestyle changes, medicines, and surgery or interventional procedures. The overall goals of treating PAD include reducing symptoms, improving quality of life (QoL), and preventing complications. Treatment is based on one's signs and symptoms, risk factors, and results from physical examinations and tests (http://www.nhlbi.nih.gov/health/health-topics/topics/pad/treatment; accessed on April 4, 2015). These treatments can also help reduce one's risk of developing other types of cardiovascular diseases (CVD) such as coronary heart disease, stroke, and heart attack. In addition to exercising and stopping smoking, there are a number of other lifestyle changes that one can make to reduce one's risk of developing other forms of CVD. Different medications (statins, antihypertensives, antiplatelets, and naftidrofuryl oxalate) can be used to treat the underlying causes of PAD while also reducing one's risk of developing another CVD (http://www.nhs.uk/Conditions/peripheralarterialdisease/Pages/Treatment.aspx; accessed on April 4, 2015)

Data on QoL associated with SFA treatment

While there are a number of treatments for PAD, there have been few previous studies that have examined treatment patterns for PAD or sought to systematically identify opportunities to improve care. Most importantly, there have been no rigorous studies examining the impact of the disease from patients' perspectives, such as their symptoms, functions, and QoL, as a function of different patient characteristics and treatments. Currently, the Portrait study is designed to systematically document treatments and outcomes of 240 patients from two centers to address these gaps in knowledge. It will illuminate whether disparities in treatment or outcomes exist as a function of patients' gender, race, and socioeconomic or psychological characteristics. The Portrait study will substantially elevate the field and identify critical gaps in the manner in which PAD is currently managed to improve the quality of care (https://clinicaltrials.gov/ct2/show/NCT01419080; accessed on April 4, 2015).

Available data mainly focus on the comparison of techniques, such as QoL, after balloon angioplasty versus primary stenting. In one study, 104 patients were randomly assigned to primary stent implantation (n=51) or balloon angioplasty (n=53), with optional stenting for a suboptimal angioplasty result (17 of 53). QoL was measured by the SF-36 questionnaire at baseline and at 3, 6, and 12 months postintervention. QoL was significantly improved postintervention and up to 12 months in both treatment groups. Significant inverse associations were observed between QoL parameters and restenosis. On comparing primary stenting (n=51) versus balloon angioplasty with optional stenting (n=53) by the intention to treat, no significant differences in QoL were observed. However, analysis of stented patients (n=68) versus balloon angioplasty (n=36) patients demonstrated significantly improved measures of QoL after stenting. Endovascular revascularization of SFA disease improves QoL, and restenosis negatively affects QoL outcomes. After stent implantation, whether primary or secondary, QoL was significantly ameliorated compared with that after balloon angioplasty alone (http://www.ncbi.nlm.nih.gov/pubmed/17696615; accessed on April 4, 2015).

Special Session
Management of renal malignancies

1704.1

Triage of the renal cancer patient

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Learning Objectives

1. To know about the role of observation in RCC patient
2. To know the role of biopsy in a renal mass
3. To know about the imaging pattern of the most common renal mass

The incidence of renal cell carcinomas (RCCs) has increased over the past years, with about 200,000 new RCCs diagnosed per year. Many RCCs are early detected thanks to improvement of imaging. Ultrasound is often used as a detection tool. CT also detects many tumors and also helps to better characterize most of them. For complex cases such as low-fat-content angiomyolipomas, oncocytomas, and atypical cysts MRI is particularly helpful.

Small renal masses correpond to tumors less than 4 cm in diameter. Their natural average growth rate is about 2-5 mm/year. However, 60% are indolent and 20-25% grow rapidly. Despite earlier detection and improved treatments, overall mortality rates of RCCs continue to increase. This paradox could be explained by the fact that early detection may concern mainly indolent tumors.

According to the international urology guidelines, surgery remains the gold standard to treat RCCs if patients can tolerate surgery. For small renal masses (SRM), partial nephrectomy shows similar oncological outcomes with better preservation of renal function. Thermal ablation with radiofrequency or cryoablation offers a less invasive alternative for poor surgical candidates; the rate of recurrence seems

to be slightly higher with thermal ablation compared to surgery. However, renal function is better preserved with ablationthan with surgery.
In some reported series, up to 42% SMR may be benign; thus, biopsy should systematically be performed before renal ablation. Renal biopsy is a safe procedure, and its overall accuracy is about 90% for all renal masses (small and large).
Up to 23% of resected renal masses are benign; thus, biopsy should also be considered before surgery in selected doubtful cases.
Active surveillance may also be a valid option for elderly patients or patients with limited life expectancy due to severe comorbidities. Indeed, competing causes of mortality rise with increasing age. Cardiovascular disease remains the leading cause of death for patients aged 75 years or older. Thus, for weak patients, follow-up imaging may be performed to better estimate the capacity of the tumor to grow and to metastasize.
In conclusion, small RCCs in patients with long life expectancy and linear tumor growth should be treated promptly; on the other hand, active surveillance should be first considered for patients with limited life expectancy/comorbidities and slow tumor growth.

1704.2

Ablation vs. nephron-sparing surgery: the evidence

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Learning Objectives
1. To know efficacy, survival and complications of ablation techniques
2. To know about the efficacy, survival and complications of nephron-sparing surgery
3. To understand the best indications for the ablation of a renal mass

The management of renal cell carcinoma (RCC) is shifting. We are undoubtedly seeing more smaller, indolent renal tumours, detected incidentally at imaging, often for unrelated symptomatology. However, in the background, the incidence of this disease is also increasing along with life expectancy as mortality from cardiovascular and cerebrovascular disease continues to decline. Undoubtedly, there is a clear role for active surveillance (AS) in case of small renal tumours in very elderly individuals. The natural history of these tumours and current practice trends would suggest that this threshold currently lies at about 20–25 mm in patients who are approximately 80 years of age and over, dependent on their comorbidities. However, AS does require repeated radiological follow-up and many patients – the European Association of Urology (EAU) reckons on ~40% [1] – seek to default to definitive management.
T1a (sub 40 mm) renal tumours are increasingly prevalent and can even make up the bulk of a urological renal cancer referral practice. The EAU guidelines [1] accept that image-guided radiofrequency ablation (RFA) and cryoablation (CRA) have a role in the management of this disease in patients unfit for surgery and in those with significant comorbidities, but there is now a wider scope for the adoption of these techniques when comparison is made with cost, complications and ipsilateral renal functional implications of open (OPN), laparoscopic (LPN) or even robot-assisted laparoscopic partial nephrectomy (RALPN).
Meta-analyses of the past few years [2] were distorted by selection bias in favour of partial nephrectomy and by the often poorly acknowledged issue that image-guided thermal ablation, both device and technique, was still in evolution in the early 2000s. More recent analysis [3] has indicated that disease-specific survival is not different between surgery and ablation, complications were less ($p = 0.04$) and eGFR was better protected by IGA ($p = 0.03$). In addition, the overall rate of complications has shown a decreasing trend in recent years. Increasing experience among IOs has shifted the practice towards CT-guided procedures along with an increase in the adoption of CRA over RFA in recent years, certainly for tumours with a diameter of >35 mm [4]. Probably similar to a more recent result, larger meta-analyses [5] have indicated little or no difference in cancer-specific or overall survival between ablation and radical or partial nephrectomy.
However, it is important that IGA outcomes do not hide behind the relative indolence of small RCC, which can help to obscure differences between therapeutic techniques. In such a setting, costs and complications of active treatment options take on a critical significance. Here again, cost analyses from both surgical [6] and radiological [7] author groups suggest a clear benefit of IGA over resection. This will become increasingly important as hospital managers look in depth at these procedures in the setting of a patient group, sometimes unhappy to settle for AS. This particularly appears to be the case on comparing with the costs of RALPN.
It will be essential that IGA case series and matched-cohort studies only detail biopsy-proven cancers, and that due diligence is undertaken to absolutely minimize sub-total treatments and the requirement for re-intervention. It remains the case that all recent trends suggest that IGA is set to play an increasingly vital role in the management of small RCC.

References

1. Ljungberg B et al. EAU guidelines on renal cell carcinoma: the 2010 update. Eur Urol. (2010) 58 : 398.
2. Kinkle DA et al. Excise, ablate or observe: the small renal mass dilemma--a meta-analysis and review. J Urol. (2008) 179 : 1227.
3. Katsanos K et al. Systematic review and meta-analysis of thermal ablation versus surgical nephrectomy for small renal tumours. Cardiovasc Intervent Radiol. (2014) 37 : 427.
4. Atwell TD et al. Percutaneous cyroablation of large renal masses: technical feasibility or short-term outcome. AJR Am J Roentgenol. (2007) 188 : 1195.
5. Choueiri TK et al. Thermal ablation versus surgery for localized kidney tumours: a surveillance, epidemiology, and end results (SEER) database analysis. Urology. (2011) 78 : 93.
6. Castle SM et al. Cost comparison of nephron-sparing treatments for cT1a renal masses. Urol Oncol. (2013) 31 : 1327.
7. Link RE et al. Cost analysis of open, laparoscopic and percutaneous treatment options for nephron-sparing surgery. J Endourol. (2006) 10 : 782.

1704.3

Ablation: what's new?

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Learning Objectives
1. To know about new technologies in ablation
2. To know about advanced techniques for large tumours
3. To know about the benefits of new technologies

Hyperthermal (radiofrequency and microwave) and hypothermal (cryotherapy) ablation for percutaneous renal tumor ablation are highly developed and established in clinical routine. Some new technical aspects on tissue dissection (carbon dioxide vs. saline) and pain control (cryoablation under local anesthesia) were published. The latest developments like focused ultrasound (FUS) and irreversible electroporation (IRE) are still anecdotal, and clinical investigations have not been published until recently. However, the number of clinical studies concerning outcome and survival data is increasing, pushing percutaneous ablation of small renal masses more and more towards first-line therapy. Reliable results in large renal tumors (> 5 cm) are still limited.

There is an increasing interest on tumor imaging details predicting the nature of small renal masses and differentiation of atypical angiomyolipoma, as well as monitoring the ablation process and postinterventional control by contrast-enhanced US, MRI, and CT. Further, new studies highlight the role of needle biopsy before therapy and suggest biopsy to become standard even in presumably typical cases.
This presentation will summarize the latest studies on technical and clinical aspects of renal tumor ablation, pre- and postinterventional imaging, and the role of tumor biopsy.

References

1. Wah TM et al: Radiofrequency Ablation (RFA) of Renal Cell Carcinoma (RCC): Experience in 200 Tumors. BJU Int 2014;113:416-428.
2. Bratslavsky G et al: Long-term Management of Bilateral, Multifocal, Recurrent Renal Carcinoma. Nat Rev Urol 2010;7:267-275.
3. Sahni VA et al: Imaging Management of Incidentally Detected Small Renal Masses. Semin Intervent Radiol 2014;31:9-19.
4. Iannuccilli JD et al: Percutaneous Ablation for Small Masses - Imaging Follow-Up. Semin Intervent Radiol 2014;31:50-63.
5. Ha SB et al: Current Status of Renal Biopsy for Small Renal Masses. Korean J Urol 2014;55:568-573.

1704.4

Is there any role for intra-arterial therapies?

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Learning Objectives

1. To define the role of intra-arterial therapies in non-operable RCC
2. To know about the role of embolisation in the palliative setting
3. To know about the role of intra-arterial therapies in combination with ablation

The initial indications for renal artery embolization (RAE), developed in the 70s, were limited to palliation for metastatic renal cancers and symptomatic hematuria. At present, intra-arterial renal therapies are widely used in a broad range of urological, renal, and vascular conditions. Renal malignancies and benign renal lesions can benefit from an endovascular therapy. Even if the role of pre-surgical renal embolization is controversial in the treatment of renal malignancies, RAE is useful if combined with percutaneous ablation techniques, achieving a lower risk of bleeding and a more effective thermal damage. With technical advances and growing experiences, the indications for intra-arterial treatments have broadened to include conditions such as benign lesions (angiomyolipomas), vascular malformations, and others. With current techniques and development of new materials, RAE is well tolerated and provides a valid support in the management of renal malignancies and in other renal and urological conditions.

References

1. Benefits and shortcomings of superselective transarterial embolization of renal tumors before zero ischemia laparoscopic partial nephrectomy. D'Urso L, Simone G, Rosso R, et al. Eur J Surg Oncol. 2014 Dec;40(12):1731-7.
2. Innovations of surgical techniques for the management of inferior vena cava tumor thrombus of renal cell carcinoma. Yuan SM. Minerva Urol Nefrol. 2014 Sep;66(3):189-200.
3. Incidence of postembolization syndrome after complete renal angioinfarction: a single-institution experience over four years. Vora A, Brodsky R, Nolan J, Ram S, et al. Scand J Urol. 2014 Jun;48(3):245-51.
4. Improving surgical outcomes in renal cell carcinoma involving the inferior vena cava. González J, Andrés G, Martínez-Salamanca JI, et al. Expert Rev Anticancer Ther. 2013 Dec;13(12):1373-87.

Fundamental Course
Basic principles of transcatheter embolisation in thoracic haemorrhage

1801.1

Treatment of bronchial artery bleeding

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Learning Objectives

1. To learn about the indications for this procedure including the role of pre-angiography imaging
2. To learn how to perform this procedure
3. To learn about the complications and expected outcomes

Life-threatening hemoptysis is one of the most serious emergencies in medicine. Hemoptysis when severe and untreated has a mortality rate of more than 50%.
The most common causes of massive hemoptysis are as follows: bronchiectasis secondary to tuberculosis or chronic infections, tuberculosis, chronic bronchitis, cystic fibrosis, aspergillosis, and bronchogenic carcinoma.
In 90% of patients, bronchial arteries are the source of bleeding. They originate from the descending thoracic aorta between the level of 5th and 6th thoracic vertebrae. In about 30% of cases, bronchial arterial origin is aberrant.
Preliminary investigations in hemoptysis include plain X-ray, CT, and angio CT of the chest. CT can demonstrate underlying disease and localize the site of bleeding in 65%–100% of patients. Angiography nowadays is performed usually in patients considered for treatment with bronchial artery embolization (BAE). Typical symptoms indicating the bleeding site are as follows: hypertrophy and tortuosity of the bronchial arteries, shunting to pulmonary arteries or veins, pseudoaneurysms, parenchymal blush, and contrast extravasation.
BAE is considered as an emergency treatment of choice for massive hemoptysis. After the selective catheterization of the bleeding vessel, embolization is performed manually in a controlled manner. The particles with a size of 350–500 μm are the most commonly used embolic material. Embolization is terminated when antegrade flow stagnates. Liquid materials are not routinely used because they can cause tissue necrosis. Metallic coils are not the preferred embolizing material because they can lead to proximal vessel occlusion and loss of subsequent access to the bleeding site. However, they can be used to embolize large arteriovenous malformation.
Immediate control of bleeding is achieved successfully in 80%–94% of cases. Hemoptysis can recur with a frequency of up to 20%, especially in cases with chronic tuberculosis, aspergilloma, and neoplasia. Recurrent bleeding in the first months after embolization is usually due to undetected bronchial or systemic collaterals caused by diffuse pulmonary disease. Late recurrent bleeding is usually due to disease progression.
The most common complication of BAE is transient chest pain. Dysphagia, which can occur secondary to embolization of the esophageal branches, usually resolves spontaneously.
Subintimal dissection of bronchial arteries or the aortic wall has been reported in less than 6% of patients. Rare complications of BAE include bronchoesophageal fistula, aortic and bronchial necrosis, pulmonary infarction, and pericarditis. Nontargeted embolization of anterior spinal arteries leading to spinal cord ischemia is the most serious complication occurring in a range of 1.5%–6.5%.

References

1. Al-Refaie RE, Amer S, El-Shabrawy M. Surgical treatment of bronchiectasis: a retrospective observational study of 138 patients. J Thorac Dis 2013;5:228-233.

2. Anuradha C, Shyamkumar NK, Vinu M, Babu NR, Christopher DJ. Outcomes of bronchial artery embolization for life-threatening hemoptysis due to tuberculosis and post-tuberculosis sequelae. Diagn Interv Radiol 2012;18:96-101.
3. Gümüstas S, Akça A, Ciftçi E, Topçu S, Akgül AG. A minimal invasive surgical alternative to aberrant systemic arterial supply: coil embolization. Interv Med Appl Sci 2013;5:34-38.
4. Hori D, Noguchi K, Nomura Y et al. Successful endovascular treatment of ruptured bronchial artery aneurysm. Asian Cardiovasc Thorac Ann 2013;21:615-617.
5. Ittrich H, Klose H, Adam G. Radiologic management of haemoptysis: diagnostic and interventional bronchial arterial embolisation. Rofo 2015;187:248-259.
6. Kaufman C, Kabutey NK, Sgroi M, Kim D. Bronchial artery pseudoaneurysm with symptomatic mediastinal hematoma. Clin Imaging 2014;38:536-539.
7. Lorenz J, Sheth D, Patel J. Bronchial artery embolization. Semin Intervent Radiol 2012;29:155-160.
8. Remy-Jardin M, Bouaziz N, Dumont P, Brillet PY, Bruzzi J, Remy J. Bronchial and nonbronchial systemic arteries at multi-detector row CT angiography: comparison with conventional angiography. Radiology 2004;233:741-749.
9. Sehitogullari A, Bilici S, Sayir F, Cobanoglu U, Kahraman A. A long-term study assessing the factors influencing survival and morbidity in the surgical management of bronchiectasis. J Cardiothorac Surg 2011;6:161-168.
10. Sidhu M, Wieseler K, Burdick TR, Shaw DW. Bronchial artery embolization for hemoptysis. Semin Intervent Radiol 2008;25:310-318.
11. Sopko DR, Smith TP. Bronchial artery embolization for hemoptysis. Semin Intervent Radiol 2011;28:48-62.
12. Swanson KL, Johnson CM, Prakash UB, McKusick MA, Andrews JC, Stanson AW. Bronchial artery embolization: experience with 54 patients. Chest 2002;121:789-795.
13. Yoon W, Kim JK, Kim YH, Chung TW, Kang HK. Bronchial and nonbronchial systemic artery embolization for life-threatening hemoptysis: a comprehensive review. Radiographics 2002;22:1395-1409.

1801.2

Treatment of pulmonary artery aneurysms

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Learning Objectives
1. To learn about the aetiology of pulmonary artery aneurysms
2. To learn about the indication for treatment
3. To learn about the interventional treatment options

Introduction
Any segment of a pulmonary artery (PA), either focal or diffuse, which is dilated to more than 1.5 times its normal diameter is called pulmonary artery aneurysm (PAA). If the PAA is contained by all layers of the vascular wall, it is considered to be a true aneurysm; if one or more wall layers are absent, it is called as a false aneurysm.

Epidemiology
PAA is a very rare condition. It is reported in about 1:14000 autopsies. Most PAAs are secondary and associated with, for instance, Hughes-Stovin or Behçet's disease. Behçet's disease is a connective tissue disease affecting mainly young men in the eastern Mediterranean. Other fairly common causes of secondary PAA are syphilis, iatrogenic, and traumatic.
Rupture risk of a PAA is not well known, but may be very limited for small and incidentally discovered PAA. However, if rupture does occur, mortality rate is likely to be very substantial.

Treatment
Follow-up imaging
As the natural history of PAA may be quite benign, a strategy of "watchful waiting" appears to be appropriate, at least in cases of incidentally discovered PAA.
Underlying disease
If treatment is considered, the first-line of defense should naturally be the treatment for any underlying disease. In Behçet's disease, this entails high doses of corticosteroids. This treatment has been shown to be efficacious in a great number of Behçet-related aneurysms as well as in thrombosing and subsequently obliterating PAA.
Endovascular
Endovascular treatment should only be considered if there is a documented growth of PAA or if it is symptomatic. Treatment may consist of coil embolization of the aneurysm sac or plug/coil embolization of the aneurysm neck. If possible, occlusion of the entire segmental branch PA should be avoided not only because it may lead to the loss of viable pulmonary tissues but also because it might lead to collateral perfusion of PAA. In selected cases, a covered stent may be a treatment option.
Surgical
Surgical treatment may be considered in selective cases but carries a considerable risk of rupture, which may be very difficult to control surgically. Therefore, surgery should probably be reserved for very severe cases in which endovascular treatment is unsuccessful.
Several cases will be discussed during the oral presentation.

1801.3

Treatment of thoracic wall and aortic arch branches haemorrhage

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Learning Objectives
1. To learn about the indications for this procedure including the role of pre-angiography imaging
2. To learn how to perform this procedure
3. To learn about the complications and expected outcomes

No abstract available.

1801.4

Thoracic duct embolisation

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Learning Objectives
1. To learn about the indications for this procedure including the role of pre-procedural imaging
2. To learn how to perform this procedure
3. To learn about the complications and expected outcomes

Chylothorax is an uncommon type of pleural effusion, and its etiology can be classified as nontraumatic or traumatic. Nontraumatic causes are congenital, neoplastic, infectious, and mechanic. Traumatic etiology is mostly after thoracic surgery or penetrating trauma.
Chylothorax results in metabolic and immunologic disorders, with mortality rate reaching to 50%. Interventions are used to treat only leaks unresponsive to medical management or those with an output exceeding 1 L/day. Low-output chylothoraces usually respond well to conservative management. High-output chylothoraces are more likely to require surgical or interventional treatment. A medium-chain triglyceride diet or TPN is useful to treat chylothorax by reducing chyle flow.

Surgical management can be technically difficult due to high incidence of variant anatomy and high-risk patient population. Thoracic duct embolization (TDE) has rapidly developed and evolved in the past 17 years to represent a successful minimally invasive, image-guided treatment compared with the more invasive nature of surgery (including VATS), with higher morbidity up to 38.8% and mortality of 2.1%. Percutaneous therapies provide a range of treatment options despite difficult or variant anatomy, with reported high success rates (75%–100%) and low morbidity (0%–2%).

Mainstay of a successful TDE is lymphography for visualizing the lymphatic system including abdominal lymphatic ducts, cisterna chyli, thoracic duct, and leakage site. Lymphography is performed by injecting lipiodol in the lymphatic system by (bi)pedal access or by (bi)inguinal node access. Embolization of chylothorax can be performed using local anesthesia, with the patient under conscious sedation.

Embolization is performed by image-guided (fluoroscopy and CT fluoroscopy) transperitoneal needle access to the cisterna chyli. Despite transgression through several abdominal structures, the morbidity is acceptable. Once a catheter is inserted into the cisterna, the thoracic duct is opacified with nonionic contrast medium. After the identification of the leak, embolization of the duct is performed with microcoils and glue. In cases in which catheterization of the cisterna chyli has failed, a disruption of the cisterna chyli can be performed.

Percutaneous therapies are evolving to provide a range of treatment options despite difficult or variant anatomy and are associated with high success rates coupled with low morbidity and mortality. However, surgical repair is continued to be considered as the best option for the treatment of chylothorax, and in some papers, percutaneous treatment is not even mentioned as an option for treatment.

In this presentation, TDE techniques will be discussed. Furthermore, our NCI-AvL data and a proposal for treatment algorithm will be presented.

References

1. *Diagnosis and local*ization of laceration of the thoracic duct: usefulness of lymphangiography and CT. Sachs PB, Zelch MG, Rice TW, Geisinger MA, Risius B, Lammert GK. AJR Am J Roentgenol. 1991 Oct;157(4):703-5.
2. *Diagnosis and treatment of postoperative chyle leakage via percutaneous transabdominal catheterization of the cisterna chyli: a preliminary study.* Cope C. J Vasc Interv Radiol. 1998 Sep-Oct;9(5):727-34.
3. *Treatment of chylothorax: percutaneous catheterization and embolization of the thoracic duct.* Hoffer EK, Bloch RD, Mulligan MS, Borsa JJ, Fontaine AB. AJR Am J Roentgenol. 2001 Apr;176(4):1040-2.
4. *Management of unremitting chylothorax by percutaneous embolization and blockage of retroperitoneal lymphatic vessels in 42 patients*. Cope C, Kaiser L. J Vasc Interv Radiol. 2002 Nov;13(11):1139-48.
5. *Chylous ascites: a rare complication of thoracic duct embolization for chylothorax.* Gaba RC, Owens CA, Bui JT, Carrillo TC, Knuttinen MG. Cardiovasc Intervent Radiol. 2011 Feb;34(Suppl 2):S245-9.
6. *Percutaneous treatment of thoracic duct injuries.* Marcon F, Irani K, Aquino T, Saunders JK, Gouge TH, Melis M. Surg Endosc. 2011 Sep;25(9):2844-8.
7. *Intranodal lymphangiography: feasibility and preliminary experience in children.* Rajebi MR, Chaudry G, Padua HM, Dillon B, Yilmaz S, Arnold RW, Landrigan-Ossar MF, Alomari AI. J Vasc Interv Radiol. 2011 Sep;22(9):1300-5.
8. *Thoracic duct embolization for chylous leaks*. Chen E, Itkin M. Semin Intervent Radiol. 2011 Mar;28(1):63-74.
9. *Feasibility of ultrasound-guided intranodal lymphangiogram for thoracic duct embolization.* Nadolski GJ, Itkin M. J Vasc Interv Radiol. 2012 May;23(5):613-6.
10. *Computed tomography-guided access to the cisterna chyli: introduction of a technique for direct lymphangiography to evaluate and treat chylothorax.* Schoellnast H, Maybody M, Getrajdman GI, Bains MS, Finley DJ, Solomon SB. Cardiovasc Intervent Radiol. 2011 Feb;34(Suppl 2):S240-4.
11. *Thoracic duct embolization for the management of chylothoraces.* Nadolski G, Itkin M. Curr Opin Pulm Med. 2013 Jul;19(4):380-6.
12. *Role of interventional radiology in the management of chylothorax: a review of the current management of high output chylothorax.* Lyon S, Mott N, Koukounaras J, Shoobridge J, Hudson PV. Cardiovasc Intervent Radiol. 2013 Jun;36(3):599-607.
13. *Therapeutic effectiveness of diagnostic lymphangiography for refractory postoperative chylothorax and chylous ascites: correlation with radiologic findings and preceding medical treatment.* Kawasaki R, Sugimoto K, Fujii M, Miyamoto N, Okada T, Yamaguchi M, Sugimura K. AJR Am J Roentgenol. 2013 Sep;201(3):659-66.
14. *Thoracic duct embolization and disruption for treatment of chylous effusions: experience with 105 patients.* Pamarthi V, Stecker MS, Schenker MP, Baum RA, Killoran TP, Suzuki Han A, O'Horo SK, Rabkin DJ, Fan CM. J Vasc Interv Radiol. 2014 Sep;25(9):1398-404.
15. *The changing management of chylothorax in the modern era.* Bender B, Murthy V, Chamberlain RS. Eur J Cardiothorac Surg. 2015 Mar;pii:ezv041.

Special Session
State-of-the-art visceral artery aneurysm and pseudoaneurysm management

1802.1

Epidemiology, clinical presentation and imaging

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Learning Objectives

1. To report the incidence of visceral aneurysms and pseudo aneurysms
2. To explain the physiopathology, focus on high-flow aneurysm, the difference between aneurysms and pseudoaneurysms and the technical consequence for endovascular treatment
3. To learn about imaging strategies for aneurysms and pseudoaneurysms

Visceral artery aneurysms (VAAs) are generally defined as aneurysms that involve the branches of the celiac, superior mesenteric, inferior mesenteric, or renal arteries. VAAs are rare with a reported incidence of 0.01 to 0.2% on routine autopsies. However, VAAs are clinically important and potentially lethal; 22% of all VAAs present as clinical emergencies, and 8.5% result in death. VAAs include both true aneurysms, limited by all three layers of the arterial wall, which undergo progressive dilation and wall thinning, and pseudoaneurysms (VAPAs), where there is a tear of the vessel wall and a periarterial hematoma, corresponding to a contained rupture of the artery that is lined by adventitia or by perivascular tissues. Most VAAs are secondary to vessel wall degeneration and demonstrate deficiency or the arterial media with loss and/or fragmentation of elastic fibers and reduced smooth muscle. Arteriosclerosis, congenital syndromes, fibromuscular dysplasia, gestational alterations, and collagen disorders are other possible causes of VAAs. Pseudoaneurysms can develop as a result of blunt or penetrating trauma, inflammation, infection, vasculitis, and iatrogenic trauma secondary to surgical, endoscopic, and radiological procedures. As a result of improvements in cross-sectional imaging technology, including ultrasound (US), multidetector computed tomography (MCDT), and magnetic

resonance imaging (MRI), VAAs are diagnosed with increased frequency. The main indication for treatment is the size of the aneurysm. Because of the lack of data on natural history of untreated aneurysms, there is debate regarding the size criteria for intervention vs. surveillance. The general consensus is that when a true aneurysm is 2 cm or larger, irrespective of the anatomical site, the rupture risk is probably sufficient to indicate treatment. Aneurysms smaller than 2 cm are generally monitored closely by serial imaging. Other indications for treatment include symptomatic patients and documented evidence of growth of the aneurysm. In addition, most interventionalists treat smaller true aneurysms (1-2 cm or even less) in women of childbearing age, pregnant women, and liver transplant recipients; rupture of splenic artery aneurysms in pregnant women is associated with maternal and fetal mortality. Although the decision to intervene on a true aneurysm may depend on a size threshold above which the potential for rupture increases, it is generally advised that all pseudoaneurysms should be treated, whatever their size or location. In contrast to splenic artery aneurysms, which are historically the most common VAAs, hepatic artery aneurysms have been the most frequently reported VAAs during the past two decades, owing to the growing use of percutaneous biliary procedures, liver transplantation, and nonoperative management of blunt abdominal trauma. True splenic artery aneurysms (SAAs) are the most common type of VAAs, accounting for up to 60% of all VAAs, with an estimated prevalence of less than 0.1%. They may be associated with other mesenteric aneurysms (3%) and with renal artery aneurysms (4%). SAAs are 3-4 times more common in women than in men and are associated with multiparity. Pseudoaneurysms of the splenic artery are generally caused by inflammation, infections including pancreatitis, and trauma. Pseudoaneurysm size does not correlate with risk of rupture. Indications for treatment of SAAs are symptomatic aneurysms (LUQ pain radiating to the left shoulder), aneurysms with more than 2 cm diameter, smaller aneurysms in women of childbearing age, and patients with SAA who are candidates for liver transplantation. Hepatic artery aneurysms (HAAs) are the second most common true VAA. True HAAs are more common in men than in women (ratio of 3:2), occur mainly in patients aged between 60 and 70 years, and are commonly associated with hypertension in up to 72% of patients. Up to 31% of patients with HAA have VAAs at other sites, but most HAAs are solitary and are due to atherosclerosis. Other etiologies include connective tissue diseases like polyarteritis nodosa, fibromuscular dysplasia, and mycotic aneurysms. True HAAs are 4 times more frequent in the extrahepatic than the intrahepatic arteries. Fifty percent are the result of percutaneous biliary interventions. The main risk factors for HAA rupture are the presence of multiple HAAs and nonatherosclerotic etiology. Mortality rates of up to 21% have been reported for ruptured HAA. The majority of HAAs are found incidentally on axial imaging. Rapidly expanding aneurysms may manifest with back or abdominal pain. When rupture occurs, hemorrhage is more common into the biliary tree than to the peritoneum, and it may present with jaundice, biliary colic, and upper gastrointestinal hemorrhage. The indications for HAAs are similar to those for all VAAs. True aneurysm of the celiac artery (CAAs) are rare (approximately 4% of all VAAs), although true and false aneurysms involving the branches of the celiac artery are more common. True CAAs are usually atherosclerotic in etiology. Most CAAs are asymptomatic and are found incidentally on cross-sectional imaging. Symptomatic CAAs may mimic acute pancreatitis. CAAs are strongly associated with other aneurysms, including aortic, renal, femoral, and popliteal aneurysms. True and false aneurysms of the SMA (SMAAs) are rare. They usually involve the most proximal 5 cm of the SMA. Underlying etiologies include atherosclerosis, collagen vascular disease, cystic medial dysplasia, polyarteritis nodosa, and infection. SMAAs may be incidental finding on axial imaging or may present with abdominal pain and bleeding. True gastroduodenal aneurysms (GDAs) and pancreaticoduodenal aneurysms (PDAs) are relatively uncommon but well described in the presence of celiac artery stenosis or occlusion. Gastroduodenal and pancreaticoduodenal pseudoaneurysms are much more common. They usually have an inflammatory or infectious etiology like pancreatitis and as with all pseudoaneurysms, they should be treated irrespective of size. Renal artery aneurysms (RAAs) account for 22% of all VAAs. The main causes are atherosclerosis, fibromuscular dysplasia, and arteritides. The indications for treatment are similar for VAAs elsewhere: aneurysm size 2 cm or larger and symptomatic aneurysms (hypertension, hematuria, and flank or abdominal pain). Pseudoaneurysms are often associated with trauma, but they may be due to dissection and should in general be treated. Surgical and endovascular treatment of VAAs share the common goal of preventing aneurysm expansion and rupture. Treatment of VAAs, either by surgery or endovascular procedures, should be individualized depending on the location of the aneurysm, regional vascular anatomy, and associated or coexisting conditions. High-resolution multiplanar cross-sectional imaging answers questions concerning access vessel pathology, vessel tortuosity, suitability of a particular treatment strategy, and collateral blood flow and may reveal any other aneurysms. Operator ability to treat VAAs requires knowledge of vascular anatomy and collateral pathways, training in the catheterization of visceral arteries, familiarity with various interventional tools, and experience in complex embolization and stenting procedures. Many of the embolic agents used to treat VAAs, such as coils and liquid agents like Onyx (ethylene vinyl alcohol copolymer), create radiographic artifacts on follow-up imaging and may mask VAA reperfusion or aneurysm sac growth. As a result, there is no agreed protocol for imaging after endovascular treatment. Possible follow-up imaging may include magnetic resonance angiography (MRA), computed tomography angiography (CTA), Doppler ultrasound (DUS), or a combination of these. Scan intervals at 1, 3, and 6 months or, more frequently, annual intervals are recommended, according to location and body profile.

References

1. Belli AM et al. The role of interventional radiology in the management of abdominal visceral artery aneurysms. Cardiovasc Intervent Radiol 2012; 35:234-243.
2. Huang Y-K et al. Visceral artery aneurysm: risk factor analysis and therapeutic opinion. Eur J Vasc Surg 2007; 33(3):293-301.
3. Nosher J L et al. Visceral and renal artery aneurysms: a pictorial essay on endovascular therapy. Radiographics 2006; 26(6):1687-1704.
4. Schadved U et al. Management of aneurysms involving branches of the celiac and superior mesenteric arteries: a comparison of surgical and endovascular therapy. J Vasc Surg 2006;44(4):718-724.
5. Chiesa R et al. Visceral artery aneurysms. Ann Vasc Surg 2005; 19(1):42-48.
6. Ikuda O et al. Nonoperative management of unruptured visceral artery aneurysms: treatment by transcatheter coil embolization. J Vasc Surg 2008; 47(6):1212-1219.
7. Chadha M et al. Visceral artery aneurysms: diagnosis and percutaneous management. Semin Intervent Radiol 2009; 26(3):196-206.
8. Liu Q et al. Visceral Artery Aneurysms: Evaluation Using 3D Contrast Enhanced MR Angiography. AJR 2008; 191:826-833.
9. Ha JF et al. Splenic artery aneurysm rupture in pregnancy. Eur J Obstet Gynecol Reprod Biol 2009; 146:133-137.
10. Pilleul F et al. Diagnosis of splanchnic artery aneurysms and pseudoaneurysms, with special reference to contrast enhanced 3D magnetic resonance angiography: a review. Acta Radiol 2004; 45:702-708.
11. Barceli SA. Hepatic and splenic artery aneurysm. Semin Vasc Surg 2005; 18:196-201.
12. Gabelmann A et al. Endovascular treatment of visceral artery aneurysms. J Endovasc Ther 2002; 9:38-47.
13. Abbas MA et al. Hepatic artery aneurysm: factors that predict complications. J Vasc Surg 2003; 38:41-45.

14. Stone WM et al. Celiac arterial aneurysms: a critical reappraisal of a rare entity. Arch Surg 2002; 137:670-674.
15. Stone WM et al. Superior mesenteric artery aneurysms: is presence an indication for intervention? J Vasc Surg 2002; 36:234-237.

1802.2

Current evidence and patient triage

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Learning Objectives
1. To learn about the rupture risk regarding size number and location
2. To learn how to select patients on a regular basis and in emergency situations

Visceral artery aneurysms (VAAs) are a regular feature of most interventional practices. The majority are incidental findings found during routine cross-sectional imaging for other pathologies. Splenic are by far the most prevalent, followed by hepatic, renal and coeliac/mesenteric/GDA. In the acute setting, visceral aneurysms most commonly arise from the GDA in the setting of pancreatitis. Other visceral aneurysms present acutely if there are particular patient risk factors such as pregnancy, anticoagulation or trauma. The presentation will review the incidence, prevalence and distribution of VAAs.

Proper triage requires a full 3D CT angiogram with review of the approach, stability of access and optimal exclusion technique. The imaging must be contextualized to the patient factors and local resources available. Most are managed according to anatomic configuration rather than their true/false nature and aetiology. We shall address outcomes based on the nature of the aneurysm.

Elective management of visceral artery aneurysms centre on a 2-cm dimension that is an arbitrary cut-off that appears to have served us well over the decades. One could debate whether a maximum dimension from an axial 2D CT suffices or should be replaced by 3D multidimensional measurements that include volume. However, I think it unlikely that any single centre will have a large enough patient cohort to usefully conclude such measurements. Clearly, regardless of size, any dynamic interval change such as increase in dimension requires therapy. Some patients and their caregivers will elect for treatment of sub-2-cm aneurysms as leads to closure rather than life-long anxiety and imaging follow-up.

Up to 20% of VAA have been reported to present acutely.

In the acute setting of VAA rupture, it would be standard practice to consult IR in the first instance. Haemodynamic stability is the key issue in selecting an endovascular therapy over surgery. Even in the best interventional hands, bleeding control will be achieved faster by surgical intervention than by endovascular approach. Although we can achieve an endovascular therapy, patient safety demands that it only be applied where suitable. Minimally invasive is not always safer.

Most approaches apply a prothrombotic technique of direct coiling, thrombin or exclusion through flow diverters. Most sites have access and financial support for pushable or detachable coils, and the efficacy of this approach is well established. The best procedure depends on anatomic configuration and what the operator is most comfortable with. Outcomes in 2015 show 90% technical success (though two therapies may be required), partial organ infarction in 30-50% and uncommon complications of abscess formation or non-target embolization. Surgical conversion would be highly unusual. The literature reports mortality up to 5% post-VAA therapy, but this number strikes me as high unless there are significant comorbidities.

In conclusion, you do not need a trial to show that jumping out of an airplane without a parachute is unwise. Similarly, there is now a well-established practice of endovascular and percutaneous therapy of VAA that is safe and efficacious, though it lacks a large evidence base. We probably do err on the side of overtreatment of elective VAAs, and we should remember we are not always the best specialists to treat the hemodynamically crashing patient.

References

1. Hemp JH, Sabri SS. Endovascular management of visceral arterial aneurysms.Tech Vasc Interv Radiol. 2015 Mar;18(1):14-23. doi: 10.1053/j.tvir.2014.12.003. PubMed PMID: 25814199.
2. Abu-Khalaf MM, Al-Ameer SM, Smadi MM, Qatawneh A, Smara OA, Hadidy AT. Intrasplenic arterial aneurysms during pregnancy. Case Rep Obstet Gynecol. 2015;2015:248141. doi: 10.1155/2015/248141. PubMed PMID:25810934.
3. Shukla AJ, Eid R, Fish L, Avgerinos E, Marone L, Makaroun M, Chaer RA. Contemporary outcomes of intact and ruptured visceral artery aneurysms. J Vasc Surg. 2015 Mar 6. doi: 10.1016/j.jvs.2015.01.005. [Epub ahead of print] PubMed PMID: 25752692.
4. Huang Y, Banga P, Reis de Souza L, Oderich GS. Endovascular treatment of visceral artery aneurysms. J Cardiovasc Surg (Torino). 2015 Mar 10. [Epub ahead of print] PubMed PMID: 25752257.
5. Pitton MB, Dappa E, Jungmann F, Kloeckner R, Schotten S, Wirth GM, Mittler J, Lang H, Mildenberger P, Kreitner KF, Oberholzer K, Dueber C. Visceral artery aneurysms: Incidence, management, and outcome analysis in a tertiary care center over one decade. Eur Radiol. 2015 Feb 19. [Epub ahead of print] PubMed PMID:25693662.
6. Won Y, Lee SL, Kim Y, Ku YM. Clinical efficacy of transcatheter embolization of visceral artery pseudoaneurysms using N-butyl cyanoacrylate (NBCA). Diagn Interv Imaging. 2015 Feb 13. doi:10.1016/j.diii.2015.01.003. [Epub ahead of print] PubMed PMID: 25686776.
7. Lu M, Weiss C, Fishman EK, Johnson PT, Verde F. Review of visceral aneurysms and pseudoaneurysms. J Comput Assist Tomogr. 2015 Jan-Feb;39(1):1-6. doi:10.1097/RCT.0000000000000156. Review. PubMed PMID: 25319606.
8. Van Holsbeeck A, Decock S, Vandaele P, Ramboer K. Visceral artery aneurysm. JBR-BTR. 2014 May-Jun;97(3):176-7. PubMed PMID: 25223135.
9. Cochennec F, Kobeiter H, Gohel M, Marzelle J, Desgranges P, Allaire E, Becquemin JP. Feasibility and safety of renal and visceral target vessel cannulation using robotically steerable catheters during complex endovascular aortic procedures. J Endovasc Ther. 2015 Apr;22(2):187-93. doi:10.1177/1526602815573228. PubMed PMID: 25809359.
10. Roberts KJ, McCulloch N, Forde C, Mahon B, Mangat K, Olliff SP, Jones RG. Emergency treatment of haemorrhaging coeliac or mesenteric artery aneurysms and pseudoaneurysms in the era of endovascular management. Eur J Vasc Endovasc Surg. 2015 Apr;49(4):382-9. doi: 10.1016/j.ejvs.2014.12.019. PubMed PMID: 25736287.

1802.3

Stentgrafts and embolisation: technique

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Learning Objectives
1. Outline the endovascular materials available for the procedure
2. Describe the strategy between embolisation and stentgrafting
3. To define the desired goal for a complete treatment

Several techniques and material are used to treat visceral aneurysms (VA).

The most common material used is coils. These can be macro- (0.35") or micro-coils (0.18" or 0.14"), either pushable or detachable. The main advantage of the latter is precision. Some of the new coil designs allow for 3D shaping, which is particularly useful in aneurysms with a

wide neck. Other coils are basically used for packing of the sac.
Covered stents are alternative material that can be useful in certain circumstances such as a wide neck. Those stent grafts can be self-expandable or balloon-expandable. The main downsides of this material are the relative rigidity and high profile that could preclude the use of the stent in tortuous anatomy.
Liquid embolic material is useful to achieve complete filling of the aneurysm sac and thereby reduce the risk of recurrence.
Flow-diverting stents use the hemodynamic alteration of blood flow to promote stagnation and subsequent thrombosis.
Occlusion devices are quite thrombogenic material and are easy to use when the anatomy is suitable. They have proved to be quick and cost effective.
The ultimate goal of treating the VA is complete exclusion from the rest of circulation and prevention of recurrence.
Stent graft is a straightforward option when the artery is not tortuous and there is suitable proximal and distal landing zone. Coil embolization is an alternative option when the aneurysm is distal or vessel diameter is small. Liquid embolics are good option if the catheter can achieve a secure position to avoid non-target embolization. For VA with challenging anatomy such as wide neck or bifurcated lesions, stent assisted coiling, Y stenting, or balloon remodeling are useful adjuncts.
The final choice of material and approach depends largely on the anatomy of the inflow and outflow vessels, width of aneurysm neck, location, size, and operator's experience.
Comprehensive understanding of imaging anatomy and procedure planning are essential prior to intervention.

1802.4

Periprocedural care and patient follow-up

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Radiologie Interventionnelle et Vasculaire Neuroangiographie Thérapeutique, Cliniques Universitaires Saint-Luc-UCL, Brussels, Belgium

Learning Objectives
1. To learn about the results and complications of embolisation stenting
2. To learn about the elements of ideal medical periprocedural care (blood pressure control, antibiotics, anticoagulation)
3. To learn about follow-up

No abstract available.

Special Session
State-of-the-art BTK interventions

1803.1

Trials update

H. van Overhagen
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Learning Objectives
1. To learn about the currently published trials
2. What are the immediate and long-term technical and clinical outcomes
3. To understand if any technique or technology is superior

Critical limb ischemia (CLI) is a limb- and life-threatening condition with a yearly incidence of around 220 new cases per million population. Infrapopliteal arterial occlusive disease is a leading source of CLI. Especially in patients with diabetes, the risk of peripheral arterial disease is 3- to 4-fold higher and CLI tends to be more aggressive than in patients without diabetes, with a major amputation rate 5-10 times higher.
Primary goals of CLI treatment are relief from ischemic pain, healing of neuroischemic ulcers, prevention of limb loss, and improvement of patient function and quality of life. Some kind of revascularization, first endovascular and sometimes surgical, is usually necessary to achieve these goals. Treatment should also be directed towards pain control, infection control, atherosclerosis control, anticoagulation, and cardiovascular management.
Patients with CLI should receive cardiovascular risk reduction therapy. Antithrombotic drugs, statins, and antihypertensive drugs should be administered to reduce cardiovascular events, to prevent periprocedural complications, and to increase post-procedural patency rates. Aggressive blood glucose lowering is recommended in all patients with types 1 and 2 diabetes to reach glucose levels as close to normal as possible. Acetylsalicylic acid (aspirin) is the standard antiplatelet therapy in CLI. Although there is not enough evidence, some authors recommend dual antiplatelet therapy of clopidogrel (75 mg/day) and aspirin (100 mg/day). During the procedure, 3000-5000 IU of heparin is administered intra-arterially.
At present, percutaneous transluminal angioplasty (PTA) is the primary technique to consider in treatment of infrapopliteal occlusive disease. Technical success rates of infrapopliteal PTA are reported to be as high as 80-100%. Limb salvage rates after PTA vary, and depend on the clinical and anatomical extent of the disease. There are no prospective randomized trials comparing endovascular treatment and bypass surgery in patients with CLI and infrapopliteal occlusive disease. In a meta-analysis of infrapopliteal PTA for chronic CLI, results of PTA were compared with those of a meta-analysis of popliteal to distal vein bypass grafts. Primary patency of PTA at 6 months (65±7.0%) and 12 months (58.1±4.6%) was significantly lower than those of bypass surgery (85.8±2.1%, $p<0.05$, and 81.5±2.0%, $p<0.05$, respectively), but there was no significant difference between limb salvage at 6 months (88.2±4.4% vs. 90.9±1.9%) and 12 months (86.0±2.7% and 88.5 ±2.2%). By preferentially using PTA for CLI and bypass surgery for patients not suited for PTA, 2-year primary cumulative patency rates and limb salvage rates of 60% and 76% were reported for 32 limbs with mainly TASC D classification that underwent infrapopliteal PTA. In the 82 limbs that underwent infrapopliteal bypass surgery, primary cumulative patency was 53% and limb salvage 57%. At 30 days, mortality and complication rates were higher for all patients undergoing bypass than those undergoing PTA. A propensity score analysis of 1023 patients, of whom 262 underwent PTA and 761 surgical bypass, reported similar 5-year results for leg salvage (75.3 vs. 76.0%), survival (47.5 vs. 43.3%), and amputation-free survival (37.7 vs. 37.3%).
Drug-eluting balloons (DEB) have recently been introduced as local drug delivery-assisted angioplasty systems that are an alternative to drug-eluting stents. Theoretical advantage of these DEB is that they offer anti-proliferative effect of local drug elution without leaving a metallic platform behind on the arterial wall. This could reduce restenosis rates and facilitate future interventions especially at anatomical sites such as the infrapopliteal bifurcations and the distal tibial arteries where stenting is not recommended. The first data regarding BTK treatment with a paclitaxel-eluting balloon were encouraging. A single-centre study investigating 104 patients (82.6% of whom had CLI) reported clinical improvement in 91.2% and complete wound-healing in 74.2% of patients. One-year target lesion revascularization and limb-salvage rates were 17.3% and 95.6%, respectively. The 3-month restenosis rate was significantly lower than that in the historical control group treated with conventional PTA (27.4 vs. 69%, respectively). In the DEBATE-BTK trial, results of DEB were compared with those of non-eluting balloons in 132 patients with 158 lesions. Binary restenosis occurred in 27% of lesions in the DEB group and in 74% of lesions in the PTA group ($P<0.001$). Target lesion revascularization in 18% vs. 43% ($P=0.002$) and target vessel occlusion in 17% vs. 55% ($P<0.001$). Only one

amputation occurred, in the PTA group (P=0.9). However, in the IN.PACT Deep trial, use of the IN.PACT Amphirion DEB did not result in a different treatment result for patients with below-the-knee CLI compared with the use of a standard PTA balloon. Clinically driven TLR at 12 months was 9.2% with DEB vs. 13.1% with PTA. Late lumen loss was 0.61±0.78mm vs. 0.62±0.78mm, respectively. At 6 months, all-cause mortality, major amputation and clinically driven TLR was 17.7% for the DEB group and 15.8% for the PTA group of patients.

Use of bare metal stents in the infrapopliteal arteries is generally reserved for patients with residual stenosis, flow-limiting dissections or elastic recoil after PTA. A small single-centre prospective randomized study with 38 limbs in 35 patients with CLI found no statistically significant difference in survival (69.3 vs. 74.7%), limb salvage (90 vs. 91.7%) or primary (66 vs. 56%) and secondary (79.5 vs. 64%) patency at 1-year follow-up after PTA or primary stenting.

Enthusiastic results have been reported regarding the use of drug-eluting stents (DES), especially sirolimus-eluting stents in infrapopliteal arteries. In the industry-initiated DESTINY trial, 140 patients with CLI were randomized to receive either a bare metal stent or an everolimus-eluting stent below the knee. Primary arterial patency was significantly higher after treatment with the everolimus vs. bare stents (85 vs. 54%), but was only obtained in 46% of patients at follow-up. There was no difference in pain relief or limb salvage between both groups. The major amputation rate was only 3% at 12 months, which may be due to the selection of patients. Other randomized trials that investigated the use of DES BTK are the industry-initiated ACHILLES trial (sirolimus-eluting stent vs. PTA in patients with CLI and intermittent claudication). A systematic review of infrapopliteal drug-eluting stents, involving the ACHILLES, DESTINY and YUKON-BTX trials with a total of 501 patients, reported that at 1 year there was superiority of DES compared with control treatments in terms of higher primary patency (80.0 vs. 58.5%), improvement of Rutherford classification (79 vs. 69.6%), decreased TLR events (9.9 vs. 22.0%), improved wound healing (76.8 vs. 59.7%) and better overall event-free survival (72.2 vs. 57.3%). Another systematic review by a different group of authors, however, reported equal efficacy of DES vs. PTA and also equal efficacy for DES vs. bare metal stents. Thus, the use of DES below the knee in patients with CLI remains controversial. Finally, 6- and 12-month results of the PADI trial, PTA with bail-out bare metal stenting vs. DES in infrapopliteal arteries in patients with CLI, an investigator-initiated trial in 137 patients will be presented.

References

1. Van Overhagen H, Spiliopoulos S, Tsetis D. Below the knee interventions. Cardiovasc Intervent Radiol 2013; 36: 302-311.
2. Romiti M, Albers M, Brochado-Neto FC et al.Meta-analysis of infrapopliteal angioplasty for chronic critical limb ischemia. J Vasc Surg 2008; 47: 498-503.
3. Haider SN, Kavanagh EG, Forlee M et al.Two-year outcome with preferential use of infrainguinal angioplasty for critical ischemia. J Vasc Surg 2006; 43: 504-512.
4. Söderström MI, Arvela EM, Korhonen M et al. Infrapopliteal percutaneous transluminal angioplasty versus bypass surgery as first-line strategies in critical limb ischemia. A propensity score analysis. Annals of Surgery 2010; 252: 765-773.
5. Schmidt A, Piorkowski M, Werner M et al. First experience with drug-eluting balloons in infrapopliteal arteries. J Am Coll Cardiol 2011; 58: 1105-1109.
6. Liistro F, Porto I, Angioli P et al. Drug-eluting balloon in peripheral intervention for below the knee angioplasty evaluation (DEBATE-BTK): a randomized trial in diabetic patients with critical limb ischemia. Circulation 2013; 128: 615-621.
7. Randon C, Jacobs B, De Ryck F et al. Angioplasty or primary stenting for infrapopliteal lesions: results of a prospective randomized trial. Cardiovasc Intervent Radiol 2010; 33: 260-269.
8. Katsanos K, Spiliopoulos S, Diamantopoulos A et al. Systematic review of infrapopliteal drug-eluting stents: a meta-analysis of randomized controlled trials. Cardiovasc Intervent Radiol 2013; 36: 645-658.
9. Jens S, Conijn AP, Koelemay MJW et al. Randomized trials for endovascular treatment of the infrainguinal arterial disease: systematic review and meta-analysis (part 2: below the knee). EJVS 2014; 47: 536-544.
10. Martens JM, Knippenberg B, Vos JA et al. Update on PADI trial: percutaneous transluminal angioplasty and drug eluting stents for infrapopliteal lesions in critical limb ischemia. J Vasc Surg 2009; 50: 687-690.

1803.2

Techniques and complication management

L.M. Palena

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Learning Objectives

1. Understand the basic technique used and the alternatives
2. What specialist equipment and devices are required
3. To learn about the major complications and how to treat them

No abstract available.

1803.3

Wound care and patient follow-up

K.N. Katsanos

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Learning Objectives

1. Understand the basic principles of venous/arterial ulcer care
2. Evidence for ulcer healing with different techniques
3. To learn about drug therapies and diabetic control for prevention and healing

No abstract available.

1803.4

Bioresorbable vascular scaffolds

T.W.I. Clark

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Learning Objectives

1. To learn about the available stents
2. Basic technique of deployment and adjunctive procedures
3. To learn about the technical and clinical outcomes, short- and medium-term in comparison to other techniques

No abstract available.

Special Session
Credibility and value for money: the keys to success

1805.1

Cost effectiveness in medicine: what is it, and how do you measure it?

P. McCrone
Centre for the Economics of Mental and Physical Health, King's College London, London, United Kingdom

Learning Objectives
1. To learn what cost effectiveness means in medicine
2. To learn about the potential of cost effectiveness in IR
3. To learn how cost effectiveness in IR can be measured

No abstract available.

1805.2

Quality assurance and value for money: how IR can prove its worth

L.M. Kenny
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Learning Objectives
1. To learn about the requirements for quality assurance systems in medicine
2. To learn about quality assurance systems in interventional radiology
3. To learn how quality assurance systems can be cost-effective

Interventional Oncology (IO) has a tremendous opportunity to demonstrate its worth to the cancer community. It has the potential to be equivalent to other local treatments with less short and long-term morbidity and less cost than open procedures.
It must however be able to demonstrate that it can do so. Randomized controlled trials are unlikely to be designed and completed satisfactorily. The creation and maintenance of sophisticated databases that incorporate appropriate cancer outcome measures is a priority and these should include:
- The appropriateness of the choice of treatment
- Appropriate measure of local control/cure within a quality framework
- Overall economic burden to the patient and the syste
- Quality of life and other relevant patient reported outcome measure

IO must strive to prove its worth in this comprehensive manner in order to become part of mainstream cancer care.

1805.3

Comparative effectiveness research: IR states its case

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Learning Objectives
1. To learn what comparative effectiveness research is in medicine
2. To learn what comparative effectiveness research is in IR
3. To learn how comparative effectiveness research can and should be used in IR

Comparative effectiveness research is designed to inform healthcare decisions by providing evidence on effectiveness, benefits, and harms of different treatment options. Evidence is generated from research studies that compare drugs, medical devices, tests, surgeries, and ways to deliver healthcare. There are two ways in which this evidence is found: (1) researchers look at all of the available evidence about benefits and harms of each choice for different groups of people from existing clinical trials, clinical studies, and other researches, and these are called research reviews because they are systematic reviews of existing evidence; (2) researchers conduct studies that generate new evidence of effectiveness or comparative effectiveness of a test, treatment, procedure, or healthcare service. Comparative effectiveness research requires development, expansion, and use of various data sources and methods to conduct timely and relevant research and to disseminate results in a form that is quickly usable by clinicians, patients, and policymakers as well as health plans and other payers. In this presentation, the available data on the comparative effectiveness of interventional radiology treatments will be reviewed and issues involved in the design of clinical trials will be discussed.

1805.4

Next important steps for IR

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Learning Objectives
1. To learn about factors defining succes for IR
2. To learn about future strategies for advancing IR
3. To learn how quality improvement advances IR

Interventional procedures have been used for the treatment of patients with cancer for several decades. At the beginning, these were mainly palliative techniques such as percutaneous biliary drainage and percutaneous nephrostomy. These methods made a significant contribution to the quality of life of cancer patients. However, as they were seen as adjuncts to other oncological treatments, interventional radiologists who performed them provided a largely technical service. Consequently, it was unnecessary for them to have a detailed understanding of the malignant conditions that they were treating as the decisions were largely taken by others.
The advent of potentially curative interventional radiological techniques, particularly thermal ablation and cryotherapy, has completely changed the role of interventional radiologists in the treatment of cancer patients, and this has created a new discipline of interventional oncology (IO). Imaging-guided therapy is a step change in the local treatment of tumours. Although modern imaging has provided the surgeon with very accurate methods of localisation of tumours, when the surgeon operates on a solid organ, he or she is still like a person who has the floor plan of a house but enters it in darkness and has to find the way to a particular room. In contrast, the interventional radiologist is like a person who in addition to the map, has a torch to find his way to the target.
There are two sets of future developments in IO. The first one consists of scientific and technological advances. As interventional radiologists are by nature innovative people, these developments are inevitable, and I am sure that we shall see excellent progress in these areas. The second set is more difficult, as there is no individual gain involved; professional and educational developments require strategic thinking and collective political will from organisations such as CIRSE and SIR.

Scientific and technological developments

Imaging guidance for interventional radiological procedures is improving rapidly. The fusion of functional and structural imaging and greater computing power providing 'instant' 3D images increase the accuracy of tumour targeting. Ablation technology is getting ever more sophisticated and powerful; combined approaches with chemotherapy and radiotherapy promise improved clinical outcomes and lower recurrence rates.

Ablation improves vascular permeability and increases tumour sensitivity to chemotherapy. In addition, chemotherapeutic agents increase the area of coagulation after thermal ablation. There have been some excellent animal researches in these areas, which is now being followed by early clinical studies. For example, the combination of radiofrequency ablation and brachytherapy seems to be an effective method of treatment of early non-small cell lung cancer.

Professional and educational developments

The future of IO will depend, to a significant extent, on the credibility of this discipline within the oncological community. It will also be influenced by the acquisition of infrastructure necessary for interventional oncologists to practise as clinicians and by ensuring that interventional radiological procedures are funded appropriately.

Cancer is complicated. We used to think that malignant tumours consisted of a relatively homogeneous population of cells. We now know that this is far from being correct; mutations take place within tumours, giving rise to different cell populations. Each of these groups of cells may give rise to metastases that are very different from the primary tumour and from each other. This process is repeated within each metastasis, thereby giving rise to many different types of secondary tumours.

Other factors contributing to the complexity of cancer are the gradient of acidity and hypoxia within tumours, which depend on the distance from tumour vessels. These can have a profound influence on the response to treatment. For example, we know that doxorubicin depends on free radical formation for its action, and that hypoxia inhibits this process.

Credibility within oncology will depend on the following factors:

a) Education: it is important that future interventional oncologists are trained appropriately, and that a curriculum to ensure that this happens is created; this should include a basic understanding of chemotherapy and radiotherapy as well as knowledge of the elements of tumour biology.

b) Presence: interventional oncologists should be present at multidisciplinary meetings where cancer patients are discussed in order to have an opportunity to contribute their knowledge and to participate in decisions related to the management of patients.

c) Clinical pattern of practise: interventional oncologists should practise as clinicians rather than as technicians; they should conduct ward rounds and outpatient clinics as well as follow up their own patients.

d) A robust quality assurance system for IO: this is a very important development; this will ensure that the processes we use are fit for purpose and will increase the safety of patients.

IO and radiation oncology are natural partners; both rely heavily on imaging, undertake local tumour treatment and have common potential research themes such as studies on the combination of radiotherapy and thermal ablation. Also, some procedures such as brachytherapy for cholangiocarcinoma rely on skills from both disciplines. Therefore, there are great potential opportunities from collaboration between radiation oncology and IO. There could be joint appointments of interventional oncologists in departments of radiology and radiation oncology. These would provide great opportunities for clinical practise and greater access to patients.

CIRSE, SIR and other organisations involved in the training of interventional radiologists should create a curriculum for training in IO, set up a credible quality assurance system in this discipline and encourage clinical practise.

Fundamental Course
Men's health – basic principles of BPH treatment

2501.1

Indication for treatment – patient triage

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Learning Objectives

1. To learn how to select patients for BPH treatment
2. To learn about pre-treatment imaging requirements and urodynamic assessment
3. To describe other non-endovascular options, including medical and surgical treatments currently available

1- Understand lower urinary tract symptoms (LUTS)

Benign prostatic hyperplasia (BPH) is the primary cause of LUTS, which affects more than 50% of men >60 years of age (1). Many men with LUTS are not bothered enough by their symptoms to need drug treatment or surgical intervention. All men with LUTS should be formally assessed prior to any allocation of treatment.

It is important to understand that there are many other causes of LUTS such as neurological disease, urogenital infection, urinary incontinence, urethral stones, and malignant disease of the urinary tract.

2- What is the standard of care?

Men with mild-to-moderate so-called "uncomplicated LUTS" are suitable for watchful waiting. Lifestyle advices include reduction of fluid intake, avoidance of caffeine, bladder retraining, and treatment of constipation (2).

The first-line treatment of bothersome LUTS related to BPH is medical therapy as recommended by European guidelines (2,3). The first-line drugs are alpha-blockers because they allow a rapid improvement of symptoms and are usually well tolerated. In case of insufficient improvement or LUTS, 5 alpha-reductase inhibitors (5-ARIS) can be combined with an alpha-blocker, which allows additional benefits for LUTS as well as reduction of the prostate size (4). Phytotherapy based on various species may also be used, although there are limitations in their evaluation (2).

The indication for an invasive treatment is based on the severity of the symptoms according to the patient's perception (International Prostate Symptoms Score [IPSS] and QoL scale); the reference method is trans-urethral resection of the prostate (TURP) for prostate <80 ml, while open trans-vesical prostatectomy is indicated when the prostate volume is >80 ml.

Since 10 years, several other minimally invasive approaches have been introduced such as various types of lasers, radiofrequency ablation, intra-prostatic injection of botox, and urethral stents. Their level of validation is variable, but they are usually offered by urologists as an alternative to TURP.

The introduction of PAE by the pioneer Portuguese and Brazilian teams is changing the field and represents another minimally invasive therapy for these patients. There are many potential advantages of PAE over surgical treatment, and the most important one is probably the absence of sexual complications. In fact, most surgical approaches aim at destroying/ablating the prostate around the intra-vesical urethra, where the internal smooth muscle cell sphincter is placed, thus preventing its normal function after surgery. This results in a very high rate of retrograde ejaculation.

The experience of PAE is not widespread, and the validation is still in its infancy. Like all interventional techniques including surgery, there is a need for the development of the technique in a well-controlled multidisciplinary environment to ensure that the learning curve is covered on patients in whom there is no alternative treatment and

after full informed consent. At a later stage, appropriate randomized trial would be needed to provide level 1 evidence.

Those who intend to offer a PAE program in their environment should understand that there is a need for a high level of commitment, given the complexity of the technique, which is related to the size of the prostatic arteries, numerous anatomical variations, and pelvic navigation that is often complex. It is also important to have access to CBCT in the angio room as it is a very helpful tool in guiding the intervention in some cases.

3- Patients triage for PAE?

There is no risk to overstate the need for a consultation both with the IR and the urologist to ensure that appropriate patients will be selected. The clinical work-up of patients with bothersome LUTS in whom PAE is considered consists of digital rectal examination, transrectal ultrasound, PSA, IPSS, WOL, and IIEF (International Index of Erectile Function). MR should also be performed as it helps to rule out cancer and allows visualizing median lobe hyperplasia.

In most reported experiences, after appropriate work-up and only in case of bothersome LUTS PAE will be discussed in the following situation.

- Bothersome LUTS with at least 2 of following conditions: IPSS > 8, QOL >3, Q max < 15 ml/s
- Patients in whom surgey is contra-indicated
- Patients who do not want surgery (most of the time because of the fear of retrograde ejaculation)
- Patients with chronic indwelling catheter

At the beginning of the experience, we recommend to treat patients with large prostate (>50 ml). In fact, even if the size of the arteries is not always large, the prostatic blush on selective angiography will be more visible and will help to guide the intervention.

4- Which patients should not be treated?

In addition to the usual absolute contra-indications to iodine contrast, one should consider before offering PAE to a patient that the intervention will be long and the patient needs to stay quiet on the angio table for 2 hours. Therefore, patients with poor understanding of the technique and their condition as well as those with severe osteo-articular disease should be considered for appropriate sedation. In addition, PAE should not be proposed in the following situations.

- Known or suspected prostate cancer requiring specific management
- Known acute or chronic prostatitis
- On-going acute urinary infection
- Acontractile detrusor
- Neurogenic lower urinary tract dysfunction
- Urethral stenosis
- Bladder diverticulum
- Bladder stone with surgical indication
- Patients ineligible for pelvic angiography and embolization including severe atheromatous condition or any anatomical condition

The role of the IR together with the urologist is to offer the best treatment to each patient; this is possible only when there is a global understanding of the disease and of the embolization technique and results by both of them.

References

1. Eckhardt MD, Van Venrooij GE, et al. Prevalence and bothersomeness of lower urinary tract symptoms in benign prostatic hyperplasia and their impact on well-being. J Urol 2001;166:563-568.
2. Oelke M, Bachmann 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;64:118-140.
3. Descazeaud A, Robert G, et al. Bilan initial, suivi et traitement des troubles mictionnels en rapport avec l'hyperplasie bénigne de la prostate: recommandations du CTMH de l'AFU. Progrès en Urologie 2012;22:977-988.
4. Roehrborn CG, Siami P, et al. The effects of combination therapy with dutasteride and tamsulosin on clinical outcomes in men with symptomatic benign prostatic hyperplasia: 4-year results from the CombAT study. Eur Urol 2010;57:123-131.

2501.2

Current evidence on prostate artery embolisation

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Learning Objectives

1. To learn about the results of current relevant trials
2. To outline the outcomes of non-endovascular techniques and PAE
3. To become familiar with the evidence regarding outcomes

Promising clinical studies from Sao Paulo (1,3) and Lisbon (2) published by Carnevale *et al.* and Pisco *et al.*, respectively, from 2010 to 2013 have suggested an 80% improvement in men with symptomatic prostatic enlargement who were treated by prostate artery embolisation (PAE).

This has encouraged many other interventional radiology/urology centres around the world to engage in PAE research to establish its position in treatment algorithms for symptomatic prostatic enlargement.

At Southampton, UK, a successful pilot study was conducted by Dr. Hacking and Dr. Bryant (4), which stimulated the launch of a multidisciplinary registry comparing PAE with trans-urethral resection of prostate (TURP). The UK-ROPE (6), a CEDAR, NICE, BSIR and BAUS sponsored study has till date (April 2015) recruited over 50 patients into the PAE arm and 25 into the TURP arm. Initial results will be presented at this meeting. Twelve-month follow-up data is due at the end of 2016.

Registries in Italy and the USA are now underway and recruiting.

The first randomised controlled trial (RCT) of PAE vs. TURP has been published by Gao *et al.* from two Chinese institutions in 2014 (5). One hundred and fourteen men were enrolled into the study, with 57 in each arm. Once again, the effectiveness and safety of PAE was confirmed. Symptom scores (IPSS), flow studies, QOL and prostate volumes improved after PAE in the majority, although not quite as well as the improvement in the TURP group. The authors reported a higher incidence of complications after PAE compared with that after TURP; however, these were minor, with acute retention requiring catheterization and mild post-embolisation syndrome making up the majority of these 'complications'. In the TURP group, one patient required an ITU stay for TUR syndrome and another patient required blood transfusion for blood loss. Two patients needed further surgery for bladder neck stenosis and urethral stricture, respectively.

There were no cases of non-target embolisation reported from the PAE group.

Further RCTs are planned in Switzerland (7) and elsewhere, and results should be available by 2016–2017.

Although PAE is technical and requires a high level of experience and training, it appears to be safe and efficacious. Further good quality evidence is being collected.

Although not as effective as TURP in most parameters measured, it is a day-case procedure and can be offered to suitable symptomatic men, with a good chance of success and low morbidity. Symptomatic failures (20%) can still be offered conventional TURP.

References

1. Carnevale FC, Antunes AA, da Motta Leal Filho JM, et al. Prostatic artery embolization as a primary treatment for benign prostatic hyperplasia: preliminary results in two patients. Cardiovasc Intervent Radiol 2010;33(2):355–361.
2. Pisco J, Campos Pinheiro L, Bilhim T, et al. Prostatic arterial embolization for benign prostatic hyperplasia: short- and intermediate-term results. Radiology 2013;266(2):668–677.

3. Carnevale FC, Da Motta-Leal-Filho JM, Antunes AA, et al. Quality of life and clinical symptom improvement support prostatic artery embolization for patients with acute urinary retention caused by benign prostatic hyperplasia. J Vasc Interv Radiol 2013;24(4):535–542.
4. Somani BK, Hacking N, Bryant T, et al. Prostate artery embolization (PAE) for benign prostatic hyperplasia (BPH). BJU Int 2014;114(5):639–640.
5. Gao Y, Huang Y, Zhang R, et al. Benign prostatic hyperplasia: prostate artery embolization versus transurethral resection of the prostate--a prospective, randomised and controlled clinical trial. Radiology 2014;270(3).
6. UK-ROPE. Multicentre, multi-disciplinary UK registry for PAE. http://www.cedar.wales.nhs.uk/rope-register.
7. Abt D, Mordasini L, Hechelhammer L, et al. Prostatic artery embolization versus conventional TUR-P in the treatment of benign prostatic hyperplasia: protocol for a prospective randomized non-inferiority trial. Single centre Swiss RCT recruiting from 2015. BMC Urol 2014;14:94.

2501.3

Prostate artery embolisation: technique

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Learning Objectives
1. To learn about materials used including selective catheters, guidewires and embolic agents
2. To describe the technique for super-selective embolisation
3. To demonstrate the technical success rates and clinical outcome

A refined embolization technique is crucial for imaging and clinical success when performing PAE. Before the procedure, a Foley catheter is introduced into the bladder and filled with a mixture of 10-20% iodinated contrast medium and 70% normal saline solution. This technique is used as a landmark. In patients without indwelling catheter, due to urinary retention, the Foley catheter is removed immediately after PAE and every 7-10 days for patients with chronic use.

The PErFecTED Technique: Proximal Embolization First, Then Embolize Distal.

Selective digital subtraction arteriography of the internal iliac artery with a 5-French cobra or vertebral diagnostic catheter placed at the common internal iliac trunk is performed to assess the blood supply to the prostate and perform the internal vesical artery (IVA), catheterization under ipsilateral 25-55° oblique view. 5-French catheters like cobra, vertebral, Simmons, and RUC can be used.

After entering the inferior vesical artery, vasodilator is injected through the microcatheter to prevent vasospasm and to increase artery size in order to facilitate microcatheter navigation and distal positioning. The microcatheter should cross any collateral branch to the bladder, rectum, corpus cavernosum, gonad, or penis and be placed distally into the prostatic artery before its branching to the central gland (urethral group of arteries) and peripheral zone (capsular group of arteries). Any embolic agent can be used. We think that a high dilution and very slow injection with 1-cc injection syringe is essential to avoid early proximal occlusion and get diffuse gland parenchymal ischemia.

When reaching "near stasis," the microcatheter should be advanced into the prostatic parenchyma branches for an intraprostatic embolization. Because BPH develops primarily in the periurethral region of the prostate, the urethral group of arteries should be embolized first. Since we added the second step to the PErFecTED technique, we have observed infarcts in all patients.

Patients treated with the PErFecTED technique have moderate post-embolization syndrome, including dysuria, urethral burning, and pollakiuria. Antibiotics, oral hydration, non-opioid pain relievers, and nonsteroidal anti-inflammatory drugs are fully recommended. Laxative diet and medication are useful for constipation. Due to concern over risk of urinary retention, we continue to administer alpha-blockers for 1 week after PAE due to their affect on smooth muscle tone.

References

1. Carnevale FC, Antunes AA, da Motta Leal Filho JM, et al. Prostatic artery embolization as a primary treatment for benign prostatic hyperplasia: preliminary results in two patients. Cardiovasc Intervent Radiol. 2010;33(2):355-61.
2. Carnevale FC, da Motta Leal Filho JM, Antunes AA, et al. Midterm follow-up after prostate embolization in two patients with benign prostatic hyperplasia. Cardiovasc Intervent Radiol. 2011;34(6):1330-3.
3. Carnevale FC, Antunes AA. Prostatic artery embolization for enlarged prostates due to benign prostatic hyperplasia. How I do it. Cardiovasc Intervent Radiol. 2013;36(6):1452-63.
4. Frenk NE, Baroni RH, Gonçalves OMG, et al. MRI findings after prostatic artery embolization for treatment of benign hyperplasia. AJR Am J Roentgenol. AJR Am J Roentgenol. 2014;203(4):813-21.
5. Câmara-Lopes G, Matteddi R, Antunes AA, et al. The histology of prostate tissue following artery embolization for the treatment of benign prostatic hyperplasia. Int Braz J Urol. 2013;39:222-7.

2501.4

Tips and tricks for difficult PAE procedures

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Learning Objectives
1. To learn how to perform pre-procedural imaging that may influence difficult cases
2. To learn technical tips and tricks to overcome challenging procedures
3. To describe possible technical and clinical complications

Prostate artery embolization (PAE) can be a challenging procedure due to the following reasons:
1. tortuous iliacs
2. angled/atherosclerotic prostate artery (PA) origin
3. variant anatomy
4. anastomoses

1. When facing tortuous iliac arteries, a bilateral femoral puncture may be adequate for the catheterization of the ipsilateral internal iliac artery (IIA) origin. Navigation inside the IIA remains mostly dependent on the microcatheter. This approach may be limited due to poor catheter support and loss of steerability. Another option is to try the crossover over the aortic bifurcation and place a long sheath in the contralateral IIA providing better support for catheters. This approach can be very time-consuming.

2. Entering PAs from the superior vesical artery is frequently challenging. The superior vesical artery usually has a 90° angled origin, and sometimes an atherosclerotic plaque may be present near the ostium. The PA also has another 90° angled origin from the superior vesical artery. This double 90° curve can be very difficult to cross, and forcing the microcatheter to go down into the PA can sometimes be impossible. Atherosclerotic stenoses or occlusions of the IIA or PA can lead to technical failure and unilateral PAE procedures.

3. PAs may arise from many different branches of the IIA and aberrant obturator arteries and from the external iliac artery. PAs may arise from the posterior division of the IIA, accessory pudendal arteries, penile arteries, and prostatorectal trunks. Correct identification of these variant origins is necessary to obtain central gland embolization of the prostate.

4. Anastomoses of PAs with the surrounding organs are found in 60% of pelvic sides. Potential untargeted ischemia to the bladder, seminal glands, the rectum, and the penis poses an additional

technical difficulty. When large anastomoses between PAs and penile (accessory pudendal arteries) or rectal arteries are present, coil embolization of anastomosis before particulate embolization of the prostate is a good option. If the accessory pudendal artery is the main supply to the penis, advancing the microcatheter distally into the PA and sparing the accessory pudendal artery may be the best option.

Planning PAE procedures with CTA allows identifying the IIA and PA with confidence and guiding the procedure through hostile iliac arteries and variant anatomies as well as helps in excluding potential technical failures. Correct identification and management of anastomoses and knowledge of the PA and IIA anatomy are necessary for safe PAE procedures without untargeted embolization to surrounding organs.

References

1. 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.
2. Bilhim T, Tinto HR, Fernandes L, Martins Pisco J. Radiological anatomy of prostatic arteries. Tech Vasc Interv Radiol 2012; 15:276-85.
3. Martins Pisco J, Pereira J, Rio Tinto H, Fernandes L, Bilhim T. How to perform prostatic arterial embolization. Tech Vasc Interv Radiol 2012; 15:286-9.
4. Bilhim T, Pereira JA, Tinto HR, et al. Middle rectal artery: myth or reality? Retrospective study with CT angiography and digital subtraction angiography. Surg Radiol Anat 2013; 35:517-22.
5. 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.
6. Bilhim T, Pisco J, Rio Tinto H, et al. Unilateral versus bilateral prostatic arterial embolization for lower urinary tract symptoms in patients with prostate enlargement. Cardiovasc Intervent Radiol 2013; 36:403-11.
7. Bilhim T, Pisco J, Pinheiro LC, Rio Tinto H, Fernandes L, Pereira JA. The role of accessory obturator arteries in prostatic arterial embolization. J Vasc Interv Radiol 2014; 25:875-9.
8. Garcia-Monaco R, Garategui L, Kizilevsky N, Peralta O, Rodriguez P, Palacios-Jaraquemada J. Human cadaveric specimen study of the prostatic arterial anatomy: implications for arterial embolization. J Vasc Interv Radiol 2014; 25:315-22.
9. Kawai N, Sato M, Hosokawa S, et al. Prostate-supplying arteriogram created by multidetector-row CT during pelvic arteriography: contribution to the treatment strategy of prostatic artery embolization for prostatic hyperplasia. Jpn J Radiol 2014; 32:491-5.

Special Session
State-of-the-art aorto-iliac disease treatment

2502.1

Current evidence and practice since TASC II

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Learning Objectives

1. To learn about recent developments of the TASC classification and beyond
2. To learn about which lesions to treat
3. To learn about the newest developments in classification

Since 2007, when TASC II was published, major changes have taken place in the treatment techniques and strategies for aortoiliac occlusive disease (AIOD). One third of the lesions in patients with peripheral artery obstructive disease (PAOD) affect the aortoiliac segment [1, 2]. Prevalence of PAOD increases with age, rising from 6% in patients 38-50 years of age, to 16% in patients 60-69 years of age, to 34% in patients greater 70 years of age [3]. Former patients requiring aortofemoral bypass can now be treated with less invasive procedures showing comparable or even superior results [1]. Evidence in that regard is found in the literature depicting that endovascular treatment (EVT) should be considered as a first-line therapy even for complex and long aortoiliac stenosis and/or occlusions [1].

According to the recommendations of TASC II published in 2007, for lesions classified as type A lesions, EVT is the method of choice [4]. Reconstructive surgery is preferred for type D lesions [4]. Patients with type B and C lesions can be managed by either EVT or surgery depending on patients' comorbidities [4]. However, these guidelines are outdated and not practicable because new data supports other treatment strategies.

In 2012, guidelines on EVT in AIOD were published by the Cardiovascular and Interventional Radiological Society of Europe (CIRSE). These guidelines recommend an EVT for TASC A-C aortoiliac lesions as a first-line strategy due to the low morbidity and mortality rates and high technical success obtained, with a class 1 recommendation and level of evidence C [1]. Technical success rate is > 90% in almost all series with regard to TASC A-C lesions [1, 5]. The reason for such high technical success rates are new treatment strategies and technologies in AIOD, which have evolved over the past years with a new wider range of balloon-expandable and self-expandable stents/covered stents as well as re-entry devices for safe and reliable re-entry into the true lumen after subintimal recanalization [6-8]. A recently published, prospective, nonrandomized, multicenter, multinational trial (Bravissimo study) confirmed these high technical success rates for TASC A-C lesions [9].

CIRSE guidelines also recommend EVT for TASC D lesions, with a class of recommendation 2b and a level of evidence C [1]. Technical success rate for TASC D lesions have been reported to be around 90% [1, 8, 10].

Supporting the recommendations of EVT in former TASC A-D lesions are the high patency data obtained over the past years. In the literature, primary patency rates for TASC A and B lesions after 3, 4, 5, and 10 years are 84%, 80%, 77%, and 69%, respectively, and secondary patency rates are 96%, 90%, 90%, and 80%, respectively [1]. Primary patency rates for TASC C and D lesions after 3, 5, and 10 years are 88%, 80%, and 71%, respectively, and secondary patency rates are 98%, 95.4%, and 98%, respectively [1, 11]. Patency data for TASC C and D lesions appear to be longer than that of TASC A and B lesions, which is most likely due to more recent studies published for TASC C and D lesions than for TASC A and B lesions [1]. Also, the recently published practice guidelines of the Society of Vascular Surgery in March 2015 recommend an EVT as first-line treatment in focal and advanced AIOD, with a class 1 recommendation and level of evidence B [12]. The guidelines recommend that open surgery should nowadays be reserved for patients with such an extensive disease that EVT is impossible or ill-advised, in patients with severe disease and associated aortic aneurysms, and in those with failed endovascular interventions [12].

Furthermore, several studies have compared EVT versus open reconstruction of AIOD, showing equivalent patency, limb salvage, and survival rates [8, 13, 14]. For example, a study published in 2008 compared open repair versus EVT of AIOD, reporting a primary patency at 3 years being greater for aorto-bifemoral bypass (93% versus 74%). However, secondary patency (97% versus 95%), limb salvage (98% versus 98%), and long-term survival (80% versus 80%) were similar [1, 13]. Most importantly, these studies showed no preclusion or disadvantage of any surgical option in case of unsuccessful outcome after EVT, making EVT the first-line therapy in AIOD [5, 13, 14]. In addition, these reports revealed a decreased morbidity and mortality for endovascular procedures compared to open surgical reconstructions [8, 13, 14]. Indes *et al.*, for example, report an overall in-hospital complication rate of 16% in the endovascular group

versus 25% in the surgical group ($p < 0.001$) [3]. Length of hospital stay in the endovascular group was significantly shorter, and it was less costly than open surgical treatment [3].

The most dangerous and life-threatening complication during EVT is iliac artery rupture with a mean rate of 1.73% (range, 0.2-3.4), as described in the literature [1]. Other complications during EVT are arterial dissection, treated vessel thrombosis, distal embolization, pseudoaneurysm, groin hematoma, retroperitoneal hematoma, device malfunction, and acute aortic occlusion, with a cumulative complication rate of 7.51% [1]. In comparison with open surgical reconstruction complications like cardiac arrest, hematoma, and post-hemorrhagic anemia with transfusion, all respiratory complications, postoperative and device-related infections, oliguria, and wound seroma are significantly higher ($p < 0.05$) in the surgical group [3].

However, some topics in EVT remain unclear like primary versus secondary stenting [10, 15, 16]. For example, in the study by Ye *et al.* over the first 4 years, primary stenting resulted in a patency rate that was 10% higher than that for selective stenting [10]. At 5 years, however, the two groups showed comparable patency rates (67.1% versus 63.0%) [10]. The issue of lesions extending from the EIA to the CFA, an area of high biomechanical stress, also being described as a "no-stent area," remains a surgical domain. New treatment strategies though, e.g., a combination of covered stent implantation with surgical femoral patch plasty, show good initial and short-term patency data; however, long-term data is limited and should be discussed critically [12, 17-19]. The issue of lesion and/or stent lengths used in regards to patency rates in the treatment of AIOD is also unclear. One study revealed a significant difference in the primary and assisted-primary patency rates for iliac artery occlusions over 10 cm in length [20]. However, other studies did not find any significant difference between localized versus extensive AIOD [5]. A recently published study in 2015 revealed a significant difference ($p = 0.016$) in primary and secondary patency rates of 90.6% (after 12 months) and 86.6% (after 24 months) for stents < 61 mm and 67.7% (after 12 months) and 60.2% (after 24 months) for stents > 61 mm in the treatment of AIOD for TASC B-D lesions.

Since TASC II, different treatment strategies have evolved due to recent evidence in the literature resulting in EVT as a first-line therapy for AIOD. Nowadays, therapy planning has changed in regards to the strict TASC II classification of lesions, recommending EVT over surgery due to lower morbidity and mortality rates. Similar patency rates for EVT are achieved, and, importantly, EVT does not preclude or worsen surgical treatment options as second-line treatment.

References

1. Rossi, M. and Iezzi R., Cardiovascular and Interventional Radiological Society of Europe guidelines on endovascular treatment in aortoiliac arterial disease. Cardiovasc Intervent Radiol, 2014. 37(1): p. 13-25.
2. Kavaliauskiene, Z., et al., Factors affecting primary patency of stenting for TransAtlantic Inter-Society (TASC II) type B, C, and D iliac occlusive disease. Medicina (Kaunas), 2014. 50(5): p. 287-94.
3. Indes, J.E., et al., Endovascular procedures for aorto-iliac occlusive disease are associated with superior short-term clinical and economic outcomes compared with open surgery in the inpatient population. J Vasc Surg, 2010. 52(5): p. 1173-9.
4. Norgren, L., et al., Inter-Society Consensus for the Management of Peripheral Arterial Disease (TASC II). Eur J Vasc Endovasc Surg, 2007. 33 Suppl 1: p. S1-75.
5. Jongkind, V., et al., A systematic review of endovascular treatment of extensive aortoiliac occlusive disease. J Vasc Surg, 2010. 52(5): p. 1376-83.
6. Chen, B.L., et al., Subintimal angioplasty of chronic total occlusion in iliac arteries: a safe and durable option. J Vasc Surg, 2011. 53(2): p. 367-73.
7. Minko, P., et al., Subintimal revascularization of chronic iliac artery occlusions using a reentry-catheter. Rofo, 2011. 183(6): p. 549-53.
8. Tewksbury, R., et al., Outcomes of covered expandable stents for the treatment of TASC D aorto-iliac occlusive lesions. Vascular, 2015.
9. Bosiers, M., et al., BRAVISSIMO study: 12-month results from the TASC A/B subgroup. J Cardiovasc Surg (Torino), 2012. 53(1): p. 91-9.
10. Ye, W., et al., Early and late outcomes of percutaneous treatment of TransAtlantic Inter-Society Consensus class C and D aorto-iliac lesions. J Vasc Surg, 2011. 53(6): p. 1728-37.
11. Pulli, R., et al., Early and long-term comparison of endovascular treatment of iliac artery occlusions and stenosis. J Vasc Surg, 2011. 53(1): p. 92-8.
12. Society for Vascular Surgery Lower Extremity Guidelines Writing; G., et al., Society for Vascular Surgery practice guidelines for atherosclerotic occlusive disease of the lower extremities: Management of asymptomatic disease and claudication. J Vasc Surg, 2015. 61(3 Suppl): p. 2S-41S.
13. Kashyap, V.S., et al., The management of severe aortoiliac occlusive disease: endovascular therapy rivals open reconstruction. J Vasc Surg, 2008. 48(6): p. 1451-7.
14. Leville, C.D., et al., Endovascular management of iliac artery occlusions: extending treatment to TransAtlantic Inter-Society Consensus class C and D patients. J Vasc Surg, 2006. 43(1): p. 32-9.
15. Klein, W.M., et al., Dutch iliac stent trial: long-term results in patients randomized for primary or selective stent placement. Radiology, 2006. 238(2): p. 734-44.
16. Tetteroo, E., et al., Intraarterial pressure gradients after randomized angioplasty or stenting of iliac artery lesions. Dutch Iliac Stent Trial Study Group. Cardiovasc Intervent Radiol, 1996. 19(6): p. 411-7.
17. Bonvini, R.F., et al., Angioplasty and provisional stent treatment of common femoral artery lesions. J Vasc Interv Radiol, 2013. 24(2): p. 175-83.
18. Baumann, F., et al., Endovascular treatment of common femoral artery obstructions. J Vasc Surg, 2011. 53(4): p. 1000-6.
19. Paris, C.L., et al., Catheter-based therapy of common femoral artery atherosclerotic disease. Vasc Med, 2011. 16(2): p. 109-12.
20. Scheinert, D., et al., Stent-supported recanalization of chronic iliac artery occlusions. Am J Med, 2001. 110(9): p. 708-15.

2502.2

Treatment of bifurcational lesions

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Learning Objectives

1. To learn about the indications for bifurcational treatment
2. To learn about which material to use and how
3. To learn about the outcomes of bifurcational treatment

Percutaneous endoluminal therapy is the treatment of choice for aortic bifurcational lesions, due to reduced invasiveness as well as shorter patient recovery and hospital stay. Clinical indications include pelvic and lower limb ischemia (short-distance claudication, critical ischemia, blue toe syndrome) due to atherosclerosis or Takayasu's disease. Due to the rapid evolution of minimally invasive endovascular materials and accumulation of experience, endoluminal therapy can be applied successfully even in TASC C and D lesions. Reconstruction of the aortoiliac bifurcation with "kissing" angioplasty and/or stenting is the most commonly used endoluminal technique. The procedure is normally performed under local anesthesia with full cardiorespiratory monitoring. Access is typically obtained percutaneously using bilateral common femoral access. The obstructive lesions are commonly crossed using hydrophilic guide wires and selective catheters, which are then exchanged for

stiffer wires. In case of subintimal guidewire passage, a re-entry device maybe useful in order to avoid extensive dissection above the aortic bifurcation. Sometimes, a brachial approach may also be required to help cross difficult lesions and is useful for reference imaging. Stenting may be performed as a primary or secondary procedure due to failed or inadequate PTA. Predilatation can facilitate primary placement of stents; however, primary stent placement without predilatation (so-called "direct" stenting) is commonly used, as it potentially reduces distal embolization by trapping atheroma and clot between the stent and the arterial wall. In addition, there is some evidence that this technique results in less intimal hyperplasia. It is suggested that primary (or direct) stenting may be particularly good for complex stenosis (irregular, eccentric, ulcerated, or calcified lesions) and occlusions. According to the "kissing" technique, bilateral stents are deployed simultaneously and ideally should extend 5–15 mm into the distal aorta. New self-expanding stent design has enabled better anatomic results with kissing stenting, but there is no solid evidence of any long-term advantage of self-expanding over traditional balloon-mounted stents. The covered endovascular reconstruction of aortic bifurcation (CERAB) technique is a new approach for extensive and/or recurrent aortoiliac occlusive disease using three covered balloon-expandable stents to reconstruct the aortic bifurcation. This configuration provides the ability to deal with TASC II C and D lesions, simulating a neo-bifurcation or flow divider in combination with the benefits of covered stents.

Complications include aorto-iliac rupture, aortoiliac dissection with or without associated thrombosis, distal embolization, access-site hematoma, pseudoaneurysm, puncture-site infection, infected stent, and myocardial infarction. To prevent arterial rupture, as a general rule, balloons and balloon-expandable stents should not be sized to a maximum of the native aorta immediately proximal to the diseased segment, especially in heavily calcified lesions.

To prevent thromboembolic complications, anticoagulant/antiaggregant therapy is essential and includes a) low-dose LMWH until hospital discharge; b) aspirin (100-325mg/d) on a lifetime basis alone or in combination with clopidogrel; and c) dicumarol anticoagulation in selected cases.

References

1. Sabri SS et al. Outcomes of covered kissing stent placement compared with bare metal stent placement in the treatment of atherosclerotic occlusive disease at the aortic bifurcation. J Vasc Interv Radiol. 2010;21(7):995-1003.
2. Uberoi R and Tsetis D. Standards for the endovascular management of aortic occlusive disease. Cardiovasc Intervent Radiol. 2007;30:814-9.
3. Björses K et al. Kissing stents in the aortic bifurcation--a valid reconstruction for aorto-iliac occlusive disease. Eur J Vasc Endovasc Surg. 2008;36(4):424-31.
4. Greiner A et al. Does stent overlap influence the patency rate of aortoiliac kissing stents? J Endovasc Ther. 2005;12(6):696-703.
5. Goverde PC et al. Covered endovascular reconstruction of aortic bifurcation (CERAB) technique: a new approach in treating extensive aortoiliac occlusive disease. J Cardiovasc Surg (Torino). 2013;54(3):383-7.

2502.3

Treatment of long occlusions

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Learning Objectives

1. To learn about the indications for long occlusion treatment
2. To learn about which material to use and how
3. To learn about the outcomes of different materials (BMS, DEB, DES)

Definitions and Classifications

There is no generally accepted definition of what length an iliac lesion has to have to be regarded as "long". Most interventionalists would agree that occlusions ≥ 10 cm in length are long. Some define 5-cm occlusions to be long (1,2). However, length of a lesion is only one factor influencing its complexity, the other is anatomy. Complexity of an iliac lesion in combination with the clinical state of the patient triggers the choice of treatment that may be either endovascular or open surgical. This is also reflected by the recommendations of the Trans-Atlantic Inter-Society Consensus (TASC II) for the Management of Peripheral Arterial Disease (3). According to TASC, an iliac stenosis ≤ 3 cm is "short" and defined as a type A lesion. Type A lesions should be treated endovascularly. An external or common iliac artery occlusion that is dependent on the height of the patient may have a length of about 5 to 9 cm regarded as a type B lesion, whereas an occlusion of the external iliac artery involving the internal iliac and/or the common femoral artery artery - that may be of similar length as the simple external iliac occlusion - is considered a type C lesion. According to the TASC recommendations type B lesions should be treated endovascularly, whereas surgery is the preferred treatment for low-risk patients with type C lesions. "The patient's comorbidities, fully informed patient preference and the local operator's long-term success rates must be considered when making treatment recommendations for type B and type C lesions" (3).

The TASC recommendations date back to the year 2007. Endovascular techniques have improved and endovascular experiences have increased since then. Type C lesions are nowadays frequently treated on an endovascular way. Surgery is still the treatment of choice for type D lesions which among others comprise (a) the unilateral occlusion of one common iliac artery and the distal abdominal aorta, and (b) the unilateral occlusion of the common and external iliac artery (3). The standard treatment of complex aortoiliac lesions is still surgical y-graft-implantation. In the hands of an experienced vascular surgeon mortality and morbidity of surgery is low, and long-term patency is very good.

Preinterventional Imaging and Examination

Usually, a recent MRA, CTA, or diagnostic angiography of the aortoiliac and femoral arteries is available for planning the intervention. Prior to the intervention a colour duplex ultrasound examination of the lower extremity arteries is performed, and the ankle-brachial index is measured bilaterally. The medical history and the actual symptoms of the patient are recorded (Fontaine/Rutherford classification) (4). The typical symptom is claudication; in more adavanced disease, the patient complains of rest pain and ulcers. A clinical examination is performed. Groins are inspected and the pulse state is determined and recorded.

The clinical evaluation is important because an acute iliac artery occlusion should be treated surgically. A subacute occlusion (< 30 days) is also preferably treated surgically or with a hybrid intervention. Percutaneous lysis and/or mechanical therapy are possible; however, due to the large amount of thrombus and plaque material to be lysed and/or removed, there is considerable risk of distal embolization. Finally, the cardiovascular risk factors and the antiplatelet and anticoagulant medication of the patient are noted.

Access

It is a matter of personal experience and preference whether an ipsi- or contralateral approach is preferred for crossing a long iliac occlusion (1,2,5-9). There are arguments in favour of both ways. Visa-tergo and manoeuvrability of catheters and guidewires are better with the retrograde ipsilateral approach. However, advancing devices in the direction of flow, i.e. cross-over via the contralateral groin, may reduce the risk of dissections and increase the rate of successful passages of an occlusion. Therefore, if one way fails, one chooses the other. Hence, both groins should be prepared prior to the intervention. A 6-F sheath is mostly used. If access is obtained from the contralateral groin, a cross-over sheath is required. In case of an iliac occlusion involving the distal abdominal aorta, access via the left or right axillary or brachial artery may be necessary.

Guidewires and Catheters

Guidewires and catheters used are a matter of personal preference (1,2,5-9). Most interventionalists prefer a hydrophilic guide wire. The wire may be floppy or stiff; it may have an angled or straight tip. A straight guidewire with a movable core may be a further alternative. Various types of catheters may be used to cross the lesion. Preferentially, short multi-purpose 4- or 5-F catheters with angled tips are engaged. A straight 4-F catheter may be helpful. Frequently, passage of the occlusion is partly subintimal (8). Usually, it is not difficult to enter the occlusion with a guidewire and catheter, but it may be difficult to re-enter the true lumen at the end of the occluded segment. If standard catheters and guidewires fail, a re-entry device may be the ultimate option (10).

Stents and Stentgrafts

At least bare metal stents should be implanted after successful crossing of long iliac occlusions. PTA alone is considered inferior to primary stent placement with regard to technical success, complications, and likely also long-term patency (6,11). Selective stent placement was inferior to primary stent placement in a recent meta-analysis of endovascular treatment of TASC C and D aorto-iliac lesions (2). Predilatation with a balloon about 2 mm smaller than the original diameter of the artery to be treated is recommended by some investigators (6,8,9); other groups avoid predilatation to prevent distal embolization (1). Self-expanding or balloon-expandable stents can be inserted. Self-expanding stents are made from stainless steel or cobalt-chromium alloy. Most self-expanding stents are made from nitinol, a nickel-titanium alloy. Patency of both types of stents seem to be similar in the iliac arteries. However, the use of balloon-expandable stents is less time-consuming since no additional balloon dilatation is needed after stent placement to adapt the stent to the arterial wall. On the other hand, balloon-expandable stents are available only up to a length of about 8 cm; they are stiffer and less easily manoeuvred through and placed into tortuous vessels. If advanced rigorously in heavily calcified iliac lesions, balloon-expandable stent may get caught and slip off the balloon catheter. Therefore, it is advisable to cross the lesion with a long sheath first and place the balloon expandable stent only later after retrieval of the sheath. There is no risk of dislocation from the catheter in self-expanding stents, and they are more flexible and more easily to push through highly tortuous vessel. The diameter of the stents used is 6-10 mm (6,9).

A recent prospective study indicated that stent-grafts may have better long-term patency in TASC C and D iliac lesions compared to bare metal stents (12). In 2012, a prospective double blind randomized study (DISCOVER) was started to compare covered and uncovered balloon expandable stents in the common iliac arteries (13). Results have not yet been published. However, it has to be taken into consideration that stentgrafts are much more expansive, and results of bare metal stents are already quite good even in TASC C and D iliac lesions. Since data is still sparse, primary implantation of stentgrafts in long iliac occlusions is not a generally accepted indication until now (14). There is no sufficient data on the performance of drug eluting iliac stents or ballons to give any founded recommendations.

Anti-platelet and Anticoagulant Therapy

Many patients are already treated with acetylsalicylic acid (ASA) (100 mg/d) and clopidogrel before the intervention. This medication is not discontinued before the intervention. During the intervention, unfractioned heparin is applied intraarterially. Either a standard bolus of 5,000 IU of heparin, or a weight adjusted bolus (i.e. 70 IU/kg bodyweight) is administered. The optimal time for bolus administration is after placement of the sheaths.

After the intervention, anti-platelet medication with ASA 100 mg/d is continued unlimited. In addition, thienopyridines (prasugrel, clopidogrel, ticlopidine) are administered for at least 1 month. However, the effectiveness of this medication is proven only for secondary prevention of general cardiovascular events. Evidence for prevention of restenosis is only weak (15). Long-term data is not available.

Postinterventional Imaging and Examination

Usually, at the day after the intervention, a colour duplex ultrasound is performed to exclude complications at the puncture site (haematoma, arteriovenous fistula, false aneurysm) and assess the perfusion of the treated segment. The ankle-brachial index is measured and compared with the results before treatment.

Results and Discussion

With some experience, the technical success rate of recanalization of long iliac artery occlusions is > 90 % (5-9). Reported 1-, 3- and 5-year primary patency rates are 85-95%, 70-85%, and 55-75%, respectively (1,2,5-9). Secondary patency rates are roughly 10% higher. The rate of major complications ranges from 7% to 20% (1,2,5-9). Besides access site problems, such as haematomas, arteriovenous fistulas, and false aneurysms, other frequently reported complications are acute stent thrombosis (about 3% of cases) and ipsi- or contralateral distal embolization of thrombotic and/or plaque material (about 5%) of cases (5-9). The latter is treated by endovascular methods, such as aspiration thrombectomy and/or local thrombolysis, or surgery. The most serious complication is iliac rupture that occurred in 3/103 procedures in a recent study; however, this rate is rather high (9). A rare complication reported is infection (< 1%).

Some authors advocated lysis therapy in combination with mechanical recanalization (5); however, results do not appear to be better than with mechanical recanalization alone, at least in chronic occlusions (> 3 months).

In a recent retrospective comparative study of aortobifemoral bypass surgery versus endovascular therapy in iliac artery occlusions, primary patency after 72 months was significantly higher in patients treated surgically (91% vs 73%, $p = 0.01$); however, the secondary patency rate did not differ significantly (98% vs 85%; $p > 0.05$). The length of hospital stay was significantly shorter, and the perioperative mortality was lower in the endovascular group (9).

In summary, there is increasing evidence that even long iliac occlusions may successfully be treated by endovasclular techniques in the first line.

References

1. Gandini R, Fabiano S, Chiocchi M, Chiappa R, Simonetti G. Percutaneous treatment in iliac artery occlusion: long-term results. Cardiovasc Intervent Radiol 2008; 31: 1069-1076.
2. Ye W, Liu, CW, Ricco JB, Mani K, Zeng R, Jiang J. Early and late outcome of percutaneous treatment of TransAtlantic Inter-Society Consensus class C and D aorto-iliac lesions. J Vasc Surg 2011: 53(6): 1728-1737.
3. Norgren L, Hiatt WR, Dormandy JA et al. Inter-Society Consensus for the Management of Peripheral Arterial Disease (TASC II). J Vasc Surg 2007; 45 Suppl S:S5-67.
4. Rutherford RB, Baker JD, Ernst C, Johnston KW, Porter JM, Ahn S, et al. Recommended standards for reports dealing with lower extremity ischemia: revised version. J Vasc Surg 1997; 26: 517-538.
5. Blum U, Gabelmann A, Redecker M, Nöldge G, Dornberg W, Grosser G, Heiss W, Langer M. Percutaneous recanalization of iliac artery occlusions: results of a prospective study. Radiology. 1993; 189(2): 536-540.

6. Vorwerk D, Guenther RW, Schürmann K, Wendt G, Peter I. Primary stent placement for chronic iliac artery occlusions: follow-up results in 103 patients. Radiology 1995; 194: 745-749.
7. Ozkan U, Oguzkurt L, Tercan F. Technique, complication, and long-term outcome for endovascular treatment of iliac artery occlusion. Cardiovasc Intervent Radiol 2010; 33: 18-24.
8. Ko YG, Shin S, Kim KJ, Kim JS, Hong MK, Jang Y, Shim WH, Choi D. Efficacy of stent-supported subintimal angioplasty in the treatment of long iliac artery occlusions. J Vasc Surg 2011; 54(1): 116-122.
9. Sachwani GR, Hans SS, Khoury MD, King TF, Mitsuya M, Rizk YS, Zachwieja JA, Sayed L. Results of iliac stenting and aorto-femoral grafting for iliac artery occlusions. J Vasc Surg 2013; 57: 1030-1037.
10. Abisi S, Kapur R, Braithwaite B, Habib S. The feasibility of reentry device in recanalization of TASC C and D iliac occlusions. Vasc Endovascular Surg 2011; 45(4): 352-355.
11. Goode SD, Cleveland TJ, Gaines PA. Randomized clinical trial of stents versus angioplasty for the treatment of iliac artery occlusions (STAG trial). Br J Surg 2013; 100(9): 1149-1153.
12. Mwipatay BP, Wong TS,.Temple SE et al. A comparison of covered vs bare expandable stents for the treatment of aortoiliac occlusive disease. J Vasc Surg 2011; 54(6): 1561-1570.
13. Bekken JA, Vos JA, Aarts RA, de Vries JP, Fioole B. DISCOVER: Dutch Iliac Stent trial: COVERed balloon-expandable versus uncovered balloon-expandable stents in the common iliac artery: study protocol for a randomized controlled trial. Trials 2012; 13: 215.
14. Grimme FA, Goverde PA, Van Oostayen JA et al. Covered stents for aortoiliac reconstruction of chronic occlusive lesions. J Cardiovasc Surg (Torino) 2012; 53(3): 279-289.
15. Robertson L, Ghouri MA, Kovacs F. Antiplatelet and anticoagulant drugs for prevention of restenosis/reocclusion following peripheral endovascular treatment. Cochrane Database Syst Rev 2012; 8: CD002071.

2502.4

Treatment of iliac aneurysms

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Learning Objectives
1. To learn about the indications for iliac aneurysm treatment
2. To learn about which material to use and how
3. To learn about the outcomes of iliac aneurysm treatment

Iliac aneurysms represent approximately 2% of all arterial aneurysms. They are most common in males aged 70 years and above. Most present in combination with an abdominal aortic aneurysm (75-95%); isolated iliac aneurysms are uncommon to rare and most frequently occur in the common iliac and internal iliac arteries. It is not uncommon that common iliac artery aneurysms involve the origin of the internal iliac artery.

Generally, as the size of an aneurysm increases, the risk of rupture also increases. Many smaller aneurysms are at low risk of rupture and are generally stable and may be followed up with surveillance. Treatment of common iliac artery aneurysms associated with an abdominal aortic aneurysm includes surgical repair or endovascular stent-graft placement. Treatment of isolated iliac artery aneurysms includes stent-graft placement, iliac branch devices, or embolization.

Special Session
HCC in liver transplantation

2503.1

Patient selection and criteria for organ allocation

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Learning Objectives
1. To learn how to stage patients with HCC
2. To learn how to select patients for liver transplantation
3. To learn how to use the criteria for organ allocation

No abstract available.

2503.2

Imaging before transplantation

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Learning Objectives
1. To learn how to define the tumour burden in patients with HCC
2. To learn how to diagnose vascular invasion
3. To learn how to understand imaging findings that may be relevant for locoregional therapy before liver transplantation

Imaging prior to liver transplantation is crucial and has several goals. In patients with hepatocellular carcinoma (HCC), which represent a major group of patients, the role of imaging is first to perform intrahepatic staging of the disease, namely to assess the number, size and characteristics of the tumour. Liver transplantation is the best curative treatment when the tumour is confined to the liver and has limited extension. Indeed, best survival is observed in Milan In patients compared to Milan Out patients. Second, most patients with HCC awaiting liver transplantation are treated either with intra-arterial treatments (transarterial chemoembolization or radioembolization) or percutaneous tumour ablation. Imaging is needed to assess tumour response and is performed when complications are suspected.

In all patients planned for liver transplantation, pretransplant imaging is required and is mostly focused on liver vessels. Presence of extrahepatic portal vein obstruction might contraindicate liver transplantation or change the surgical procedure. Splenic artery aneurysms should be checked because they are at risk of bleeding in this clinical setting. Similarly, celiac artery stenosis can impair the postoperative course, and careful analysis of the celiac artery should be done prior to liver transplantation. The imaging workup mainly relies on CT and MRI.

Imaging plays also a very important role in living donors before donation.

2503.3

The role of bridging therapies

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Learning Objectives

1. To learn how to use the term bridging
2. To learn how to use bridging therapies in liver transplantation
3. To learn how to select the most appropriate bridging technique

Approximately 90% of hepatocellular carcinomas (HCCs) are associated with an underlying risk factor (1). Liver cirrhosis is an important risk factor and may be a result of chronic hepatic B or C infection, alcohol abuse, inherited metabolic disorders, or non-alcoholic steatosis hepatis. For patients with HCC and cirrhosis, liver transplantation is the treatment of choice with excellent oncological results and providing a cure for cirrhosis. Due to a shortage of liver donors, not all patients with HCC and cirrhosis are candidates for liver transplantation. In most transplant centers, the Milan criteria (single HCC ≤5cm or ≤3 tumor of ≤3cm each) are used to assess the eligibility for liver transplantation (2). After admission to the waiting list, patients with HCC are at risk of tumor growth beyond accepted transplant criteria. The probability of drop-out from the transplant list due to tumor progression has been reported to be 15-30% at 1 year (3,4). Many transplant centers have therefore adopted a strategy of using locoregional therapies as neoadjuvant treatment for patients on the transplant list. These therapies are referred to as 'bridging' procedures aimed at preventing tumor growth beyond transplant criteria. Bridging therapy differs from 'downstaging' which refers to treatment of patients initially outside of transplant criteria. After downstaging therapy, the tumor burden will be re-assessed and patients fulfilling transplant criteria for an adequate period of follow-up may be allowed to enter the transplant list.

Robust randomized trials evaluating the effectiveness of bridging therapies are lacking. Case series and cohort studies have suggested that locoregional therapies may reduce the drop-out rate of HCC patients on the waiting list to 0-25% (5,6). The impact of bridging procedures on survival is difficult to assess. Data from a large registration study showed a higher 3-year post-liver transplantation survival in HCC patients who received ablation prior to transplantation compared to those who did not (7). Other studies indicate similar survival rates after liver transplantation in patients with or without pre-transplantation locoregional therapy (8,9). The benefit of locoregional therapy is likely to be lower when waiting time for transplantation is relatively short. A cost-effectiveness analysis pointed to benefits of neo-adjuvant bridging therapies when waiting times exceed 6 months (10).

Radiofrequency ablation (RFA) and transarterial chemoembolization (TACE) are the most commonly used bridging therapies. RFA is accepted as a first-line therapy for HCC at early stages (BCLC 0-A), and TACE is the treatment of choice for intermediate stage HCC (BCLC B). RFA is recommended as the preferred bridging therapy as it achieves higher rates of complete necrosis compared with TACE (1). Local tumor progression rates after RFA are higher for tumors >3cm than for smaller lesions. Several studies indicate better results of combined RFA and TACE in HCCs >3cm, but combined RFA-TACE has not been shown to be superior as a bridging therapy to RFA or TACE alone (11). Other ablative techniques, such as microwave ablation (MWA), irreversible electroporation (IRE) and high-focused ultrasound (HIFU), or stereotactic radiation therapy (SRT), may be an alternative to RFA in individual cases. MWA may be chosen over RFA in cases with an increased risk of heat-sink. IRE is a non-thermal ablation technique and may be considered in cases where the tumor is abutting a central bile duct. HIFU and SRT are non-invasive techniques and may be a valuable alternative when percutaneous placement of a RFA probe into a tumor is impossible or difficult due to the location of the tumor. TACE is considered as an alternative to ablation and is best performed super-selectively in order to minimize ischemia of the non-tumorous liver parenchyma. Either lipiodol-based conventional TACE or drug-eluting bead TACE may be performed with the latter being associated with less systemic toxicity. Transarterial radioembolization (TARE) with Yttrium-90 microspheres has also been shown to be an effective treatment for HCC and can be safely performed in patients with portal vein thrombosis as the embolic effect of TARE is limited. Radioembolization in infrequently used as a bridging therapy, but may be of particular value in individual patients with non-tumorous portal vein occlusion. Surgical resection is a potentially curative treatment for early HCC stages, but may also be used as a bridging therapy. Local tumor progression rates are lower after resection compared to RFA in HCCs >2cm, but resection is associated with higher rates of morbidity and mortality. It is questionable whether the higher rate of complication of resection is acceptable when the aim of treatment is to offer tumor control while a patient awaits curative transplantation.

Whatever type of locoregional therapy is chosen as a bridge to transplant, treatment should be evaluated using modified Response Evaluation Criteria in Solid Tumors (mRECIST) (12). Although mRECIST has not been validated in assessing response after bridging therapy, it is generally regarded to be superior to RECIST in treatment evaluation after ablation or transarterial therapies. Reassessment of treatment response and transplant eligibility criteria at 3-montly intervals is recommended. The probability of dropout from the transplant list has been shown to be reduced in patients with a complete or partial response after locoregional therapy compared to patients with no response (13,14). Other factors associated with a higher dropout probability are more advanced tumor stage and poor liver function. In a retrospective study, patients with partial or no response to bridge therapy experienced a significantly higher recurrence-rate after liver transplantation compared to patients with complete response (14). It has been suggested that response to locoregional bridging therapies may be regarded as a predictor of biological tumor behavior that may be helpful in selecting and prioritizing liver transplant candidates (12).

In conclusion, locoregional bridging therapies have been adopted by most transplant centers to prevent tumor progression in patients on the waiting list. Bridging procedures are most beneficial when waiting times are longer and may reduce the dropout rate. Ablation is the bridging therapy of first choice and TACE may be used as an alternative.

References

1. EASL-EORTC Clinical Practice Guidelines: Management of hepatocellular carcinoma. Journal of Hepatology 2012;56;908–943.
2. Mazzaferro V, Chun YS, Poon TP, et al. Liver transplantation for hepatocellular carcinoma. Ann Surg Oncol 2008 Apr;15(4):1001–1007.
3. Yao FY, Ferrell L, Bass NM, et al. Liver transplantation for hepatocellular carcinoma: expansion of the tumour size limits does not adversely impact survival. Hepatology 2001;33:1394–1403.
4. Llovet JM, Fuster J, Bruix J. Intention-to-treat analysis of surgical treatment for early hepatocellular carcinoma: resection versus transplantation. Hepatology 1999;30:1434–1440.
5. Pomfret EA, Washburn K, Wald C, et al. Report of a national conference on liver allocation in patients with hepatocellular carcinoma in the United States. Liver Transpl 2010;16:262–278.
6. Mazzaferro V, Battiston C, Perrone S, et al. Radiofrequency ablation of small hepatocellular carcinoma in cirrhotic patients awaiting liver transplantation: a prospective study. Ann Surg 2004;240:900–909.
7. Freeman RB Jr, Steffick DE, Guidinger MK, et al. Liver and intestine transplantation in the United States, 1997-2006. Am J Transplant. 2008 Apr;8(4 Pt 2):958-76.
8. Decaens T, Roudot-Thoraval F, Bresson-Hadni S, et al. Impact of pretransplantation transarterial chemoembolization on survival and recurrence after liver transplantation for hepatocellular carcinoma. Liver Transpl 2005;11:767–775.

9. Porrett PM, Peterman H, Rosen M, et al. Lack of benefit of pre-transplant locoregional hepatic therapy forhepatocellular cancer in the current MELD era. Liver Transpl 2006;12: 665–673.
10. Llovet JM, Mas X, Aponte JJ, et al. Cost effectiveness of adjuvant therapy for hepatocellular carcinoma during the waiting list for liver transplantation. Gut 2002;50:123–128.
11. Lu Z, Wen F, Guo Q, et al. Radiofrequency ablation plus chemoembolization versus radiofrequency ablation alone for hepatocellular carcinoma: a meta-analysis of randomized-controlled trials. Eur J Gastroenterol Hepatol. 2013 Feb;25(2):187–194.
12. Cescon M, Cuchetti A, Ravaiolo M, et al. Hepatocellular carcinoma locoregional therapies for patients in the waiting list. Impact on transplantability and recurrence rate. J Hepatol 2013;58:609–618.
13. Vitale A, D'Amico F, Frigo AC, et al. Response to therapy as a criterion for awarding priority to patients with hepatocellular carcinoma awaiting liver transplantation. Ann Surg Oncol 2010;17:2290–2302.
14. Cuchetti A, Cescon M, Bigonzi E, et al. Priority of candidates with hepatocellular carcinoma awaiting liver transplantation can be reduced after successful bridge therapy. Liver Transpl 2011;17:1344–1354.

2503.4

Downstaging

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Learning Objectives
1. To learn how to use the term downstaging
2. To learn how to use downstaging therapies in liver transplantation
3. To learn how to select the most appropriate downstaging technique

This lecture will discuss the various ways in which percutaneous image-guided tumor ablation can be used to further liver transplantation as "definitive therapy" in the treatment of end-stage liver disease in the presence of hepatocellular carcinoma formation as well as to address specific issues regarding optimization of these important clinical tools. Two primary roles of interventional oncology (IO), namely the "downstaging" of overall tumor burden in order to enable a patient to meet accepted transplantation criteria and the methods of treatment to minimize malignancy progression during the window prior to transplantation (i.e., tumor ablation serving as a bridge to transplantation) will be highlighted. The benefits of various ablation strategies (embolic strategies and ablation devices) will be compared. Finally, recently characterized important systemic considerations, including experimental evidence, for potential accelerated tumorigenesis following IO therapies and potential methods to deal with this issue will be presented.

Special Session Quality in IR

2504.1

Influence of data on quality

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Learning Objectives
1. To learn about the use of registries in IR
2. To learn about quality improvement through IR registries
3. To learn how to start an IR registry

Why use a registry: is there a truth beyond randomized trials?

Evidence-based medicine strategies replace traditional, anecdotal, and theoretical reasoning by evidence from high-quality randomized controlled trials and observational studies in combination with clinical expertise and the needs and wishes of patients. Evidence-based medicine quickly became an energetic intellectual community committed to making clinical practice more scientific and empirically grounded, and thereby achieving safer, more consistent, and more cost-effective care. Wide variation in implementing evidence-based practice remains a problem. However, there are several problems involved with the attempt of collecting evidence-based data such as unmanageable volume of clinical guidelines, marginal statistically significant benefits in clinical practice, or poor mapping to complex multimorbidity (http://www.bmj.com/content/348/bmj.g3725; accessed on April 3, 2015).

We do not have prospective randomized-controlled trials (RCT) available for many or most of our clinical questions. Professional registries provide knowledge on a large scale. Tracking down the best available evidence is a key step in searching for evidence, which answer clinical or research questions (http://www.cebm.net/; accessed on April 3, 2015). Large-scale registries are not the average company-driven, single-device, post-marketing registries to promote the transition of a new device into the market. Such registries are scaled on a national level or by means of a professional society potentially collecting data of large cohorts.

Quality improvement through IR registries

IR may be more accepted if professional societies would stimulate, foster, or organize registries, with the potential advantage of faster enrolment. Clinical results of IR may be documented on a national or professional society level, providing a database for technical/clinical complications, success, or relevant results such as survival or quality of life. Such a database triggered and provided by a national or a professional society may also be used to monitor new devices drifting into the market on the basis of CE labelling in Europe without clinical trials being available. The registry of the German IR Society (DeGIR) organized within the National Society of Radiology (DRG) will be explained as a potential tool.

How to start an IR registry

Since 2005, the DeGIR launched a server-based central data management and online documentation. Software modifications and improvements are implemented during the year and released at the beginning of each year. Each participating institution may extract their own data compared with the pooled data of all other participating institutions. Specific data per case are required for documenting a patient completely such as patient selection criteria, procedural details, outcome, i.e., technical success, medical success, complications, or radiation exposure, and involved interventionalists. The name of the involved interventionalist is also forwarded for quality programs. The number of participating institutions is steadily increasing, and these receive an annual certificate, which may be used for strategic purposes within or outside the hospital. The pool of data is a valuable source for systematic reviews of the DeGIR,

proving the broad coverage of interventions across the spectrum of vascular and non-vascular interventions such as quality reports. The number of documented cases has increased to >100,000 in 2012.
The most recent development targets the issue of new devices with CE marks. Sometimes, they lack clinical data compared with those needed for drug approval. On the other hand, the rapid development of interventional radiology in the last decade would not have been possible without the rapid technical progress made in the field of medical devices; no major complications have occurred so far. Nonetheless, new devices shall be separately monitored with more care to ensure patient safety and even further technical and clinical success. In summary, a registry such as the DeGIR QM-software may be used as a tool for quality assessment and quality assurance in interventional radiology. It is adaptive to modifications of interventional procedures and to the introduction of new techniques and devices. Furthermore, it is the basis of documented expertise in the certification of qualified departments and radiologists (http://www.degir.de/site/qualitaetssicherung?PHPSESSID=v8oe7d7164cmlqchjgmt0io37me3shuq; accessed on April 4, 2015).

2504.2

Influence of checklist use on patient safety

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Learning Objectives
1. To learn about the use of checklists in medicine
2. To learn about the use of checklists in IR
3. To learn how checklists improve patient safety in IR

No abstract available.

2504.3

Influence of standardisation on outcome (CIRSE guidelines)

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Learning Objectives
1. To learn about the process of establishing guidelines in IR
2. To learn about implementation of guidelines in IR
3. To learn how guidelines can improve patient outcomes in IR

No abstract available.

2504.4

Factors influencing patient satisfaction

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Learning Objectives
1. To learn about factors influencing patient satisfaction in IR
2. To learn about ways to measure patient satisfaction in IR
3. To learn about ways of improving patient satisfaction in your IR practice

Patient satisfaction is often individually based, and at times is difficult to achieve and quantify. What is considered either satisfactory or indeed exemplary by one may be considered to have little importance by another. It is also true that something that is unnoticed by one person is unacceptable to others.
In addition, satisfaction comes at a number of levels. Most doctors and Allied Healthcare Professionals would consider the most important issue to be the success and outcomes of an intervention. Whilst it is clear that a patient will want the best outcomes possible, they will balance this against other factors. For example, when the Sheffield Vascular Institute was being established, a patient questionnaire clearly identified that patients from a surrounding city would accept a 2.5% increase in mortality for aneurysm repair, if it meant that they did not need to travel outside the city for that improved outcome.
Thus, what healthcare deliverers may consider to be paramount (and the previous presentations in this symposium will have addressed), patients may be prepared to compromise on, so long as other factors are addressed.
Thus we have to consider, whilst accepting that we will not be able to please all the people all of the time:
- The factors influencing satisfaction in interventional radiology
- Ways to measure satisfaction in interventional radiology
- Ways to improve satisfaction in interventional radiology

The patient journey may be a long one, or it may be short in the case of emergency care. Interventional radiology is directly involved in both extremes. Thus, we need to consider the entire process potentially including the following:
- Waiting lists or planned admissions
  - o Choice
  - o Waiting to be admitted
  - o Transition between services
- The hospital/ward
  - o Waiting to get to the ward
  - o Single sex accommodation
  - o Noise at night
  - o Cleanliness
  - o Security
  - o Food
- Doctors and nurses
  - o Communication
  - o Confidence and trust
  - o Staff availability
- Care and treatment
  - o Involvement in decisions
  - o Privacy
  - o Pain management
  - o Operations and procedures
  - o Before the procedure
  - o After the procedure
- Leaving hospital
  - o Preparing to leave
  - o Delays to discharge
  - o Medication
  - o Information provision
  - o Transition from hospital

Some (or many) of the stages above may seem to be at some distance for interventional radiologists. However, if a patient has (either as a day case or an in-patient) one of our procedures performed, this will be seen as the over-riding factor. Thus, if a patient is happy, they will describe their procedure (EVAR, biliary drainage, ureteric stent) as being satisfactory, they will not say "my angioplasty was great", they will say "the ward toilet was dirty". Thus, it is important to the perception of interventional radiology procedures that interventional radiologists take an active, and leading role in as many of these areas as possible.
As far as the procedure itself is concerned, it is vital that the expectation of that procedure is managed and set at appropriate levels. How often have many of us been in Multiple Disciplinary Meetings, where it has been said, "Mr X is not fit/suitable for an open procedure, therefore we must try an endovascular approach"? This may be the only active treatment option for Mr X, but unless he understands the potential risks, limitations and alternatives, should the risky procedure fail, he will be disappointed. On the other hand, if there is a realistic understanding that there is little alternative, then a good outcome will be met with joy, a failure with an understanding and

appreciation that an effort was made. Interventional radiology outpatient clinics provide an excellent route to ensure this properly approached, as well as being a vehicle to a good consent process (Consent: patients and doctors making decisions together[1]).

So, how can we approach measuring the degree of satisfaction (or otherwise) felt by our patients?

The modern patient is much more aware of the importance of their opinions and input into the process. Web-based forums (such as the Patient Experience Network – www.institute.nhs.uk) provide easy access for patients to express their views and document their experiences. However, it is still true to say that a significant proportion of our patients are not regular Internet users, and more personal traditional approaches to measurements remain prevalent.

The most commonly researched approaches include surveys, interviews and patient stories. There is little comparative information about the relative merits of each, but it should be remembered that there is also much to be learned from complaints as well as compliments. The Health Foundation performed an evidence scan, measuring patient experience[2] and concluded that it was not possible to suggest a certain approach or a particular tool as the most effective, but their evidence base suggested 10 things to consider when planning how to measure changes in patient and carer experience over time:

- How experience is to be defined, to inform what needs to be measured.
- Consider why the experience is being measured and how the information will be used.
- Assess if it would be useful to combine approaches to include both qualitative and quantitative material.
- Consider whether to ask everyone using the service or only a sample.
- Think about whether the best time to collect feedback is immediately after using the service, when experiences are fresh in people's minds.
- Allocate enough time at the outset to plan and test measurement methods.
- Think about how the end-result needs to be presented for various audiences as this may shape how the data are collected.
- Make sure there is appropriate infra structure at an organizational level to analyse and use the data.
- Make sure that patients, carers, managers and health professionals are comfortable with why the feedback is being collected and how it will be used.
- Ensure that patient experience measures are seen as one component of a broader framework of measurement and that all of the approaches work well together, without excessive burden for staff or patients.

So how do we set about improving satisfaction?

Clearly, the first step in improving anything is to take note of the information available. This can be at a national or more local level. Taking the UK as an example, the 2008 report "high quality care for all"[3] highlighted the importance of the entire patient experience within the NHS, ensuring that people are treated with compassion, dignity and respect in a clean, safe and well-managed environment. Leading on from this the NHS Constitution (2013) describes the purpose, principles and values of the NHS and illustrates what both patients and staff can expect from the service. Leading on from this are national initiatives aimed at improving patients experience of healthcare, which include NHS Choices which provides patients and carers with information and choice about their care. Patient advice and liaison services (PALS) are also available in most NHS hospitals. Despite these initiatives in the UK, there remains further work to deliver the best possible experience for users. In 2012, NICE published quality standard 15, Quality Standard for Patient Experience in Adult NHS Services[4] . This describes markers of "high-quality, cost-effective care that, when delivered collectively, should contribute to improving the effectiveness, safety and experience of care for patients using adult NHS services".

Clearly, there are organizational as well as individual motivations to improve patient experience. In addition to these professional and altruistic motivations, healthcare systems may include a financial "carrot" such as the CQUIN payment framework that allows purchasers to reward excellence, by linking a proportion of the providers' income to the achievement of local quality improvement goals.

It is worth remembering that we do not just experience healthcare as patients, we are tax payers, we have friends and family who use it and we read about it. Its political, cultural and social importance is reflected in the fact that it is the second most important issue to us when we are deciding how to vote in national elections (Nuffield Trust).

Interventional radiology and interventional radiologists undertake procedures that, in general, provide significant benefits to patients, as judged by clinical assessment of outcomes. However, ultimately, they will be judged by our patients in the environment of how and where these are delivered. It is simply not sufficient to deliver a technically sound and ingenious minimally invasive treatment; it is essential that we do this in a pathway that delivers a high-quality patient experience. We ignore that fact, and avoid involvement of achieving it at the peril of the perception of the procedures.

References

1. http://www.gmc-uk.org/static/documents/content/Consent_-_English_0911.pdf.
2. Measuring Patient Experience. The Health Foundation- Inspiring Improvement. Debra de Silva 2013.
3. https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/228836/7432.pdf.
4. guidance.nice.org.uk/qs15.

Fundamental Course
Women's health – basic principles of UAE for symptomatic fibroids

2601.1

Indication for treatment – patient triage

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Learning Objectives

1. To learn how an IR should assess patient suitability for UAE
2. To learn which patients are unsuitable
3. To learn how to manage patients under your care

Most patients with symptomatic fibroids are suitable candidates for embolization. There are both patient factors and anatomical considerations that might guide the gynecologist in advising patients concerning their options.

The important patient factors are age, prior fibroid and surgical history, interest in future fertility, interest in uterine preservation, and preferences in terms of recovery and tolerance of fibroid recurrence. While women of any reproductive age may be good candidates for embolization, UFE is most common in women in their 40s. Younger women are candidates, but the decision is more complex as there must be consideration of the patient's interest in future child bearing. Based on current evidence, those with a strong interest in having a child in the future are likely better served by myomectomy. Women can become pregnant after UFE, but the pregnancy and delivery rates appear to be lower than with myomectomy. However, in those with fibroids too extensive for myomectomy, those who have had a prior myomectomy, and those who are poor surgical candidates, UFE may be the best alternative to surgery. The question of UFE and future fertility is discussed in greater detail in a later section. Another important consideration is whether the patient wishes to

retain her uterus. Despite having completed child bearing, many women do not want to lose their uterus. In this case, uterine embolization and myomectomy are both considerations with similar outcomes, although embolization allows a much easier and faster recovery. Any of the uterine-sparing therapies has the potential to allow growth of new fibroids until the patient reaches menopause. Recurrence rates for both myomectomy and embolization are 20–25% by 5 years after treatment. Hysterectomy is the only definitive therapy for uterine fibroids. For those who do not wish to have the potential of recurrence and who do not mind losing their uterus, hysterectomy may be the best choice. For those who wish to retain their uterus and avoid surgery, UFE is often the most effective choice. There are some anatomical factors to consider with any fibroid therapy. The uterine size, number of fibroids, size of the largest fibroids, and the location of key fibroids are all important to consider when recommending therapies. For small intracavitary fibroids, hysteroscopic resection is preferred, provided they are resectable. For very large pedunculated serosal fibroids, particularly if they are attached by a narrow base, surgical resection may be preferred.

2601.2

Pre-procedural imaging, patient preparation and medication

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Learning Objectives

1. To learn what imaging information is essential before UAE
2. To learn how to prepare a patient for UAE
3. To learn about the medication required before and during UAE

The aim of the presentation is to delineate a suitable patient care process before UFE.

Before planning pre-therapeutic consultation, imaging should be performed. MRI is the preferred pre-therapeutic imaging technique. The first goal of MRI is to verify that there is no morphological contraindication to perform embolisation, especially by ruling out pedunculated subserosal fibroma. Secondly, MRI serves as baseline and post-UFE imaging data (evaluation of the volume of the uterus and volume, location and enhancement of fibroids). MRI also checks for associated diseases such as adenomyosis and endometriosis and helps to identify the risk of major and minor complications regarding fibroid location. Due to the fact that UFE is a procedure with moderate risk of bleeding (category 2), biological tests should include serum blood urea nitrogen, serum creatinine INR and APTTs as well as menorrhagia hematocrit and platelet count for this population. Complete clinical history should be provided.

During consultation, the interventional radiologist should confer information to the patient regarding risks and benefits. The procedure should be scheduled after menses and before ovulation during complete hospitalisation. The procedural technique of UAE and ancillary care is described as follows: placement of a Foley catheter, injection of antibiotics given as prophylaxis and set-up of a conscious sedation. Post-embolisation pain management can involve an anaesthesiologist and should be planned. Patients are informed of the following complications that can arise: uterine necrosis, expulsion of fibroid tissue, infection or sepsis, post-embolisation syndrome, chronic vaginal discharge, amenorrhea and UAE failure. Some specific situations are discussed as follows: UFE and contraception, UFE and intrauterine devices, UFE and specific patient care such as allergy to contrast agent and pre-menopausal evaluation. The post-embolisation process including counseling for rest, drug against pain and information concerning symptoms requiring readmission (infection, pain and fibroid sloughing) is given. Clinical and imaging follow-up is planned.

2601.3

Tips and tricks for difficult UAE procedures

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Learning Objectives

1. To recognise an alternative arterial supply of fibroids
2. To learn how to avoid technical failure
3. To learn how to manage procedural complications

In the past, cases were considered too difficult/dangerous for uterine artery embolization (UAE), with contraindications based more on theory and not on fact. Today, fibroid size is no longer a contraindication for uterine fibroid embolization (UFE), and the so-called "rapid growing fibroids" and pedunculated fibroids can be treated successfully [1,2,3]. The difficulty in treating submucous/intracavitary, pedunculated fibroids is caused by the possibility of fibroid expulsion resulting in pain, vaginal discharge, and endometritis. Studies have reported good clinical outcome without complications after UFE of pedunculated subserosal fibroids. Women with fibroids and adenomyosis, immunocompromised/HIV+ patients, and intrauterine device (IUD) in place can be treated successfully [4]. Do not exclude cervical fibroid cases automatically. Super-selective UFE with microwires (MWs), curved microcatheters (MCs) of 45°-90°-180°, and microspheres may provide good results.

Proximal/complete UAE is not necessary. Embolization should be continued until the occlusion of uterine artery branches to the fibroid. It is useful to wait for a few minutes at the apparent conclusion of the procedure to ensure a stable endpoint. Besides the right unilateral femoral access, the bilateral femoral access allows parallel UAE, and the left brachial access is more comfortable for the patient. When catheterization becomes difficult, consider second femoral access, oblique projections, special catheters, and MCs/MWs. MWs/MCs are used to pass spastic/dissected/perforated arteries to regain arterial free flow.

Special attention is necessary when offering UFE to women with symptomatic fibroids who wish to conceive. Consider bilateral femoral access with parallel instead of sequential embolization to decrease procedure time and radiation exposure. Measures to decrease radiation are optimization of source-object-image distance, pulsed fluoroscopy, collimation, road mapping, avoidance of magnification/oblique projections, last-image-hold, and no surveys. A standard UAE procedure has a target DAP below 50,000 mGy·cm^2 [5].

Uterine-ovarian shunts increase the risk of ovarian ischemia/infarction. Under such circumstances, place the catheter tip more distally in the uterine artery beyond the shunt and consider placing the coil in the shunt or upsizing the embolic to protect the ovary.

In case of recurrent symptoms due to insufficient fibroid infarction, a second embolization procedure should be considered; repeat UAE and/or ovarian artery embolization (OAE). When performing OAE, choose a coaxial approach and advance the MC tip at 1/3 of the distance from the origin to the level of the ovary [6]. When there is no uterine/ovarian supply, look for a round ligament or for the inferior mesenteric artery. Knowledge and improvement of catheterization/embolization techniques have contributed to a wider applicability of UAE for fibroids [7,8,9,10].

References

1. Parker WH, Fu YS, Berek JS. Uterine sarcoma in patients operated on for presumed leiomyoma and rapidly growing leiomyoma. Obstet Gynecol. 1994 Mar;83(3):414-8.
2. Smeets AJ, Nijenhuis RJ, Boekkooi PF et al. Safety and effectiveness of UAE in patients with pedunculated fibroids. J Vasc Interv Radiol. 2009 Sep;20(9):1172-5.
3. Katsumori T, Akazawa K, Mihara T. Uterine artery embolisation for pedunculated subserosal fibroids. AJR Am J Roentgenol. 2005 Feb;184(2):399-402.

4. Lohle PN, De Vries J, Klazen CA et al. Uterine artery embolisation for symptomatic adenomyosis with or without leiomyomas with the use of calibrated tris-acryl gelatin micropsheres: midterm clinical and MR imaging follow up. J Vasc Interv Radiol. 2007 Jul;18(7):835-41.
5. Scheurig-Muenkler C, Powerski MJ, Muellet JC et al. Radiation exposure during uterine artery embolisation: effective measures to minimize dose to the patient. Cardiovasc Intervent Radiol Aug 23 [Epub ahead of print] PMID:25148920.
6. Kroencke T, Scheurig-Muenkler C. Safety and efficacy of ovarian artery embolisation for symptomatic uterine leiomyomata. Presented at: CVIR Society of Europe Annual Scientific Meeting: Oct 6, 2010; Valencia, Spain.
7. Spies JB, Patel AA, Epstein NB et al. Recent advances in uterine fibroid embolisation. Curr Opin Obstet Gynecol. 2005 Dec;17(6):562-7.
8. Goodwin SC, Spies JB. Uterine fibroid embolisation. N Engl J Med. 2009 Aug;361(7):690-7.
9. Bulman JC, Ascher SM, Spies JB. Current concepts in uterine fibroid embolisation. Radiographics. 2012 Oct;32(6):1735-50.
10. Chrisman HB, Minocha J, Ryu RK et al. Uterine artery embolisation: a treatment option for symptomatic fibroids in postmenopausal women. J Vasc Interv Radiol. 2007 Mar;18(3):451-4.

2601.4

Procedural complications and pain management

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Learning Objectives
1. To learn which complications can occur after UAE
2. To learn how to manage these complications
3. To learn how to manage pain following UAE

No abstract available.

Special Session
Evidence Forum: Drug-eluting devices

2602.1

Drug-eluting devices in supra-aortic lesions

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Learning Objectives
1. To learn about the indications for use
2. To learn what evidence supports their use
3. To learn whether there is evidence for cost effectiveness

Endovascular treatment of stenotic lesions of supra-aortic vessels is a widely accepted treatment both for anterior and posterior circulation.
With regard to carotid arteries, CAS has been demonstrated to be a valid alternative to carotid endoarterectomy.
Unfortunately, in-stent restenosis (ISR) still represents a potential complication occurring in self-expandable stents, ranging from 4% for atherosclerotic lesions to 14% post-TEA stenting.
To manage this problem, many approaches have been considered: medical treatment, restenting, and repeating balloon angioplasty (often with cutting balloon).
Unfortunately, none have proven to be resolutive because they did not inhibit the neointimal hyperplasia related with the stress generated by PTA and stent.
In the last decade, on the basis of positive results in terms of clinical outcomes in coronary and peripheral artery lesions using DCBs, several authors have proposed this treatment in an attempt to verify its efficacy on carotid arteries.
In 2009, Montorsi *et al.* and Liistro *et al.* evaluated the efficacy of DCBs in de novo carotid ISR in seven and three patients, respectively, who were previously treated with CAS using an over-the-wire, 6x120-mm paclitaxel-eluting balloon (Amphirion In.Pact).
Differently, for the very first time in 2007, our group used the only monorail DCB in the market (DIOR) produced for treating coronary artery lesions in a selected group of nine patients with recurrent refractory carotid ISR and multiple endovascular treatments (interventions, 3.4±0.9). Despite the limited maximum diameter of 4.2 mm and restricted indications for the procedure to maintain a 1:1 DEB size to vessel diameter ratio (ICA diameter of <4 mm and type II ISR), this balloon was effective in preventing ISR recurrence in six patients and in postponing retreatment for the remaining ones from 4 to 18, 25, and 32 months.
At that time, there were no self-expandable DES specifically designed for carotid arteries; as described by Chakhtoura *et al.*, the first and second generation of DES were related to compression, bending, torsion, and fracture. Furthermore, the risk of restenosis was also increased by the deployment of a second stent because of the narrow carotid lumen. For all these reasons, this approach should be discouraged.
With regard to the posterior circulation, the panorama is still uncertain due to lesser attention, but PTA and stenting of the vertebral artery represent a valid alternative to surgery, with less periprocedural neurologic adverse events and mortality.
Moreover, Langwieser *et al.* in a recent meta-analysis have documented that the use of DES for extracranial vertebral artery stenting compared with bare metal stents significantly reduced the overall rate of restenosis from 23.7% to 8.2% and the recurrence of symptoms from 11.6% to 4.7%.
Thus, results of clinical trials with drug-eluting devices are changing the state of the art.
In conclusion, for carotid arteries, DEBs are showing promising results despite the necessity for larger randomized studies, whereas on the vertebrobasilar trunk, the use of balloon-expandable DES is recommended.

References

1. Gandini R, Del Giudice C, Da Ros V, et al. Long-term results of drug-eluting balloon angioplasty for treatment of refractory recurrent carotid in-stent restenosis. J Endovasc Ther. 2014;21:671–677.
2. Montorsi P, Galli S, Ravagnani PM, et al. Drug-eluting balloon for treatment of in-stent restenosis after carotid artery stenting: preliminary report. J Endovasc Ther. 2012;19:734–742.
3. Liistro F, Porto I, Grotti S, et al. Drug-eluting balloon angioplasty for carotid in-stent restenosis. J Endovasc Ther. 2012;19:729–733.
4. Chakhtoura EY, Hobson RW, Goldstein J, et al. In-stent restenosis after carotid angioplasty stenting: incidence and management. J Vasc Surg. 2001;33:220–226.
5. Antoniou GA, Murray D, Georgiadis GS, et al. Percutaneous transluminal angioplasty and stenting in patients with proximal vertebral artery stenosis. J Vasc Surg. 2012;55:1167–1177.
6. Langwieser N, Buyer D, Schuster T, Haller B, Laugwitz KL, Ibrahim T. Bare metal vs. drug-eluting stents for extracranial vertebral artery disease: a meta-analysis of nonrandomized comparative studies. J Endovasc Ther. 2014;21:683–692.
7. Del Giudice C, Pellerin O, Gandini R, Sapoval M. Commentary: drug-coated balloon angioplasty to improve carotid stenting outcomes after postendarterectomy restenosis: fad or an answer to the problem of recurrent restenosis? J Endovasc Ther. 2015;22:217–219.

2602.2

Drug-eluting devices in haemodialysis access

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Learning Objectives

1. To learn about the indications for use
2. To learn what evidence supports their use
3. To learn whether there is evidence for cost effectiveness

Percutaneous transluminal balloon angioplasty (PTA) is the preferred treatment modality for hemodialysis access stenoses. However, after initial PTA, the 6-month cumulative patency rate of dialysis fistulas and grafts tends to be as low as 23% to 38% (1,2). The implantation of bare-metal stents represents a valuable bail-outs strategy for vascular recoil after primary balloon angioplasty of central venous stenoses. With respect to restenosis, however, bare-metal stents did not exhibit any advantages in dialysis access vessels. In this context, the drug-eluting technology could offer a valuable alternative.

Balloon angioplasty induces excessive mechanical stress with consecutive disruption of the vessel intima and media as well as tension of the adventitia. This triggers the migration and proliferation of fibroblasts, myofibroblasts, smooth muscle cells, and consecutive neointimal hyperplasia (3). These biological reactions to angioplasty are regarded to be equally present in arteriosclerotic arteries and shunt veins, respectively. However, in hemodialysis fistulas and grafts, the non-physiological direct conduction of high pressure fluid into a low-pressure system triggers certain hemodynamic changes. The abrupt geometric change of the vessels at their anastomoses leads to flow turbulence with consecutive spatial and temporal gradients in tangential wall stress and shear stress (4,5,6). As a consequence, neointimal formation is permanently stimulated (7). Compliance mismatch between an artery and a vein or, even more pronounced, between a polytetrafluoroethylene (PTFE) graft and a vein may stimulate neointimal growth as well (8). Periodical needle punctures are another reason of traumatic intimal formation in dialysis access vessels (9). In PTFE grafts, foreign body reaction contributes to intimal growth. Finally, patients with chronic renal failure exhibit an inflammatory condition with oxidative stress that causes endothelial dysfunction, a serious promoter of intimal hyperplasia (10, 11).

Drug-eluting balloons (DEBs) are usually coated with paclitaxel, an antineoplastic substance which deranges cell replication by stabilizing polymerized microtubules and enhancing microtubule assembly. In vitro, paclitaxel has been shown to inhibit smooth muscle cell proliferation and migration, and, thus, has the potential to prevent neointimal hyperplasia.

To date, several clinical studies on the use of DEBs in hemodialysis access vessels have been published. Two of these report consecutive results of a prospective randomized trial in 40 patients with arteriovenous fistulas (AVFs) or PTFE-grafts. Venous outflow lesions were assigned to either paclitaxel-coated or standard balloon PTA. Treatment success was significantly higher after drug-eluting balloon angioplasty than after standard balloon angioplasty with primary target lesion patency of 70% versus 25% at six months ($p<0.001$) and 35% versus 5% at one year follow-up, respectively ($p<0.001$) (12,13). The authors also judged the use of DEB to be cost-effective. In another randomized trial on ten patients with juxta-anastomotic tandem stenoses of radiocephalic arteriovenous fistulas, each of two lesions per patient was randomized to either DEB or plain balloon dilatation. At six months, DEB-PTA and plain balloon PTA revealed lesion patencies of 70% and 0%, respectively ($p< .01$). At one year, patency rates were 20% and 0%, which, however, was not significantly different ($p>0.05$) (14). A pilot study focused on the long-term results of juxta-anastomotic radiocephalic shunt stenoses of 26 consecutive patients who had been treated by DEB-PTA. Target lesion primary patency rates were rather high with 96.1%, 90.9%, and 57.8% at 6, 12, and 24 months, respectively (15). However, a randomized trial on 30 patients that was presented at the SIR 2013 annual scientific meeting reported no significant advantage of DEB-PTA over plain balloon PTA with primary target lesion patencies of 50% and 68% at 6 months, respectively ($p=0.153$) (16).

With regard to neointimal hyperplasia, drug-eluting stents (DES) might, theoretically, be superior to bare metal stents for stenoses with elastic recoil in dialysis access vessels. In a porcine model, artificially created ePTFE AV grafts were investigated for their reaction after implantation of sirolimus-eluting nitinol stents as well as uncoated nitinol stents at the graft/ vein anastomosis and in the venous outflow tract. At the sections with the sirolimus-eluting stents, intimal hyperplasia was 77% less compared to the unstented control sections ($p=0.01$), whereas intimal hyperplasia increased markedly at the uncoated stent sections ($p=0.05$) (17). However, no clinical study on the efficacy of DES in hemodialysis access vessel stenoses has been published yet.

Even though most of the clinical studies showed superiority of DEB-PTA over plain balloon PTA, one has to take into account that all trials comprised only limited numbers of patients. Hence, no general recommendation on the use of DEB-PTA in hemodialysis access vessels can be seriously stated unless prospective randomized trials with large study populations have been published (18). The performance of DES in dialysis vessel stenoses is still to be evaluated by clinical studies.

References

1. Aruny JE, Lewis AL, Caedella JF et al. Quality improvement for percutaneous management of the thrombosed or dysfunctional dialysis access. J Vasc Interv Radiol 2003; 14: S247-S253.
2. Haskal ZJ, Trerotola S, Dolmatch B et al. Stent graft versus balloon angioplasty for failing dialysis-access grafts. NEJM 2010; 262: 494-503.
3. Scott-Burden T, Vanhoutte PM. The endothelium as a regulator of vascular smooth muscle proliferation. Circulation 1993; 87(Suppl 5): 51-55.
4. Hiraguchi H, Teraoka S. Intimal hyperplasia and hemodynamic factors in arterial bypass and arteriovenous grafts: a review. J Artif Organs 2003; 6: 227-235.
5. Ojha M. Spatial and temporal variations of wall shear stress within an end-to-side arterial anastomosis model. J Biomech 1993; 26: 1377-1388.
6. Manos TA, Sokolis DP, Giagini AT, et al. Local hemodynamics and intimal hyperplasia at the venous side of a porcine arteriovenous shunt. IEEE 2010; 14: 681-690.
7. Zwolak RM, Kirkman TR, Clowes AW. Atherosclerosis in rabbit vein grafts. Arteriosclerosis 1989; 9: 374-379.
8. Abbott WM, Megerman J, Hasson JE, L'Italien G, Warnock DF. Effect of compliance mismatch on vascular graft patency. J Vasc Surg 1987; 5: 376-382.
9. Smith GE, Gohill R, Chetter IC. Factors affecting the patency of arteriovenous fistulas for dialysis access. J Vasc Surg 2012; 55: 849-855.
10. Bolton CH, Downs LG, Victory JGG et al. Endothelial dysfunction in chronic renal failure: roles of lipoprotein oxidation and pro-inflammatory cytokines. Neohrol Dial Transplant 2001; 16: 1189-1197.
11. Liu BC, Li L, Gao M, Wang YL, Yu JR. Microinflammation is involved in the dysfunction of arteriovenous fistula in patients with maintenance hemodialysis. Chin Med J 2008; 121: 2157-2161.
12. Katsanos K, Karnabatidis D, Kitrou P et al. Paclitaxel-coated balloon angioplasty vs. plain balloon dilation for the treatment of failing dialysis access: 6-months interim results from a prospective randomized controlled trial. J Endovasc Ther 2012; 19: 263-272.

13. Kitrou PM, Katsanos K, Spiliopoulos S et al. 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 (NCT01174472). Eur J Radiol 2015; 84: 418-423.
14. Lai CC, Fang HC, Tseng CJ et al. Percutaneous angioplasty using a paclitaxel-coated balloon improves target lesion restenosis on inflow lesions of autogenous radiocephalic fistulas: A pilot study. J Vasc Interv Radiol 2014; 25: 535-541.
15. Patanè D, Giuffrida S, Morale W et al. Drug-eluting balloon for the treatment of failing hemodialytic radiocephalic arteriovenous fistulas: our experience in the treatment of juxta-anastomotic stenoses. J Vasc Access 2014; 15: 338-343.
16. Teo T, Tan BS, Yin W et al. Prospective randomized trial comparing drug-eluting balloon versus conventional transluminal angioplasty (DEBAPTA) for the treatment of hemodialysis arteriovenous fistula or arteriovenous graft stenoses – interim report of first 30 patients. J Vasc Interv Radiol 2013 (supplement); 24: S40.
17. Rotmans JI, Pattynama PM, Verhagen HJ, et al. Sirolimus-eluting stents to abolish intimal hyperplasia and improve flow in porcine arteriovenous grafts: a 4-week follow-up study. Circulation 2005; 111: 1537-1542.
18. Portugaller RH, Kalmar P, Deutschmann HA. The eternal tale of dialysis access vessels and restenosis: Are drug-eluting balloons the solution? J Vasc Access 2014; 15: 439-447.

2602.3

Drug-eluting devices in SFA lesions

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Learning Objectives
1. To learn about the indications for use
2. To learn what evidence supports their use
3. To learn whether there is evidence for cost effectiveness

Femoropopliteal segment is the most commonly involved compartment in peripheral arterial disease. Until the advent of drug-eluting devices, endovascular interventions of SFA disease had a high target vessel revascularization and target lesion revascularization, ranging from 30% to 60%. Restenosis is predominantly the result of neointimal hyperplasia, intimal dissection, and elastic recoil of the arterial wall. Metallic stents were able to overcome the pitfall of elastic recoil, but bare metal stents continue to have increased restenosis, with primary patency rates ranging from 50% to 65%.

After learning from the above pitfalls, it became evident to design an endovascular intervention that would overcome factors, leading to restenosis. Thus came the drug-eluting stents (DES) for SFA. Zilver PTX is a nitinol stent, which is coated with paclitaxel. The stent platform would prevent the recoil of the arterial wall, and the drug would inhibit neointimal hyperplasia. The two key studies to be discussed, regarding the Zilver PTX stent are the randomized and single-arm studies. The randomized study compared the Zilver PTX stent with standard balloon angioplasty (bare metal stenting for suboptimal PTA). The 5-year follow-up continued to show that the Zilver PTX stent had superior patency than that of the PTA arm. The single-arm study was a prospectively defined protocol with broader inclusion criteria, including complex lesions (longer and restenotic lesions). This single-arm study demonstrated similar encouraging results to those of the randomized study. This led to the approval of Zilver PTX stenting in SFA lesions. However, the Zilver PTX study was criticized for including short lesions, thereby not representing the real-world pathology. No doubt the stent platform overcomes the arterial wall recoil; however, it becomes an Achilles heel by being the source for physical, chemical, and immunological irritation. The common femoral and popliteal arteries are considered as no-stent zones as they are prone to fractures. Finally, stenting precludes surgical bypass sites.

In view of the above drawbacks with stenting, the concept of drug-eluting balloons was very enticing. Drug-coated balloons (DCBs) are an attractive alternative to DES because they can deliver the antiproliferative agent during the critical phase of neointimal hyperplasia without leaving a permanent implant (stent) behind. There have been multiple trials over the last few years studying the efficacy and safety of DCBs in SFA lesions. The THUNDER, FemPac, LEVANT-I, and PACIFIER trials showed improved TLR and TVR rates with fewer adverse events. Some recent trials, In.Pact I and II, showed better primary patency, better clinically driven TLR and TVR rates, and fewer adverse events when compared with standard balloon angioplasty. This led to the FDA approval of DCB use in femoropopliteal lesions in October 2014. However, DCBs fail to overcome the elastic recoil of the arterial wall, and they are unable to prevent negative remodeling in heavily calcified lesions. Calcified lesions preclude the homogeneous delivery of the antiproliferative drug. Finally, there remains the concern for drug loss, which raises the plausibility of local and systemic toxic effects of the antiproliferative drug.

Biodegradable stents have the unique feature of achieving the best of DES and DCBs. It provides a temporary stent platform to overcome the elastic arterial wall recoil seen during the acute phase of angioplasty, and it also has the capability of eluting the antiproliferative agent during the critical phase of neointimal hyperplasia. Thus, the idea of biodegradable stents appears to be very enticing and promising. The REMEDY trial involving biodegradable stents has shown encouraging results.

Thus, drug-eluting technologies initiate a new promising era in the endovascular interventions of SFA lesions. It would be interesting to see if this technology stands the test of time.

2602.4

Drug-eluting devices in BTK lesions

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Learning Objectives
1. To learn about the indications for use
2. To learn what evidence supports their use
3. To learn whether there is evidence for cost effectiveness

The purpose of drug-eluting devices is to slow the rate of restenosis or neo-intimal hyperplasia. There are, therefore, four essential questions to address:
- Is there evidence for improved patency?
- Is there evidence of improved clinical outcomes?
- Is there evidence of risk associated with the drug-eluting technology?
- Are drug-eluting devices cost-effective?

The questions of efficacy need to be addressed through randomized controlled trials. Here we will review the trials that have compared drug-eluting balloons (DEBs) with plain balloons, and then those comparing drug-eluting stents (DESs) with bare metal stents (BMS).

Drug-eluting balloons versus plain balloons

Although there is a consistent body of evidence regarding the efficacy of DEBs in the femoro-popliteal segment, there is a relative paucity of data concerning the infra-popliteal arteries.

In the DEBATE-BTK Trial, the Medtronic paclitaxel-coated balloon was compared with the standard equivalent in a single-centre open-label trial (Liistro); 132 patients were enrolled. Binary restenosis was observed on angiogram at 1 year in 27% of the DEB cohort versus 74% of the standard balloon cohort ($P<0.001$). There were significantly fewer clinically driven re-interventions in the DEB cohort. Complete ulcer healing was achieved in significantly more patients in the DEB cohort. There was only a single amputation (in the standard balloon cohort).

However, the evidence of superior patency associated with DEB has not been consistently demonstrated, and the possibility that there may be additional risk associated with DEBs has recently come to light as a result of data from the In.PACT DEEP trial.

The In.PACT DEEP trial, also using the Medtronic paclitaxel-coated balloon, showed no advantage in the DEB arm in a multi-centre trial (Zeller). In the trial, 358 patients were randomized. There was no difference in late lumen loss, but there was a trend towards a higher amputation rate in the DEB arm. Amputation-free survival at 12 months was 81.1% in the DEB cohort versus 89.2% in the standard PTA arm. More major amputations within 12 months were observed in the DEB arm versus the PTA arm (8.8% versus 3.6%; p = 0.080). This was unexpected and may be related to chance difference in disease severity between the cohorts.

Drug-eluting stents versus bare metal stents

The randomized comparisons of DES versus BMS in BTK arteries have shown consistent results in favour of the drug-eluting device. The first of these (Falkowski) was a small trial of 25 patients in each arm. It showed a massive treatment effect with 6-month restenosis rates of 16% versus 76% and TLR rates of 12% and 56% in the DES and BMS groups, respectively.

Subsequently, two larger trials have also shown results in favour of DES. The DESTINY Trial (Bosiers) involved 140 patients and showed 12-month restenosis rates of 15% and 46% and TLR rates of 9% and 34% in the DES and BMS groups, respectively. However, this did not translate into improved symptom scores or reduced amputation rate.

The long-term results of the YUKON Trial have recently been published (Rastan). This was a randomized double-blind trial involving 161 patients followed up for a mean of about 1000 days. This has demonstrated a significantly reduction in amputation rate of 2.6% versus 12.2% (p=0.03) in favour of DES. This is a very important outcome, possibly unique to date in endovascular research. There was also a significantly improved symptom score in the DES cohort, and a trend towards reduced TVR. If these outcomes are confirmed in future studies, then DESs represent a major advance in clinical practice.

The DES trials in the below-knee arteries have used balloon-expandable stents designed for use in the coronary arteries. These short stents are clearly not ideal for the long segments of stenosis and occlusion that are frequently found in below-knee vessels, particularly in patients with diabetes mellitus and chronic renal failure. The practical value of these trials is therefore limited because they exclude patients with long segments of disease. They all involve lesions of less than 5cm in length. The apparent clinical benefit of DES technology in this vascular bed should stimulate the development and evaluation of technologies more suited to this area.

Conclusions

The demonstration of increased risk of amputation in the DEB arm of the In.Pact deep trial is clearly of concern. It may be a chance finding, but it should not be dismissed. Until there is further evidence to confirm effectiveness, and, more importantly, safety of below-knee DEBs, their use outside of the research context cannot be advocated. The evidence in favour of DES is consistent, in terms of reduced restenosis, and there is now evidence of improved clinical outcomes. The question of cost-effectiveness remains to be answered. Given the healthcare and societal costs associated with amputation, it seems probable that a reduction in amputation rate of the magnitude demonstrated in the YUKON Trial, if this is borne out by further experience, would translate into cost-effectiveness.

References

1. Drug-eluting balloon in peripheral intervention for below the knee angioplasty evaluation (DEBATE-BTK): a randomized trial in diabetic patients with critical limb ischemia. Liistro F1, Porto I, Angioli P, Grotti S, Ricci L, Ducci K, Falsini G, Ventoruzzo G, Turini F, Bellandi G, Bolognese L. Circulation. 2013 Aug;128(6):615-21.
2. IN.PACT DEEP Trial Investigators. Drug-eluting balloon versus standard balloon angioplasty for infrapopliteal arterial revascularization in critical limb ischemia: 12-month results from the IN.PACT DEEP randomized trial. Zeller T, Baumgartner I, Scheinert D, Brodmann M, Bosiers M, Micari A, Peeters P, Vermassen F, Landini M, Snead DB, Kent KC, Rocha-Singh KJ;J Am Coll Cardiol. 2014 Oct;64(15):1568-76.
3. The evaluation of primary stenting of sirolimus-eluting versus bare-metal stents in the treatment of atherosclerotic lesions of crural arteries. Falkowski A, Poncyljusz W, Wilk G, Szczerbo-Trojanowska M. Eur Radiol. 2009 Apr;19(4):966-74.
4. Randomized comparison of everolimus-eluting versus bare-metal stents in patients with critical limb ischemia and infrapopliteal arterial occlusive disease. Bosiers M, Scheinert D, Peeters P, Torsello G, Zeller T, Deloose K, Schmidt A, Tessarek J, Vinck E, Schwartz LB. J Vasc Surg. 2012 Feb;55(2):390-9.
5. Sirolimus-eluting stents for treatment of infrapopliteal arteries reduce clinical event rate compared to bare-metal stents: long-term results from a randomized trial. Rastan A, Brechtel K, Krankenberg H, Zahorsky R, Tepe G, Noory E, Schwarzwälder U, Macharzina R, Schwarz T, Bürgelin K, Sixt S, Tübler T, Neumann FJ, Zeller T. J Am Coll Cardiol. 2012 Aug;60(7):587-91.

Special Session
Trials and current evidence in interventional oncology

2603.1

TACE

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Learning Objectives

1. To learn about the evidence for the clinical application of TACE
2. To review the outcomes of TACE trials
3. To learn about the practical impact of evidence studies and trials on daily clinical practice

Drug-loaded carriers (beads or microspheres) have been tested over the last 10 years to deliver drugs in a precise, controlled and sustained manner in order to achieve high intra-tumor drug concentration for a sufficient period, without damaging the surrounding hepatic parenchyma. Clinical studies have shown encouraging results on local response, and level 1 evidence of decreased toxicity compared to conventional chemoembolization has been obtained (1). The local action is achieved in a two-fold manner: the beads or microspheres prevent washout of the drug from the site of tumor, and they induce ischemic necrosis. These mechanisms achieve vessel blockade and delivery of the chemotherapeutic locally (in a precise and predictable manner) for several days after embolization while at the same time the leak of the chemotherapeutic in the systemic circulation is low (2-5). In contrast to the conventional Lipiodol-based chemoembolization the drug-eluting bead chemoembolization is standardized, predictable and reproducible. Today, there are three platforms of drug-eluting beads including DC Bead™ (Biocompatibles UK Ltd, a BTG group company), Hepasphere/ Quadrasphere (Biosphere, Merit Medical Inc.) and Tandem (Celonova Biosciences Inc.). Drug eluting beads or microspheres can be loaded with a single chemotherapeutic agent, such as anthracycline derivatives or irinotecan, and infused intraarterially for selective tumor targeting (6).

Microsphere bead description: The DC Bead microspheres consist of polyvinyl alcohol–hydrogel modified by sulfonate groups (2-3). The beads are biocompatible and are capable of being loaded with

anthracycline derivatives such as doxorubicin diluted in water for injection, by an ion-exchange mechanism (2,3,6). DC Bead is available in different categories of spherical maximal diameter, ranging in size from 70 to 900 µm. The reconstituted beads after loading do not change their diameter significantly. HepaSphere/QuadraSphere are non biodegradable, superabsorbent polymer and loadable microspheres that are available at several diameters that measure 86-269 µm (30-60 µm dry), 277-478 µm (50-100 µm dry) and 400-600 µm (10-150 µm dry) (they absorb fluid and expand after loading with saline solutions of doxorubicin or epirubicin or idarubicin or irinotecan by a maximum factor of 4x). They differ from other drug loadable carriers in that they are softer and deformable and conform to the lumen of the embolized vessels. Tandem is available in smaller diameters that are tightly calibrated at 40 µm, 75 µm, and 100µm. They do not expand significantly after loading, slow good loading and release of doxorubicin and irinotecan.

Pharmakokinetics: Studies performed in animals with DC Bead or HepaSphere/ QuadraSphere, have shown drug elution at a radius of at least 1.2 mm around the embolized vessel. The tissue concentration of drug ranges from 5 µM at 8 h to 0.65 µM at 1 month (7) while the serum concentration of the chemotherapeutic is negligible and significantly lower than that of conventional chemoembolization (6,7). D'inca et al, studying pharmacokinetics in pigs with HepaSphere, showed that after embolization the concentration of doxorubicin in tissue was high while plasma levels were very low (8). The high tissue levels of the chemotherapeutic last for at least a month post embolization. Clinical studies have shown proof of favorable kinetics; Varela et al found that doxorubicin Cmax and AUC were significantly lower in DC Bead chemoembolization patients compared to conventional chemoembolization (4). A phase II study from China also showed a low peak plasma doxorubicin concentration and no systemic toxicity after DC Bead chemoembolization with doxorubicin (5). In a recent study with HepaSphere 30-60 µm showed serum peak doxorubicin concentration (Cmax) in plasma at 5 minutes after completion of the injection that was significantly lower compared to the measurements of patients treated with conventional chemoembolization using the same total amount of doxorubicin (9). Objective response rates by imaging (EASL criteria: European Association for the Study of the Liver; based on lack of contrast enhancement) range from 60 to 90% (1,19), with some patients showing complete response by necrosis criteria. The Barcelona Center for Liver Cancer (BCLC) reported midterm results of 27 Child-Pugh A cirrhotics treated with chemoembolization with doxorubicin-loaded DC Bead at doses adjusted for bilirubin and body surface with response rate 75% (4). Poon et al found that with loaded DC Bead 63.3% of patients had a partial response and 6.7% had a complete response (5). Geschwind et al reported overall tumor response of 100% (25% partial response and 75% stable disease) (19). Malagari et al at 9 months post embolization with loaded DC Bead report a complete response in 12.2%, objective response in 80.7%, progressive disease in 6.8%, and 12.2% showed stable disease (20). Kettembach et al achieved complete response in 27%, partial response in 13%, stable disease in 3%, and progressive disease in 40%, respectively (21). In a study with Hepasphere 30-60µm the objective response was 68.9% (9).

Mid term survival results document the efficacy of drug-eluting chemoembolization;Varela et al report 1- and 2-year survival of 92.5 and 88.9%, respectively (4). Kettembach et al (21) report an overall survival rate at 6 months of 93%. Up to 2013 two studies report on long term survival; Malagari et al (17) embolizing HCC of a mean diameter of 7.6±2.1cm, with a number of scheduled chemoembolizations every 6-8 weeks and then on demand found an overall survival of 93.6%, 83.8%, 62.0%, 41.0%, and 22.5 % at 1, 2, 3, 4, and 5 years respectively. Mean overall survival was 43.8 months (range 1.2–64.8). Similar 5-year survival rates have been reported by Burrel *et al.* (22) in a single-arm clinical series. However any impact on patient survival relative to conventional Lipiodol chemoembolization awaits definitive clinical trials.

The PRECISION V study is the largest prospective blinded randomized trial comparing DC Bead chemoembolization with conventional TACE (1).The primary endpoint was tumor response (EASL) at 6 months with independent blinded MRI evaluation. The drug-eluting bead group showed higher rates of complete response, objective response, and disease control compared with the conventional chemoembolization group (27% vs. 22%, 52% vs. 44%, and 63% vs. 52%, respectively). However, the difference was not statistically significant. Subgroup analysis though showed statistical significance favouring DC Bead in patients with more advanced disease (Child-Pugh B, ECOG 1, bilobar involvement, and recurrent disease). Dhanasekaran et al in their comparison study of DC Bead chemoembolization vs conventional chemoembolization showed a clear advantage of the former (23). Song et al comparing DC Bead with conventional chemoembolization found longer time to progression for the DC Bead group compared to conventional chemoembolization (11.7 and 7.6 months, respectively, p=0.018)(24). Sacco et al randomly assigning HCC patients did not find statistically significant differences between DC Bead and conventional chemoembolization by means of time to recurrence and local recurrence, radiologic progression, and survival (25). The estimated 24-month cumulative survival rates were 83.6% and 86.8% after conventional chemoembolization and drug-eluting chemoembolization, respectively.

Only a few clinical studies comparing drug-eluting chemoembolization with bland embolization are available until 2013; Nicolini et al (26) compared the two techniques in explanted livers after transplantation for HCC with favorable results with DC Bead over bland embolization with regard to histologic necrosis. In a prospective randomized trial comparing bland embolization with chemoembolization with DC Bead it was found that at 6 months local response was superior with DC Bead compared to bland embolization of similar diameters (27). Recurrences at 9 and 12 months were higher for bland embolization (78.3% vs. 45.7%) at 12 months while Time to progression (TTP) was longer for the DC Bead chemoembolization group at a statistically significant level. However, this study had only one year follow up and survival benefit cannot be assessed. Today that smaller drug eluting beads are available additional studies are required for microsphere calibers below 100 µm.

References

1. Lammer J, Malagari K, Vogl T, et al (2010) 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; 33:41-52.
2. 2.Lewis AL, Taylor RR, Hall B *et al*.: Pharmacokinetic and safety study of doxorubicin-eluting beads in a porcine model of hepatic arterial embolization. J Vasc Interv Radiol. 200617,1335-1343.
3. Biondi M, Fusco S, Lewis AL *et al*.: New Insights into the Mechanisms of the Interactions Between Doxorubicin and the Ion-Exchange Hydrogel DC Bead™ for Use in Transarterial Chemoembolization (TACE).J Biomater Sci Polym Ed. 201223,333-54.
4. Varela M, Real MI, Burrel M *et al*.: Chemoembolization of hepatocellular carcinoma with drug eluting beads: efficacy and doxorubicin pharmacokinetics. J Hepatol 2007; 46,474-481.
5. Poon RN, Tso WK, Pang RWC, *et al*.: A Phase I/II Trial of Chemoembolization for Hepatocellular Carcinoma Using a Novel Intra-Arterial Drug-Eluting Bead. Clinical Gastroenterology and Hepatology 2007,1100-1108.
6. Lewis AL, Gonzalez MV, Lloyd AW, et al. DC Bead: In Vitro Characterization of a Drug-delivery Device for Transarterial Chemoembolization. J Vasc Interv Radiol 2006;:335-342.
7. Namur J, Citron SJ, Sellers MT *et al*.: Embolization of hepatocellular carcinoma with drug-eluting beads: doxorubicin tissue concentration and distribution in patient liver explants. J Hepatol. 2011; 55,1332-1338.

8. D'inca H, Pelage JP, Baylatry MT, et al. Why do small size doxorubicin-eluting microspheres induce more tissue necrosis than larger ones? A comparative study in healthy pig liver (oral communication 2206-2). CIRSE 2012, Annual meeting, Lisbon Portugal.
9. K. Malagari, M. Pomoni, H. Moschouris, et al. Chemoembolization of hepatocellular carcinoma with HepaSphere 30-60µm. Phase I,II trial results. Cardiovasc Intervent Radiol 2013 in press.
10. Lencioni R, de Baere T, Burrel M *et al.*: Transcatheter treatmentof hepatocellular carcinoma with Doxorubicin-loaded DC Bead (DEBDOX): technical recommendations. Cardiovasc Intervent Radiol. 2012;980-985.
11. Hecq JD, Lewis AL, Vanbeckbergen D *et al.*: Doxorubicin-loaded drug-eluting beads (DC Bead®) for use in transarterial chemoembolization: a stability assessment. J Oncol Pharm Pract. 2013; 19,65-74.
12. Padia SA, Shivaram G, Bastawrous S *et al.*: Safety and efficacy of drug-eluting bead chemoembolization for hepatocellular carcinoma: comparison of small-versus medium-size particles. J Vasc Interv Radiol 2013;243:1-6.
13. Loffroy R, Lin M, Yenokyan G *et al.*: Intraprocedural C-arm dual-phase cone-beam CT: can it be used to predict short-term response to TACE with drug-eluting beads in patients with hepatocellular carcinoma? Radiology2013;266,636-648.
14. Moschouris H, Malagari K, Kalokairinou M *et al.*:Contrast-enhanced ultrasonography with intraarterial administration of SonoVue for guidance of transarterial chemoembolization: an initial experience. MedUltrason. 2011;13:296-301.
15. Georgiades C, Geschwind JF, Harrison N *et al.*: Lack of response after initial chemoembolization forhepatocellular carcinoma: does it predict failure of subsequent treatment? Radiology. 2012; 265:115-123.
16. Syha R, Ketelsen D, Heller S,: Hepatocellular carcinoma: initial tumour response after short-term and long-interval chemoembolization with drug-eluting beads using modified RECIST. Eur J Gastroenterol Hepatol. 2012; 24:1325-1332.
17. Malagari K, Pomoni M, Moschouris H *et al.*: Chemoembolization with doxorubicin-eluting beads for unresectable hepatocellular carcinoma: five-year survival analysis. Cardiovasc Intervent Radiol2012; 35:1119-1128.
18. Lencioni R, Crocetti L, Petruzzi P *et al.*: Doxorubicin-eluting bead-enhanced radiofrequency ablation of hepatocellular carcinoma: a pilot clinical study. J Hepatol. 2008; 49: 217-22.
19. Geschwind JF, Khwaja A, Hong K: New intraarterial drug delivery system: pharmacokinetics and tumor response in an animal model of liver cancer. ASCO Annual Meeting, 2005. Orlando, Florida, (2005).
20. Malagari K, Chatzimichael K, Alexopoulou E *et al.*: Transarterial chemoembolization of unresectable hepatocellular carcinoma (HCC) with drug eluting beads (DEB); Results of an open label study of 62 patients. Cardiovasc Intervent Radiol 2008; 31:269-280.
21. Kettenbach J, Stadler A, Katzler I *et al.*: Drug-Loaded Microspheres for the Treatment of Liver Cancer:Review of Current Results Cardiovasc Intervent Radiol 2008; 31:468-476.
22. Burrel M, Reig M, Forner A *et al.*: Survival of patients with hepatocellular carcinomatreated by transarterial chemoembolization (TACE) using Drug Eluting Beads.Implications for clinical practice and trial design. J Hepatol. 2012; 56: 1330-1335
23. Dhanasekaran R, Kooby DA, Staley CA *et al.*: Comparison of conventional transarterial chemoembolization (TACE) and chemoembolization with doxorubicin drug eluting beads (DEB) for unresectable hepatocelluar carcinoma (HCC). J Surg Oncol. 2010; 101:476-480.
24. Song MJ, Chun HJ, Song do S *et al.*: Comparative study between doxorubicin-eluting beads and conventional transarterial chemoembolization for treatment of hepatocellular carcinoma. J Hepatol. 2012; 57:1244-1250.
25. Sacco R, Bargellini I, Bertini M, *et al.*: Conventional versus doxorubicin-eluting bead transarterial chemoembolization for hepatocellular carcinoma. J Vasc Interv Radiol. 2011; 22:1545-1552.
26. Nicolini A, Martinetti L, Crespi S *et al.*: Transarterial chemoembolization with epirubicin-eluting beads versus transarterial embolization before liver transplantation for hepatocellular carcinoma. J Vasc Interv Radiol. 2010; 21:327-332.
27. Malagari K, Pomoni M, Kelekis A et al.: Prospective randomized comparison of chemoembolization with doxorubicin-eluting beads and bland embolization with BeadBlock for hepatocellular carcinoma. Cardiovasc Intervent Radiol 2010; 33:541-551.
28. Malagari K, Pomoni M, Spyridopoulos TN *et al.*: Safety Profile of Sequential Transcatheter Chemoembolization with DC Bead(™): Results of 237 Hepatocellular Carcinoma (HCC) Patients. Cardiovasc Intervent Radiol 2011; 34:774-785.
29. Ritter CO, Wartenberg M, Mottok A *et al.*: Spontaneous liver rupture after treatment with drug-eluting beads. Cardiovasc Intervent Radiol. 2012;35:198-202.
30. Recchia F, Passalacqua G, Filauri P *et al.*: Chemoembolization of unresectable hepatocellular carcinoma: Decreased toxicity with slow-release doxorubicineluting beads compared with lipiodol. Oncol Rep. 2012; 27:1377-1383.
31. 31.Guiu B, Deschamps F, Aho S, et al. Liver/Biliary Injuries following chemoembolisation of endocrine tumours and hepatocellular carcinoma: lipiodol Versus drug-eluting beads. *J Hepatology* Epub 2011.

2603.2

Radioembolisation

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Learning Objectives

1. To learn about the evidence for the clinical application of TARE
2. To review the outcomes of TARE trials
3. To learn about the practical impact of evidence studies and trials on daily clinical practice

No abstract available.

2603.3

Microwave and cryoablation

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Learning Objectives

1. To learn about the evidence for the clinical application of microwave ablation and cryoablation
2. To review the outcomes of trials on microwave ablation and cryoablation
3. To learn about the practical impact of evidence studies and trials on daily clinical practice

No abstract available.

2603.4

HIFU and IRE

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Learning Objectives

1. To learn about the evidence for the clinical application of HIFU and IRE
2. To review the outcomes of trials on HIFU and IRE
3. To learn about the practical impact of evidence studies and trials on daily clinical practice

No abstract available.

Special Session
State-of-the-art spinal tumour interventions

2604.1

Procedural approach and bone biopsy

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Learning Objectives

1. To learn how to evaluate pre-procedural imaging for spinal tumours
2. To learn how to choose the appropriate image guidance
3. To learn about performing bone biopsy and what to expect from it

Robertson and Ball performed the first attempts of percutaneous biopsy of the spine in the mid-1930s using a postero-lateral approach. Fluoroscopy-guided spinal biopsy has been extensively used since 1949, while CT-guided spinal biopsy has become popular since 1981. Nowadays, these techniques have been refined as imaging guidance has evolved and biopsy systems have become more sophisticated. As a result, the percutaneous biopsy of the spine at present is widely performed for the sampling of vertebrae, intervertebral discs, and paraspinal soft tissues.

Indications for biopsy in the spine include sampling of a neoplasm for characterization and spondylodiscitis for diagnosis and culture as well as metabolic bone disease or connective tissue diseases. In addition, biopsy in the spine can be used for staging patients with known or suspected malignancy with a suspicion of local spread or distant metastasis. Contraindications include coagulation disorders that cannot be corrected adequately, patient's inability to cooperate, patient's refusal for providing informed consent, lack of safe trajectory to the lesion of interest, and hemodynamic instability. There is a theoretical risk of causing or aggravating myelopathy when performing biopsy at the level of significant spinal cord compromise. This is especially associated with the biopsy of epidural tumor in the canal; sampling may result in swelling or bleeding, which might further compromise the cord. Complications of percutaneous biopsy in the spine include infection, hemorrhage, nerve root damage, and pneumothorax. In general, complications are more frequent in the thoracic and cervical spine than in the lumbar spine. In practice, complication rate is less than 1%, while mortality rate is extremely low (<0.05%).

In order to avoid an unnecessary biopsy of a lesion easily diagnosed with imaging studies (e.g., osteoid osteoma or Schmorl's node), careful review of imaging and clinical correlation is critical. Fine needle aspiration can be performed in the same session with core tissue biopsy, and it is usually performed first.

Percutaneous biopsy in the spine under imaging guidance is governed by an overall accuracy ranging from 80% to 95%. Higher accuracy rates are associated with osteolytic lesions, while spondylodiscitis and sclerotic lesions are associated with lower accuracy rates. In general, malignant lesions with soft tissue component have higher diagnostic yield than sclerotic lesions. Approaches in the lumbar spine include transpedicular or posterolateral extrapedicular trajectories. In the thoracic spine, approaches include transpedicular or posterolateral extrapedicular trajectories through the costotransverse joint or costovertebral groove or through the intercostals approach. In the cervical spine, anterolateral approach is preferred in mid- and lower cervical levels, while transoral approach is usually preferred for C1 and C2 levels. Occasionally, posterolateral approaches are performed in the cervical spine as well.

Paraspinal soft tissue masses can be biopsied with 16–18-G soft tissue biopsy needle. Vertebral lesions are biopsied with 11–15-G bone biopsy systems (most preferably coaxial). The volume of tissue required for an accurate pathologic diagnosis is an important factor, governing the choice of an appropriate biopsy system. Multiple samples (up to 3) and large diameter biopsy systems increase diagnostic accuracy.

Percutaneous biopsy is a safe and effective technique for the diagnosis of lesions in the spine. Proper selection of imaging guidance is a key factor for safe and accurate biopsy in the spine. It is also important to maximize the diagnostic yield of the technique by using large diameter biopsy system and performing multiple sampling. In case of sampling a suspected neoplasm, the spine surgeon should be advised for needle trajectory in order to exclude a potential future surgical removal.

References

1. Robertson RC, Ball RP. Destructive spinal lesions: diagnosis by needle biopsy. J Bone Joint Surg Am 1935; 37: 443-464.
2. Craig F. Vertebral bone biopsy. J Bone Joint Surg Am 1956; 38: 93-102.
3. Adapon BD, Legada BD Jr, Lim EV, Silao JV Jr, Dalmacio-Cruz A. CT-guided closed biopsy of the spine. J Comput Assist Tomogr 1981; 5: 73-78.
4. Valls J, Ottolerighi C, Shajovicz F. Aspiration biopsy in diagnosis of lesion of vertebral bodies. JAMA 1968; 136: 376-382.
5. Murphy WA, Destouet LM, Gilula LA. Percutaneous skeletal biopsy 1981: a procedure for radiologists- results, review and recommendations. Radiology 1981; 139: 545-549.
6. Bernardi L, Castellan L. Percutaneous vertebral biopsy. Assessment of results. Radiol Med (Torino) 1995; 89: 831-834.
7. Kelekis AD, Somon T, Yilmaz H, Bize P, Brountzos EN, Lovblad K, Ruefenacht D, Martin JB. Interventional spine procedures. Eur J Radiol 2005; 55: 362-383.
8. Santiago FR, Kelekis A, Alvarez LG, Filippiadis DK. Interventional procedures of the spine. Semin Musculoskelet Radiol. 2014; 18: 309-317.
9. Czervionke LF, Fenton DS. Percutaneous spine biopsy. In: Image-guided spine intervention. Eds Fenton DS, Czervionke LF. Saunders 2003. 141-186.

2604.2

Percutaneous treatment of benign tumours

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Learning Objectives

1. To learn how to treat benign spinal tumours
2. To learn how to categorise spinal haemangiomas
3. To learn how to manage benign spinal lesions

A wide variety of benign neoplasms can involve the spine, including osteoid osteoma, osteoblastoma, aneurysmal bone cyst, giant cell tumour, aggressive vertebra haemangioma (AVH) and osteochondroma.

Spinal osteoid osteomas account for 7-20% of all osteoid osteomas. Osteoblastoma (a tumour very similar to osteoid osteoma, with a larger diameter) has a greater propensity for the spine and a more aggressive biologic behaviour. Ten to thirty percent of aneurysmal bone cysts occur in the spine, with a predilection for the lumbar level and the posterior elements.

Despite their benign characteristics, the above tumours can cause significant pain and pressure on adjacent structures and impair patients' everyday activities. Pain can be due either to the biologic behaviour of the tumour or to radicular/spinal cord compression. Radiculopathy (direct nerve root compression or due to the presence of local inflammation), gait disturbances and scoliosis may also be present. Scoliosis in cases of spinal osteoid osteoma and osteoblastoma is attributed to muscle flexion contractures.

The management of patients with benign bone tumours has changed dramatically in the last decades. Image-guided techniques, as alternative to surgery, are minimally invasive therapies with excellent treatment outcome, especially for difficult cases near vital structures, where surgery may not be an option due to the associated morbidity.

A variety of percutaneous image-guided treatments can be proposed in patients with symptomatic benign spinal tumours. The therapeutic intent and the nature, size and location of the tumour should be defined before treatment planning. When the objective is to consolidate bone (i.e. AVH with no extra-osseous extension), a simple cement injection can suffice. On the other hand, when the objective is to decompress the healthy surrounding soft tissue or to destroy the painful tumour (i.e. osteoid osteoma nidus), thermal ablation techniques should be preferred. Cryoablation, radiofrequency, laser and microwave can all be used, depending on tumour-specific characteristics (nature, location, size), operator's experience and available modalities.

More specifically, the small-sized osteoid osteomas can be treated with laser photocoagulation or radiofrequency ablation (non-perfused electrodes, manual, temperature-controlled mode). Both laser and radiofrequency ablation have a similar efficacy and safety profile. We have treated 58 patients with spinal osteoid osteoma. Primary clinical success at 1 month was 98.2% and the total recurrence rate was 5.3%. All recurrences were addressed percutaneously and secondary success rate was 100%. The above results are similar to the percutaneous treatment of osteoid osteoma in extra-spinal location. No major complications were noted.

When larger-sized lesions are treated, radiofrequency, microwave, or cryo-ablation should be preferred over laser photocoagulation. Cryoablation has the advantage of visualization of the ablation zone (ice ball) with CT or MR imaging, thus ensuring complete coverage of the lesion and permitting safe ablation of lesions in proximity to nerves. All the thermal ablation techniques should be accompanied by cement injection, whenever the risk of secondary vertebral compression fracture is high.

The treatment algorithm for AVH depends on the presence of symptoms, the vascularity of the tumour and the presence or absence of an extra-vertebral mass. Symptomatic haemangiomas limited to the vertebral body should be treated with a simple vertebroplasty. Should there be an extra-osseous extension of the AVH (paravertebral or epidural), a sclerosing agent should be used to regress the extra-osseous mass and diminish the peri-operative haemorrhage. Sclerotherapy can be combined with decompression surgery whenever necessary. Anterior consolidation with cement injection can be further performed, usually with a 2-week interval.

The complex anatomy of the spine and the proximity of neural structures should be strictly taken into account when performing percutaneous thermal ablation procedures. Both the nerve roots and the spinal cord are prone to thermal damage when exposed to extreme temperatures. Thermal injury depends not only on temperature change but also on total exposure time. Temperature near the neural structures should be strictly kept between 44°C and 10°C. The presence of thick cortical bone and CSF pulsation can help warm or cool the neural structures, but should not be taken as a guarantee. Thus, whenever the distance of the closest to the ablation zone neural structure is less than 1.5 cm, the following thermal insulation, temperature and functional monitoring techniques should be applied:

Epidural CO_2 dissection for displacement and passive insulation of the thecal sac.

Active cooling/warming of a nerve root or thecal sac with continuous slow manual instillation of N/S 0.9% or dextrose (in cases of radiofrequency ablation).

Continuous temperature monitoring with thermocouples. The thermocouples are positioned in contact with the neural structures at danger, at the exact point of potential axonal damage. Multiple thermocouples can be used simultaneously.

Electrostimulation of peripheral motor nerves with the placement of electrodes in contact with the threatened nerve (proximal to the level of potential axonal damage). Electrostimulation serves as a complementary, functional technique for early detection of an impending neurologic injury.

To conclude, interventional radiology has a major role in the treatment of benign bone lesions in the spine. Thermal protection of the neural structures is mandatory in most cases of thermal ablation in the spine. Combined CT and fluoroscopic guidance is needed for precise electrode positioning. AVH with epidural extension often necessitates combined treatments and a multidisciplinary approach. Thorough consideration of the indications, profound knowledge of the complex spinal anatomy and performace of meticulous technique can help minimize complications.

References

1. 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 Roentegenol. 2011;197:510-515.
2. 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.
3. Tsoumakidou G, Garnon J, Ramamurthy N, Buy X, Gangi A. Interest of electrostimulation of peripheral motor nerves during percutaneous thermal ablation. Cardivasc Intervent Radiol. 2013;36:1624-1628.
4. Gangi A, Dietemann JL, Gasser B, et al. Percutaneous laser photocoagulation of osteoid osteomas. Semin Musculoskelet Rdiol. 1997;1(2):273-80.
5. Rosenthal DI, Alexander A, Rosenberg AE, Springfield D. Ablation of osteoid osteomas with a percutaneously placed electrode: a new procedure. Radiology. 1992;183:29-33.
6. Goldberg S, Grassi CJ, Cardella J, et al. Image-guided tumor ablation: Standardization of terminology and reporting criteria. Radiology. 2005;235:728-39.

7. Hoffman RT, Jacobs TF, Kubisch CH, Trumm CG, Weber C, Duerr HR, et al. Radiofrequency ablation in the treatment of osteoid osteoma-5 year experience. Eur J Radiol. 2010;73(2):374-9.
8. Konno S, Olmarker K, Byröd G, Nordborg C, Strömqvist B, Rydevik B. The European Spine Society AcroMed Prize 1994. Acute thermal nerve root injury. Eur Spine J. 1994;3(6):299-302.
9. Gaudino S, et al. A systemic approach to vertebral hemangioma. Skeletal Radiol. 2015;44(1):25-36.
10. Liu XW, Jin P, Wang LJ, Li M, Sun G. Vertebroplasty in the treatment of symptomatic vertebral hemangiomas without neurologic deficit. Eur Radiol. 2013; 23(9):2575-81.
11. Kelekis A, Filippiadis DK, Martin JB, Kelekis NL. Aggressive vertebral hemangioma treated with combination of vertebroplasty and sclerotherapy through transpedicular and direct approach. CVIR. 2014;37(6):1638-42.

2604.3

Percutaneous treatment of malignancies

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Learning Objectives
1. To learn how to treat malignant spinal tumours
2. To learn how to use ablation and stabilisation for malignant spinal tumours
3. To learn how to manage malignant spinal lesions

No abstract available.

2604.4

Embolisation

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Learning Objectives
1. To learn about the best indications for embolisation
2. To learn when to combine embolisation and ablation
3. To learn tips and tricks to increase success and limit complications

Introduction

Spinal tumors can result in instability, neurologic compromise and intractable pain. In the metastatic setting, corpectomy and instrumental stabilisation are the treatments of choice to restore stability and relieve or prevent neural compression. Without pre-operative embolisation, it is occasionally necessary to abandon operative resection of hypervascular tumors due to uncontrolled haemorrhage[1-2].

First described by Benati in 1974[3], embolisation of arteries feeding spinal tumours is indicated to limit the potential massive blood loss[4-16], ensuring optimal visualization facilitating an adequate resection[4] and reducing operative duration and consequently, mortality. Additional resultant benefits include a reduced recurrence rate and a potentially prolonged survival (the latter documented in Hepatocellular carcinoma[5]).

Embolisation may also be performed in the palliative setting and with curative intent for some benign primary tumours.

Patient selection

Lesions with histologies known to produce hypervascular metastases respond more favourably (Renal cell, Thyroid, some Sarcomas, Hepatocellular Carcinoma, Germ cell and neuroendocrine metastases). Some typically hypovascular metastases e.g. breast and prostate, may occasionally be hypervascular and it has been recommended that angiography (and embolisation if the tumor is hypervascular) should be performed regardless of histology prior to a thoracolumbar corpectomy or vertebrectomy[17].

Predictors of a positive outcome post-embolisation are: purely lytic tumours, associated pathologic fracture, rapid increase in size, and / or progressive destruction[9].

Angiographic anatomy

Critical to avoiding complications, specifically cord or brain ischaemia, is a thorough knowledge of the arterial anatomy, its variants and the variations in flow patterns that may occur during the procedure.

Vertebral supply

In the cervical spine, there are four potential arterial supplies, namely, the occipital artery (C1 and 2), the ascending cervical arteries (divisions of the thyrocervical trunk, typically supplying C3 and 4), the deep cervical arteries (divisions of the costocervical trunk, typically supplying C5 and C6) and the vertebral arteries (preferentially supplying C7).

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 (the right usually supplies T1-3, the left usually supplies T1-4) and supreme intercostal arteries (arising from the costocervical trunk) must be assessed.

For thoracic and lumbar levels, a pair of segmental arteries arise at each vertebral body level, coming off as separate origins in the thoracic and upper lumbar spine but usually arising from a common origin in the mid and lower lumbar spine.

For lesions in the sacrum, the median sacral artery (from the aorta) as well as the iliolumbar and lateral sacral arteries (both from the posterior division of the internal iliac artery) need to be assessed.

Radiculomedullary supply

The spinal cord is supplied by a single anterior spinal artery (ASA) in the midline and paired posterolateral posterior spinal arteries.

The ASA commences at the vertebrobasilar junction (from branches of one or both vertebral arteries) and extends to the filum terminale. Variants in appearance include calibre irregularity and "duplication" (in the cervical region), focal discontinuity (thoracic) and further "duplication" at the conus, the latter appearance arising from a "basket" of anastomoses between the ASA and dorsal pial medullary arteries. 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 this section of cord to radiculomedullary insult.

The ASA receives significant additional supply at the locations where oxygen demand is maximal e.g. the sites of cord expansion at the origin of the brachial plexus in the cervical cord and in the conus at the lumbar plexus origin.

This supplemental supply comes from the segmental arteries arising from the aorta that divide at the level of the transverse process into ventroparietal and dorsospinal branches. The dorsospinal artery divides in turn at the level of the neural foramen into radicular and muscular branches. Each radicular branch divides into anterior and posterior radiculomedullary arteries running alongside the anterior and posterior nerve roots. 6-8 anterior radiculomedullary arteries have functional communications with the ASA and 11-16 posterior radiculomedullary arteries (radiculopial) communicate with the posterior spinal arteries.

As their name suggests, the radiculomedullary arteries supply the accompanying nerve roots and the cord in addition to the dura and bony wall of the spinal canal. Crucially, at the expansions, they may be the dominant supply to the cord.

A variation, usually thoracic, is a common intersegmental trunk from which two adjacent segmental arteries arise. If this trunk is "complete", each segmental artery gives rise to a dorsospinal branch; however, if the trunk is "incomplete", one of the segmental arteries lacks a dorsospinal branch which then arises directly from the aorta. When this is the case, the direct dorsospinal artery usually gives rise to a radiculospinal artery which in turn supplies the anterior spinal artery.

The most frequently described (largest, and thus most consistently identified) radiculomedullary artery is the artery of Adamkiewicz[18], which, in 75% of cases, is found between T9 and T12, arising three times more commonly on the left. This is seen in the midline and has the classic "hairpin" appearance. This artery gives most supply to the ASA in the lower thoracic and upper lumbar levels.

The cervical radiculomedullary artery (which has a "Y", as opposed to a hairpin, configuration) usually arises from the left vertebral artery (C5-6), but can arise from the right vertebral, from one of the anterior cervical arteries, or, in 10% of cases, the deep cervical artery.

In the 15% of cases where Adamkiewicz arises above T8, a separate conus artery is more likely to be visualised at L3 or above, and rarely at L4. If Adamkiewicz arises in its typical location, the supplementary conus radiculomedullary artery is not always seen.

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.

In the majority of cases, the principal supply to a vertebral lesion is from the segmental artery of that level; however, the two levels above and below must also be interrogated to identify collateral supply via potentially rich anastomoses (which can account for greater than 50% of supply to the vertebra, compared to 30% from the named segmental artery alone), and to identify radiculomedullary branches.

Familiarity with the normal appearance of vertebral enhancement (hemivertebral blush in the lower thoracic and lumbar regions and a complete vertebral blush as a result of cross-filling anteriorly in the upper thoracic region) aids in identifying abnormal enhancement patterns when present. The angiographer should be aware of common vascular variants (e.g., aplasia of a segmental artery), and be able to recognize those variants where radiculomedullary supply is affected (as described above).

Embolisation

The goal of embolisation is complete devascularisation of the tumour. As part of the pre-procedural workup, coagulopathies must be corrected, as the embolisation procedure will fail in the absence of adequate clotting factors.

Best results are achieved with general anaesthesia which ensures optimal initial angiography to identify all target and non-target arteries, and optimal guidance during embolisation.

The choice of catheter will vary with operator preference but the thoracic and lumbar segmental arteries can be cannulated predictably with a 4 or 5 French 0.038" lumen Mikaelsson catheter. The upper thoracic levels occasionally require a modified Cobra-type catheter. 5 or 6Fr 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 target lesion should be catheterised and once access is stable, angiography performed to demonstrate the arteries supplying the tumour and potential supply to the cord. 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 either[19].

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 can be described as "flow-diversion" as this occlusion also encourages more antegrade flow of embolic into the tumour-feeding artery[20].

As above, the cervical spine has the most complex supply with the most dense anastamotic networks, resulting in increased difficulty of achieving a complete embolisation and increased risk of non-target embolisation. Some of these anastomoses may only become apparent during embolisation as a result of altered flow dynamics and thus repeated, meticulous monitoring angiography must be performed throughout the procedure.

To ensure an adequate embolisation, repeat angiography +/- further embolisation of the embolised branches is recommended, as the particles "pack" distally, which would result 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.

The more complete the embolisation, the greater the reduction in perioperative blood loss[21]. Schmidt showed that the adequacy of embolisation in a group of metastases was the only predictor of the extent of blood loss[16]. The recent randomised controlled trial by Clausen et al [22] reconfirmed the reduction in operative time and reduced blood loss in hypervascular spinal metastases. Although the use of liquid agents has been described in this setting (e.g. Onyx and n-butyl cyanoacrylate (nBCA), data is very limited, and these are not first-line agents given their expense and the expertise required for their use. Direct puncture techniques for devascularisation, including cement osteoplasty and direct injection of nBCA, have been described[23-24].

Clarençon reported two patients with spinal metastases in whom arterial embolisation was contraindicated because of an adjacent spinal artery. Onyx was injected by direct puncture without compromise of the spinal artery[25].

Alcohol is discouraged as an agent in this setting given its propensity to pass into radiculomedullary branches with resultant spinal cord infarction[10]; however, Sundaresan[26] 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 loss, as, with time, recanalization and collateral establishment occurs. Surgery within 72 hours of the embolisation (optimally within 24 hours) decreases perioperative blood loss[10, 27, 28.]

Ammirati et al[29] described direct puncture embolisation with n-butyl-cyanoacrylate of a renal cell metastasis following transarterial embolisation with satisfactory results.

Reports of pre-operative embolisation in benign lesions are limited. Sequential embolisation has been used to treat aneurysmal bone cysts (ABCs) and giant cell tumours. Pearl et al[30] embolised two children with spinal ABCs by percutaneous injection of n-BCA and concluded that this technique was a technically simple and efficient adjunct to surgery and that direct injection may be undertaken when no acceptable target artery is identified for embolisation.

In three cases, Trubenbach et al[31] demonstrated that the radical resection of osteoblastomas was facilitated by preoperative embolisation. Hai Bin Shi et al[20] reported the successful use of pre-operative embolisation in small numbers of giant cell tumors, an ABC, and an haemangioma.

Complications

In experienced hands, the risk of neurologic complications is less than the usually quoted 2%.

When a radiculomedullary artery arises directly from the segmental artery, this is usually considered an absolute contraindication to embolisation[10]; however, in centres with expertise in these techniques, test occlusion or target vessel provocation, and monitoring evoked potentials during embolisation, to determine the risk of cord infarction, are used.

Conclusions

Pre-operative embolisation is effective and safe in the reduction of perioperative blood loss. Meticulous technique and avoidance of embolisation of radiculomedullary arteries prevents serious permanent neurologic deficits.

References

1. Heran MK. Preoperative embolisation of spinal metastatic disease: rationale and technical considerations. Semin Musculoskelet Radiol. 2011 Apr; 15(2): 135-42.
2. Ozkan E, Gupta S. Embolisation of spinal tumors: vascular anatomy, indications, and technique. Tech Vasc Interv Radiol. 2011 Sep; 14(3): 129-40.
3. Benati A, Dalle Ore G, Da Pian R, Bricolo A, Maschio A, Perini S. Transfemoral selective embolisation in the treatment of some cranial and vertebro-spinal vascular malformations and tumours. Preliminary results. J Neurosurg Sci. 1974 Oct-Dec; 18(4): 233-8.
4. 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.
5. 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.
6. Jacobs W B, Perrin R G. Evaluation and treatment of spinal metastases: an overview. Neurosurg Focus. 2001; 11 (6) e10.
7. Owen R JT. Embolization of musculoskeletal tumors. Radiol Clin North Am. 2008; 46 (3) 535-543 vi.
8. Heary R F, Bono C M. Metastatic spinal tumors. Neurosurg Focus. 2001; 11 (6) e1.
9. 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.
10. Jones K, Meyers P, Gobin P, Liu A-H. Embolization of spinal tumors. In: Operative Techniques in Neurosurgery. New York, NY: Elsevier Science; 2003: 156-162.
11. 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.
12. Reuter M, Heller M, Heise U, Beese M. Transcatheter embolization of tumors of the muscular and skeletal systems. Rofo. 1992; 156 (2) 182-188.
13. Gellad F E, Sadato N, Numaguchi Y, Levine A M. Vascular metastatic lesions of the spine: preoperative embolization. Radiology. 1990; 176 (3) 683-686.
14. 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.
15. 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.
16. 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.
17. White A P, Kwon B K, Lindskog D M, Friedlaender G E, Grauer J N. Metastatic disease of the spine. J Am Acad Orthop Surg. 2006; 14 (11) 587-598.
18. Manjila S1, 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.
19. 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.
20. 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.
21. Sun S, Lang E V. Bone metastases from renal cell carcinoma: preoperative embolization. J Vasc Interv Radiol. 1998; 9 (2) 263-269.
22. 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.
23. Schirmer C M, Malek A M, Kwan E S, Hoit D A, Weller S J. Preoperative embolization of hypervascular spinal metastases using percutaneous direct injection with n-butyl cyanoacrylate: technical case report. Neurosurgery. 2006; 59 E431-432 author reply E431-432.
24. Liebig T, Henkes H, Kirsch M, Piotin M, Jans P, Kühne D. Preoperative devascularization of a circumferential osteogenic metastasis to the upper cervical spine by direct percutaneous needle puncture: a technical note. Neuroradiology. 2005; 47 (9) 674-679.
25. Clarençon F, Di Maria F, Cormier E, Sourour NA, Enkaoua E, Sailhan F, Iosif C, Le Jean L, Chiras J. Onyx injection by direct puncture for the treatment of hypervascular spinal metastases close to the anterior spinal artery: initial experience. J Neurosurg Spine. 2013 Jun; 18(6): 606-10.
26. 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.
27. Berkefeld J, Scale D, Kirchner J, Heinrich T, Kollath J. Hypervascular spinal tumors: influence of the embolization technique on perioperative hemorrhage. AJNR Am J Neuroradiol. 1999; 20 (5) 757-763.
28. Barton P P, Waneck R E, Karnel F J, Ritschl P, Kramer J, Lechner G L. Embolization of bone metastases. J Vasc Interv Radiol. 1996; 7 (1) 81-88.
29. Ammirati M, Spiliopoulos K, Epstein CR, Gabriel J, Bourekas EC. Preoperative direct percutaneous embolisation of spinal metastasis from renal cell carcinoma. J Neurointerv Surg. 2011 Sep; 3(3): 297-9.
30. Pearl MS, Wolinsky JP, Gailloud P. Preoperative embolisation of primary spinal aneurysmal bone cysts by direct percutaneous intralesional injection of n-butyl-2-cyanoacrylate. J Vasc Interv Radiol. 2012 Jun; 23(6): 841-5. doi: 10.1016/j.jvir.2012.02.005.
31. J. Trübenbach, T. Nägele, T. Bauer and U. Ernemann. Preoperative Embolisation of Cervical Spine Osteoblastomas: Report of Three Cases. AJNR Am J Neuroradiol. 2006 Oct; 27(9): 1910-2.

CIRSE meets CIRSE meets China

2605.1

Percutaneous transhepatic portosystemic shunt

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Aim: Current guidelines by the American Association for the Study of Liver Diseases (AASLD) regarded portal vein thrombosis (PVT) and hepatic carcinoma (HCC) as relative contraindications of transjugular intrahepatic portosystemic shunt (TIPS) creation since anatomical anomalies caused by such conditions may complicate the procedure [1]. To address this problem, we developed a percutaneous TIPS (pTIPS) creation technique and retrospectively analysed early cases aiming to evaluate the feasibility, safety, consistency, and clinical effect of this technique.

Materials and Methods: From November 2009 to April 2014, 150 patients underwent pTIPS and were followed up. Their age averaged at 49.6±12.3 (mean±SD). There were 23 female and 127 male patients. There were 35 (23.3%) Child-Pugh class A patients, 92 (61.3%) class B, and 23 (15.3%) class C, with Child-Pugh score averaging at 7.66±1.63. Average MELD score in this group was 10.57±5.52. Thirty-one patients were diagnosed with HCC. Further, 111 had complications of PVT (100 cases) or portal vein tumour thrombosis (PVTT, 11 cases), of which 42 demonstrated diffuse PVT. Fifty-eight patients showed >90% of lumen occupancy or complete occlusion. Statistical processing was conducted with ANOVA, logistic regression, and χ^2 tests. All tests were two-sided, and a p value of <0.05 was considered statistically significant.

Results: Technical success rate was 100%, and 215 bare stents and 57 stent grafts were deployed, averaging at 1.81±0.72 per patient. The portal pressure gradient decreased from 20.71±8.34 to 8.52±6.54 mmHg (p<0.001). There was 1 severe procedure-related complication (0.67%) and no peri-procedural mortality. During the 1-year follow-up period, 6 patients (4%) complained of reoccurrence of original symptoms. Encephalopathy occurred in 30 cases (20.0%). Multivariate analysis indicated that serum indirect bilirubin level was independent predictor of encephalopathy (OR: 1.05, CI: 1.01–1.09, p<0.05). Shunt dysfunction occurred in 48 cases (21.1%); use of covered stent grafts (OR:8.97, CI: 2.45–32.76, p<0.05), and number of stents used (OR: 2.97, CI: 1.02–8.64, p<0.05) were independent predictors of primary patency. One-year mortality rate was 12.7% (19 cases); independent predictors determined by multivariate analysis included HCC (OR: 63.76, CI: 8.96–453.72, p<0.05), PVTT (OR:14.46, CI: 3.12–67.00, p<0.05), and MELD score (OR: 1.21, CI: 1.007–1.46, p<0.05).

Conclusion: We believe that the feasibility, safety, consistency, and effectiveness of pTIPS, as demonstrated by our present study, are satisfactory and suffice to warrant further large-scale, prospective, randomized clinical trials on the effect of pTIPS on cases formerly recognized as technically unsuitable for TIPS but may be benefited from intrahepatic shunt creation.

References

1. Boyer TD, Haskal ZJ; American Association for the Study of Liver Diseases. The Role of Transjugular Intrahepatic Portosystemic Shunt (TIPS) in the Management of Portal Hypertension: update 2009. Hepatology. 2010 Jan;51(1):306. PMID: 19902484.

2605.2

Stent loaded with ^{125}I seeds in malignancies – from bench to bedside

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Implantation of ^{125}I seeds has been widely used for prostate cancer. However, it is challengeable if ^{125}I seeds could be implanted in malignancies of a luminal organ such as esophageal cancer, biliary tract obstruction caused by malignancies, and portal vein tumor thrombosis (PVTT), which is expected to have combined effects on relieving the obstruction caused by tumor burden and treating the tumor directly. A novel stent system loaded with ^{125}I seeds was developed in 2005 in the author's institute. The technical feasibility and safety of this new stent have been demonstrated in a healthy rabbit model. Both single-center and multi-center randomized controlled clinical trials were conducted, and they both demonstrated that dysphagia grades and the overall survival were significantly improved in the irradiation stent group than in the conventional stent group. The irradiation stent for the biliary tract was modified from the esophageal irradiation stent, which needs a much smaller access of 9 F as compared with 24-F access of the esophagus by a unique design. To evaluate the safety and effectiveness of this irradiation stent, a randomized controlled study was assigned with a biliary irradiation stent or a conventional biliary stent in the malignant biliary tract obstruction caused by both primary and metastatic adenocarcinomas. The results showed that both the median and mean overall survival in the irradiation stent group were longer compared with those in the control group. Recently, two other modified irradiation stent systems were dedicated to PVTT and malignant tracheal obstruction, and both showed very promising preliminary results.

2605.3

Hybrid intervention for complex cerebrovascular disease

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Outcome of hybrid surgical and endovascular recanalization of symptomatic chronic internal carotid artery occlusion

Background. The Carotid Occlusion Surgery Study showed an unacceptably high risk of periprocedural stroke or death of 14.4% in patients with symptomatic chronic ICA occlusion (SCICAO) assigned into extracranial-to-intracranial (EC-IC) bypass. Carotid endarterectomy (CEA) of SCICAO only achieves one-third recanalization efficacy, despite being relatively safe. On the contrary, endovascular therapy (ET) improves the rate, but there remains major concern on procedure-related embolism.

Objective. To determine the periprocedural outcome of combined surgical and endovascular recanalization of SCICAO.

Methods. The SCICAO was managed in hybrid neurovascular operating room by experienced CEA or ET surgeons or both. Primary efficacy endpoint was SCICAO repatency with TIMI 3 at the procedural end. Primary safety endpoint was any stroke or death within 30 days.

Results. Between January 2014 and November 2014, 26 consecutive SCICAO patients were enrolled. After completing the initial procedure of 9 ETs and 17 CEAs, 9 lesions achieved repatency (6 after ET, 3 after CEA). Intraoperative surgery modality shifting was required in 13 lesions, which again recanalized 12 lesions (all 3 lesions shifted to CEA from ET, and 9 of 10 lesions shifted to ET from CEA). Thus, the final rate of achieving primary efficacy endpoint was significantly increased to 80.8% (21/26) from 34.6% (9/26) after completing the initial procedure (p<0.05). Within 30 days, there was one primary safety endpoint event (3.8%), which was minor ischemic stroke, and one non-fatal acute myocardial infarction.

Conclusion. Hybrid surgical and endovascular intervention significantly improves recanalization efficacy on symptomatic chronic ICA occlusion, with lower complication risk compared with bypass surgery.

References

1. Failure of extracranial-intracranial arterial bypass to reduce the risk of ischemic stroke. Results of an international randomized trial. The EC/IC Bypass Study Group. The New England journal of medicine. Nov 1985;313(19):1191-1200.
2. Powers WJ, Clarke WR, Grubb RL, Jr., et al. Extracranial-intracranial bypass surgery for stroke prevention in hemodynamic cerebral ischemia: the Carotid Occlusion Surgery Study randomized trial. Journal of the American Medical Association. Nov 2011;306(18):1983-1992.
3. Reynolds MR, Grubb RL, Jr., Clarke WR, et al. Investigating the mechanisms of perioperative ischemic stroke in the Carotid Occlusion Surgery Study. Journal of neurosurgery. Oct 2013;119(4):988-995.
4. Paty PS, Adeniyi JA, Mehta M, et al. Surgical treatment of internal carotid artery occlusion. Journal of vascular surgery. Apr 2003;37(4):785-788.
5. Lin MS, Lin LC, Li HY, et al. Procedural safety and potential vascular complication of endovascular recanalization for chronic cervical internal carotid artery occlusion. Circulation. Cardiovascular interventions. Oct 2008;1(2):119-125.
6. Shih YT, Chen WH, Lee WL, Lee HT, Shen CC, Tsuei YS. Hybrid surgery for symptomatic chronic total occlusion of carotid artery: a technical note. Neurosurgery. Sep 2013;73(1 Suppl Operative):onsE117-123; discussion onsE123.
7. Klijn CJ, van Buren PA, Kappelle LJ, et al. Outcome in patients with symptomatic occlusion of the internal carotid artery. European journal of vascular and endovascular surgery : the official journal of the European Society for Vascular Surgery. Jun 2000;19(6):579-586.
8. Flaherty ML, Flemming KD, McClelland R, Jorgensen NW, Brown RD, Jr. Population-based study of symptomatic internal carotid artery occlusion: incidence and long-term follow-up. Stroke; a journal of cerebral circulation. Aug 2004;35(8):e349-352.
9. Klijn CJ, Kappelle LJ, Tulleken CA, van Gijn J. Symptomatic carotid artery occlusion. A reappraisal of hemodynamic factors. Stroke; a journal of cerebral circulation. Oct 1997;28(10):2084-2093.
10. Grubb RL, Jr., Derdeyn CP, Fritsch SM, et al. Importance of hemodynamic factors in the prognosis of symptomatic carotid occlusion. Journal of the American Medical Association. Sep 1998;280(12):1055-1060.
11. Adams HP, Jr. Occlusion of the internal carotid artery: reopening a closed door? Journal of the American Medical Association. Sep 1998;280(12):1093-1094.
12. Kao HL, Lin MS, Wang CS, et al. Feasibility of endovascular recanalization for symptomatic cervical internal carotid artery occlusion. Journal of the American College of Cardiology. Feb 2007;49(7):765-771.

Special Session
GI tract haemorrhage

2701.1

Clinical evaluation and imaging of GI bleeding

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Learning Objectives

1. To learn about the epidemiology and clinical presentation of GI bleeding
2. To learn about diagnostic strategies for GI bleeding
3. To learn about the technique and interpretation of CTA for GI bleeding

Gastrointestinal bleeding (GI) is a common problem encountered in the emergency department. For the UK and the US, annual admissions for GI bleeding have been estimated at up to 1.5/1000 inhabitants with a mortality rate of 5%–10%.

Definitions and epidemiology:

GI bleedings can be classified on the rate of blood loss: overt (acute), occult (chronic), and obscure form.

-*Overt or acute* GI bleeding is visible and can be present in the form of hematemesis, "coffee-ground" emesis, melena, or hematochezia.

-*Occult or chronic* form as a result of microscopic hemorrhage can present as hemoccult-positive stools with or without iron deficiency anemia.

-*Obscure GI bleeding* refers to recurrent bleeding, with no identified source after upper endoscopy and colonoscopy; the clinical presentation can be either overt or occult.

Depending on the location of the source, two groups are defined: upper and lower GI bleedings.

-*Upper GI bleeding* includes hemorrhage originating from the esophagus to the ligament of Treitz at the duodenal flexure.

-*Lower GI bleeding* means that the source is below the ligament of Treitz.

Recently, an "endoscopy-based" classification separated the hemorrhage above the ampulla of Vater within the reach of upper endoscopy: upper GI bleeding (5).

A location between the ampulla of Vater and the terminal ileum defines a mid-GI bleeding (from the small bowel) and lower GI bleeding originating from the colon.

Overt (acute) or obscure (presenting as an acute form) GI bleedings are clearly the target of the talk in this session dedicated to endovascular treatment.

Acute GI bleeding is more common in men, and its prevalence increases with age. Upper GI bleedings are 2–6 times more frequent than lower ones.

Acute GI bleeding is responsible for 300,000 hospital admissions a year in the US.

Etiology and pathophysiology:

The commonest causes of *acute upper GI bleeding* are peptic ulcer disease, use of aspirin and other NSAIDs, variceal hemorrhage, Mallory–Weiss tear (traumatic), and neoplasms including gastric cancers. Other causes are esophagitis, erosive gastritis or duodenitis, vascular ectasias, and Dieulafoy's lesions.

Acute lower GI bleeding may originate in the small bowel, colon, or rectum, with vascular, inflammatory, neoplastic, traumatic, or iatrogenic causes. Commonest causes are diverticular disease, angiodysplasia, neoplasms including colorectal cancer, colitis including Crohn's disease and ulcerative colitis, and benign anorectal lesions.

If the patient has an aortic graft or endograft, a secondary aortoenteric fistula should be considered until proven otherwise.

Clinical presentation:

Upper GI bleeding:

-Hematemesis, "coffee-ground" emesis, and/or melena

-Hematochezia could be present in case of briskly bleeding upper GI source

Lower GI bleeding:

-Hematochezia

-Melena or dark blood mixed with stools may be present in case the source of bleeding is located at the right side of the colon

Accompanying presentations:

-Hemodynamic instability

-Abdominal pain, anemia, fatigue, syncope, and angina

-In general, vascular causes of bleeding present with painless large volume of blood, and inflammatory causes are associated with diarrhea and pain

Diagnostic strategies:

1) Rapid assessment and resuscitation in unstable patients with acute severe bleeding

2) Evaluation of the risk of rebleeding and complications

3) Diagnostic of the underlying source of bleeding

Investigations of acute upper GI bleeding:

Upper endoscopy is considered the investigation of choice; in most patients, it permits diagnosis and targeted endoscopic treatment.

The reported sensitivity and specificity of this endoscopy for upper GI bleeding are 92%–98% and 30%–100%, respectively.

The airway should be secured by endotracheal intubation in case of massive bleeding.

Prokinetics as erythromycin or metoclopramide before upper endoscopy promotes gastric emptying and clearance of blood, clots, and food. It can reduce the need for repeat endoscopy.

Routine second-look endoscopy after hemostasis achieved on first endoscopy remains controversial.

In case of non-diagnotic endoscopy, if a bleeding site cannot be identified or treated, the next investigation depends on patient's hemodynamic stability.

If the patient is unstable (under resuscitation), with large-volume upper blood loss, urgent surgery is required.

If the patient is stable with low-volume bleeding, repeat endoscopy may be considered (with a colonoscopy in case of melena to exclude a right-sided source).

If the patient is stable with large-volume bleeding and endoscopy is inefficient with or without colonoscopy, CT angiography and catheter angiography are options to be discussed. Upper GI barium studies are contraindicated.

Investigations of acute lower GI bleeding:

Colonoscopy and CT angiography are two diagnostic tools of choice for the evaluation of acute lower GI bleeding.

American College of Gastroenterology guidelines suggest that colonoscopy should be the first-line modality for the evaluation and treatment of lower GI bleeding.

However, there are several limitations in the setting of acute bleeding (such as inadequate bowel preparation and inability to explore most of the small bowel). The sensitivity of colonoscopy for the diagnosis and successful treatment of lower GI bleeding decreases to 21% in case of the acute setting.

The American College of Radiology recommends the use of colonoscopy in the initial examination of hemodynamically stable patients (allowing for adequate bowel preparation) and the use of angiography for those unstable with massive lower GI bleeding.

If the source is unidentified by endoscopy, then CT angiography, catheter angiography, and eventually radionuclide imaging has to be discussed among the clinical presentation and local expertise.

CT angiography:

CT angiography is reliable, and it showed an ongoing arterial bleeding of as low as 0.4–0.5 ml/min and less in a recent in vitro study (0.35 ml/min).

Due to this accuracy and readily availability CT angiography, contrast-enhanced multidetector CT is widely used as a rapid and easy-to-perform diagnostic method to detect and localize acute GI bleeding; otherwise, it involves an intravenous iodine contrast agent and a substantial radiation dose. Moreover, it has limited utility in case of intermittent hemorrhage.

A systematic review of the diagnostic accuracy of CT angiography demonstrated a sensitivity of 86% and a specificity of 95% in the evaluation of patients with acute GI bleeding. This high sensitivity reduces in case of obscure GI bleeding (47%). It can also detect neoplasms or vascular malformations.

Disadvantages of CT angiography are the lack of therapeutic capability and the risk of contrast-induced nephropathy in impaired patients.

Technical aspects:

Due to the multiple-phase acquisitions needed, a radiologist has to be aware of acquisition parameters.

Example of technical data of CTA acquisition in our institution:

MDCT 64

80 cc contrast medium, with a flow rate of 5 cc/s

40 cc saline; 5 cc/s

100 Kv for arterial phase and 120 Kv for portal phase

pitch: 0.984; rotation time: 0.7 s

Interpretation:

To be accurate, the following three differently timed acquisitions are necessary (plain, arterial, and portal venous phases):

-*Plain phase:* identification of any preinjection hyperdensity inside the bowel. No oral contrast material as well as water ingestion is necessary

-*Arterial phase:* detection of a focal area of high attenuation (>90 HU) corresponding to active extravasation into the bowel lumen (linear, jet-like, swirled, and pooled configurations)

-*Portal-venous phase:* confirmation of extravasation with increasing and pooling hyperdense contrast material in the bowel lumen and complete filling in some cases

Additional postprocessing tools could be helpful as multiplanar reconstructions (MPR) and vascular tree analysis in maximum intensity projections (MIP), especially to precisely complete the localization of the source and to guide the interventional treatment if an endovascular route is chosen.

If no GI bleeding is detected, it could be due to an intermittent hemorrhage; thus, a repeated CT angiography could be indicated if the patient rebleeds.

CT angiography has to be performed as close as possible to the clinically overt GI bleeding to avoid false negative examination due to intermittent hemorrhage.

Catheter angiography (DSA):

Catheter angiography is able to detect bleeding, with a rate of 1–1.5 ml/min and probably as less as 0.5 ml/min if superselective catheterization is performed. It offers the advantage of being diagnostic and therapeutic.

No bowel preparation is necessary, but its performance drops if barium had been used in the days before.

The sensitivity for acute GI bleeding is 42%–86%, with a specificity close to 100%.

Its pitfalls are mainly the difficulty in obtaining good subtracted images with bowel movements and variable compliance of the patients, especially those with limited hemodynamic stability, intermittent bleeding, procedural delays, atherosclerotic anatomy, and venous or small vessel bleeding.

Complications occur in 0%–10% of patients, with <2% of serious complications.

Some drug infusions can help to increase diagnostic performance: IV injection of spasmolytic agent to block any bowel movement and transcatheter injection of local thrombolytic agent (urokinase).

In our clinical routine, it is important to be as sure as possible that the catheter angiogram follows a positive CT angiography to

increase the chance to observe active bleeding and then try to treat the hemorrhage in one single procedure. Catheter angiography has to be realized as fast as possible after the CT angiogram shows bleeding.
In case of non-diagnostic catheter angiography, the femoral introducer is left in place to be rapidly accessed in case of rebleeding.

References

1. Artigas J, Marti M, Soto J, Esteban H, Pinilla I, Guillen E. Multidetector CT angiography for acute gastrointestinal bleeding : technique and findings. Radiographics, 2013 ; 33 : 1453-1470.
2. Miyaoka Y, Amano Y, Ueno S, Izumi D, Mikami H et al. The role of enhanced multi-detector-row computed tomography before urgent endoscopy in acute upper gastrointestinal bleeding. Journal of Gastroenterology and Hepatology, 2014 ; 29 : 716-722.
3. Foley PT, Ganeshan A, Anthony S, Uberoi R. Multi-detector CT angiography for lower gastrointestinal bleeding : can it select patients for endovascular intervention? Journal of Medical Imaging and Radiation Oncology, 2010 ; 54 : 9-16.
4. Ohmiya N, Nakagawa Y, Nagasaka M, Tahara T, Shibata T et al. Obscure gastrointestinal bleeding : diagnosis and treatment. Digestive Endoscopy, 2015 ; 27 : 285-294.
5. Soto J, Park S, Fletcher J, Fidler JL. Gastrointestinal hemorrhage : evaluation with MDCT. Abdominal Imaging, 2015.
6. Khamaysi I, Gralnek I. Acute upper gastrointestinal bleeding (UGIB) – Initial evaluation and management. Best Practice and Research Clinical Gastroenterology, 2013 ; 27 : 633-638.
7. Marion Y, Lebreton G, Le Pennec V, Hourna E, Viennot S et al. The management of lower gastrointestinal bleeding. Journal of Visceral Surgery, 2014 ; 151 : 191-201.
8. Martin-Lagos-Maldonado A, Barrientos-Delgado A, Martínez-Tirado Mdel P, Casado-Caballero FJ. Computed tomography angiography (CTA) in the diagnosis of an infrequent cause of gastrointestinal bleeding. Revista española de enfermedades digestivas : organo oficial de la Sociedad Española de Patología Digestiva, 2013 ; 105 : 114-115.
9. Owensby S, Taylor K, Wilkins T. Diagnosis and management of upper gastrointestinal bleeding in children. Journal of the American Board of Family Medicine : Journal of the American Board of Family Medicine : JABFM., 2015 ; 28 : 134-145.
10. Saperas E, Dot J, Videla S, Alvarez-Castells A, Perez-Lafuente M et al. Capsule endoscopy versus computed tomographic or standard angiography for the diagnosis of obscure gastrointestinal bleeding. American Journal of Gastroenterology, 2007 ; 102 : 731-737.
11. Geoffroy Y, Rodallec M, Boulay-Coletta I, Jullies MC, Ridereau-Zins C et al. MDCT angiography in acute gastrointestinal bleeding : why, when and how. Radiographics, 2011 ; 31 : E35-46.
12. Kim B, Li B, Engel A, Samra J, Clarke S, et al. Diagnosis of gastrointestinal bleeding : A practical guide for clinicians. World Journal of Gastrointestinal Pathophysiology, 2014 ; 5 : 467-478.

2701.2

Treatment and outcome: upper GI bleeding

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Learning Objectives

1. To learn about the different causes of upper GI bleeding
2. To learn about embolisation techniques for upper GI bleeding
3. To learn about the results and complications of embolisation for upper GI bleeding

Upper GI bleeding is defined as bleeding occurring above the ligament of Treitz and accounts for 76% of all GI bleeding. Origin of the bleeding can be arterial, such as in ulcer disease (50% of cases), or venous, i.e., from esophageal varices. The initial management of GI bleeding is guided by the hemodynamic status of the patient. The diagnosis is usually confirmed by endoscopy, which is often accompanied with hemostatic maneuvers aiming to control the bleeding. In case of failed endoscopy, embolization of the bleeding artery is a relatively straightforward procedure with a high success rate. In case of venous bleeding, when endoscopy fails, emergency placement of a TIPSS should be considered.

2701.3

Treatment and outcome: lower GI bleeding

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Learning Objectives

1. To learn about the different causes of lower GI bleeding
2. To learn about embolisation techniques for lower GI bleeding
3. To learn about the results and complications of embolisation for lower GI bleeding

Acute lower gastrointestinal bleeding (LGIB) is a common clinical presentation that can lead to significant morbidity and mortality without appropriate treatment. Mortality rate for LGIB is estimated to be around 10%.
LGIB has many different etiologies such as infection, vascular anomaly, inflammatory diseases, trauma, and malignancy.
Patients with LGIB commonly present with hematochezia as most LGIB sources are located in the colon. Less commonly, patients may present with melena if the source of bleeding is located in the small bowel or right colon.
LGIB can manifest with various signs such as tachycardia, orthostatic hypotension, and chronic anemia. In hemodynamically unstable patients, resuscitation with fluid replacement and blood product administration should occur promptly. Correction of coagulopathy may also be needed.
Diverticulosis is the most common cause of LGIB. Other causes include inflammatory bowel disease, ischemic colitis, neoplasia, polyps, vascular malformations, postpolypectomy, and angiodysplasia.
Although most LGIB respond to conservative management, around 15% of patients eventually require endovascular intervention.
For patients suspected of having a LGI source, colonoscopy is the initial diagnostic and therapeutic intervention of choice.
If a lesion is identified endoscopically, therapeutic intervention can be performed to effectively stabilize bleeding. Metal clips are especially useful in patients who require transcatheter intervention later because these clips can be visualized by imaging studies and facilitate lesion localization during angiography.
For heavy active LGIB, endoscopic view may be limited and yield inconclusive results. When a patient has non-diagnostic endoscopic results or remains refractory to medical and endoscopic treatment, radiologic imaging and endovascular intervention are the next interventions of choice.
Noninvasive radiologic imaging options include computed tomography angiography (CTA) and nuclear scintigraphy.
CTA can detect flow rates as low as 0.3 mL/min. In addition to identifying the site of bleeding, CTA can often identify the etiology of LGIB. It also provides important information about vascular anatomy variance that becomes useful for endovascular intervention.
The role of nuclear medicine for the detection of acute GI bleeding varies on an institutional basis. On nuclear scintigraphy, bleeding rates as low as 0.1–0.35 mL/min can be detected. GI bleeding often is intermittent and nuclear scintigraphy has the advantage of continuous monitoring to localize the sites of intermittent bleeding for potential angiography and intervention.
Angiography is able to identify an active bleeding rate of at least 0.5–1 mL/min. For LGIB, DSA has a sensitivity of 60%, specificity of 100%, positive and negative predictive values of 100% and 24%, respectively.

The aim of endovascular angiography is to identify bleeding vessels and use selective catheterization to prepare for embolization.
For suspected LGIB, SMA and IMA are examined. If bleeding appears to originate in the proximal colon, SMA is initially evaluated. If bleeding appears to originate in the distal colon, IMA is selected. If negative, internal iliac arteries should be evaluated as the middle and inferior rectal arteries can be a source of hemorrhage.
Extravasation of contrast agent is indicative of active bleeding. Positive findings include mucosal blushes with abnormal vessels suggestive of tumor, prolonged contrast spots suggestive of inflammation, and visualization of arteries and veins on the same phase of the study suggestive of arteriovenous malformation. Other lesions to consider include pseudoaneurysms and arteriovenous fistulas.
One of the advantages of endovascular angiography is that it can be both a diagnostic and a therapeutic tool. Also, endovascular angiography can be performed emergently without any bowel preparation.
Transcatheter arterial embolization (TAE) is effective for controlling acute LGIB. Some studies have shown that TAE is safer than surgical intervention and has a lower mortality rate.
The goal of TAE is THE super-selective embolization of bleeding vessels to reduce arterial perfusion pressure while maintaining adequate collateral blood flow to reduce the risk of bowel infarction. A 5-French angiographic catheter is used to access celiac, superior mesenteric, or inferior mesenteric arteries. Then, a smaller coaxial 3-French microcatheter can be advanced through the 4- or 5-French catheter.
When no contrast extravasation is visualized under fluoroscopy, blind embolization of suspected bleeding vessel may be performed at the discretion of an interventional radiologist.
For LGIB, the catheter should be positioned as close to the bleeding site as possible. If the source is in the SMA, the catheter should be advanced to the vasa rectum, and if it is in the IMA, the catheter should be placed in the marginal or terminal artery, if possible.
Embolization should only be performed when the catheter has been advanced to the mesenteric border of the colon. The bowel distal to the ligament of Treitz does not have a dual supply; therefore, the risk of bowel infarction is higher.
The type of embolic agent used is conventionally dependent on experience and preference of the interventional radiologist, etiology of bleeding, and availability of the agent. Embolic agents include coils, glue, onyx, gelfoam, polyvinyl alcohol particles (PVA), and Amplatzer vascular plugs. The most commonly used embolic agents are coils and PVA.
Coils can be visualized under fluoroscopy after placement, which is an important advantage when compared with gelfoam or PVA. Newer types of embolization coils have the ability to be removed after deployment if the initial placement is unsatisfactory.
Gelfoam (absorbable compressed sponge) is a temporary agent that remains effective for weeks to months before recanalization occurs. For this reason, gelfoam is not recommended as a single agent.
Using coils with gelfoam or PVA particles on both sides of the bleeding vessel is recommended to avoid "backdoor" bleeding and to decrease the risk of recurrent bleeding.
For LGIB, some studies advocate using coils and larger PVA particles instead of gelfoam.
More peripheral embolization just proximal to the vasa recta is recommended to minimize the length of bowel at risk of ischemia.
Success rate for embolization of LGIB ranged from 88% to 93%.
N-butyl 2-cyanoacrylate (NBCA) glue is a promising, newer embolic agent to control GI bleeding. Advantages of using NBCA include the ability to occlude the vessel beyond the most distal site of microcatheter advancement, permanent vessel closure, an alternative option for using ultra-microcatheters not suitable for microcoil delivery, and more efficient obliteration of bleeding pseudoaneurysms with complex anatomy. There is a significant risk of glue reflux, bowel infarction, and future bowel stenosis. Also, the glue may polymerize with the catheter tip, which may subsequently get stripped off as the catheter is retracted. Prompt catheter removal and aspiration of the guide catheter after microcatheter removal can significantly reduce this risk.
Another potential agent, Onyx®, is a liquid embolic agent composed of ethylene-vinyl alcohol copolymer dissolved in dimethyl sulfoxide (DMSO). The main advantages of Onyx® are its nonadhesive properties, high radiopacity, and long solidification periods, which make the embolization procedure more predictable. However, the most prohibitive and restrictive factor is its high cost and requirement for DMSO compatible catheters.
Vasopressin infusion is a less frequently used treatment for acute LGIB. Vasopressin acts by constricting arteries and reducing blood flow to the target site, but it can also cause bowel ischemia. It may be indicated when GIB is caused by diffuse lesions or super-selective catheterization is not possible. Vasopressin infusion has a success rate of 59%–90% and a high rebleeding rate of up to 36%–43%.
Patients with acute LGIB who do not respond to medical and endoscopic treatment should be considered for imaging studies and endovascular interventions to prevent morbidity and mortality. CTA can localize lesions and provide information, which is helpful for endovascular intervention. Rapid LGIB stabilization can be achieved with endovascular angiography and transcatheter embolization. It is a safe and effective alternative to surgery.

2701.4

Diagnosis and treatment of chronic GI bleeding

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Learning Objectives
1. To learn about the causes of chronic GI bleeding
2. To learn about diagnostic strategies for chronic GI bleeding
3. To learn about the treatment and results for chronic GI bleeding

Chronic gastrointestinal bleeding (GIB), also called obscure GIB (OGIB), has been designated as bleeding of unknown origin that persists or recurs after a negative endoscopy. Although OGIB is uncommon, representing only 5% of all GIB, the detection of its underlying cause is clinically challenging because most of these lesions are located in the small bowel, beyond the reach of conventional endoscopy. Vascular lesions are the most common cause of OGIB, especially in elderly patients. Other causes are neoplasms, ulcerations, and Meckel diverticulum. The diagnostic and therapeutic approach to patients with OGIB will vary according to the clinical presentation of the bleeding. Patients presenting with silent OGIB who have previously undergone upper endoscopy and colonoscopy should undergo repeat upper endoscopy or colonoscopy. If no lesions are seen, the patient should undergo CT, and if CT shows no lesion, the next step will be capsule endoscopy. If a lesion is detected, double-balloon enteroscopy should be performed with diagnostic and therapeutic intentions. Catheter-directed angiography should be reserved for the selected rare cases of silent OGIB where no diagnosis is obtained. If no lesions are seen, efforts to control the OGIB with pharmacologic therapy should be considered. For patient with overt OGIB, if results are negative, tagged RBC scanning can be the next diagnostic step. If results of radionuclide scanning are positive, the following step should be catheter-directed angiography with embolization. When significant bleeding is ongoing despite a thorough evaluation with negative results, laparotomy and intraoperative enteroscopy should be performed.

References
1. Gastroenterologic and radiologic approach to obscure gastrointestinal
2. bleeding: how, why, and when? Graça BM, Freire PA, Brito JB, Ilharco JM, Carvalheiro VM, Caseiro-Alves F. Radiographics. 2010 Jan;30(1):235-52.

3. Obscure gastrointestinal bleeding: Diagnosis and treatment. Ohmiya N, Nakagawa Y, Nagasaka M, Tahara T, Shibata T, Nakamura M, Hirooka Y, Goto H, Hirata I. Dig Endosc. 2015 Mar;27(3):285-94.
4. Obscure gastrointestinal bleeding: diagnostic performance of multidetector CT enterography. Lee SS, Oh TS, Kim HJ, Chung JW, Park SH, Kim AY, Ha HK. Radiology. 2011 Jun;259(3):739-48.
5. The evaluation and management of obscure and occult gastrointestinal bleeding. Singh V, Alexander JA. Abdom Imaging. 2009 May-Jun;34(3):311-9.
6. Multiphase CT enterography evaluation of small-bowel vascular lesions. Huprich JE, Barlow JM, Hansel SL, Alexander JA, Fidler JL. AJR Am J Roentgenol. 2013 Jul;201(1):65-72.

Special Session
State-of-the-art endovascular thrombectomy

2702.1

Lower extremity aspiration thrombectomy

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Learning Objectives
1. To learn about the reasons for lower extremity emboli/thrombosis
2. To learn about different techniques and devices for thrombectomy in the lower extremeties
3. To learn about indications, alternative treatments and outcomes

Acute vessel occlusion of the lower extremity is mostly caused by arterial emboli or thrombosis. Dissection and vessel ruptures are other entities, which can lead to acute vessel occlusion. The affected limb is at risk due to the sudden onset of ischemia. Thrombus material can be removed operatively, e.g., using a Fogarty balloon. Endovascular procedures include intra-arterial thrombolysis or mechanical thrombectomy using different catheter devices.

On the other hand, chronic vessel occlusion is mostly associated with progressive atherosclerotic disease. If thrombotic material is organized, thrombolytic therapies are of limited value. However, mechanical thrombectomy procedures might also be challenging. Particularly, the passage of the occluded vessel segment and access to the true lumen distal to the occlusion might raise difficulties. A huge amount of thrombotic material in long occlusions is another issue, which can cause difficulties during the procedure.

Today, a great variety of devices is available for the endovascular treatment of acute as well as chronic vessel occlusions, which follow different therapeutic strategies. Thrombi can be removed by aspiration or rheolytic, laser, and rotational thrombectomy, which have their own advantages and disadvantages. In addition, there are dedicated devices that facilitate the passage of chronic thrombus material and re-entry into the true lumen in case of subintimal recanalization.

References

1. Rutherford RB. Clinical staging of acute limb ischemia as the basis for choice of revascularization method: when and how to intervene. Semin Vasc Surg. 2009 Mar;22(1):5-9.
2. Wissgott C, Kamusella P, Andresen R. Percutaneous mechanical thrombectomy: advantages and limitations. J Cardiovasc Surg (Torino). 2011 Aug;52(4):477-84.
3. Dosluoglu HH, Harris LM. Endovascular management of subacute lower extremity ischemia. Semin Vasc Surg. 2008 Dec;21(4):167-79.

2702.2

Visceral artery thrombectomy

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Learning Objectives
1. To learn about indications of visceral artery thrombectomy
2. To learn about different techniques and devices for thrombectomy in visceral arteries
3. To learn about indications, alternative treatments and outcomes

Clinical symptoms

Acute visceral thrombembolic event with occlusion of visceral arteries is a potential life-threatening situation, especially when the superior mesenteric artery (SMA) is affected. Patients with acute SMA embolic occlusion present with an acute abdomen having the following signs: sharp abdominal pain, nausea, vomiting, bloody diarrhea, and systemic hypotension. Splenic artery occlusion is usually accompanied by epigastric or left upper quadrant discomfort. Sharp back pain, nausea, vomiting, and hematuria may be present in sudden renal artery occlusion. Hepatic artery occlusions are either asymptomatic or associated with pain in the right upper quadrant (1).

Diagnosis

The diagnosis of visceral ischemia due to thromboembolic artery occlusions is usually established via contrast-enhanced computed tomography (CT). The range of the CT examination is from the dome of the liver to the level of the perineum. Both arterial and venous phases (slice thickness of 1-5 mm, increment 0.75 mm) are obtained. Three-dimensional multiplanar reconstructions are used in the sagittal, coronal, and transverse planes for better orientation (2).

Centre experience and results

We would like present our experience with mechanical thrombectomy of the visceral arteries. Between 2003 and 2015, we applied the endovascular recanalization technique for the treatment of SMA embolic occlusion in 44 patients and of renal artery embolic occlusion in 4. Transcatheter embolus aspiration was used as the primary technique in all 48 patients. Adjunctive local thrombolysis (n=4) and stenting (n=5) were also utilized in cases of incomplete recanalization. Laparotomy on demand was considered by the further clinical course after primary endovascular therapy of SMA occlusion.

Patient selection protocol for therapy of embolic SMA occlusion

We started with endovascular approach in patients with CT signs of embolic occlusion of main stem of the SMA and with mild or moderate clinical and laboratory signs of peritonitis. After successful endovascular procedure, we re-evaluated clinical status and course in 4 hours. Patients whose symptoms subsequently improved were treated conservatively with anticoagulation and antiaggregation therapy. Conversely, patients with progressive worsening of abdominal symptoms and deterioration of laboratory results were referred to laparotomy. Patients with signs of severe peritonitis and shock or with CT signs of advanced intestinal ischemia and perforation were primary indicated for surgical laparotomy and based on the findings, subsequent therapy was given.

Patient selection protocol for therapy of embolic renal artery occlusion

Only large embolic occlusions of the main renal artery with renal function impairment were treated. Small, unilateral, segmental occlusions without renal function impairment were not indicated for treatment despite initial significant pain.

Endovascular revascularization techniques

- Transcatheter embolus aspiration (3-6): Femoral access was used in all cases. An 8-9-F angled guiding catheter (JCV Vistabritetip, Cordis, Miami Lakes, USA) was inserted behind the origin of the SMA or renal artery to gain a stable position. The aspiration catheters (5F, 6F, 7F) were advanced coaxially close to the embolus, and then negative pressure for suction was created. The aspiration was applied manually using a 20- or 50-ml syringe. The aspiration catheter was

removed during continuous suction with captured embolus. To achieve good recanalization, several passes and aspirations were necessary.

- Local thrombolysis with rt-PA: in cases of incomplete embolus aspiration from the SMA or renal artery trunk (7)

- SMA or renal artery stenting: in cases of flow-limiting stenosis at the origin of the SMA or renal artery

Center results

In the group with **SMA embolism** (n=44), we endovascularlly achieved complete recanalization of the stem of the SMA in 39 patients (88.6%). After a failed endovascular approach, two patients underwent successful surgical Fogarty embolectomy. Subsequent laparotomy was performed in 32 patients (72.7%), and bowel necrosis required resection in 18 (40.9%). One fatal hemorrhagic complication based on injury of the jejunal branches developed after endovascular therapy. We observed moderate groin hematoma in three patients, which was treated conservatively. In one patient, groin haematoma was associated with postcatheterization pseudoaneurysm, which was treated by ultrasound-guided thrombin injection. Peripheral embolization associated with the aspiration technique developed in two patients (renal artery, common femoral artery). Renal embolization was successfully treated by means of another aspiration; femoral artery occlusion was solved surgically. The total in-hospital mortality within this group was 22.7% (10/44).

In the group with **renal embolism** (n=4), we endovascularlly recanalized main renal artery trunk in all cases. Significant segmental artery occlusion was still present after treatment in one patient. Clinical improvement was achieved in 3 patients (75%), and one required dialysis for the progressive deterioration of renal function.

Other techniques for visceral artery thrombectomy may be applied and are available in current literature.

Mechanical thrombectomy by Rotarex (8).

Suction thrombectomy by AngioJet (9).

Pharmacologic thrombolysis with EKOS catheter (10).

Mechanical thrombectomy with a carotid filter (11).

Mechanical thrombectomy with stent retriever.

Thrombectomy system Penumbra/Indigo.

References

1. Kansal S, Feldman M, Cooksey S, Patel S (2008) Renal artery embolism. A case report and review. J Gen Intern Med 23:644-647.
2. Furukawa A, Kanasaki S, Kono N, Wakamiya M, Tanaka T, Takahashi M, Murata K (2009) CT diagnosis of acute mesenteric ischemia from various causes. Am J Roentgenol 192:408-416.
3. Ogihara S, Yamamura S, Tomono H, Iwabuchi H, Ebihara T, Mingawa Y, et al (2003) Superior mesenteric arterial embolism treatment by transcatheter thrombo-aspiration. J Gastroenterol 38:272-277.
4. Acosta S, Sonesson B, Resch T (2009) Endovascular therapeutic approaches for acute superior mesenteric artery occlusion. Cardiovasc Intervent Radiol 32:896-905.
5. Hladik P, Raupach J, Lojik M, Krajina A, Voboril Z, Jon B, et al (2005) Treatment of acute mesenteric thrombosis/ischemia by transcatheter thromboaspiration. Surgery 137:122-123.
6. Heiss P, Loewenhardt B, Manke C, Hellinger A, Dietl KH, Schlitt HJ, et al (2010) Primary percutaneous aspiration and thrombolysis for the treatment of acute embolic superior mesenteric artery occlusion. Eur Radiol 20:2948-2958.
7. Björnsson S, Björck M, Block T, Resch T, Acosta S (2011) Thrombolysis for acute occlusion of the superior mesenteric artery. J Vasc Surg 54:1734-1742.
8. Popovič P, Kuhelj D, Bunc M (2011) Superior mesenteric artery embolism treated with percutaneous mechanical thrombectomy. Cardiovasc Intervent Radiol 34:S67-69.
9. Sternbergh WC, Ramee SR, Devon DA, Money SR (2000) Endovascular treatment of multiple visceral artery paradoxical emboli with mechanical and pharmacological thrombolysis. J Endovasc Ther 7:155-160.
10. Ballehaninna UK, Hingorani A, Ascher E, Shiferson A, Marks N, Aboian E, et al (2012) Acute superior mesenteric artery embolism: reperfusion with AngioJet hydrodynamic suction thrombectomy and pharmacologic thrombolysis with the EKOS catheter. Vascular 20:166-169.
11. Zeleňák K, Sinák I, Janík J, Mikolajčík A, Mištuna D (2013) Successful recanalization of acute superior mesenteric artery thromboembolic occlusion by a combination of intraarterial thrombolysis and mechanical thrombectomy with a carotid filter. Cardiovasc Intervent Radiol 36:844-847.

2702.3

Venous thrombectomy

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Learning Objectives

1. To learn about indications for venous thrombectomy
2. To learn about different techniques and devices for venous thrombectomy
3. To learn about indications, alternative treatments and outcomes

Deep vein thrombosis (DVT) is a serious health problem and accounts for approximately 300-500,000 admissions to U.S. hospitals each year. Traditional treatments for DVT rely on anticoagulation to diminish the incidence of proximal propagation but do not directly address the thrombus itself.

Not all DVTs are the same, and essentially, the more proximal the DVT, the more painful and swollen the leg is initially and the more serious the long-term problems (the post-thrombotic syndrome). Therefore, more attention is focused on the ilio-femoral segment than elsewhere.

Methods of attacking the thrombus include surgical removal, chemical thrombolysis, ultrasound accelerated thrombolysis, mechanical thrombectomy, pharmaco-mechanical thrombectomy, aspiration, and a combination of these. The latter techniques are usually achievable in a single treatment session.

Venous thrombectomy relies on accurate diagnosis, usually a patent popliteal vein, and aggressive thrombus removal. Finally, successful thrombectomy commonly reveals an underlying venous stenosis, and this will require large-bore stent placement.

References

1. O'Sullivan GJ. Thrombolysis versus Thrombectomy in Acute Deep Vein Thrombosis. Interv Cardiol. 2011;3(5):589-596.
2. Comerota AJ, Paolini D. Treatment of Acute Iliofemoral Deep Venous Thrombosis: A Strategy of Thrombus Removal. Eur J Vasc Endovasc Surg. 2007; doi:10.1016.
3. Martinez Trabal JL, et al. The Quantitative Benefit of Isolated, Segmental, Pharmacomechanical Thrombolysis (ISPMT) for Iliofemoral Venous Thrombosis. J Vasc Surg. 2008;48:1532-1537.
4. O'Sullivan GJ, et al. Pharmacomechanical Thrombectomy of Acute Deep Vein Thrombosis with the Trellis-8 Isolated Thrombolysis Catheter. J Vasc Interv Radiol. 2007;18:715-724.
5. Kahn SR, Ginsberg JS. Relationship Between Deep Venous Thrombosis and the Postthrombotic Syndrome. Arch Intern Med. 2004;164:17-26.
6. Kahn SR, Ducruet T, et al. Prospective Evaluation of Health-Related Quality of Life in Patients with Deep Venous Thrombosis. Arch Intern Med. 2005;165:1173-1178.
7. Kahn SR, Shrler I, et al. Determinants and Time Course of the Postthrombotic Syndrome after Acute Deep Vein Thrombosis. Ann Intern Med. 2008;149:698-707.
8. Arko F, et al. Aggressive Percutaneous Mechanical Thrombectomy of Deep Vein Thrombosis. Arch Surg. 2007;142: 513-519.
9. Sharafuddin M, et al. Endovascular Management of Venous Thrombotic and Occlusive Diseases of the Lower Extremities. J Vasc Interv Radiol. 2003;14:405-423.

10. Enden T, Haig Y, et al. Long-Term Outcomes After Additional Catheter-Directed Thrombolysis Versus Standard Treatment for Acute Iliofemoral Deep Vein Thrombosis (the CaVent Study): A Randomized Controlled Trial. Lancet. 2012;379:31-38.
11. Rao AS, Konig G, et al. Pharmacomechanical Thrombectomy for Iliofemoral Deep Vein Thrombosis: An Alternative in Patients with Contraindications to Thrombolysis. J Vasc Surg. 2009;50:1092-1098.
12. Parikh S, Motarjeme A, et al. Ultrasound-accelerated Thrombolysis for the Treatment of Deep Vein Thrombosis: Initial Clinical Experience. J Vasc Interv Radiol. 2008;19:521-528.
13. Comerota AJ, Gravett MH. Iliofemoral Venous Thrombosis. J Vasc Surg. 2007;46:1065-1076.
14. Jaff MR, et al. Managment of Massive and Submassive Pulmonary Embolism, Iliofemoral Deep Vein Thrombosis, and Chronic Thromboembolic Pulmonary Hypertension: A Scientific Statement from the American Heart Association. Circulation. Apr 26, 2011.
15. Comerota AJ, Grewal N, et al. Postthrombotic Morbidity Correlates with Residual Thrombus Following Catheter-Directed Thrombolysis for Iliofemoral Deep Vein Thrombosis. J Vasc Surg. 2012;55:768-773.
16. Mewissen M, et al. Catheter-directed Thrombolysis for Lower Extremity Deep Venous Thrombosis: Report of a National Registry. Radiology 1999;211:39-49.
17. Kasirajan K, Gray B, Ouriel K. Percutaneous Angiojet Thrombectomy in the Management of Extensive Deep Venous Thrombosis. J Vasc Interv Radiol. 2001;12:179-185.
18. Comerota AJ. Thrombolysis for Deep Venous Thrombosis. J Vasc Surg. 2012;55:607-611.
19. National Quality Forum. National Voluntary Consensus Standards for Prevention and Care of Venous Thromboembolism: Additional Performance Measures. 2008.

2702.4

Mechanical intracranial thrombectomy

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Learning Objectives

1. To learn about the logistic requirements around intracranial thrombectomy
2. How to use different devices for thrombectomy
3. To learn about recent outcomes of intracranial thrombectomy

Mechanical thrombectomy has proven its efficacy in acute stroke with major vessel occlusion in recently published randomized trials (MR CLEAN, ESCAPE, and EXTEND IA). All studies showed the superiority of mechanical thrombectomy compared with conventional stroke therapy including IV lysis. Studies differ in patient selection, recanalization rate, and clinical outcome.

However, the studies to date provide no clear criteria for patient selection and treatment indication.

All studies proved the efficacy of stent retrievers, whereas aspiration techniques without retrievers have no positive clinical evidence yet.

Mechanical thrombectomy with stent retrievers can be performed in different technical strategies. The use of a proximal balloon-guiding catheter, intermediate catheters, or normal-guiding catheter represents different technical strategies. We present multicenter data comparing those techniques.

Special Session
Transcatheter embolisation in liver metastatic disease

2703.1

Neuroendocrine liver metastases

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Learning Objectives

1. To learn about pathology pathways of neuroendocrine liver metastases
2. To learn about when and how to treat neuroendocrine liver metastases
3. To learn about the outcomes of the treatment

Liver metastases from neuroendocrine tumors (NETs) have, similar to hepatocellular carcinomas (HCCs), a predominant blood supply from the hepatic artery. Using the ischemic effect of embolization particles alone (bland embolization; TAE) or combined with an intra-arterial injected chemotherapeutic agent (TACE), these minimally invasive procedures are indicated in NETs with progressive liver metastases or in a palliative situation, when symptoms do not respond to somatostatin analogs.

Loading the chemotherapeutic agent into embolization particles (drug-eluting beads, DEBs), the so-called DEB-TACE, offers a higher local toxicity but significantly lower rate of doxorubicin-related side effects. In the literature, there is still no significant difference regarding the time to progression between SIRT, TAE, and TACE/DEB-TACE, with a positive trend for TACE & DEB-TACE. (1-8)

References

1. Maire F, Lombard-Bohas C, O'Toole D, Vullierme MP, Rebours V, Couvelard A, et al. Hepatic arterial embolization versus chemoembolization in the treatment of liver metastases from well-differentiated midgut endocrine tumors: a prospective randomized study. Neuroendocrinology. 2012;96(4):294-300.
2. Guiu B, Deschamps F, Aho S, Munck F, Dromain C, Boige V, et al. Liver/biliary injuries following chemoembolisation of endocrine tumours and hepatocellular carcinoma: lipiodol vs. drug-eluting beads. Journal of hepatology. 2012;56(3):609-17.
3. Gaur SK, Friese JL, Sadow CA, Ayyagari R, Binkert CA, Schenker MP, et al. Hepatic arterial chemoembolization using drug-eluting beads in gastrointestinal neuroendocrine tumor metastatic to the liver. Cardiovascular and interventional radiology. 2011;34(3):566-72.
4. Peppa M, Brountzos E, Economopoulos N, Boutati E, Pikounis V, Patapis P, et al. Embolization as an alternative treatment of insulinoma in a patient with multiple endocrine neoplasia type 1 syndrome. Cardiovascular and interventional radiology. 2009;32(4):807-11.
5. de Baere T, Deschamps F, Teriitheau C, Rao P, Conengrapht K, Schlumberger M, et al. Transarterial chemoembolization of liver metastases from well differentiated gastroenteropancreatic endocrine tumors with doxorubicin-eluting beads: preliminary results. Journal of vascular and interventional radiology. 2008;19(6):855-61.
6. Marrache F, Vullierme MP, Roy C, El Assoued Y, Couvelard A, O'Toole D, et al. Arterial phase enhancement and body mass index are predictors of response to chemoembolisation for liver metastases of endocrine tumours. British journal of cancer. 2007;96(1):49-55.
7. Strosberg JR, Choi J, Cantor AB, Kvols LK. Selective hepatic artery embolization for treatment of patients with metastatic carcinoid and pancreatic endocrine tumors. Cancer control: journal of the Moffitt Cancer Center. 2006;13(1):72-8.

8. Gupta S, Johnson MM, Murthy R, Ahrar K, Wallace MJ, Madoff DC, et al. Hepatic arterial embolization and chemoembolization for the treatment of patients with metastatic neuroendocrine tumors: variables affecting response rates and survival. Cancer. 2005;104(8):1590-602.

2703.2

CRC liver metastases

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Learning Objectives
1. To learn about the newest guidelines on the treatment of CRC liver metastases
2. To learn about the role of embolisation techniques for CRC
3. To learn about the different techniques, and how and when to use them

No abstract available.

2703.3

Other liver metastases

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Learning Objectives
1. To learn whether there are guidelines for non-CRC treatment
2. To learn about different approaches and how these compare with those for CRC
3. To learn about the outcomes of different metastases

No abstract available.

2703.4

Portal vein embolisation

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Learning Objectives
1. To learn about the indications for portal vein embolisation
2. To learn about different approaches and techniques for PVE
3. To learn how to evaluate treatment success and outcome data

In patients suffering from liver malignancies (metastasis or primary liver cancer), surgical liver resection is usually the treatment method of choice. Depending on the extent of liver diseases, this may not be possible in the majority of patients (>70%). This is mostly due to extensive liver disease, which would result in insufficient healthy liver tissue (remnant liver tissue) after resection. Postoperative liver failure is feared as it occurs in up to 30% of patients. Portal vein embolisation (PVE) is performed in patients in whom resection cannot be performed due to small liver remnant. The rationale behind PVE is to occlude portal vein vessels of the diseased liver part, thereby stimulating compensatory contralateral hypertrophy to increase future liver remnant (FLR).
Different approaches are currently being used and have been evaluated in the literature: mainly perioperative portal branch ligation and percutaneous PVE. For interventional PVE, different embolisation materials have been used and described. Depending on local preference and availability, microparticles, coils, gelatin sponge, n-butyl cyanoacrylate with lipiodol, plugs and fibrin glue have been used. Often different embolisation materials are combined, e.g. peripheral embolisation with microparticles and proximal occlusion with plugs. Due to lack of prospective trials with different embolisation materials, evidence remains unclear as to the best embolisation material to choose; nevertheless, n-butyl cyanoacrylate resulted in the highest increase in FRL in the published studies (27.5-69.4%). Technical success rate is almost 100%. Usually four weeks prior to surgery, PVE is performed. PVE is performed if FLR to total liver ratio is <25-30%. Prior to surgery, FLR is calculated again, usually based on CT imaging. Portal venous access is usually gained under ultrasound guidance. No consensus exists regarding the choice of contralateral or ipsilateral approach. A 5-Fr access sheath is most commonly used. After visualisation of the portal branches, especially anatomical variants and segment IV branches, embolisation is performed from distal branches superselectively to central branches. Some authors recommend closure of the puncture route by gelfoam or other material, but again no consensus exists on this technique. Fortunately, complication rate is low. Most common minor complications are abdominal pain (20-23%) and fever (25-37%), while major complications such as liver abscess (0.3%) and cholangitis (0.2%) are extremely rare.

References

1. Denys A, Bize P, Demartines N, Deschamps F, De Baere T; Cardiovascular and Interventional Radiological Society of Europe. Quality improvement for portal vein embolisation. Cardiovasc Intervent Radiol 2010; 33(3):452–6.
2. van Lienden KP, van den Esschert JW, de Graaf W et al. Portal vein embolisation before liver resection: a systematic review. Cardiovasc Intervent Radiol 2013; 36(1):25–34.
3. Abulkhir A, Limongelli P, Healey AJ et al. Preoperative 37. portal vein embolization for major liver resection: a meta-analysis. Ann Surg 2008; 247:49–57.
4. Broering DC, Hillert C, Krupski G et al. Portal vein embolisation vs. portal vein ligation for induction of hypertrophy of the future liver remnant. J Gastrointest Surg 2002; 6:905–13.
5. Nagino M, Kamiya J, Nishio H et al. Two hundred forty consecutive portal vein embolizations before extended hepatectomy for biliary cancer: surgical outcome and long-term follow-up. Ann Surg 2006; 243:364–72.
6. de Baere T, Roche A, Elias D et al. Preoperative portal vein embolization for extension of hepatectomy indications. Hepatology 1996; 24:1386–91.
7. Kinoshita H, Sakai K, Hirohashi K et al. Preoperative portal vein embolisation for hepatocellular carcinoma. World J Surg 1986; 10:803–8.

Special Session
Malignant bone tumours: current evidence and new frontiers

2704.1

Focal treatment: when and how

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Learning Objectives
1. To learn about the indication of focal therapies
2. To learn about the differences of focal therapies
3. To learn about combination with systemic therapies

No abstract available.

2704.2

Pain palliation of bone metastases

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Learning Objectives
1. To learn about the different IR options
2. To learn about the role of radiation therapy
3. To learn about patient selection

No abstract available.

2704.3

Fractures: prevention and treatment

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Learning Objectives
1. To learn about technique of osteoplasty
2. To learn when osteoplasty is not enough
3. To learn the role of IR in minimal invasive osteosynthesis

Management of bone metastases is multidisciplinary, and the interventional radiologist has a key role to play. Several minimal percutaneous techniques have been developed over the past years to treat and prevent fractures. It offers an alternative to surgery in some indications. Fractures may occur because of an underlying bony tumour but also because of bone insufficiency. Another issue in cancer patients is the management of impending fractures, especially when the patient is asymptomatic. The interventional radiologist may face different clinical situations, and should be able to choose the most appropriate treatment regarding the location of the lesion, but also the symptoms and the general status of the patient. He should also be aware of the existing surgical possibilities, as interventional radiology is not appropriate for all situations. We will review the indications and evidences in the literature for different locations of lesions.

Spine

Vertebroplasty is indicated to consolidate malignant compression fractures of the vertebral body in the cervical, thoracic and lumbar spine. Publications about the use of cementoplasty to consolidate pathological fractures of the vertebral body have been published for more than 20 years, with a high level of evidence. Vertebroplasty reduces the pain related to pathological fractures and provides bone stabilization, thus avoiding further vertebral collapse. Although several publications have highlighted the safety and efficacy of other vertebral augmentation techniques (such as kyphoplasty, vertebral body stenting, and kiva implants), the benefit of these devices over conventional vertebroplasty in the management of malignant fractures is unclear.

With the improvement of imaging and follow-up, more and more asymptomatic lytic lesions are detected before a fracture occurs. Decision of prophylactic consolidation should be based on imaging features. The risk of vertebral body collapse increases with the percentage of bone destruction, and becomes significant if the tumour infiltrates more than 50% to 60% of the vertebral body in the thoracic spine and more than 35% to 40% in the lumbar spine. These rates decrease if there is an associated destruction of the posterior elements of the vertebra. Scores of spinal instability exist and may be used to decide whether vertebroplasty or surgery is the most appropriate.

In case of posterior wall disruption with epidural infiltration, surgery has to be discussed as the first-line treatment especially if the patient presents neurological symptoms. Percutaneous procedures associated to cementoplasty, such as plasma mediated radiofrequency ablation or mechanical removal of the tumour, have been reported but there are only case series and the level of evidence is low.

Pelvis

Pelvis is very frequent location of bone metastases. Cementoplasty has been widely used to treat lytic lesions of the acetabular roof with good results. Care should be taken in case of cortical disruption, as intra-articular cement leakage may have disastrous functional consequences.

Fixation of pathological fractures of the iliac wing with open surgery is effective and is usually performed in patients with a long life expectancy. In many cases, end-stage patients cannot benefit from a surgical treatment, as it is associated with a high morbidity. Cementoplasty may be used but mechanical properties of the cement are not adapted to stress forces applying to the iliac wing. Secondary fracture of a cemented zone is therefore likely to occur. Recently, percutaneous screw fixation has been proposed to treat these fractures. Several publications already reported the feasibility and safety of CT-guided screw fixation in the pelvis of trauma patients. Performing percutaneous osteosynthesis in cancer patients is feasible but may be technically more demanding, as the underlying bone is usually pathologic (whether it is lytic, blastic or both). Associated cementoplasty may help to fix the screws in the bone, therefore avoiding secondary dislodgement. It should be emphasized that there is only scarce literature available on the subject. Further studies are needed to confirm that percutaneous screw fixation is really effective.

Fractures or impending fractures of the proximal extremity of the femur requires surgery whenever possible. In non-surgical patients presenting with an impending fracture, combination of cementoplasty and screw fixation of the femoral neck may be proposed. Treatment should be proposed based on imaging and Mirel's score. To date, only 20 cases have been reported in the literature

Long bones of the limbs

Metastases in the limbs are associated with a high risk of fractures. To evaluate this risk, Mirel's score is widely used in the literature. The score evaluates the risk of secondary fracture based on the site, the size and the kind of lesion, and the presence of pain. In case of fracture or score>8, surgical fixation has to be considered. Intramedullary Nailing seems to be the most effective technique and offers an immediate consolidation with a minimal invasive approach. Alternatives to surgery, such as cement-filled catheters of flexible nails, have been proposed but there are only small case series in the literature. Cementoplasty alone has also been reported and seems effective to improve the pain and the mechanical function of the limb, especially for lesions measuring less than 3cm and located in the upper limb. Secondary fractures may occur (up to 10% in the literature). However, fracture in a cemented long bone does not preclude secondary surgery.

In conclusion, interventional radiology may help to treat patients, which are not surgical candidates. Except vertebroplasty, level of evidence of other percutaneous techniques is still low; and further studies are needed.

2704.4

The potential of high-intensity focused ultrasound

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Learning Objectives
1. To learn about the technique of MR guided HIFU
2. To learn about MR-HIFU beyond palliation
3. To learn about patient selection

Malignant bone tumors: current evidence and new frontiers

Bone is the third most common organ to which cancer metastasizes (1). The increase in life expectancy has resulted in more patients with

cancer and thus in an increase in the incidence of bone metastases, particularly in patients with prostate or breast cancer (2). However, while systemic disease progression is managed with chemotherapy alone, bone metastases may often require an additional independent local therapy in order to prevent skeletal complications and preserve the quality of life (1, 3). Pain is the most common symptom of bone metastases, with 50%–70% of patients suffering from severe pain.

Current treatments for patients with bone metastases are primarily palliative and include localized therapies (radiation and surgery), systemic therapies (chemotherapy, hormonal and radiopharmaceutical therapies, and bisphosphonates, although the primary goal of the use of these therapies is often to address the disease itself), and analgesics (opioids and non-steroidal anti-inflammatory drugs). Recently, radiofrequency ablation has been tested as a treatment option for bone metastases. Following large efforts in the field of technological and medical research to significantly reduce side effects of the conventional treatment and provide additional therapeutic options, several new modalities have been introduced in the last decades including radiofrequency, laser, microwaves, and cryoablation. External beam radiotherapy (EBRT) is the current noninvasive standard for local pain palliation; however, 20%–30% of patients do not achieve symptom relief (4, 5), and pain may recur in up to 25% of patients following treatment (6).

Magnetic resonance-guided focused ultrasound (MRgFUS) is already clinically approved in the European Union for the palliative care of bone metastases (7-9). MRgFUS combines focused ultrasound energy to thermally ablate tissue in combination with continuous MR imaging and thermal feedback. The treatment is noninvasive, does not require ionizing radiation, and usually conducted in an outpatient setting. Because focused ultrasound energy is nonionizing, there is no dose limit; treatment can be repeated, if needed, upon symptom recurrence or new tumor appearance. The major advantages of MRgFUS include MR-guided three-dimensional visualization for high-accuracy treatment planning, real-time monitoring of thermal damage in the target zone using MR thermometry, continuous temperature mapping of treated tissue (10), and immediate post-treatment assessment of therapy. An additional advantage of MRgFUS over other ablative techniques is the totally noninvasive nature of the focused ultrasound intervention. During treatment, real-time multislice MR thermometry was used to evaluate the rise in temperature of the tissue. Based on this feedback, portions of the periosteum and/or tumor that were not fully ablated may be retreated. This real-time MR feedback also enables the physician to overcome mis-registration due to respiratory or bulk patient movement (11-13).

In general, focused ultrasound systems produce acoustic energy by using a piezoelectric transducer that operates at frequencies of 200 kHz–4 MHz. At these energy levels, the interaction between focused ultrasound beams and biologic tissue results in a rise in cell temperature over the treated volume of tissue. The increased cell temperature leads to coagulative necrosis at a thermal range of 65–85°C depending on the tissue absorption coefficient (14-15). To achieve a greater and more rapid elevation in temperature, each sonication is usually limited to focal volumes of 0.2–5 mm^3, with a substantially negligible effect on the surrounding tissue. Sonications are limited in duration to only a few seconds, thereby reducing the potentially detrimental effects of perfusion and blood flow on energy distribution (16-17).

For pain palliation, the concentration of acoustic energy on the intact surface of cortical bone rapidly creates a temperature increase that determines critical thermal damage to the adjacent periosteum; because the periosteum is the highest innervated component of the mature bone tissue, its ablation is an extremely effective approach for pain management (18-19).

MRgFUS ablation is indicated to treat painful bone lesions from metastatic disease in patients with known history of malignancy, as shown by clinical or imaging examinations. In particular, MRgFUS ablation is indicated in patients who are considered radiation failures (those patients who received radiation without adequate symptom relief, those who can no longer undergo ERBT for safety reasons, and those who refuse other therapy options. In our department, we have evaluated the safety and efficacy of MRgFUS treatment for the pain palliation of lesions from different known primary tumors. Our study was conducted in patients who had exhausted EBRT as well as in patients not previously treated with EBRT for target metastases, and it demonstrated that MRgFUS can be effectively applied as primary noninvasive technique for pain palliation related to bone metastases (20). Clinical data include evaluation of visual analog pain score (VAS), changes in the drug schedule, and improvements in the quality of life. The VAS is an 11-point pain scale that ranges between 0 and 10 where 0 is considered to be no pain at all and 10 is the worst pain.

As compared with other biological tissues, the absorption rate of ultrasound by the cortical bone is up to 50 times higher, thereby allowing only a minimal fraction of the applied energy to penetrate across the cortex (16-17). As a result, for many years, the general consensus was that high-intensity focused ultrasound could not be used for the therapeutic ablation of lesions localized deeply within the bone marrow, thereby limiting its application to pain palliation in superficial lesions (13). Recently, it has been demonstrated that while both high acoustic absorption and low thermal conductivity of the cortical bone limit the diffusion of the conventional focused ultrasound energy to the cortex surface, the use of treatment protocols with modulated treatment parameters may achieve heating effect at therapeutic level deeper into the bone marrow (21). The modulation of treatment parameters for tumor control relies on system tuning to increase acoustic energy levels and sonication duration and to decrease the frequency, allowing heating beyond the cortex (22-24). In fact, lower the frequency, deeper is the penetration. Therefore, this technique also has a potential role in achieving local tumor control allowing remineralization of the trabecular bone or reducing the lesion size (25).

In our department, to evaluate treatment efficacy in terms of local tumor control, lesion changes were evaluated according to MD Anderson (MDA) criteria (20). High-intensity focused ultrasound creates a variable degree of lesion necrosis quantifiable with nonperfused volume (NPV) defined as the volume of cancer tissue enhancing at baseline that did not show any contrast uptake after treatment. The use of NPV parameter can represent an added value in the evaluation of treated area and should be analyzed in association with MDA criteria. The use of NPV as the immediate predictor of tumor necrosis and thus of the efficacy of the treatment might play an important role in future patient management, thereby avoiding persistence with a potentially ineffective treatment and consequences such as toxic effects and morbidity, accelerated tumor growth, delay in potentially effective treatment, and unnecessary expense.

MRgFUS is performed on an outpatient basis and has the potential to be repeated if necessary; moreover, the absence of adverse events suggests this treatment option as a viable alternative to standard pain palliation treatments including EBRT.

In conclusion, MRgFUS ablation is an extremely promising alternative therapy for pain palliation in patients suffering from bone metastases. The treatment can be performed in a single session, is non-invasive, does not use ionizing radiation, and utilizes MR guidance for precise targeting and thermal control, which confers a high-safety profile. Focused ultrasound energy creates bone metastasis necrosis, which might have a future role in local tumor control.

References

1. Selvaggi G, Scagliotti GV. Management of bone metastases in cancer: a review. Crit Rev Oncol Hematol 2005;56:365–378.
2. Kurup AN, Callstrom MR. Ablation of skeletal metastases: current status. J Vasc Interv Radiol 2010;21:S242–S250.
3. Mundy GR. Metastasis to bone: causes, consequences and therapeutic opportunities. Nat Rev Cancer 2002;2:584–593.
4. Hartsell WF, Scott CB, Bruner DW, et al. Randomized trial of short-versus long-course radiotherapy for palliation of painful bone metastases. J Natl Cancer Inst 2005;97:798–804.

5. 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.
6. Saarto T, Janes R, Tenhunen M, Kouri M. Palliative radiotherapy in the treatment of skeletal metastases. Eur J Pain 2002;6:323–330.
7. Liberman B, Gianfelice D, Inbar Y, et al. Pain palliation in patients with bone metastases using MR-guided focused ultrasound surgery: a multicenter study. Ann Surg Oncol 2009;16:140–146.
8. Catane R, Beck A, Inbar Y, et al. MR-guided focused ultrasound surgery (MRgFUS) for the palliation of pain in patients with bone metastases: preliminary clinical experience. Ann Oncol 2007;18:163–167.
9. Jolesz FA, McDannold N. Current status and future potential of MRI-guided focused ultrasound surgery. J Magn Reson Imaging 2008;27(2):391–399.
10. Gianfelice D, Gupta C, Kucharczyk W, Bret P, Havill D, Clemons M. Palliative treatment of painful bone metastases with MR imaging-guided focused ultrasound. Radiology 2008;249:355–363.
11. Rieke V, Vigen KK, Sommer G, Daniel BL, Pauly JM, Butts K. Referenceless PRF shift thermometry. Magn Reson Med 2004;51:1223–1231.
12. Arora D, Cooley D, Perry T, Skliar M, Roemer RB. Direct thermal dose control of constrained focused ultrasound treatments: phantom and in vivo evaluation. Phys Med Biol 2005;50:1919–1935.
13. Orsi F, Arnone P, Chen W, Zhang L. High intensity focused ultrasound ablation: a new therapeutic option for solid tumors. J Cancer Res Ther 2010;6:414–420.
14. Simon CJ, Dupuy DE, Mayo-Smith WW. Microwave ablation: principles and applications. Radiographics 2005;25:S69–S83.
15. Sapareto SA, Dewey WC. Thermal dose determination in cancer therapy. Int J Radiat Oncol Biol Phys 1984;10:787–800.
16. Jolesz FA, Hynynen K. Magnetic resonance image-guided focused ultrasound surgery. Cancer J 2002;8:S100–S112.
17. Jolesz FA. MRI-guided focused ultrasound surgery. Annu Rev Med 2009;60:417–430.
18. Gianfelice D, Gupta C, Kucharczyk W, et al. Palliative treatment of painful bone metastases with MR imaging-guided focused ultrasound. Radiology 2008;249:355–363.
19. Liberman B, Gianfelice D, Inbar Y, et al. Pain palliation in patients with bone metastases using MR-guided focused ultrasound surgery: a multicenter study. Ann Surg Oncol 2009;16:140–146.
20. Napoli A, Anzidei M, Cavallo Marincola B, et al. Primary pain palliation and local tumor control in bone metastases treated with magnetic resonance-guided focused ultrasound. Invest Radiol 2013;48:351–358.
21. Chen W, Zhu H, Zhang L, et al. Primary bone malignancy: effective treatment with high-intensity focused ultrasound ablation. Radiology 2010;255:967–978.
22. Chen WZ, Wu F, Zhu H, et al. High intensity focused ultrasound in the treatment of experimental malignant bone tumor. Chin J Ultrasonography 2001;10:313–315.
23. Chen WZ, Wu F, Zhu H, et al. Preliminary study on high intensity focused ultrasonic treatment of osteosarcoma. Chin J Clin Oncol 2001;28:489–491.
24. Chen W, Wang Z, Wu F, et al. High intensity focused ultrasound in the treatment of primary malignant bone tumor [in Chinese]. Zhonghua Zhong Liu Za Zhi 2002;24:612–615.
25. Napoli A, Anzidei M, Cavallo Marincola B, et al. MR imaging-guided focused ultrasound for treatment of bone metastasis. Radiographics 2013;33:1555–1568.

Honorary Lecture
Josef Roesch Lecture

2901.1

CLI beyond pipe fitting

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Critical limb ischemia (CLI) is an ill-defined clinical status. In daily practice, the diagnosis of CLI is based on clinical symptoms such as pain at rest, non-healing ulcers, or gangrene. These clinical signs can be supported by more or less objective parameters such as ABI, absolute ankle pressure, toe pressure, and transcutaneous oxygen measurement. In 1992, European consensus document, Nordgren, was published by defining CLI based on these parameters. It has been known for a long time that these objective parameters are variable and not an absolute proof of CLI but are merely supportive for the diagnosis of CLI. In daily practice, CLI is an absolute indication for revascularization as without revascularization, the limb will be lost. If this is true, it is very important to have a clear and undisputed agreement about what CLI is. From the literature, it has been shown that about 50% of patients who have CLI under the definition of the consensus document will not lose their limb, and their ulcers will heal without revascularization. It is also known that around 15% of patients with CLI will lose their leg despite revascularization. Therefore, according to the definition of CLI, 50% does not need revascularization and 15% will not benefit from any revascularization. It has been known for a long time that the result of revascularization by any technique for the endpoint limb salvage is around 85%. This is with or without a patent bypass or PTA. Because 50% will not lose their limb even without revascularization and 15% will, anyhow, be amputated, revascularization is only beneficial for the remaining 30% of the patients with CLI. The most important research question for the coming decade regarding CLI is therefore to develop tests to identify those 30% for whom revascularization is mandatory. This personalized treatment regarding CLI will lead to a huge reduction in costs without an extra limb loss.

Hot Topic Symposium
Paediatric IR – expand your horizons

2902.1

Aneurysmal bone cysts

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Aneurysmal bone cysts (ABCs) are benign, locally aggressive bone tumors most commonly diagnosed in the first and second decades of life. Historically, treatment consists of surgical intralesional excision or en bloc resection; however, recurrence rates are generally high ranging from 12% to 71%, with the highest recurrence rates seen in younger patients. In the 1990s, sclerotherapy was introduced as an alternative to surgical therapy and has proven to be highly effective with low recurrence rates and more favorable side-effect profile. Sclerotherapy offers a minimally invasive percutaneous option for therapy with decreased length of recovery, greater mobility, and lesser disruption of daily activities during treatment. This presentation will focus specifically on techniques, potential pitfalls, and expected outcomes when performing percutaneous sclerotherapy of ABCs as well as on the use of doxycycline as a chemical ablation agent for these lesions.

2902.2

Lymphatic malformations of the orbit

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Lymphatic malformations (LMs) of the orbit are benign vascular malformations, often diagnosed in early childhood. They are defined within the group of slow-flow malformations in the classification devised by Mulliken and Glowacki and recently updated by the International Society for the Study of Vascular Anomalies (ISSVA). Most commonly, orbital LMs present with slow, insidious proptosis or pseudoptosis, but they also can present with acute, painful proptosis secondary to intra-lesional haemorrhage. Complications include cellulitis, amblyopia and impaired visual acuity (VA). Historically, the management of orbital LMs has involved complex, aggressive surgical intervention with variable results and high recurrence rates; thus, oculoplastic surgeons are, understandably, reluctant to intervene in order to treat these lesions.

LMs of the orbit appear to be more commonly macrocystic than microcystic, although macrocystic orbital LMs may be associated with microcystic disease elsewhere on the face. The malformations may have a slow-flow venous component to them of variable significance. Orbital macrocysts occur in both intra- and extra-conal locations, often surrounding the optic nerve complex. Cysts vary in size and often contain altered blood, as demonstrated by varying signal characteristics on MRI. Long-standing lesions can be associated with bony orbital expansion.

Small published series have reported the use of percutaneous sclerotherapy for orbital LMs, with a variety of sclerosing agents and techniques. Results are very promising in terms of reduction in lesion size and improvement in proptosis. Detailed post-sclerotherapy VA outcomes are poorly documented, but the risk of damage to or the loss of VA appears to be low in experienced hands; in the author's experience, generally, VA improves significantly post-sclerotherapy.

Sodium tetradecyl sulphate and bleomycin are the sclerosing agents most commonly used in the orbit. Technique must be meticulous, with every effort made to exclude aberrant intra-cranial drainage or arterial communication before injecting the sclerosant. The initial post-operative course can be stormy due to swelling and inflammation within the orbit; hence, a robust ophthalmological back-up is essential. The volume of sclerosant must be titrated carefully according to the size and distribution of the lesion and the patient's recent ophthalmological history. The procedure usually needs to be repeated several times for complex, long-standing lesions. Recurrence is recognised.

There is a steep learning curve associated with orbital sclerotherapy, and treatment by an experienced team is strongly recommended.

2902.3

Lymphatic intervention in children

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Lymphatic system is an integral part of the body fluid exchange. Injury or disease of lymphatic ducts can result in significant morbidity and mortality. Over the years, the main impediment for the diagnosis and treatment of lymphatic flow disorders was the inability to image the lymphatic system. The new methods of central lymphatic imaging such as intranodal lymphangiogram and contrast-enhanced MR lymphangiogram provided new insights into the lymphatic anatomy and lymphodynamics in pathological conditions (1-3). Using these imaging techniques, it became possible to develop treatment algorithm of non-traumatic chylothorax (4). Minimally invasive intervention techniques of the central lymphatic system, including thoracic duct embolization and lymphatic disruption, proved to be effective methods in the treatment of the chylous effusions (5).

The new imaging techniques also allowed an understanding of the pathophysiology of diseases such as plastic bronchitis, neonatal chylothorax, and pulmonary lymphangiomatosis. This knowledge allowed the subsequent development of successful minimally invasive treatment strategies for these conditions (6,7).

Protein-losing enteropathy is a disease that is characterized by the loss of proteins in stool that results in significant reduction of the level of albumin in blood. Contrast-enhanced MR lymphangiogram and liver lymphangiogram allowed the successful identification of the leakage point of the intestinal and liver lymph into the intestinal lumen. Selective catheterization and embolization of the leaking vessels was successfully used to treat this condition.

Future, wider application of the MR lymphangiogram and liver lymphangiogram would allow the discovery of the role of the lymphatic flow in conditions such as ascites in liver cirrhosis, heart failure, and interstitial lung disease. An understanding of the underlying pathophysiology of these conditions will improve outcomes of the percutaneous treatment.

Lymphatic imaging and interventions are future frontiers of interventional radiology, and they would soon become a part of the treatment options that are offered by every interventional radiology department to treat both unique and common conditions.

References

1. Nadolski GJ, Itkin M. Feasibility of ultrasound-guided intranodal lymphangiogram for thoracic duct embolization. J Vasc Interv Radiol. 2012 May;23(5):613–6.
2. Dori Y, Zviman MM, Itkin M. Dynamic contrast-enhanced MR lymphangiography: feasibility study in swine. Radiology. 2014 Nov;273(2):410–6.
3. Itkin M, Kucharczuk JC, Kwak A, Trerotola SO, Kaiser LR. Nonoperative thoracic duct embolization for traumatic thoracic duct leak: experience in 109 patients. J Thorac Cardiovasc Surg. 2010 Mar;139(3):584–9; discussion 589–90.
4. Dori Y, Keller MS, Rychik J, Itkin M. Successful treatment of plastic bronchitis by selective lymphatic embolization in a Fontan patient. Pediatrics. 2014 Aug;134(2):e590–5.
5. Gray M, Kovatis KZ, Stuart T, Enlow E, Itkin M, Keller MS, et al. Treatment of congenital pulmonary lymphangiectasia using ethiodized oil lymphangiography. J Perinatol. 2014 Sep;34(9):720–2.

2902.4

Thrombolysis in children and adolescents

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Endovascular thrombolysis in children comprises mechanical, pharmacomechanical and catheter-directed therapies, as in the adult population, with options of angioplasty and stent placement when required.

In children, the use of thrombolytic therapy for non-limb-threatening DVT is based on the rationale that rapid clot dissolution will result in improved valve preservation and reduced post-thrombotic syndrome (PTS) risk, and it must be balanced with the risk of major hemorrhage. Goldenberg *et al.* in a small retrospective study of "high risk" lower extremity DVT in children identified significant difference in the incidence of PTS in children receiving thrombolysis (incidence, 22%) compared with that in children receiving anticoagulation alone (77%). To date, there are no randomized controlled trials comparing systemic thrombolytic therapy to catheter-directed therapy in children. Kukreja *et al.* reported greater than 90% thrombolysis response in a cohort of

41 children as young as 3 months of age undergoing endovascular thrombolysis for upper and lower extremity DVT, with a PTS incidence of 14%. In addition, this group also reported successful endovascular thrombolysis in 11 children less than 24 months of age, with positive thrombolysis response and rates of 95%–100% in 64% of cases.
Goldenberg *et al.* also reported rates of 94% for endovascular lysis in adolescents with a similar PTS rate of 13% at 1–2-year follow-up. Major bleeding rates and pulmonary embolism rates that were reported ranged from 2% to 8% and 0% to 2%, respectively.
PTS assessment, a major outcome assessment, is challenging in children due to the inability to accurately assess symptoms and the lack of validation of test/retest reliability. The two most used existing tools include modified Villalta and Manco-Johnson scales, both with limitations notwithstanding the lack of ability to compare with the standard Villalta score reported for adults. A recent-hematology working group recommended that when reporting PTS in a pediatric population, both scales are used for comparison, and that "definite PTS" is not reported until at least 1 year post-presentation and with two independent tests performed at least 3 months apart.
Randomized controlled trials need to be performed to assess risks and benefits of thrombolysis in children with extensive venous thrombosis limited somewhat by incidence. Currently, the prospective randomized ATTRACT trial will help define the benefits of catheter-based thrombus removal over anticoagulation alone in the adult population and provide guidance regarding inclusion and exclusion criteria for CDT, with a 2–4-year follow-up anticipated.

References

1. Thrombolysis for intravascular thrombosis in neonates and children. Raffini L. Curr Opin Pediatr. 2009 Feb;21(1):9-14. Review.
2. The fibrinolytic system in newborns and children. Parmar N, Albisetti M, Berry LR, Chan AK. Clin Lab. 2006;52(3-4):115-24. Review.
3. The influence of age on in vitro plasmin generation in the presence of fibrin monomer. Parmar N, Mitchell LG, Berry LR, Andrew M, Chan AK. Acta Haematol. 2006;115(3-4):141-51.
4. Long-term outcomes of venous thrombosis in children. Goldenberg NA. Curr Opin Hematol. 2005 Sep;12(5):370-6. Review.
5. A thrombolytic regimen for high-risk deep venous thrombosis may substantially reduce the risk of postthrombotic syndrome in children. Goldenberg NA, Durham JD, Knapp-Clevenger R, Manco-Johnson MJ. Blood. 2007 Jul;110(1):45-53.
6. Venous thromboembolic complications (VTE) in children: first analyses of the Canadian Registry of VTE. Andrew M, David M, Adams M, Ali K, Anderson R, Barnard D, Bernstein M, Brisson L, Cairney B, DeSai D, et al. Blood. 1994 Mar;83(5):1251-7.
7. Percutaneous mechanical and pharmacomechanical thrombolysis for occlusive deep vein thrombosis of the proximal limb in adolescent subjects: findings from an institution based prospective inception cohort study of pediatric venous thromboembolism. Goldenberg NA, Branchford B, Wang M, Ray C Jr, Durham JD, Manco-Johnson MJ. J Vasc Interv Radiol. 2011 Feb;22(2):121-32.
8. Post-thrombotic syndrome in children: a systematic review of frequency of occurrence, validity of outcome measures, and prognostic factors. Goldenberg NA, Donadini MP, Kahn SR, Crowther M, Kenet G, Nowak-Göttl U, Manco-Johnson MJ. Haematologica. 2010 Nov;95(11):1952-9.
9. Developing a pediatric endovascular thrombolysis program: a single-center experience. Kukreja K, Gruppo R, Chima R, Ristagno R, Racadio J. Pediatr Radiol. 2013 Aug;43(8):1024-9.
10. Safety and efficacy of catheter directed thrombolysis in children with deep venous thrombosis. Darbari DS, Desai D, Arnaldez F, Desai K, Kallen J, Strouse J, Streiff MB, Hong K, Takemoto CM. Brit J Haematol. 2012 Nov;159(3):376-8.
11. Low-dose tissue plasminogen activator thrombolysis in children. Wang M, Hays T, Balasa V, Bagatell R, Gruppo R, Grabowski EF, Valentino LA, Tsao-Wu G, Manco-Johnson MJ, et al. J Pediatr Hematol Oncol. 2003 May;25(5):379-86.
12. May-Thurner syndrome (iliac vein compression) and thrombosis in adolescents. Raffini L, Raybagkar D, Cahill AM, Kaye R, Blumenstein M, Manno C. Pediatr Blood Cancer. 2006 Nov;47(6):834-8.
13. The ATTRACT trial: rationale for early intervention for iliofemoral DVT. Comerota AJ. Perspect Vasc Surg Endovasc Ther. 2009 Dec;21(4):221-4; quiz 224-5.

Special Session
Venous Forum IV: Portal hypertension

3201.1

TIPS for refractory ascites and variceal bleeding

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Learning Objectives

1. To review the role of TIPS in the management of portal hypertension, with a particular focus on refractory ascites and variceal bleeding, according to the latest evidence
2. To review the role of TIPS as a bridge to liver transplantation, based on the experience at the IR Unit of CHBPT in Lisbon
3. To evaluate the likely role of TIPS in the future

Transjugular intrahepatic portosystemic shunt (TIPS) conception began over five decades ago, with the work of Rosch and Hanafee in the 1960s, although its widespread clinical use was only established in the 1990s, with great contributions from Colapinto and Richter the decade before. TIPS was in itself a problem solver for the treatment of portal hypertension. Being a percutaneous technique, it avoided the main problems raised by the creation of surgical shunts: open surgery and the requirement for revision or ligation at liver transplant. However, TIPS was also born with two important problems: patency, which was limited until the development of expanded polytetrafluoroethylene (e-PTFE)-covered stents, and hepatic encephalopathy, which can be a contraindication to, or a complication from, TIPS. The former benefitted from the development of e-PFTE-covered stents, and a significant improvement in patency ensued. The latter remains a challenge, with 3-7% of patients developing encephalopathy refractory to medical therapy, as a consequence of TIPS placement.
Two major indications were established for referring patients for TIPS placement: refractory ascites and variceal bleeding. Ascites refractory to medical treatment leads to poor prognosis and is currently the most frequent indication for TIPS placement. TIPS can relieve the ascites and decrease the need for diuretics and large-volume paracentesis, although survival and quality of life benefits have not been consistently shown. Acute variceal bleeding is the most immediately life-threatening complication of portal hypertension. In most cases, it can be controlled with pharmacologic and endoscopic treatment, and TIPS is usually reserved for failure of these approaches. Although technically feasible, mortality rates in this setting, with critically ill patients, are unsurprisingly high. The work of Garcia-Pagan and colleagues on early TIPS has shown that the role of TIPS can be expanded with direct benefits to selected patients.
Technically, the creation of TIPS requires appropriate training. There are numerous variations in TIPS placement technique, and the most important aspect is to use the one with which the interventional radiologist is most familiarized and which offers the best safety profile. From the literature and from our experience at the IR Unit of CHBPT in Lisbon, continuous experience is a critical factor in improving patient outcomes and procedure time, which is potentiated by working in a team environment.

In this lecture, we will review the role of TIPS in the management of portal hypertension, with a particular focus on refractory ascites and variceal bleeding, according to the latest evidence, on the role of TIPS as a bridge to liver transplantation, from our experience, and on projecting the role of TIPS into the future.

References

1. Cárdenas A, Baiges A, Hernandez-Gea V, García-Pagán JC. Endoscopic hemostasis in acute esophageal variceal bleeding. Gastroenterol. Clin. North Am. 2014 Dec;43(4):795–806.
2. Hernandez-Gea V, García-Pagán JC. Liver: Can we identify failure to control acute variceal bleeding? Nat Rev Gastroenterol Hepatol. 2014 Dec;11(12):705–6.
3. Ble M, Procopet B, Miquel R, Hernandez-Gea V, García-Pagán JC. Transjugular liver biopsy. Clin Liver Dis. 2014 Nov;18(4):767–78.
4. Copelan A, Kapoor B, Sands M. Transjugular intrahepatic portosystemic shunt: indications, contraindications, and patient work-up. Semin Intervent Radiol. 2014 Aug;31(03):235–42.
5. García-Pagán JC, Barrufet M, Cárdenas A, Escorsell A. Management of gastric varices. Clin Gastroenterol Hepatol. 2014 Jun;12(6):919–28.e1–quize51–2.
6. Garcia-Pagán JC, Di Pascoli M, Caca K, Laleman W, Bureau C, Appenrodt B, et al. Use of early-TIPS for high-risk variceal bleeding: Results of a post-RCT surveillance study. J Hepatol. European Association for the Study of the Liver; 2013 Jan;58(1):45–50.
7. Farsad K, Fuss C, Kolbeck KJ, Barton RE, Lakin PC, Keller FS, et al. Transjugular intrahepatic portosystemic shunt creation using intravascular ultrasound guidance. J Vasc Interv Radiol. 2012 Dec;23(12):1594–602.
8. García-Pagán JC, Caca K, Bureau C, Laleman W, Appenrodt B, Luca A, et al. Early use of TIPS in patients with cirrhosis and variceal bleeding. N Engl J Med. 2010 Jun;362(25):2370–9.
9. Boyer TD, Haskal ZJ. The role of transjugular intrahepatic portosystemic shunt (TIPS) in the management of portal hypertension: update 2009. Hepatology. 2010.
10. Bosch J, Berzigotti A, Garcia-Pagan JC. The management of portal hypertension: Rational basis, available treatments and future options. J Hepatol. 2008.
11. Colombato L. The role of transjugular intrahepatic portosystemic shunt (TIPS) in the management of portal hypertension. Journal of Clinical Gastroenterology. 2007 Nov;41(Supplement 3):S344–51.
12. D'Amico G, García-Pagán JC, Luca A, Bosch J. Hepatic vein pressure gradient reduction and prevention of variceal bleeding in cirrhosis: A Systematic Review. Gastroenterology. 2006 Nov;131(5):1611–24.

3201.2

Percutaneous treatment options in portal vein thrombosis

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Learning Objectives

1. To describe the indications for acute and chronic portal and mesenteric vein occlusion treatment
2. To outline techniques and devices for recanalising portal and mesenteric vein occlusion
3. To describe the results of thrombectomy, thrombolysis, and mechanical recanalisation

The portal vein (PV) is a closed system between two low-pressure capillary networks (1). Its thrombosis mainly occurs not only in patients with liver cirrhosis (2-4) but also in patients without liver disease (5, 6) as a complication of hypercoagulable syndromes, latent or overt myeloproliferalive disorder (7), and inflammatory processes in the abdominal cavity and as a result of iatrogenic injury (8, 9).

PV obstruction causes portal hypertension. There are several terms describing various clinical settings in relationship with PV obstruction in the current literature.

1. PV thrombosis in liver cirrhosis could be caused by impaired blood flow due to intrahepatic sinusoidal block, and it is observed in up to 17% of patients with liver cirrhosis, especially in more advanced stages of disease. PV invasion frequently occurs in hepatocellular carcinoma, and it has become one of the most important prognostic factors for this disease (10).

2. Extrahepatic PV obstruction (EHPVO) is a vascular disorder of the liver. It is defined by the obstruction of the extra-hepatic PV with or without the involvement of intra-hepatic PV branches or splenic or superior mesenteric veins.

3. Isolated occlusion of the splenic vein caused by pancreatitis and/or external compression or infiltration by pancreatic tumorous expansion or tumors.

4. Acute PV thrombosis nonspecifically presents with abdominal pain, fever, and nausea. Majority of patients have splenomegaly. In contrast to the Budd-Chiari syndrome, ascites are rarely present. The most significant complication is venous bowel ischemia due to the extension of thrombosis to mesenteric veins (11).

5. Chronic PV thrombosis has a variety of clinical presentations. Majority of patients could be asymptomatic, and PV chronic thrombosis is an incidental finding. This can be explained by two compensatory mechanisms. There is compensatory increase of arterial blood flow in the hepatic artery and fast development of the collateral venous network bypassing the obstruction. Due to this compensatory arterial and venous blood flow, there is no or minimal reduction of blood inflow to the liver. However, portal hypertension develops with bleeding from gastroesophageal varices and portal gastropathy. There is a 12% risk of bleeding per year; higher risk is observed in patients with larger varices and previous history of bleeding. Portal biliopathy is another possible complication of chronic PV obstruction. It results from the obstruction of bile ducts by ectatic venous collaterals in their wall. There is a risk of extension of thrombosis to mesenteric veins with bowel ischemia (6).

Percutaneous recanalization of acute PV thrombosis significantly differs from chronic PV occlusion in indications, technique, technical results, clinical outcome, and complications.

Partial or complete acute PV thrombosis, which arises frequently as an urgent indication for TIPS because of endoscopically uncontrolled variceal bleeding, does not change the usual technique of TIPS. Released thrombi in the PV can cause obstruction of the new shunt and have to be mechanically removed. As soon as sufficient flow is established, remaining thrombi in the PV will dissolve with time.

TIPS is technically difficult in chronic EHPVO, and its indication depends on the patency of some intrahepatic PV branches and on the extension of chronic thrombosis towards splenic and/or mesenteric veins. Technical success depends on the possibility to cross chronic vein obstruction with hydrophilic guidewire (12-15).

Isolated splenic vein occlusion is usually indicated to splenectomy and/or surgical porto-systemic bypass. However, endovascular recanalization via transjugular or trans-splenic approach is feasible (16).

Percutaneous endovascular procedures are used as an alternative to sclerotherapy or surgical shunting in order to improve clinical symptoms. Their main role is to debulk the thrombus by means of mechanical thrombectomy or pharmacological thrombolysis alone or by blood flow facilitation using TIPS (1,17,18).

Techniques of portal vein recanalization

The crucial imaging modality is contrast-enhanced CT, which demonstrates patency of intrahepatic portal branches, splenic, mesenteric, and hepatic veins, and the inferior vena cava, and extension of the thrombus towards feeders of the PV.

Our primary approach is a transjugular one for the portal vein access using Rosch-Uchida set (Cook Inc., USA) and 180-cm angled

tip hydrophilic guidewire (Terumo, Japan). As soon as the guidewire is safely in the PV, TIPS is performed using bare stent. Through this approach, we utilize various mechanical devices to fragment and aspirate the thrombus (Arrow-Trerotola Over-The-Wire PTD Kit; Arrow International, Inc.). As soon as the blood flow is reestablished, we wait for at least 10 minutes for any sign of recurrent thrombosis or flow impairment.

Acute and subacute thrombus is soft and easy to cross with hydrophilic guidewire. In case blood flow is not established, a 5-F catheter is left wedged in the thrombus for overnight local thrombolysis infusion. Thrombolysis is allowed to proceed only if there are no contraindications such as recent variceal bleeding or multiple errant punctures made during the PV access (19).

Recanalization of chronic PV occlusion is difficult and should be performed as an elective procedure by an experienced interventional radiologist. In this procedure, we use transjugular access as a primary approach and transhepatic or trans-splenic as auxiliary accesses if transjugular approach fails. In some cases, combined approach is necessary as the initial one (20, 21). The crucial step is crossing the occluded segment of the vein by hydrophilic guidewire. Balloon angioplasty is performed with a 4–5-mm balloon catheter. Portogram should follow immediately after dilatation to exclude extravasation. Recanalized segment is definitively dilated with a bare stent, including intrahepatic channel. Usually two overlapped stents are required to cover the whole tract.

Embolization of portosystemic collaterals can facilitate blood flow through the shunt. Stent implantation should be performed always with respect to future liver transplant (22-24).

Besides complications of TIPS or transhepatic access, there is a higher risk of intraperitoneal bleeding in the recanalization of chronic PV occlusion. This increased risk is because of more complex procedures lasting usually twice as long as regular TIPS. Acute rethrombosis of relatively long shunt can occur early. This can be facilitated by low flow through the shunt and possible hypercoagulation syndrome presented in patients with myeloproliferative disease. These patients require strict anticoagulation, and the long-term patency of their shunts is always worse than that in patients with regular liver cirrhosis.

Technical success rate in acute PV thrombosis does not differ from the usual TIPS. Good long-term patency in patients with thrombophilia has to be maintained by anticoagulation therapy, and more frequent ultrasonographic controls are required to reveal asymptomatic stenosis of the shunt. Use of dedicated ePTFE stent-grafts is recommended in these patients because these stent-grafts proved to be less thrombogenic than bare stents.

Technical success rate of recanalization procedures performed for chronic PV occlusion varies among centers. It has been reported from 35% to 100%. Investigated series included 12–57 patients (13-15,17).

References

1. Bilbao JI, Elorz M, Vivas I et al. Transjugular intrahepatic portosystemic shunt (TIPS) in the treatment of venous symptomatic chronic portal thrombosis in non-cirrhotic patients. Cardiovasc Intervent Radiol 2004; 27: 474-480.
2. Tsochatzis EA, Senzolo M, Germani G, Gatt A, Burroughs AK. Systematic review: portal vein thrombosis in cirrhosis. Aliment Pharmacol Ther 2010; 31: 366-374.
3. Fimognari FL, Violi F. Portal vein thrombosis in liver cirrhosis. Intern Emerg Med 2008; 3: 213-218.
4. Gulley D, Teal E, Suvannasankha A, Chalasani N, Liangpunsakul S. Deep vein thrombosis and pulmonary embolism in cirrhosis patients. Dig Dis Sci 2008; 53: 3012-3017.
5. Hall TC, Garcea G, Metcalfe M, Bilku D, Dennison AR. Management of acute non-cirrhotic and non-malignant portal vein thrombosis: a systematic review. World J Surg 2011; 35: 2510-2520.
6. Sarin SK, Solano JD, Chawla YK et al. Consensus on extra-hepatic portal vein obstruction. Liver Int 2006; 26: 512-519.
7. Tripodi A, Anstee QM, Sogaard KK, Primignani M, Valla DC. Hypercoagulability in cirrhosis: cause and consequences. J Thromb Haemost 2011; 9: 1713-1723.
8. Adani GL, Baccarani U, Risaliti A et al. Percutaneous transhepatic portography for the treatment of early portal vein thrombosis after surgery. Cardiovasc Intervent Radiol 2007; 30: 1222-1226.
9. Cai M, Zhu K, Huang W et al. Portal vein thrombosis after partial splenic embolization in liver cirrhosis: efficacy of anticoagulation and long-term follow-up. J Vasc Interv Radiol 2013; 24: 1808-1816.
10. Zhang XB, Wang JH, Yan ZP, Qian S, Liu R. Hepatocellular carcinoma invading the main portal vein: treatment with trancatheter arterial chemoembolization and portal vein stenting. Cardiovasc Intervent Radiol 2009; 32: 52-61.
11. Pfammatter T, Benoit C, Cathomas G, Blum U. Budd-Chiari syndrome with spleno-mesenteric-portal thrombosis: treatment with extended TIPS. J Vasc Interv Radiol 2000; 11: 781-784.
12. Senzolo M, Tibbals J, Cholongitas E et al. Transjugular intrahepatic portosystemic shunt for portal vein thrombosis with and without cavernous transformation. Aliment Pharmacol Ther 2005; 73: 767-775.
13. Luo JJ, Yan ZP, Wang JH, Liu QX, Qu XD. Endovascular treatment of nonacute symptomatic portal venous thrombosis through intrahepatic portosystemic shunt approach. J Vasc Interv Radiol 2011; 22: 61-69.
14. Fanelli F, Angeloni S, Salvatori FM et al. Transjugular intrahepatic portosystemic shunt with expanded-polytetrafuoroethylene-covered stents in non-cirrhotic patients with portal cavernoma. Dig Liver Dis 2011; 43: 78-84.
15. Qi X, Han G, Yin Z et al. Transjugular intrahepatic portosystemic shunt for portal cavernoma with symptomatic portal hypertension in non-cirrhotic patients. Dig Dis Sci 2012; 57: 1072-1082.
16. Luo X, Nie L, Wang Z, Tsauo J, Tang C, Li X. Transjugular endovascular recanalization of splenic vein in patients with regional portal hypertension complicated by gastrointestinal bleeding. Cardiovasc Intervent Radiol 2014; 37: 108-113.
17. Han G, Qi X, He C et al. Transjugular intrahepatic portosystemic shunt for portal vein thrombosis with symptomatic portal hypertension in liver cirrhosis. J Hepatol 2011; 54: 78-88.
18. Cao G, Ko GY, Sung KB, Yoon HK, Gwon D II, Kim JH. Treatment of postoperative main portal vein and superior mesenteric vein thrombosis with balloon angioplasty and/or stent placement. Acta Radiologica 2013; 54: 526-532.
19. Bilbao JJ, Longo JM, Rousseau H et al. Transjugular intrahepatic portocaval shunt after thrombus disruption in partially thrombosed portal veins. Cardiovasc Intervent Radiol 1994; 17: 106-109.
20. Zhu K, Meng X, Zhou B et al. Percutaneous transsplenic portal vein catheterization: technical procedures, safety, and clinical applications. J Vasc Interv Radiol 2013; 24: 518-527.
21. Citron SJ. TIPS in portal vein occlusions: facilitation with percutaneous splenic access. J Vasc Interv Radiol 1998; 9: 363-364.
22. Marini M, Gómez-Gutierrez M, Cao I et al. Endovascular treatment of splenomesenteric-portal vein thromboses during orthotopic liver transplantation. J Vasc Interv Radiol 2005; 16: 1135-1142.
23. Yerdel MA, Gunson B, Mirza D et al. Portal vein thrombosis in adults undergoing liver transplantation: risk factors, screening, management, and outcome. Transplantation 2000; 69: 1873-1881.
24. Englesbe MJ, Schaubel DE, Cai S, Guidinger MK, Merion RM. Portal vein thrombosis and liver transplant survival benefit. Liver Transpl 2010; 16: 999-1005.

3201.3

Percutaneous management of Budd-Chiari syndrome

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Learning Objectives

1. To review the indications, pre-procedural imaging and clinical evaluation
2. To outline IR techniques for patients with Budd-Chiari syndrome
3. To discuss the results of early TIPS in comparison with other treatments in acute, subacute and chronic Budd-Chiari syndrome

Budd-Chiari Syndrome

Synonyms

Thrombotic hepatic vein obstruction, nonthrombotic hepatic vein obstruction, obliterating hepatic vein endophlebitis, hepatic obstruction, and acute parenchymatous jaundice.

Definition

Budd-Chiari syndrome (BCS) is a rare condition, and it describes an entity of diseases characterized by thrombotic or nonthrombotic obstruction to hepatic venous outflow (1). The obstruction may completely or partially block the hepatic veins. George Budd (1808–1882) described it in 1845, and Hans Chiari added the first pathologic description of the liver with "obliterating endophlebitis of hepatic veins" in 1899.

Pathology/histopathology

Obstruction of intrahepatic veins leads to hepatic congestion and hepatopathy as blood flows into but not out of the liver. Characteristically, the caudate lobe of the liver is spared due to direct venous channels from the inferior vena cava. The blood accumulation in the liver raises the pressure in non-occluded hepatic veins and portal veins leading to portal hypertension. Hepatocellular injury results from microvascular ischemia due to congestion, thereby resulting in liver insufficiency.

Clinical presentation

In the western world, BCS is predominantly seen in women. Age at presentation is usually the third or fourth decade of life, although the condition may also occur in children or elderly persons. Rajani *et al.* (2) found an incidence of approximately one case per million population per year in Sweden. Symptoms of BCS may begin suddenly and severely, but usually, they begin gradually. Hepatomegaly, ascites, and abdominal pain characterize BCS, but all these symptoms are nonspecific. Four main clinical variants have been described (3): A) acute form (20%), which is characterized by rapid development of abdominal pain, ascites, hepatomegaly, jaundice, and renal failure; B) fulminant form (5%) in which the patients may present with fulminant or subfulminant hepatic failure along with ascites, tender hepatomegaly, jaundice, and renal failure; C) subacute/chronic form that is the most common form (60%) complicated by the symptoms of portal hypertension and varying degrees of liver insufficiency, and approximately 50% of patients also have renal impairment. Further severe complications in these patients and parameters determining the outcome are progressive liver insufficiency, hydrothorax, hepatic encephalopathy, portal vein thrombosis, inferior vena cava thrombosis, and variceal bleeding. Approximately 15%–20% of patients with BCS may be asymptomatic (4).

Imaging

As imaging modalities, we use ultrasound, magnetic resonance imaging (MRI), and computed tomography (CT) scan to diagnose BCS. Using ultrasound, thrombi can be visualized, and duplex sonography is the preferred mode. Sensitivity and specificity on combining different modes of ultrasound are 85%–90%. MRI scanning with pulsed sequencing helps in the assessment of hepatic venous and portal blood flow, and sensitivity and specificity are more than 90%. CT is the workhorse imaging system in most radiology departments and diagnostic centers dealing with liver diseases. Contrast CT is fast and patient friendly, and it has the unique ability to image all thoracic and abdominal structures. Advances in technology and clinical performance using multidetector CT enable the diagnosis of BCS and the accompanying complications (e.g., liver cirrhosis, ascites, and hydrothorax).

Diagnosis

The most important diagnostic workup is the imaging modalities such as duplex sonography and CT. In addition to routine laboratory tests (usually nonspecific), the following tests should be performed to evaluate hypercoagulable state: protein C activity, antithrombin, total and free protein S, activated protein C resistance, prothombin gene G2021OA mutation, homocysteine concentration, factor V Leiden mutation, lupus anticoagulants, plasminogen, fibrinogen, and heparin antibodies. The diagnosis of bone marrow disorders, such as polycythemia vera, essential thrombocytosis, myeloproliferative syndrome, and myelofibrosis, has to be established or excluded according to international definitions (3, 5). Examination of ascitic fluid provides useful clues to the diagnosis because patients usually have high protein concentrations (>2 g/dL), but this may not be present in persons with the acute form of BCS. A biopsy of the liver is not compulsory for the diagnosis. Typical histologic findings after liver biopsy are high-grade venous congestion and centrilobular liver cell atrophy and thrombi within terminal hepatic venules. The extent of fibrosis and cirrhosis can be determined based on biopsy findings.

Interventional radiological treatment

Treatment options include medical therapy, balloon dilation (PTA) of hepatic vein, portal systemic shunt surgery, transjugular intrahepatic portosystemic shunt (TIPS), and liver transplantation. Irrespective of the course of the disease, a side-to-side shunt or liver transplantation is indicated if medical treatment fails. In recent years, a number of reports of TIPS as a treatment for BCS have appeared (3, 5, 6, 7).

TIPS

Definition and pathophysiological background

Patients with severe liver diseases, such as cirrhosis and BCS, suffer from circulation problems. The blood from the lower part of the body normally returns to the heart through blood vessels passing through the liver (hepatic portal vein). If the liver is damaged or the hepatic venous outflow is obstructed, this upward flow of blood becomes difficult, leading to portal hypertension. The consequences are that the fluid tends to pool in the legs (edema) and inside the abdomen (ascites) and blood may flow in unusual pathways such as through vessels around the esophagus and stomach. These vessels may become swollen with blood over time (esophageal and gastral varices) and bleed.

One way to treat this portal hypertension is to form a new connection inside the damaged liver, which allows for the better flow of blood back to the heart (7). This procedure is called as the intrahepatic shunt (tube connection inside the liver). It can be performed by inserting a metallic endoprosthesis (stent) into place through a vein in the neck (transjugular) down into the liver. The link between the high-pressure portal and low-pressure hepatic vein is an incomplete side-to-side shunt (H-shunt). In patients with bleeding, TIPS can be combined with the embolotherapy of varices (8). The rationale for embolotherapy is at the same setting via the transjugular vein to use long-acting occluding agents embolizing proximal and peripheral collateral veins by combining liquid and mechanical materials in order to prevent collateralization and reperfusion.

Indication and contraindication

The purpose of TIPS is to achieve portal decompression. Since the first TIPS was performed on patients with poor liver function and active variceal hemorrhage in 1988, indications for performing TIPS have increased. Recommendations from a consensus meeting are to discuss accepted indications (+++), potential indications with proven efficacy (++), experimental indications with efficacy not proven by large-scale series (+), indications not accepted (case reports only) (-), and absolute contraindications (--) for shunting with TIPS.

Accepted indications (+++) are as follows: 1. acute variceal bleeding that can neither be successfully controlled with pharmacological agents nor can it be controlled with mechanical compression or endoscopic techniques and 2. recurrent variceal bleeding in patients who are refractory or intolerant to conventional medical management, including sclerotherapy and pharmacological therapy.
Potential indications with proven efficacy (++) are as follows: 1. refractory ascites (serious tense ascites that does not respond to standard therapy within 4 weeks or when the patient develops secondary effects, making treatment impossible) and 2. symptomatic BCS and veno-occlusive syndrome if medical therapy fails. The rationale for TIPS in BCS is to improve hepatic blood flow and function by the creation of an artificial outflow via the portal vein bed. The side-to-side shunt allows retrograde arterial perfusion of sinusoids thus reducing the hypoxic damage of hepatocytes, leading to improvement in liver histology.
Absolute contraindications are as follows: 1) hepatic insufficiency and chronic, severe encephalopathy; 2) severe right heart cardiac insufficiency; 3) diffuse or multinodular liver cancer or tumors in the proposed route of TIPS; 4) advanced cancer; 5) bacterial peritonitis or systemic infection; and 6) unrelieved biliary obstruction.
Results
From a technical point of view, successful placement of TIPS is achieved in more than 95% of patients. Performing TIPS in a patient with BCS can be difficult if the hepatic vein is completely occluded. In meta-analyses of the TIPS literature, the incidence of fatal complications (intra-abdominal hemorrhage, laceration of the hepatic artery or the portal vein, and right heart failure) was 1.7% (range, 0.6%–4.3%). Major procedural complications are expected in no more than 3% of cases.
Both randomized and nonrandomized studies have strengthened the evidence that TIPS is more effective than endoscopic therapy in the prevention of variceal bleeding. In randomized trials, the 1-year rebleeding rate ranged between 10% and 27% for TIPS and between 21% and 57% for endoscopic treatment. In a nonrandomized study, 2-year and 4-year rates of patients who were free of rebleedings were 61% and 53%, respectively, in patients treated with TIPS alone and 84% and 81%, respectively, in patients treated with TIPS and adjunctive embolotherapy of gastroesophageal collaterals (8).
All randomized trials, but one, found TIPS to be more effective than endoscopic therapy for avoiding variceal rebleeding, but the average survival of patients treated with TIPS was not higher than the average survival of patients treated with endoscopic therapy. The incidence of encephalopathy was significantly higher in patients treated with TIPS in four of nine trials.
Several nonrandomized and five randomized studies have evaluated the effect of TIPS on refractory ascites compared with that of large volume paracentesis (LVP). In the TIPS group, the control of ascites was more frequently achieved at 4 months (66% vs. 24%) and 12 months (55% vs. 19%), whereas encephalopathy was higher (55% vs. 38%). Survival at 1 year and 2 years was not different between patients treated with TIPS and those with LVP.
There have been a number of case reports and three small series on the outcome of patients with BCS who have received TIPS. The largest series reports the technical and clinical success rates of 35 patients (6). TIPS was successfully implanted in 33 patients (94%). Clinical symptoms (11 patients had fulminant/acute form; 13, subacute; and 11, chronic course of disease) as well as biochemical test results improved significantly during 4 weeks after treatment. One-year and 5-year survival rates without transplantation in all patients were 93% and 74%, respectively.
In summary, BCS is a rare, life-threatening disease caused by the obstruction of hepatic veins, and patients should be managed by a step-wise approach using anticoagulation, angioplasty/thrombolysis, TIPS, and orthotopic liver transplantation. The decision to create TIPS in a patient with BCS should be based on the severity of disease, and only patients with moderate disease primarily appear to be good candidates for TIPS. Patients with BCS and mild disease can be managed medically, whereas those with more severe disease or acute hepatic failure are best managed by liver transplantation. On the other hand, in the light of not enough available compatible organ for transplantation, transjugular shunt should always be considered as a treatment for fulminant/acute, subacute, and chronic, severe BCS.

References

1. Dilawari JB, Bambery P, Chawla Y et al (1994) Hepatic outflow obstruction (Budd-Chiari syndrome). Experience with 177 patients and a review of the literature. Medicine (Baltimore) 73:21-36.
2. Rajani R, Melin T, Björnsson E et al (2009) Budd-Chiari syndrome in Sweden: epidemiology, clinical characteristics and survival - an 18-year experience. Liver Int 29:253-259.
3. Senzolo M, Cholongitas EC, Patch D, Burroughs AK (2005) Update on the classification, assessment of prognosis and therapy of Budd-Chiari syndrome. Nat Clin Pract Gastroenterol Hepatol 2:182-190.
4. Hadengue A, Poliquin M, Vilgrain V et al (1994) The changing scene of hepatic vein thrombosis: Recognition of asymptomatic cases. Gastroenterology 106:1042-1047.
5. Susana S, Aurelie P, Jildou H et al (2013) Good long-term outcome of Budd-Chiari syndrome with a step-wise management. Hepatology 57:1962-1968.
6. Rössle M, Olschewski M, Siegerstetter V et al (2004) The Budd-Chiari syndrome: outcome after treatment with transjugular intrahepatic portosystemic shunt. Surgery 135:394-403.
7. Boyer TD, Haskal ZJ (2010) AASLD practice guidelines: The role of transjugular intrahepatic portosystemic shunt in the management of portal hypertension. Hepatology. Web only.
8. Tesdal IK, Filser T, Weiss C et al (2005) Transjugular intrahepatic portosystemic shunt: adjunctive embolotherapy of gastroesophageal collaterals in the prevention of variceal rebleeding. Radiology 236:360-367.

3201.4

BRTO – why, when and how?

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Learning Objectives

1. To learn who the suitable patients for BRTO are
2. To learn how to perform BRTO
3. To compare the results of BRTO and TIPS in the treatment of gastric varices

No abstract available.

Special Session
State-of-the-art biliary and pancreatic malignancy treatment

3202.1

Intrahepatic cholangiocarcinoma: interventional treatments

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Learning Objectives

1. To learn about the indications for IR treatments
2. To learn about the role of radioembolisation and ablation
3. To learn about the outcomes and complications

No abstract available.

3202.2

Hilar cholangiocarcinoma: palliation strategies

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Learning Objectives

1. To learn about the indications for IR treatments
2. To learn about the role of stenting vs. brachytherapy vs. external radiation
3. To learn about the outcomes and complications

Tumours growing from the epithelium of the biliary tract are most common in the hilar region (65% of cases), and the complexity of the perihilar liver region causes curative surgical resection to be very complicated. Only a small percentage of such tumours are detected at an early stage. Tumours located in the hilar region often infiltrate early and encircle the vascular system (the branches of the common hepatic artery and portal vein), and cholangiocarcinomas also expand longitudinally into the intra- and extrahepatic bile ducts, submucosally and perineurially. Even though surgical techniques are continually improving, resectability of hilar cholangiocarcinomas is in the range of 15–20%, the 5-year survival rate is in the range of 10–30%, and local recurrence occurs in 75% of cases.

The effect of systemic chemotherapy alone in the treatment of non-resectable cholangiocarcinomas is very limited. On the other hand, it is very difficult to objectively evaluate the effectiveness of treating locally advanced biliary tumours by radiological means, although this situation is somewhat better in the metastatic stage. In the past, the application of fluoropyrimidine derivatives achieved therapeutic response in only 30% of cases. These days, gemcitabine in combination with platinum agents is widely accepted as the first-line therapy for locally advanced biliary tract cancer. Regional chemotherapy aims to increase the concentration of chemotherapeutics in the affected area while decreasing side effects, and that should result in better response rates to the agents. There are many tested therapeutic regimes combining systemic delivery with intra-arterial chemotherapy or chemoembolization, which, in some selected patients, are able to achieve successful palliation. No combination, however, has yet become the standard therapy.

Currently, a wide choice of palliative treatments for biliary obstruction is offered. In addition to palliative surgical procedures, there are many endoscopic therapeutic methods [e.g. nasobiliary drainage, implantation of plastic prostheses or self-expandable metallic stents (SEMS)] and percutaneous therapeutic methods such as percutaneous drainage (PTBD) and implantation of plastic endoprostheses or metallic stents. There are several competing techniques and interventions for palliative treatment of hilar cholangiocarcinoma, including radiation therapies (external beam, intraluminal brachytherapy), photodynamic therapies, and intraluminal radiofrequency ablation, and they, with the exception of intravenous chemotherapy, cannot be considered as standard care. More often, they are so-called tailored oncological therapies.

Endoscopic drainage of hilar strictures is also technically possible, although this has a lower success rate and higher risk of complications. In light of its difficulty, percutaneous access is usually recommended instead. An advantage of percutaneous access is precise choice of drainage lobe, while disadvantages include local pain and complications at the site of the puncture. Historical data supports the drainage of hilar strictures crossing at the proximal branch of the biliary tree using multipath stents. According to Deviere, insertion of two or more stents was associated with significantly higher survival in patients (179 vs. 119 days), decreased incidence of cholangitis (17 vs. 38%), lower 30-day mortality (8 vs. 29%), and decreased incidence of early death (13 vs. 46%) when compared with the group of patients who underwent unilateral drainage.

Even though drainage of merely 25% of liver volume can successfully relieve symptoms of jaundice also in cases of hilar strictures, the question remains whether a single stent can provide for long-term survival, either independently or with the use of other palliative techniques.

The advantage of plastic temporary stents is their low price, while their high occlusion rate is a disadvantage. Repeated replacement of endoscopically inserted stents or percutaneous internal-external biliary drainage means lower quality of life for the patient in comparison with drainage using SEMS. Percutaneous internal-external drainage necessitates caring for the outer part of the drain, as this constitutes a direct external pathway for microbial flora into the biliary ducts. With long-term use of internal-external drainage, there is a risk of frequent pain at the point of insertion, drain dislocation, or dysfunction. Commonly, there is leakage of bile, which irritates the skin even when the drain is functional, or ascites may leak if this is present.

This can be resolved by inserting SEMS. Stent implantation is an optimal solution for malignant obstructions in patients who are not candidates for surgical intervention and where the expected survival is longer than 3–6 months. Insertion of stents is associated with shorter patient hospitalization time, longer period of duct patency, and lower costs overall in comparison with plastic drains. The insertion of metal stents percutaneously and endoscopically is now a routine procedure. In the case of hilar stents, the success rate for percutaneous SEMS drainage is higher (92.7 vs. 77.3%), although the incidences of complications and survival times in successfully drained patients are similar.

The most frequent complication of SEMS is their closure. The stent gradually becomes covered with bile duct mucosa. In some patients, benign obstruction can occur due to its hyperplasia. Very frequently, stent occlusion is also associated with migration or closure by detritus and sludge formation. As disease progresses, there can occur ingrowth or overgrowth of the stent edge by the tumour.

Despite the fact that adenocarcinomas of bile ducts are regarded as tumours with low radiosensitivity, data in the literature supports the use of radiotherapy in palliating tumours at this location. Most cases of palliation failure, however, consist of loco-regional progression; therefore, several authors recommend increasing the dosage in order to improve the results. Lethal radiation doses against adenocarcinomas are high (up to 60 Gy), and escalating doses increases the risk of damage to the surrounding healthy tissues. Perihilar location of tumours is risky due to the liver's radiation sensitivity (the tolerance dose for liver parenchyma is 30–40 Gy). In contrast to conventional radiation therapy, such modern radiation methods as intensity-modulated radiation therapy (IMRT) and stereotactic radiation therapy are able to reach this higher effective dose intra-tumorally while applying a markedly lower dose to tissues outside the planning volume. According to several studies, patients treated with IMRT or stereotactic therapy achieve higher survival, although (despite well-targeted volumes) both acute and late toxicity increases (Milano, 2004).

Intraluminal brachytherapy of the bile ducts is a minimally invasive method which can overcome the disadvantages of high-dose external beam radiation therapy (EBRT). Relative to EBRT, intraluminal brachytherapy, can administer higher radiation doses in a shorter time. The effectiveness of brachytherapy has been observed in several non-randomized, retrospective studies. It has contributed to prolonging median survival to the range of 10–14 months. The largest retrospective study was published in 2010 by Shinohara, who analysed 193 patients having cholangiocarcinomas treated with brachytherapy. Overall median survival in the group was up to 11 months, while that in the robust control group without radiotherapy (6,859 patients) reached only 4 months. A randomized study of brachytherapy and EBRT performed at our institution in a sample of 42 patients demonstrated a significant difference in survival (12.9 vs. 9.9 months).

Brachytherapy, while prolonging stent patency, can be a means of achieving longer patient survival times and improving quality of life. For preventing re-occlusion, brachytherapy could be used as a solitary source of radiation therapy. Chen applied HDR brachytherapy after insertion of SEMS. Significantly longer stent patency duration was achieved in patients undergoing brachytherapy (12.6 vs. 8.3 months), but extended survival did not reach a statistically significant level.
Local ablation techniques, such as endoluminal radiofrequency ablation with simple and one-time application, are potentially useful in palliating endoluminal tumours, preventing early ingrowth of the tumours through the stent mesh, and even helping to resolve stent obstruction. There are still no randomized, prospective studies for these applications, however.
Hilar cholangiocarcinoma remains a complex medical problem. Chemotherapy or combinations of chemo- and radiation therapy can prolong survival, but their results are still far from satisfactory. Survival times can be influenced by optimal drainage, brachytherapy, photodynamic therapy, or other ablation treatments. In view of its morphological diversity, relatively low incidence, and high patient age, it is very difficult to create a sufficiently homogenous set of patients to demonstrate the effectiveness of the individual therapeutic methods or combinations. It seems that in highly selected patient groups, very good prognoses can be achieved, while in a part of the patients, all therapeutic methods either fail or cannot be fully used due to patients' status or unavailability of the necessary technology.

References

1. Serrablo A, Tejedor L. Outcome of surgical resection in Klatskin tumors. World J Gastrointest Oncol. 2013;5(7):147-58.
2. Yang R, Wang B, Chen YJ, Li HB, Hu JB, Zou SQ. Efficacy of gemcitabine plus platinum agents for biliary tract cancers: a meta-analysis. Anticancer Drugs. 2013;24(8):871-7.
3. Andrasina T, Valek V, Panek J, Kala Z, Kiss I, Tucek S, et al. Multimodal oncological therapy comprising stents, brachytherapy, and regional chemotherapy for cholangiocarcinoma. Gut Liver. 2010;4 Suppl 1:S82-8.
4. Deviere J, Baize M, de Toeuf J, Cremer M. Long-term follow-up of patients with hilar malignant stricture treated by endoscopic internal biliary drainage. Gastrointest Endosc. 1988;34(2):95-101.
5. Dowsett JF, Vaira D, Hatfield AR, Cairns SR, Polydorou A, Frost R, et al. Endoscopic biliary therapy using the combined percutaneous and endoscopic technique. Gastroenterology. 1989;96(4):1180-6.
6. Raju RP, Jaganmohan SR, Ross WA, Davila ML, Javle M, Raju GS, et al. Optimum palliation of inoperable hilar cholangiocarcinoma: comparative assessment of the efficacy of plastic and self-expanding metal stents. Dig Dis Sci. 2011;56(5):1557-64.
7. Lammer J, Klein GE, Kleinert R, Hausegger K, Einspieler R. Obstructive jaundice: use of expandable metal endoprosthesis for biliary drainage. Work in progress. Radiology. 1990;177(3):789-92.
8. Lameris JS, Stoker J, Nijs HG, Zonderland HM, Terpstra OT, van Blankenstein M, et al. Malignant biliary obstruction: percutaneous use of self-expandable stents. Radiology. 1991;179(3):703-7.
9. Milano MT, Chmura SJ, Garofalo MC, Rash C, Roeske JC, Connell PP, et al. Intensity-modulated radiotherapy in treatment of pancreatic and bile duct malignancies: toxicity and clinical outcome. Int J Radiat Oncol Biol Phys. 2004;59(2):445-53.
10. Shinohara, ET, Guo, M, Mitra, N, Metz, JM. Brachytherapy in the treatment of cholangiocarcinoma. Int J Radiat Oncol Biol Phys. 2010; 78:722-8.
11. Chen Y, Wang XL, Yan ZP, Cheng JM, Wang JH, Gong GQ, et al. HDR-192Ir intraluminal brachytherapy in treatment of malignant obstructive jaundice. World J Gastroenterol. 2004;10(23):3506-10.
12. Dolak W, Schreiber F, Schwaighofer H, Gschwantler M, Plieschnegger W, Ziachehabi A, et al. Endoscopic radiofrequency ablation for malignant biliary obstruction: a nationwide retrospective study of 84 consecutive applications. Surg Endosc. 2013.

3202.3

IRE for pancreatic tumours: the evidence

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Learning Objectives

1. To learn about the indications for IRE ablation
2. To learn about the technique of IRE
3. To learn about the outcomes and complications

Irreversible electroporation (IRE) is an ablation modality that uses short electrical pulses of high voltage but low energy in order to obtain the desired result rather than heat (RFA, Microwaves) or cold (Cryo). The electrical pulses induce apoptosis without damage to the tissue structure, e.g. collagen. Thus, treatment is possible close to and, indeed, across sensitive structures, such as blood vessels and bile ducts, as even though all cells in the treated area are dead, the collagen skeleton in intact and new cells can grow back.
Ablations of otherwise untreatable liver lesions have been successful, and attempting IRE in patients with locally advanced pancreatic cancer is a logical step. Early results show that ablations in the area of the pancreatic head can be performed with an acceptably low complication rate, adding significantly to both progression-free survival and overall survival.

3202.4

HIFU for pancreatic tumours: the evidence

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Learning Objectives

1. To learn about the indications for HIFU
2. To learn about the technique of HIFU
3. To learn about the outcomes and complications

No abstract available.

Special Session
How to deliver high-quality IR services

3203.1

IR as clinical specialty

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Learning Objectives

1. To learn about the role of interventional radiologists as clinical specialists
2. To learn about patient-focused pathways in optimising patient care

Interventional radiologists play an increasingly important clinical role, which is expanding beyond the IR suite. They are medical doctors who are trained in imaging but have undergone additional specialist training in highly demanding image-guided techniques. For this reason, IR practice is fundamentally different from diagnostic imaging.
Interventional radiologists should act as the patient's primary doctor and have direct clinical responsibility for the patient under their care. They should clinically assess and counsel patients before a procedure, inform them about the risks of the procedure and possible alternative treatment options, obtain valid consent, and follow up with them after the procedure. In this context, they should convince hospital authorities to establish outpatient clinic facilities with

nursing and clerical support, where referred patients can be counseled and reviewed in a quiet environment.
One important task for interventional radiologists is the effective communication with referring physicians and the development of strategies to deal with complex clinical situations and difficult clinical scenarios. It is therefore imperative for IRs to participate regularly in multidisciplinary clinical meetings and multidisciplinary forums to ensure optimum care.
As clinicians, interventional radiologists are required to be involved with the day-to-day management of their patients' care to ensure optimal outcomes for them. This may involve shared care with a broad range of specialists; however, interventional radiologists should aim to have direct access to inpatients beds, where they can admit and discharge patients as necessary, with sufficient time allocated for this activity. As the number and demand of IR day cases steadily increases, IR units should organize day-care facilities staffed with nursing and clerical staff, which can result in major cost savings to hospitals.
In order to maintain high-quality clinical standards, IR units must carry out regular audits and, where available, submit data to national or international registries. Furthermore, as clinicians, we have a duty of care to ensure that the IR procedures are safe and effective, which can only be demonstrated by high-quality research.
For IR to survive as clinical specialty, IR training must be adapted in order to ensure that future interventional radiologists will acquire both clinical knowledge and confidence in the disease processes as well as in dealing with patients. Core IR training must include communication skills, clinical assessment, and knowledge of the various alternative treatments to IR, both surgical and medical. In order to fulfill these expectations, IR training must move to a certified residency program; an attractive format would be one year of internship, three years of Diagnostic Radiology, and then two years of IR. This IR certification will hopefully have a huge impact on local organizational issues so that at a local institution an interventional radiologist will be listed independently and next to surgery and medicine. Towards this direction, appropriate curricula and formal assessment of the appropriate skills such as the European Board of Interventional Radiology (EBIR) examination are available to ensure the high standards of the future IR workforce.
The CIRSE Clinical Practice in IR Manual provides a comprehensive approach to patient care, including numerous well-structured forms for gathering data on patient or social history and conducting examinations, as a part of its content (www.cirse.org/Clinical_Practice).

3203.2

Provision of IR: requirements

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Learning Objectives

1. To learn about the infrastructural requirements for providing high quality interventional services, including outpatient clinics, ward work and interventional suites
2. To learn about the requirements within job plans for a clinical interventional radiologist
3. To learn about using research and audits to improve the quality of patient care

IR is a vital part of modern medical healthcare, providing essential high quality patient-focused care and delivering safe and effective treatments often at reduced costs compared to the surgical alternatives. IR procedures often replace open surgical procedures as they are less invasive, reduce morbidity and mortality and allow more rapid patient recovery and hospital discharge. IR has expanded to play a vital role in both elective and emergency treatment.
Although there are high costs in equipping, staffing and training a suitable 24/7 IR service, it can offer significant savings compared to surgical treatments by reducing in patient bed and ITU utilization (1). The specialty has grown to support a wide variety of patient treatments (2-26), challenging the ability of many radiology departments to provide a high quality sustainable service 24/7. It is vital, however, for patient care that we ensure we have the right infrastructure to support IR and that we do not compromise on the quality of patient care and, in particular, safety.
Key requirements and facilities for IR units.
Outpatient clinics:
Outpatient clinics should become part of normal practice for IR practitioners advising and guiding patients in making treatment decisions in a calm outpatient environment, where the full range of options can be discussed, the technical elements of the procedure explained, and the benefits as well as risks clarified so that patients have a full understanding of the procedure prior to consenting. Follow-up should become a routine part of interventional radiologists' workload to assess the impact of treatments and best direct any further treatments that sometimes require referral to other specialties. This is also an opportunity to discuss possible research studies that may be underway. This is also a huge training opportunity, and trainees should be encouraged to attend.
Equipment:
Non-invasive imaging such as ultrasound, magnetic resonance imaging, computed tomography and high quality fluoroscopy in an angiographic suite are key components. For combined procedures with the implantation of permanent devices such as EVAR, TEVAR and TAVI, these should ideally be in a hybrid theatre, where sterility is paramount. The equipment requirements for many specific procedures are available from the professional standards documents produced by CIRSE, SIR and national professional bodies.
Inpatient beds and day-care facilities:
Interventional radiologists should be involved with the day-to-day management of patient care which sometimes involve shared care with other specialists; however, interventional radiologists should aim to have direct access to inpatients' beds where they can admit and discharge patients. Often treatments are carried out using day-care facilities, which we have run in our unit for >15 years and which are staffed with nursing and clerical staff and can result in huge costs.
Facilities for sedation and analgesia:
Most treatments can be undertaken with local anaesthesia with nursing support and monitoring. The minimum should be for a trained nurse who can independently administer drugs and review the patients' vital signs during the procedure so that the operator can focus on the procedure itself. General anaesthesia with piped gasses to the room and an anaesthetic machine may be required for more complex cases.
Interventional radiology team.
Nursing and allied health staff:
Technicians, radiographers and nursing staff are integral members of the IR team, ensuring the best outcomes for patients and minimizing radiation doses while obtaining the highest quality of images. Experienced radiology nursing staff are often required to scrub to assist for a wide variety of complex procedures, as well as in ensuring patient comfort and safety. The minimum would be to have two nurses in a room during a complex procedure but healthcare assistants or equivalent personnel may be used in certain circumstances, although they are not a replacement for nurses. On-call provision for trained radiographic and nursing staff should be available in all centres providing emergency IR care (27).
IR units and provision of service 24/7:
Access to complex imaging equipment ranging from ultrasound, CT, MR and angiographic facilities is fundamental. There are a few procedures which account for the vast bulk of out-of-hours emergency procedures, and these include arterial embolization for

haemorrhage and nephrostomy for obstructed kidneys. Hospital units which admit acute medical and surgical patients should have access to these modern IR techniques, either on site or by formal arrangement to transfer the patient to other sites. Units may need to provide a large number of specialty and subspecialty procedures, and some hospitals may not be able to provide all types of treatments, and guidance on optimizing training opportunities for low-volume procedures is available (28,29). Where transfer of patients and or staff is agreed, it is vital that there are clear agreed written pathways between all parties, which are understood by local managerial as well as clinical colleagues.

For smaller units, a formal network with a neighbouring unit could be developed to share resources with possible transfer of patients and/or staff. An example would be the provision of a 24/7 IR service, which in part is limited by shortage of trained interventional radiologists, estimated to be around 222 in the UK (30). Although it is impossible to recommend set criteria for all individual centres in Europe, the following guidance has been suggested for the numbers of IR specialists within UK hospitals required to provide a safe and sustainable rota (31).

Services with fewer than four interventional radiologists should liaise with neighbouring units to develop a model of care that will permit robust interventional radiologist rotas.

Services with 4-6 interventional radiologists may be able to provide an independent on-call rota, depending on the intensity of activity. Most services in this range should consider networking with neighbouring units to ensure a more robust long-term service.

Services consisting of >6 interventional radiologists will usually be able to provide a robust 24/7 service compliant with the European Working Time Directive (EWTD). For populations greater than one million, a 1:8 rota may be more sustainable. Similar rotas will also be required for allied health staff.

Maintaining safety and improving quality:

We need to demonstrate the improvements in patient outcomes and quality of service we provide. This can only be done by research, regular audits and submitting data to national or international registries. Registries offer a systematic approach record data, view individual practice against peers within the specialty in other centres and, where necessary, drive improvements by sharing best practice. Examples include the NVR, BIAS, BDSR, NVR and SIRT in the UK (32-35) and the CIRSE SIRT registries. Several bodies such as CIRSE, SIR, RCR and NICE have produced standards against which centres can audit and compare their unit outcomes to ensure the quality of their service (2-7,13,15-17,20,23-28,36-43). CIRSE and national societies have a responsibility to give guidance on how IR services are delivered and to set standards to improve quality. In the UK, the BSIR has developed a quality-improvement (BSIRQI) programme for IR to allow units the opportunity to self-assess against specific criteria. Currently, these focus on four key areas: scope of services, providing good quality care, patient focus and service improvement (www.bsir-qi.com). The Royal College of Radiologists in the UK and CIRSE (www.cirse.org.uk) have developed checklists based on the WHO surgical safety checklists with guidance on successful implementation to improve safety in IR (43-46), and this should be mandatory in all IR units.

Conclusion.

IR has come a long way since the time of Charles Dotter in the 1960s, but there is still a long road ahead. There are clear benefits of IR treatments which need to be demonstrated by research and development of national registries to demonstrate the benefits and quality of service we provide. We need well-trained medical, nursing and radiographic staff as well as good quality imaging and interventional facilities. As a clinical specialty, we need to take clinical responsibility for our patients with dedicated time and appropriate training.

References

1. Simonetti G, Bollero E, Ciarrapico AM, et al. Hospital organization and importance of an interventional radiology inpatient admitting service: Italian single-center 3-year experience. Cardiovasc Interv Radiol 2009; 32: 213e20.
2. The Royal College of Radiologists. Standards in vascular radiology. London: RCR 2011.
3. National Institute of Health and Care Excellence. NICE lower limb peripheral arterial disease guidance. London: NICE, 2012.
4. The EVAR Trial Participants. Endovascular aneurysm repair versus open repair in patients with abdominal aortic aneurysm (EVAR trial I): randomised controlled trial. Lancet 2005; 365: 2179–2186.
5. National Institute of Health and Care Excellence. Abdominal Aortic Aneurysm – endovascular stent grafts: guidance. London: NICE, 2012.
6. IMPROVE trialists, Powell JT, Thompson SG et al. The immediate management of the patient with rupture: Open versus endovascular repair (IMPROVE) aneurysm trial – ISRCTN 48334791 IMPROVE Trial. Acta Chir Belg 2009; 109(6): 678–680.
7. Drury D, Michaels JA, Jones L, Ayi L. Systematic review of recent evidence for the safety and efficacy of elective endovascular repair in the management of infrarenal abdominal aortic aneurysm. Br J Surg 2005; 92: 937–946.
8. Zealley IA, Chakraverty S. The role of interventional radiology in trauma. BMJ 2010; 340: c497.
9. Christie A, Robertson I, Moss J. Interventional radiology emergency service provision for a large UK urban population: initial 3.5 years of experience. Clin Radiol 2013; 68(8): e440–e446.
10. Jairath V, Kahan BC, Logan RF et al. National audit of the use of surgery and radiological embolization after failed endoscopic haemostasis for non-variceal upper gastrointestinal bleeding. Br J Surg 2012; 99(12): 1672–1680.
11. Defreyne L, Vanlangenhove P, De Vos M et al. Embolisation as a first approach with endoscopically unmanageable acute nonvariceal gastrointestinal haemorrhage. Radiology 2001; 218(3): 739–748.
1. d'Othée BJ, Surapaneni P, Rabkin D, Nasser I, Clouse M. Microcoil embolization for acute lower gastrointestinal bleeding. Cardiovasc Intervent Radiol 2006; 29(1): 49–58.
2. Jalan R, Hayes PC. UK guidelines on the management of variceal haemorrhage in cirrhotic patients. London: British Society for Gastroenterology, 2000.
3. Ripoll C, Banares R, Beceiro I et al. Comparison of transcatheter arterial embolization and surgery for treatment of bleeding peptic ulcer after endoscopic treatment failure. J Vasc Interv Radiol 2004; 15(5): 447–450.
4. Scottish Intercollegiate Guidelines Network. SIGN 105: Management of acute upper and lower gastrointestinal bleeding. Edinburgh: Scottish Intercollegiate Guidelines Network, 2008.
5. The Renal Association, The Vascular Society, the British Society of Interventional Radiology. The organisation and delivery of the vascular access service for maintenance haemodialysis patients. London: The Renal Association, The Vascular Society, the British Society of Interventional Radiology, 2006.
6. Ansell D, Feest T, Rao R et al. UK Renal Registry Report 2005. Bristol: UK Renal Registry, 2005.
7. Lencioni R, Cioni D, Crocetti L et al. Early Stage Hepatocellular Carcinoma in Patients with Cirrhosis: Long-term Results of Percutaneous Image-guided Radiofrequency Ablation. Radiology 2005; 234: 961–967.
8. Montgomery RS, Rahal A, Dodd GD, Leyendecker JR, Hubbard LG. Radiofrequency Ablation of Hepatic Tumors: Variability of Lesion Size Using a Single Ablation Device. AJR Am J Roentgenol 2004; 182: 657–661.
9. National Institute for Clinical Excellence. Interventional Procedure Guidance 2: Radiofrequency Ablation for Hepatocellular Carcinoma. London: NICE, 2003.

10. N'Kontchou G, Mahamoudi A, Aout M et al. Radiofrequency ablation of hepatocellular carcinoma: long-term results and prognostic factors in 235 Western patients with cirrhosis. Hepatology 2009; 50(5): 1475–1483.
11. Ryder S. Guidelines for the diagnosis and treatment of hepatocellular carcinoma (HCC) in adults. Gut 2003; 52(Suppl III): iii1–iii8.
12. Pereira PL, Salvatore M. Standards of Practice: Guidelines for Thermal Ablation of Primary and Secondary Lung Tumors. Cardiovasc Intervent Radiol 2012; 35: 247–254.
13. Basile B, Carrafiello G, Lerardi AM, Tsetis D, Brountzos E. Quality-Improvement Guidelines for Hepatic Transarterial chemoembolization. Cardiovasc Intervent Radiol 2012; 35(4): 765–774.
14. Gangi A, Tsoumakidou G, Buy X, Quoix E. Quality improvement guidelines for bone tumour management. Cardiovasc Intervent Radiol 2010; 33: 706–713.
15. Dormann A, Meisner S, Verin N, Wenk Lang A. Self-expanding metal stents for gastroduodenal malignancies: systematic review of their clinical effectiveness. Endoscopy 2004; 36: 543–550.
16. Guidelines for nursing care in interventional radiology: The roles of the registered nurse and nursing support. London: RCR, 2014.
17. NHS Improvement. Towards best practice in Interventional Radiology. Leicester: NHS Improvement, 2012.
18. British Society of Interventional Radiology. RAG status map for NHS England. London: BSIR, 2012.
19. Centre for Workforce Intelligence. Securing the future workforce supply: clinical radiology stocktake. London: Centre for Workforce Intelligence, 2012.
20. The Royal College of Radiologists.The Provision of Interventional radiology . London: RCR, 2014.
21. Uberoi R, Milburn S, Moss J, Gaines P, BIAS Registry Contributors. British Society of Interventional Radiology Iliac Artery Angioplasty-Stent Registry III. Cardiovasc Intervent Radiol 2009: 32(5): 887–895.
22. Uberoi R, Das N, Moss J, Robertson I. British Society of Interventional Radiology: Biliary Drainage and Stenting Registry (BDSR). Cardiovasc Intervent Radiol 2012; 35(1): 127–138.
23. www.bsir.org/registries/sirt-registry/ (last accessed 11/09/2014)
24. www.bsir.org/registries/national-vascular-registry-nvr/ (last accessed 11/09/2014)
25. Sabharwal T, Morales JP, Irani FG, Adam A, CIRSE: Cardiovascular and Interventional Radiological Society of Europe. Quality assurance guidelines for the placement of oesophogeal stents. Cardiovasc Intervent Radiol 2005; 28(3): 284–288.
26. Chalmers N, Jones K, Drinkwater K, Uberoi R, Tawn J. The UK nephrostomy audit. Can a voluntary registry produce robust performance data? Clin Radiol 2008; 63(8): 888–894.
27. Medicines and Health products Regulatory Agency, The Royal College of Radiologists, the British Society of Interventional Radiologists, the Vascular Society of Great Britain and Ireland, the Vascular Anaesthesia Society of Great Britain and Ireland, the Medicines and Healthcare Products Regulatory Agency Committee on the Safety of Devices. Joint working Group to produce guidance on delivering an endovascular aneurysm repair (EVAR) service. London: MHRA, 2010.
28. Uberoi R. Quality assurance guidelines for superior vena cava stenting in malignant disease. Cardiovasc Intervent Radiol 2006; 29(3): 319–322.
29. The Vascular Society of Great Britain and Ireland. The provision of vascular services for patients with vascular disease. London: Royal College of Surgeons, 2012.
30. The Royal College of Radiologists. Interventional oncology: guidance for service delivery. London: RCR, 2013.
31. British Society of Interventional Radiologists. First Biliary Drainage and Stent Audit Report. London: BSIR, 2009.
32. The Royal College of Radiologists. Image-guided ablation, second edition. London: RCR, 2013.
33. National Patient Safety Agency. WHO Surgical Safety Checklist: for radiological interventions only. London: NPSA, 2010.
34. The Royal College of Radiologists. Standards for the NPSA and RCR safety checklist for radiological interventions. London: RCR, 2010.
35. The Royal College of Radiologists. Guidance for Fellows in implementing surgical safety checklists for radiology procedures. London: RCR, 2013.

3203.3

24/7 access to IR services

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Learning Objectives
1. To learn about the workforce and infrastructural requirements for providing a 24/7 service
2. To learn about options for networking to provide comprehensive 24/7 cover

24/7 access to IR service: a 10-point plan
1. Determine local needs and inform stake holders
2. Identify the scope of service and the time frame of response
3. Ensure appropriate and adequate facility
4. Formulate plan of communication/transportation/receiving anaesthesia
5. Consider staffing, training and remuneration issues
6. Determine the needed stock and formulate plan for replenishment/rapid provision
7. Establish care pathways for post-procedure care and/or support from other specialties; be aware of the Standards of Practice
8. Establish methodology for follow-up and collection of outcome data
9. Apply audits and QA initiatives to identify opportunities for improvement
10. Consider "networking" to provide service where demand is small and subspecialty issues are relevant

These points will be discussed with clinical examples.

References
1. Standards of Practice at CIRSE web site.
2. Christie A, Robertson I, Moss J. Interventional radiology emergency service provision for a large UK urban population: initial 3.5 years of experience. Clin Rad 2013, 68: e440-e446.

3203.4

Efficient workforce planning

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Learning Objectives
1. To learn about the requirement for interventional radiologists to provide a high quality service
2. To learn about training requirements to provide sufficient IR specialists for the future
3. To learn about the requirements for allied health professionals

A very broad field of interventional radiology (IR) has evolved over the past decades. Pioneers have developed new techniques, procedures, and materials. Even new subspecialties within IR have evolved.

These procedures have widely entered the market of medicine, and other allied health professionals (such as cardiologists, angiologists, and vascular surgeons) have claimed substantial parts of it.

High-quality service is the key to effectively and sustainably help patients and to hold one's ground in the market.

Recruiting and training new IR specialists is and will be a challenge. The specialty diagnostic radiology (DR) itself is considered very attractive among young physicians. The degree of administrative

work is bearable; this work is not only challenging but also fulfilling, and a satisfactory work-life balance can be realized most of the time. For the subspecialty IR, however, it becomes trickier. Those radiologists that like being 'invasive', work closely with patients and can commit themselves to a possibly challenging and sometimes long lasting procedures need to be identified. When it comes to IR services beyond regular office hours, an additional degree of commitment is mandatory.

High-quality training paired with a high degree of motivation for the subject are crucial and may be triggered by the following actions:

- young radiology residents and also students should be exposed to IR early – IR is not the holy grail
- IR can best be learned by actually performing it and not only by observing it
- as for DR, a compound, standardized training curriculum for IR should be implemented for each interventional radiologist in training (e.g., CIRSE syllabus)
- allow for attendance at scientific and educational meetings (e.g., CIRSE)
- if special procedures are not covered by the local IR portfolio in one's own clinic, then allow for hospitalizations and/or rotations
- interdisciplinary board meetings [e.g., (neuro-)vascular, tumor] need to be established for the following: case discussion, concerted treatment planning, and patient follow-up
- contribute your cases to national and/or international registries (e.g., DeGIR and European MR/CT Registry)
- achieve certification for both your interventionalists and your institution
- Requirements for allied health professionals include the following:
- willingness for referral
- management and attendance at interdisciplinary board meetings
- truly concerted treatment planning
- patient care and ward work when the actual procedure is performed by an IR
- readiness for joint-venture procedures (in OR, angio suite, or hybrid OR)
- sometimes, standby for rescue procedures (e.g., vascular surgeons)

Special Session
State-of-the-art pedal angioplasty

3301.1

Current evidence

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Learning Objectives

1. To learn about the currently published trials
2. What are the immediate and long-term technical and clinical outcomes
3. To understand if any technique or technology is superior

There is solid evidence that infrapopliteal angioplasty is an effective therapy for chronic critical limb ischemia, with limb salvage rates comparable to those of distal bypass surgery. However, antegrade recanalization of calcified total occlusions of below-the-knee arteries fails in up to 30% of cases, even when using both intraluminal and subintimal techniques. To improve the success rate of tibial angioplasty, retrograde recanalization techniques by using the pedal plantar loop technique (Fusaro et al) or transmetatarsal artery access (Palena et al) were developed. Further, some studies imply that better wound healing and limb salvage can be achieved by recanalization of the vessels supplying the target angiosome of the ischemic lesion (Alexandrescu et al). Thus, even very distal angioplasty might improve clinical success in selected cases.

Manzi et al reported the results of an observational retrospective study on 135 patients with critical ischemia treated with the pedal plantar loop technique. An acute technical success was obtained in 100% and good angiographic result in 85% of patients. All patients improved clinically with ulcer healing and significant increase of transcutaneous oxygen tension. Gandini et al also reported excellent technical and clinical outcomes in 50 patients with significant reduction of amputation rate compared to patients treated with conventional antegrade approach only. Palena et al reported their results of an observational retrospective study of 38 patients who underwent transmetatarsal artery access after antegrade recanalization failure, followed by retrograde recanalization of the foot and tibial arteries. Technical success was achieved in 87% of cases, with <50% residual stenosis and no complications. During a mean follow-up of 7 months, clinical improvement was observed in all patients having technical success. Amputation-free survival rate by Kaplan-Meier analysis was 81.5% at 12 months. The authors conclude that the technique appears feasible and beneficial in cases with a failed antegrade recanalization and unsuitable for retrograde pedal/plantar access.

Preliminary results from a few retrospective observational case series analyses from very experienced centers imply that pedal angioplasty might be safe and effective in carefully selected patients.

References

1. Fusaro M et al. Pedal-plantar loop technique for challenging below-the- knee chronic total occlusion: a novel approach to percutaneous revascularization in critical lower limb ischemia. J Invasive Cardiol 2007;19:E34-7.
2. Alexandrescu VA et al. Selective primary angioplasty following the angiosome model of reperfusion in the treatment of Wagner 1-4 diabetic foot lesions: Practice in a multidisciplinary diabetic limb service. J Endovasc Ther 2008;15:580-93.
3. Manzi M et al. Clinical results of below-the-knee intervention using pedal-plantar loop technique for the recanalization of the foot arteries. J Invasive Cardiol 2009;50:331-7.
4. Candini R et al. Alternative techniques for treatment complex below-the-knee arterial occlusions in diabetic patients with critical limb ischemia. Cardiovasc Intervent Radiol 2013;36:75-83.
5. Palena LM et al. The clinical utility of below-the-ankle angioplasty using "transmetatarsal artery access" in complex cases of CLI. Catheter Cardiovasc Interv 2014;83:123-9.

3301.2

Access routes and technical considerations

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Learning Objectives

1. To learn about patient selection and choice of access sites
2. What specialist equipment and devices are required
3. To learn the tips and tricks

No abstract available.

3301.3

Procedural complications and their management

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Learning Objectives

1. To learn about the major complications and how to treat them
2. Specialist devices to help avoid or treat complications
3. To learn the tips and tricks

No abstract available.

3301.4

Special considerations in the diabetic patient

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Learning Objectives
1. To learn about factors specific to diabetic foot PAD
2. How do these factors affect the outcomes in limb salvage
3. To learn about the importance of medical therapies including glucose control

Diabetes mellitus can be complicated by the occurrence of foot ulcers, which may be the cause of significant impairment in the quality of life and may lead to enormous socio-economical costs due to high amputation rate. Wound healing is typically slow and poor due to the combination of diabetic neuropathy and macro- and micro-angiopathy. Therefore, revascularization as a stand-alone therapy needs to be complemented by providing mechanical relief and by preventing or treating infection. When options for endovascular or surgical revascularization are not feasible (anymore), alternative therapies need to be implemented. In this paper, the advantages and limitations of endovascular therapy for diabetic critical limb ischemia will be described. The applicability of the angiosome concept in diabetic foot will be discussed. Finally, adjunct and alternative therapies will be dealt with.

Special Session
Lung metastases: facts and controversies

3302.1

Patient triage for lung metastases: where is the evidence?

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Learning Objectives
1. To understand which patients to ablate
2. To know about the results of ablation in metastatic lung patients
3. To know about the results of surgery and SBRT in lung metastases

Parallel with the progress of chemotherapy and targeted therapies, techniques for the local destruction of tumours using minimally invasive image-guided therapies have considerably developed in recent years, thereby widening the potential indications for local treatments, reducing morbidity and mortality and decreasing costs.
Destruction by radiofrequency, microwaves or cryotherapy has raised a lot of hope, but many questions remain with regard to the following:
- the impact of this treatment on the improvement of local control and on overall progression-free survival
- its place in treatment strategy
- the target population

It is assumed that radiological ablathermy could extend chemotherapy-free interval for metastatic colorectal cancer, which did not benefit from surgical management, with a significant improvement of the quality of life, and finally, it offered an alternative to discontinue chemotherapy treatment. In other metastatic diseases from thyroid, renal or sarcoma origin, the possibility to perform a local treatment that is repeatable and well supported has offered new opportunities for metastatic patients, delaying the setting up of a general treatment.
In the future, after solid prospective studies, it is reasonable to hope that the pattern of care for pulmonary metastatic cancer could change. Combined or sequential systemic therapy and local treatment offers good survival, with a possibility of complete remission. In parallel, other questions are also necessary regarding the following: which patient remains candidate to surgery and how to compare thermoablative techniques with other non-invasive techniques such as stereotactic radiotherapy?

References

1. Schlijper RCJ. et al What to choose as radical local treatment for lung metastases from colo-rectal cancer: Surgery or radiofrequency ablation? Cancer Treat Rev. 2014 Feb;40(1):60-7.
2. de Baère T, et al Radiofrequency ablation is a valid treatment option for lung metastases: experience in 566 patients with 1037 metastases. Ann Oncol. 2015 Feb 16.
3. Gillams A. Ablation of lung tumours. Cancer Imaging. 2012 Sep 28;12:361-2.
4. Palussière J, et al Sarcoma lung metastases treated with percutaneous radiofrequency ablation: results from 29 patients. Ann Surg Oncol. 2011 Dec;18(13):3771-7.
5. Nuyttens JJ, et al Stereotactic body radiation therapy for oligometastases to the lung: a phase 2 study. Int J Radiat Oncol Biol Phys. 2015 Feb 1;91(2):337-43.

3302.2

Ablation of lung tumours: present and future

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Learning Objectives
1. To know about the possible advantages of cryoablation versus RFA
2. To know about possible advantages of MWA versus RFA
3. To know how new technologies will affect patient selection

No abstract available.

3302.3

Radiation therapy for lung tumours: with or without ablation?

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Learning Objectives
1. To learn about the results of SBRT in metastatic lung disease
2. To learn about the role of SBRT in lung metastases today and in the future
3. To know about the role of possible combinations of SBRT with ablation or chemotherapy

Metastases of the lung are often the first site of distant metastases in many cancers. To find out which is the best therapy is a great challenge considering the potentially curative treatment options. Surgical resection is the standard approach with well-defined advantages such as histopathological information. However, there are also other highly effective local treatment options available.
Results of SBRT in metastatic lung cancer:
Stereotactic body radiation therapy (SBRT) represents a highly effective treatment modality in oligometastatic lung tumors. Using SBRT, local control rates of about 90% and survival rates comparable to surgical series, at least after sublobar resection, and very low toxicity rates were reported [1-5]. Baschnagel *et al.* showed that a local control rates of 97%, 92%, and 85% after 1, 2, and 3 years, respectively, is achievable using a median of 60 Gy in four fractions [4]. In this analysis, the 1-, 2-, and 3-year survival rates were 83%, 76%, and 63%, respectively. In a prospective study by Rusthoven *et al.*, an actuarial 2-year local control rate of 96% was seen [2]. In a retrospective analysis performed by Ricardi *et al.* including 61 patients with 1–3 lung metastases, the 2- and 3-year local control rates were 89% and 84% and the overall survival rates were 67% and 53%, respectively [3]. The toxicity profile is very low in this series using SBRT.

The high efficacy as well as the safety of the SBRT approach in malignant lung tumors could also be demonstrated by a pattern-of-care and outcome analysis performed by Guckenberger *et al.* [6]. Overall, 582 patients with stage-I/II non-small-cell lung cancers were included. After an average follow-up of 21 months, the 3-year local relapse-free and overall survival were 80% and 47%, respectively. In this analysis, the biological effective dose (BED) was the most significant factor influencing local control and survival. For the 164 patients receiving more than 106-Gy BED as the planning target volume (PTV) encompassing dose, the 3-year local relapse-free and overall survival were 93% and 62%, respectively. The most commonly used fractionation schemes were 3 x 12.5 Gy prescribed to 60%–65% isodoses and 3 x 15 Gy prescribed to the 65% isodoses.

Considering the prognostic potential of SBRT, it is important to take into account the strong radiation dose-response relationship, which was independently demonstrated by several groups [6-8]. It is well known that a BED of more than 100 Gy led to tumor control rates of more than 90%. The fractionation scheme of 3 x 15 Gy as D95 [more than 95% of PTV) should receive ≥15 Gy] or D98 to PTV, with a D05 or D02 PTV dose of 150% is recommended by the German Stereotactic Radiotherapy Working Group for peripherally located NSCLC with a diameter of <5 cm [9].

Role of SBRT today and in the future:

Conclusion from the published results using SBRT in malignant lung tumors is that very high local control rates are achievable. Realistically, further improvements of local control rates will not be achievable. Interestingly, it could also be demonstrated that the dose-dependent increase in local control leads to an improved overall survival [7, 10].

The challenge for the future will rather be to improve metastases-free and overall survival, thereby developing better as well as more individualized systemic therapies. A number of promising systemic options, such as the targeted therapies, are by now in clinical use.

Role of possible combinations of SBRT with ablation or chemotherapy:

In addition to SBRT or surgery of lung malignancies, particularly lung metastases, another local technique is available, i.e., radiofrequency ablation (RFA). Using this approach, very high local control rates are also published. De Baère *et al.* reported an impressive local control rate of 89% after 4 years [10]. Interpreting their own data, the authors reduced their recommendations to tumors smaller than 2–3 cm. Additionally, it should be mentioned that the authors encountered pneumothoraces in 67% (no treatment needed in 28% of pneumothorax cases) and chest tube in 58% of the procedures.

Because of the lack of randomized data comparing surgery, SBRT, and RFA in case of lung metastases, the interdisciplinary discussion is essential.

No valid data are available to combine the stereotactic radiotherapy with the RFA technique. However, considering the high local efficacy of both techniques, there is no need of such a combined approach in our opinion.

Moreover, an interesting question is to clarify if and in what way the combination between the systemic treatment and local ablation (surgery, SBRT, or RFA) is useful.

Considering the unsatisfactory overall survival rates, the systemic treatment is an important factor in metastatic disease. However, in cases of oligometastatic disease, i.e., a singular lung nodule, the local treatment can prolong the time period to chemotherapy with a consequent advantage to the quality of life. On the other hand, after finishing chemotherapy, the optimal point of time to locally treat residual metastatic tumor is not known.

These essential questions should be clarified in further studies.

In conclusion, with SBRT for lung tumors, a highly effective treatment option is available with a very low-toxicity profile. SBRT is completely noninvasive, which can be an interesting aspect for the patient in an almost palliative setting. Especially, patients with a reduced cardiopulmonary health status should be offered SBRT.

References

1. Hof H, Hoess A, Oetzel D, et al., Stereotactic single-dose radiotherapy of lung metastases. Strahlenther Onkol. 2007;12:673-8.
2. Rusthoven KE, Kavanagh BD, Burri SH, et al., Multi-institutional phase I/II trial of stereotactic body radiation therapy for lung metastases. J Clin Oncol. 2009;27:1579-84.
3. Ricardi U, Filippi AR, Guarneri A, et al., Stereotactic body radiation therapy for lung metastases. Lung Cancer 2012;75:77-81.
4. Baschnagel AM, Mangona VS, Robertson JM, et al., Lung metastases treated with image-guided stereotactic body radiation therapy. Clin Oncol. 2013;25:236-41.
5. Roesch J, Andratschke N, Guckenberger M. SBRT in operable early stage lung cancer patients. Transl Lung Cancer Res. 2014;3:212-24.
6. Guckenberger M, Allgäuer M, Appold S, et al., Safety and efficacy of stereotactic body radiotherapy for stage I non-small-cell lung cancer in routine clinical practice. A pattern-of-care and outcome Analysis. J Thorac Oncol. 2013;8:1050-8.
7. Onishi H, Araki T, Shirato H, et al., Stereotactic hypofractionated high-dose irradiation for stage I nonsmall cell lung carcinoma: clinical outcomes in 245 subjects in a Japanese multiinstitutional study. Cancer. 2004;101:1623-31.
8. Wulf J, Baier K, Mueller G, et al., Dose-response in stereotactic irradiation of lung tumors. Radiother Oncol. 2005;77:83-7.
9. Guckenberger M, Andratschke N, Alheit H, et al., Definition of stereotactic body radiotherapy: principles and practice for the treatment of stage I non-small cell lung cancer. Strahlenther Onkol. 2014;190:26-33.
10. Onimaru R, Fujino M, Yamazaki K, et al., Steep dose-response relationship for stage I non-small-cell lung cancer using hypofractionated high-dose irradiation by real-time tumor-tracking radiotherapy. Int J Radiat Oncol Biol Phys. 2008;70:374-81.

3302.4

Treatment options and cost effectiveness

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Learning Objectives

1. To know about the cost effectiveness of surgery, ablation and SBRT
2. To know about the real costs versus reimbursement of surgery, ablation and SBRT
3. To compare efficacy of ablation, surgery and SBRT

The lung is a frequent site of metastatic disease with up to 30% of cancer patients developing lung metastases. The initial treatment in metastatic lung disease commonly entails chemotherapy, which is often considered as the treatment of choice. Despite its early introduction with an initial report in 1882, locoregional therapy such as resection of lung metastases has long been discussed to be controversial. With evolving experience in pulmonary metastasectomy over the last 130 years, the approach to cancer patient with pulmonary metastasis has evolved with an important role in surgery, which is the most traditional locoregional treatment in select cases. In a collective of 5206 cases with lung metastases from various primary tumors, the actuarial survival after metastasectomy was 26% at 10 years [1]. In several indications such as lung metastases from colorectal or germ cell tumors, even better results are achieved [2].

At present, the management of lung metastases is a multifaceted topic with various local treatment options. For selected patients, typically high-risk patients unfit for surgery, these options include stereotactic body radiation therapy (SBRT), thermal ablations such as radiofrequency ablation (RFA) and microwave ablation, transarterial therapy, and investigational approaches such as bronchial

artery infusion therapy and transpulmonary chemoembolization [3]. Despite their theoretical appeal, the latter did not show sufficient potential for a broad clinical application.

Unfortunately, there is only weak evidence based on retrospective case series indicating survival benefit from locoregional therapies in lung metastases. These data are used to justify the clinical practice, but this practice has never been subjected to randomized controlled trials. In the most recent systematic review on the locoregional treatment of lung metastases from colorectal cancer, only four studies on RFA and 23 surgical series out of 798 publications met the quality criteria for inclusion in this analysis; interestingly, no study on radiosurgery was of sufficient quality. Results were inhomogeneous, with 5-year survival rates ranging from 34.9% to 45% for RFA and from 29% to 71.2% for surgery [2]. Due to the lack of phase III trials, no firm conclusions could be drawn, and the authors called for high-quality trials comparing the currently used treatment modalities such as SBRT, RFA, and surgery.

Data on the cost effectiveness of locoregional treatments for lung metastases is completely (almost) missing. A case study on activity-based costing in RFA showed the economic value of this therapy from the business point of view [4], while an older cost effectiveness analysis proved the superiority of resection over chemotherapy in patients with lung metastases from soft tissue sarcoma [5]. In contrast, a limited number of studies assessed surgery, stereotactic and conventional radiation therapies, and RFA from a cost-effectiveness perspective [6-8]. In all of these studies, RFA was the least costly treatment; among nonsurgical therapies, it was the most cost-effective treatment strategy for small lesions (T1) in cases in which stereotactic radiation therapy was not available or contraindicated. As metastatic lung disease affects a different group of patients and follows different principles than those followed by primary lung cancer, these data cannot be transferred without interpretation. Nevertheless, thermal ablation may be considered cost effective in elderly patients and in patients not eligible for surgery. Moreover, it is most cost effective from the business point of view. Considering the paucity of data, there is a strong need for cost-effectiveness studies comparing different locoregional treatments for lung metastases.

References

1. Pastorino U, Buyse M, Friedel G, Ginsberg RJ, Girard P, Goldstraw P, Johnston M, McCormack P, Pass H, Putnam JB Jr; International Registry of Lung Metastases. Long-term results of lung metastasectomy: prognostic analyses based on 5206 cases. J Thorac Cardiovasc Surg. 1997 Jan;113(1):37-49.
2. Schlijper RC, Grutters JP, Houben R, Dingemans AM, Wildberger JE, Van Raemdonck D, Van Cutsem E, Haustermans K, Lammering G, Lambin P, De Ruysscher D. What to choose as radical local treatment for lung metastases from colo-rectal cancer: surgery or radiofrequency ablation? Cancer Treat Rev. 2014 Feb;40(1):60-7.
3. Demmy TL, Dunn KB. Surgical and nonsurgical therapy for lung metastasis: indications and outcomes. Surg Oncol Clin N Am. 2007 Jul;16(3):579-605.
4. Mahnken AH, Bruners P, Günther RW, Rasche C. Process-oriented cost calculation in interventional radiology. A case study. Radiologe. 2012 Jan;52(1):74-80 [German].
5. Porter GA, Cantor SB, Walsh GL, Rusch VW, Leung DH, DeJesus AY, Pollock RE, Brennan MF, Pisters PW. Cost-effectiveness of pulmonary resection and systemic chemotherapy in the management of metastatic soft tissue sarcoma: a combined analysis from the University of Texas M. D. Anderson and Memorial Sloan-Kettering Cancer Centers. J Thorac Cardiovasc Surg. 2004 May;127(5):1366-72.
6. Alexander ES, Machan JT, Ng T, Breen LD, DiPetrillo TA, Dupuy DE. Cost and effectiveness of radiofrequency ablation versus limited surgical resection for stage I non-small-cell lung cancer in elderly patients: is less more? J Vasc Interv Radiol. 2013 Apr;24(4):476-82.
7. Puri V, Crabtree TD, Kymes S, Gregory M, Bell J, Bradley JD, Robinson C, Patterson GA, Kreisel D, Krupnick AS, Meyers BF. A comparison of surgical intervention and stereotactic body radiation therapy for stage I lung cancer in high-risk patients: a decision analysis. J Thorac Cardiovasc Surg. 2012 Feb;143(2):428-36.
8. Sher DJ, Wee JO, Punglia RS. Cost-effectiveness analysis of stereotactic body radiotherapy and radiofrequency ablation for medically inoperable, early-stage non-small cell lung cancer. Int J Radiat Oncol Biol Phys. 2011 Dec;81(5):e767-74.

Lisbon, Portugal
September 26-30

CIRSE 2015

PART 2

Abstracts of Free Papers (oral communications) sorted by presentation numbers

Cardiovascular and Interventional Radiological Society of Europe

CIRSE

Free Paper Session
MRgFUS and IRE

607.1

Ultrasound-guided irrigation in calcific tendonitis of the rotator cuff: review of 1,450 treatments

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Purpose: We performed a systematic review of current evidence regarding ultrasound-guided percutaneous irrigation of calcific tendinopathy (US-PICT) in the shoulder aimed to assess the different techniques published, evaluate the clinical outcome in a large combined cohort, and propose suggestions for homogeneous future reporting.
Material and Methods: Cochrane Collaboration for Systematic Reviews of Interventions Guidelines were followed. We searched MEDLINE/MEDLINE In-Process/EMBASE/Cochrane databases from 1992 to 2013 using the keywords "ultrasound, shoulder, needling, calcification, lavage, and rotator cuff" combined in appropriate algorithms. References of the resulting papers were also screened. Risk of bias was assessed with a modified Newcastle–Ottawa scale.
Results: Out of 284 papers found, 15 were included and 1,450 shoulders in 1,403 patients (females, n=838; mean age interval, 40–63 years) were treated. No exclusion was done due to the risk of bias. We demonstrated a mean of 55% pain improvement at an average of 11 months, with a minor complication rate of 10%.
Conclusion: US-PICT of rotator cuff is a safe and effective procedure, with an estimated mean of 55% pain improvement at an average of 11 months with a minor complication rate of 10%. No evidence exists in favor of using a specific size/number of needles. Imaging follow-up may not be used routinely. Future studies may be aimed at structural uniformity, including the use of the Constant score to assess outcomes and 1-year minimum follow-up period. Alternatives to steroid injection may also be explored.

607.2

Recurrence rate evaluation of uterine fibroids treated using MRgFUS: retrospective study of MRI imaging and correlation between age and clinical outcomes

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Purpose: To evaluate the recurrence rate of uterine fibroids treated using MRgFUS after 12 months from the treatment, correlating the age of patients to the clinical and imaging results.
Material and Methods: Thirty-eight patients with symptomatic uterine fibroids (13 single fibroid and 25 multiple fibroids) were treated using MRgFUS. Twenty-two of them were aged between 40 and 50 (Group 1), 10 patients between 30 and 40 (Group 2) and 6 patients between 20 and 30 (Group 3). We submitted the patients to contrast-enhanced MRI respectively before treatment, and after 10 days, 3 months, 6 months and 12 months. We analysed the treated volume extension (non-perfused volume) and the possible recurrence of the pathology in the area of the treatment. Clinical evaluation was performed by the SSS questionnaire.
Results: We found the mean value of non-perfused volume of 91.5% in all patients. Thirty-four women belonging to all groups showed a complete reabsorption of the necrotic area with a good recovery of uterine wall after 12 months. Four younger women belonging to Group 3, showed hypointense tissue in the peripheral part of the treated area after 3-6 months from the treatment. One of them, who underwent myomectomy, showed tissue made of necrotic and fibrotic cells. Clinically, Group 1, Group 2 and Group 3 showed an SSS-Q mean value of 7.8, 8.1 and 6.4, respectively, after 12 months.
Conclusion: MRgFUS is an effective technique in older and younger women. In Group 3, the excellent clinical response was not associated to significant morphological results; this however did not impair the response to the treatment.

607.3

Magnetic resonance-guided focus ultrasound surgery (MRgFUS) compared to uterine artery embolization (UAE): main differences, advantages, therapeutic response, and definition of selection criteria

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Purpose: To compare effectiveness of UAE and MRgFUS for uterine fibroid treatment in terms of non-perfused volume extent and reabsorption, complications, hospitalization time, and clinical outcomes.
Material and Methods: Sixty-five patients affected by symptomatic uterine fibroids were treated in our department. Thirty-eight of them were treated using MRgFUS and 27 with UAE. The choice of treatment selection criteria were established according to patient age, fibroid vascularization, and accessibility. We compared patients of the same age, affected by the same number of fibroids, and showing similar dimensions and localization. They were controlled after 3, 6, and 12 months from the treatment, respectively. We evaluated the non-perfused-volume extent (NPV), reabsorption time, clinical response, and hospitalization time.
Results: The NPV mean value was 95% using UAE and 91.5% using MRgFUS. We observed a reabsorption of the necrotic area of 50%-70% in both techniques. Twenty-five out of 27 patients (92.5%) treated with UAE presented with abdominal pain and bloating, fever, and vomiting, with a mean hospitalization time of 3 days and returned to a normal life in 25 days. Only 2 out of 27 (7.5%) returned to a normal life in 10 days. Patients treated with MRgFUS had less post-treatment symptoms, no complications, and a mean hospitalization time of 1 day and returned to a normal life in 5 days.
Conclusion: UAE is more radical; it seems to have a shorter reabsorption time but a longer convalescence. MRgFUS is more repeatable with a good clinical response and should be the first choice when possible.

607.4

MR-guided focused ultrasound surgery (MRgFUS) vs radiofrequency thermal ablation (RFA) in minimally invasive treatment of osteoid osteoma (OO)

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Purpose: To evaluate effectiveness and safety of minimally invasive treatment of OO with two imaging-guided techniques: MRgFUS and RFA
Material and Methods: From March 2011, we treated 32 OO, 15 with MRgFUS and 17 with RFA. The possibility to reach the lesion with the US beam led to the choice of the technique used for each patient. If this condition was satisfied, patients were treated with MRgFUS, otherwise with RFA. Thirteen OO were treated with MRgFUS in the lower arm and 2 in the upper arm. Lesions treated with RFA were 14 in the lower arm, 1 in the upper arm and 2 in the vertebral body (L3

and L5). Follow-up was performed by MRI and CT up to two years; clinical evaluation was performed using the VAS scale.
Results: All patients, except one treated with MRgFUS, showed, immediately after the procedure, a regression in painful symptomatology. After treatment, they no longer needed any pain medication. The mean VAS value, 2 years after the treatment, improved overall of 100% [from 8.3 (MRgFUS) or 8.4 (RFA) to 0]. The results of MRI and CT, 2 years after the treatment, showed in all cases the disappearance of bone edema (MRI) and of some of the typical findings of the osteoid osteoma (CT). In no case were major complications observed.
Conclusion: Though based on a limited group of patients, our study demonstrates the safety and effectiveness of both the techniques with an optimal clinical outcome confirmed by imaging. The MRgFUS shows a lower rate of invasiveness but requires an adequate acoustic window.

607.5

Ablation of locally advanced pancreatic carcinoma by percutaneous irreversible electroporation: final results of the PANFIRE trial

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Purpose: Irreversible electroporation (IRE) is increasingly used to treat unresectable tumors surrounding major blood vessels and bile ducts, such as pancreatic tumors. The purpose of the PANFIRE trial was to investigate the safety and efficacy of percutaneous IRE for locally advanced pancreatic carcinoma (LAPC).
Material and Methods: Patients with histologically and radiologically proven LAPC (AJCC stage III) ≤5cm were prospectively included to undergo percutaneous CT-guided IRE. All procedures were performed under general anesthesia. Complications were graded according to the CTCAE v4.0. The study (registered at clinicaltrials.gov NCT01939665) was approved by the local review board.
Results: From October 2012 to January 2015, twenty patients underwent percutaneous IRE. Mean largest tumor diameter was 4.0cm (± 0.5cm). Two patients were treated twice due to local recurrence. Seven patients received chemotherapy prior to IRE (6 FORFIRINOX, 1 gemcitabine) and 3 after IRE (1 FORFIRINOX, 2 gemcitabine); in all 3 cases, it was to treat metastatic disease. Median length of hospital stay was 3 days (range 2-18). No deaths due to IRE occurred. Eleven minor (grade I/II) and eight major complications (6 grade III; 2 grade IV: severe pancreatitis and bleeding duodenal wall ulcer) occurred. After a mean follow-up period of 8 months (range 2-18), median PFS from IRE was 11 months and median OS was 13 months from IRE and 17 months from diagnosis.
Conclusion: Percutaneous IRE for LAPC is generally well tolerated, although major adverse events can occur. Preliminary survival data is encouraging and supports the setup of larger phase II and III clinical trials.

607.6

Alterations of bile ducts after hepatic irreversible electroporation: evaluation of MRI findings and laboratory findings

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Purpose: To evaluate biliary complications after the irreversible electroporation (IRE) of hepatic malignancies.
Material and Methods: Twenty-four patients (17 men; mean age, 59.3 years) were identified in whom bile ducts were located within a perimeter of 1.0 cm of the ablation zone at subacute follow-up (i.e., 1–3 days after IRE) after the percutaneous IRE of 53 hepatic tumors (primary hepatic tumors, 14). Magnetic resonance imaging (MRI) performed with a hepatocyte-specific contrast agent before and after treatment were examined for evidence of bile duct alterations. Serum bilirubin and alkaline phosphatase levels measured at subacute and 4–8-week follow-up were analyzed for evidence of biliary injury.
Results: A total of 55 bile ducts were located within a distance of 1.0 cm to an ablation defect. Location regarding ablation zone were as follows: encased, 33 of 55; abutting, 14 of 55; 0.1–1.0 cm distant, 8 of 55. At subacute follow-up MRI in 15 of these bile ducts, alterations were found, with dilation in 7 and narrowing in 8 cases. Abnormal laboratory findings at subacute follow-up were found in three patients after three IRE sessions (bilirubin, 1.6–4.4 mg/dL), which were transient in all the three cases. Abnormal laboratory findings at 4–8-week follow-up were found in one patient (increase of alkaline phosphatase by 533 U/L from baseline) due to local tumor recurrence.
Conclusion: IRE is a treatment option for liver tumors located in close proximity to bile ducts, and bile ducts adjacent to an IRE ablation zone remain largely unaffected by this procedure.

Free Paper Session
Vascular: BTK

1405.1

Statins reduce major amputations in patients with peripheral arterial disease: a systematic review and meta-analysis of more than 100,000 cases

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Purpose: Statins have well known pleiotropic vascular effects, such as stabilizing atherosclerotic plaques and reducing major cardiovascular events (stroke, myocardial infarction, and cardiovascular death). However, little is known on the effect of statins on limb salvage in patients with peripheral arterial disease.
Material and Methods: PubMed (MEDLINE), EMBASE, AMED, and Scopus were searched in December 2014 for eligible randomized controlled or observational clinical trials following the PRISMA selection process. Patients were stratified between statin users and non-users. The primary endpoint was major amputations, and it was synthesized on the log-hazard scale. Hazard ratios (HR) were calculated using THE random effects model (DerSimonian-Laird) to account for clinical and conceptual heterogeneity, and meta-regression analysis was performed to explore the predictive value of confounders.
Results: In total, 18 clinical studies (6 randomized/propensity matched trials, 6 multivariate reports, and 6 with univariate analysis), including 128,083 patients (34,952 following endovascular or surgical revascularization) were analyzed. Statin users suffered from significantly fewer major amputation events (HR: 0.71; 95%CI: 0.60–0.84; p<0.001). Reduction in major amputations was observed consistently across all study subgroups (randomized/propensity-matched trials: HR: 0.71; 95%CI: 0.55–0.91; p=0.007; multivariate reports: HR: 0.67; 95%CI: 0.51–0.88; p=0.004; and univariate reports: HR: 0.81; 95%CI: 0.59–1.10; p=0.18). Results were stable across all meta-regression analyses of age, gender, smoking, diabetes, renal impairment, baseline critical leg ischemia, and surgical or endovascular revascularization.
Conclusion: Statins significantly reduce major amputations in patients with peripheral arterial disease (around 30% relative risk reduction), and they should be prescribed before the need for revascularization arises.

1405.2

Endothelial cell seeding to promote vascular healing

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Purpose: Despite state-of-the-art advancements in endovascular interventional procedures, the problem of intimal hyperplasia and restenosis remains unsolved. Endovascular manipulations generally result in extensive endothelial cell (EC) damage and active stimulation of smooth muscle cell proliferation. Because natural repair of the EC lining is very slow in humans, we aim to speed up this process by combining autologous cultured ECs with percutaneously implantable biomaterials (stents). To ensure clinical applicability a maximum delay of two weeks between cell harvest and implantation readiness was targeted.
Material and Methods: A carrier for EC incorporation was developed. ECs were isolated from human veins and cultured in vitro. Culture protocols, cell seeding efficiency, and surface characteristics of the biomaterials were optimized. The influence of exposure to physiological flow on cellular attachment and function was studied in an in vitro setting.
Results: Isolation of ECs from veins was robust and reproducible, producing large quantities of cells within 14 days. Cultured ECs readily attached to the carrier when appropriate coatings such as gelatin and serum were applied. Attached cells remained functional and proliferative in culture. Cells were prone to detach upon physical contact, yet attached cells were flow resistant immediately after a 24h seeding period under hypoxic conditions. Therefore there is no need for expensive bioreactors to allow for cell maturation.
Conclusion: EC seeded devices may provide a means to speed up re-endothelializion of damaged vessel walls. Although off-the-shelf use of autologous cell products is impossible, we believe the non-immunogenic nature of the cells provides major advantages.

1405.3

Clinical efficacy of infrapopliteal drug-eluting stenting in diabetic patients with critical limb ischemia: 10-year outcomes

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Purpose: To investigate the long-term clinical outcomes of infrapopliteal drug-eluting stenting (DES) in diabetic patients with critical limb ischemia (CLI).
Material and Methods: This was a single-center study of all diabetic patients treated with infrapopliteal DES between January 2002 and September 2012. Follow-up period was terminated in September 2014. Primary outcome measures included patient survival and amputation-free survival (AFS). Secondary outcome measures were procedural success, identification of independent predictors influencing primary outcomes, and clinically driven target limb re-interventions (TLR).
Results: In total, 214 CLI patients [168 men (78.5%), mean age: 70 ± 9 years] with 311 limbs, 562 arteries, and 679 lesions were treated. According to Kaplan-Meier analysis, survival and AFS rates were 90.8%, 55.5%, and 36.2% and 94.9%, 90.4%, and 90.4% at 1, 5, and 10 years, respectively. Additional 168 infrapopliteal TLR procedures were necessary, and TLR-free survival was 79.7%, 55.2%, and 49.7% at 1, 5, and 10 years, respectively. Overall procedural success was 98.7% (473/479 procedures). Cox multivariable analysis demonstrated that procedural failure was the only independent predictor of decreased AFS (HR: 61.3; 95%CI: 13.8-271.9), while statin use was an independent predictor of increased survival (HR: 0.55; 95%CI: 0.31-0.98). Coronary disease (HR: 1.9; 95%CI: 1.01-3.54), dialysis (HR: 2.2; 95%CI: 1.21-4.06), and duration of diabetes (HR: 1.5; 95%CI: 1.02-2.34) were identified as independent predictors of decreased survival.
Conclusion: The use of infrapopliteal DES in the demanding subgroup of diabetic CLI patients yields excellent 10-year survival and AFS rates, with low re-intervention rates. Technical failure was associated with increased amputations and statin intake with increased survival.

1405.4

Paclitaxel-coated balloon for the treatment of infrapoplilteal arteries: 12-month results from the BIOLUX P-II randomized trial

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Purpose: Drug-eluting balloons (DEB) have shown promising results in femoropopliteal lesions, but data for infrapopliteal lesions are scarce. BIOLUX P-II aimed to compare the safety and efficacy of a novel paclitaxel-coated DEB versus an uncoated balloon (PTA) in de novo or restenotic lesions of the infrapopliteal arteries in patients with claudication and critical limb ischemia (CLI).
Material and Methods: BIOLUX P-II was a prospective, international, multicenter, randomized, first-in-man (FIM) study with 72 patients randomized 1:1 to either Passeo-18 Lux DEB (n=36) or Passeo-18 PTA (n=36). Follow-up assessments were scheduled at 1, 6, and 12 months, with angiographic assessment at 6 months. Adverse events were adjudicated by an independent Clinical Events Committee, and angiographic parameters were assessed by an independent core laboratory.
Results: The primary safety endpoint, major adverse events, a composite of all-cause mortality, target extremity major amputation, target lesion thrombosis, and target vessel revascularization at 30 days was 0.0% in the DEB group versus 8.3% in the PTA group (p=0.239). The primary performance endpoint, patency loss at 6 months, was 17.1% in the DEB group versus 26.1% in the PTA group (p=0.298), and clinical improvement of Rutherford 5 subjects was significant for the DEB group (p=0.002) compared with PTA group (p=0.058). Major amputations of the target extremity occurred in 3.3% versus 5.6% of the patients at 12 months.
Conclusion: In this small FIM patient population, including claudicants and CLI patients, the Passeo-18 Lux DEB has been proven to be safe and effective in infrapopliteal lesions with comparable outcomes to PTA, with a positive trend towards DEB.

1405.5

Morphological results of PADI trial: percutaneous transluminal angioplasty versus drug-eluting stents for infrapopliteal lesions in critical limb ischemia

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Purpose: Endovascular infrapopliteal treatment of patients with critical limb ischemia (CLI) with percutaneous transluminal angioplasty (PTA) and bail-out bare metal stenting (BMS) is hampered by restenosis. In interventional cardiology, drug-eluting stents (DES) have shown better patency rates and are standard practice nowadays. An investigator-initiated, multicenter, randomized trial was conducted to assess if DES also improves the patency rates of infrapopliteal lesions in CLI.
Material and Methods: Adults with CLI (Rutherford score≥4) and infrapopliteal lesions were randomized to receive PTA with bail-out BMS or DES with paclitaxel. Primary endpoint was 6-month primary binary patency of treated lesions, defined as ≤50% stenosis on computed tomography angiography. Stenosis of >50%, treatment in interim, major amputation, and CLI-related death were regarded as treatment failure. Severity of failure was assessed with an ordinal score, ranging from vessel stenosis through occlusion to the clinical treatment failures.
Results: Seventy-four limbs (73 patients) were treated with DES, and 66 limbs (64 patients) received PTA±BMS. Six-month patency rates were 48.0% for DES and 35.1% for PTA±BMS (p=0.096) in the modified intention-to-treat and 51.9% and 35.1% (p=0.037) in the per-protocol analysis. The ordinal score showed significantly worse treatment failures for PTA±BMS vs. DES (p=0.041), respectively.
Conclusion: In CLI patients with infrapopliteal lesions, DES provide better 6-month patency rates compared with those provided by PTA with bail-out BMS. Therefore, a treatment strategy with DES should be considered in these patients.

1405.6

Diabetes mellitus in patients with infrapopliteal critical limb ischemia

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Purpose: Diabetes mellitus (DM) is considered a major risk factor for peripheral arterial disease (PAD). However, implications of DM for the prognosis of critical limb ischemia (CLI) are not well known, since diabetic and non-diabetic CLI patients are typically reported as one group. DM was a common comorbidity in the earlier conducted PADI trial [percutaneous transluminal angioplasty (PTA) versus drug-eluting stents (DES) for infrapopliteal lesions]. In order to determine the implications of DM, we compared the clinical outcomes in diabetics and non-diabetics.
Material and Methods: In the PADI trial, adults with CLI (Rutherford score ≥ 4) and infrapopliteal lesions were randomized to receive PTA or DES. Patients were considered diabetic when they were treated with oral antidiabetic agents and/or insulin therapy at baseline. The observed rates of amputation and survival were compared in both groups. Hazard ratios of diabetes were calculated, unadjusted as well as adjusted for treatment strategy, age, and smoking.
Results: Of our cohort of 133 patients (included for 140 limbs), 84 patients (63.2%) suffered from DM. The rate of major amputations was significantly higher in diabetics (p=0.03). Unadjusted and adjusted hazard ratios of diabetes for the risk of major amputation were 3.54 (95% CI 1.04–12.10) and 3.51 (95% CI 1.01–12.16), respectively. Survival rates were comparable.
Conclusion: Diabetic CLI patients are at a substantially higher risk of major amputation. If one is aware of this higher risk, diabetics could benefit from prompt recognition and early referral to a specialized limb salvage team.

Free Paper Session
Embolisation: special areas

1406.1

Bariatric embolization using large calibrated spheres (300-500µm): assessing safety, long-term efficacy and changes in gut hormones in a swine model

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Purpose: Preclinical studies of bariatric arterial embolization (BAE) with small (40-50µm) calibrated spheres in growing swine have been effective in preventing weight gain and altering gastric hormone profiles. The current study examines the use of larger microspheres (300-500µm) in growing swine to investigate the effects on weight gain, gastric motility, and gastric neuro-hormonal axis.
Material and Methods: Fundal artery targeting using cone beam CT (CBCT) was performed in 55-60lb juvenile farm pigs (n=5 BAE, n=5 sham). From a celiac DSA, two of the three fundal arteries were selected with a SureFire mt catheter (SureFire Medical) and 0.016 wire. At each location, a pre-embolization DSA and CBCT were performed. In the BAE group, 300-500µm Embospheres (Merit Medical) were delivered until stasis; the sham group received saline. Weights and blood samples were collected serially for 16 weeks. Upper endoscopy was performed at 1 week and gastric emptying (oral acetaminophen technique) at 3-5 weeks post-BAE. Statistical analysis was performed (STATA); P<0.05 was considered statistically significant.
Results: Weight gain was not different in BAE animals relative to sham pigs. Gastric emptying was not altered by BAE. Ghrelin and GLP-1 both fasting and in response to feeding did not significantly differ between the treated and sham pigs. Superficial mucosal ulcers in the gastric fundus were present in 2 of 5 pigs.
Conclusion: BAE using larger beads (300-500µm) produced neither significant weight loss or changes in gastric emptying nor significant changes in ghrelin or GLP-1. This suggests that a smaller caliber bead size is likely to be more effective for bariatric embolization.

1406.2

Bariatric embolization of arteries for the treatment of obesity (BEAT Obesity): study design and 6-month safety and efficacy data

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Purpose: Bariatric embolization is a new endovascular procedure developed for the treatment of obesity. This procedure, in which the gastric fundus is embolized with small particles via the left gastric artery, has shown great promise in animal studies. BEAT Obesity is an investigator-initiated IDE, approved by the FDA designed to assess the safety and efficacy of bariatric embolization to treat morbidly obese patients using 300-500 micron Embospheres (Merit Medical).
Material and Methods: This single-arm prospective study enrolls 5 morbidly obese (BMI 40-60; weight <400 lbs) adult patients without co-morbid conditions. Exclusion criteria include history of malignancy, vascular disease, prior abdominal surgery, diabetes, variant gastric arterial anatomy, and ulcer disease. Primary endpoints include weight loss and 30-day adverse events. Secondary endpoints (at 12 months) include blood pressure, lipid profile, serum obesity hormones (e.g., ghrelin/leptin/GLP-1/PYY), eating/hunger/satiety assessments, Quality Of Life (QOL), and results from endoscopy and gastric emptying studies. Key aspects of the study design include the following: 1) pre-procedural CTA, upper endoscopy, gastric emptying study, gastric hormone panels, as well as QOL- and obesity-related psychological assessment; 2) post-procedural endoscopy (week 2, month; and 3) gastric emptying studies (months 1, 6), lab and gastric hormone panels, well as QOL and obesity-related psychological assessments (weeks 1, 2; months 1, 3, 6, 12). The procedure specifics include celiac and selective left gastric artery (as well as other fundal branches) DSA and cone beam CTs, followed by embolization with 300-500 micron Embospheres.
Results: Thirty-day safety data will be collected by May 2015. Six-month safety and efficacy data will be fully collected by September 2015.

1406.3

Gastric Artery Embolization Trial for LEssening Appetite Nonsurgically (GET LEAN)

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Purpose: The purpose of this pilot study is to achieve the collection of safety and efficacy data in patients undergoing left gastric artery embolization for morbid obesity in the Western Hemisphere.
Material and Methods: This is an FDA-IDE pilot study. 5 patients have been approved to undergo the left gastric artery embolization procedure for the purpose of weight loss using Beadblock 300-500 micron particles. All patients will undergo EGD follow up pre and post procedure. Ghrelin, Leptin and CCK levels will also be measured at baseline and post procedure per follow up protocol.
Inclusion Criteria
- Morbid obesity with a BMI ≥ 40
- Age ≥ 22years
- Ability to lay supine on an angiographic table
- <400lbs due to table weight limits
- Appropriate anesthesia risk as determined by certified anesthesia provider evaluation preprocedure

Subjects who have failed previous attempts at weight loss through diet, exercise, and behavior modification (as it is recommended that conservative options, such as supervised low-calorie diets combined with behavior therapy and exercise, should be attempted prior to enrolling in this study).
Results: The first patient has lost 30lbs at 3 months. Second patient has lost 12lbs at 1 month. Third patient has lost 6lbs in 1 week. There have been no major adverse events. The final 2 patients in this study are still being selected.
Conclusion: This is the first experience in the United States of performing left gastric artery embolization for the purpose of treating morbid obesity. Early results are promising and show no major adverse events thus far. The radial artery has also proven to be a feasible approach to performing this procedure with implications for a safer access site.

1406.4

Superior rectal artery embolization "EMBORRHOID" as the first-line treatment in patients suffering from haemorrhoidal disease: mid-term results

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Purpose: Embolization of the superior rectal arteries (EMBORRHOID) has recently been shown to be effective in hemorrhoidal disease for compassionate patients. We report the results of the first study of superior rectal arteries embolization as the first line treatment in patients suffering from haemorrhoidal disease.
Material and Methods: Twenty-six patients (30 to 72 years old) with symptoms of hemorrhoidal disease (chronic, disabling rectal bleeding and/or pain) were embolized de novo after multidisciplinary discussion (proctologist, general surgeon and radiologist). Embolization of the terminal branches of the superior rectal arteries were performed via the inferior mesenteric artery using a microcatheter and coils (0.018", 2 and 3 mm in diameter).
Results: Technical success of the embolization procedure was 100%. Clinical success (lack of bleeding and/or pain, or insignificant amounts of bleeding and/or pain that was well tolerated by the patients) at 6 months was 81.8% (5/26). Four of these five patients described amelioration of the symptoms and of the quality of life but with residual pain. One patient who experienced rebleeding underwent an additional embolization of the posterior rectal arteries with success. No ischemic complications were observed in 26 patients.
Conclusion: We believe that rectal bleeding and pain occur when venous hemorrhoidal pressure reaches a certain threshold. Embolization may decrease the arterial flow significantly leading to a decrease of the venous pressure below this threshold. This hypothesis may explain the positive clinical results observed with this first-line treatment. Additional studies are needed to evaluate the efficacy of this new "emborrhoid" technique in the management of hemorrhoidal disease.

1406.5

Usefulness of C-arm cone-beam computed tomography in embolization of acute bleeding

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Purpose: To evaluate the feasibility and utility of C-arm cone-beam computed tomography (CBCT) and the Emboguide software during endovascular embolization of acute bleeding.
Material and Methods: At our institute, between December 2013 and December 2014, 85 acute bleeding embolizations were performed; seven procedures (1 bronchial artery bleeding, 2 traumatic, and 4 spontaneous abdominal bleedings) were completed under C-arm CBCT and constituted the study cohort.
Intraprocedural C-arm CBCT after intraarterial contrast administration was performed to visualize bleeding and determine the bleeding arterial feeders using the Emboguide software to schedule the selective embolization. Embolization was performed with different embolization materials, and non-enhanced CBCT was performed after embolization. CBCT images acquired before and after procedure were registered to evaluate embolization.
CBCT bleeding detection accuracy and bleeding arterial feeder detection on the basis of CBCT and Emboguide software information were recorded. Clinical success was measured as an absence of bleeding on post-procedural DSA.
Results: All procedures were completed successfully without complications. Intraprocedural C-arm CBCT were detected at 7/7 sites of bleeding (100%), while only 5/7 were detected at the angiographic images. In each case, the Emboguide software detected the bleeding arterial feeders, allowing a correct procedural planning; microcatheters were positioned on the basis of CBCT and the Emboguide software in 6/7 cases (85.7%).
Conclusion: C-arm CBCT is a useful instrument in the angio-suite to achieve targeted and efficient embolization more safely and easily, reducing operative time and contrast media injection as well as improving outcomes.

1406.6

Lymphatic embolization using N-butyl cyanoacrylate in patients with postoperative ascites associated with lymphatic leakage

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Purpose: To assess the feasibility, efficacy, and safety of lymphatic embolization using N-butyl cyanoacrylate (NBCA) in patients with postoperative ascites secondary to lymphatic leakage.
Material and Methods: Nineteen consecutive patients with postoperative ascites who were referred for lymphatic intervention between April 2014 and February 2015 were retrospectively analyzed. After identifying leakage from the iliac chains by intranodal lymphangiography, the leakage site was embolized by directly puncturing the iliac lymphatic vessel or lymph node proximal to the leakage site and injecting NBCA. The amount of daily drainage via surgical drains was recorded as were the results of routine laboratory tests including complete blood counts and serum chemistry. Clinical success was defined as significant decrease in the amount of surgical drainage until the drains could be removed and the patients uneventfully discharged. All medical records during admission and follow-up were reviewed to identify possible complications associated with the procedure.
Results: Twenty-three procedures were performed in nineteen patients, including four repeat procedures performed in three patients due to persistent leakage. Fluid analysis revealed chylous content in five of the patients. Significant decrease in the amount of drainage (from a mean of 1258 ml/day to 189 ml/day) was eventually seen in all patients after their final procedures. Recovery of serum albumin level was noted in seven patients in whom it was initially altered. All patients were uneventfully discharged after their surgical drains were removed. No complications were identified.
Conclusion: Lymphatic embolization using NBCA is feasible, effective, and safe for the management of patients with postoperative ascites secondary to lymphatic leakage.

Free Paper Session
Liver ablation

1407.1

Preliminary application of CT-guided radiofrequency ablation under contrast-enhanced ultrasound combined with intelligent guiding device in malignant liver tumors

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Purpose: Computer tomography (CT)-compatible robots have been developed with the intention of increasing the accuracy of needle placement and reducing clinical staff and patient exposure to radiation during CT fluoroscopy. To estimate the clinical value of contrast-enhanced ultrasound (CEUS) before and after CT-guided radiofrequency ablation (RFA) combined with intelligent guiding device called MAXIO in the treatment of liver tumors.
Material and Methods: We report our preliminary experience of performing RFA using the MAXIO CT-guided positioning system on 17 liver tumor patients (22 lesions). CEUS were performed and compared on all patients before and after RFA procedures.
Results: RFA was successfully completed in 16 patients, with 21 lesions confirmed on CEUS. The remaining one received once more RFA owing to partial residual, and then achieved complete ablation. Only 2 mild procedure-related complications were noted in this study.
Conclusion: MAXIO CT-guided positioning system appears to be safe and highly accurate in the treatment of percutaneous RFA on using liver tumors. It has lower radiation dose to both patient and clinical staff during the procedure. CEUS can be used promptly to evaluate the RFA efficacy by compared the results before and after procedures.

1407.2

What are the factors associated with an increased risk of local recurrence after radiofrequency ablation or surgical metastasectomy?

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Purpose: To compare the local recurrence rate of radiofrequency ablation (RFA) and metastasectomy for colorectal cancer liver metastases and define the best candidates for each treatment.
Material and Methods: A lesion-by-lesion analysis was done in 121 liver metastases ablated by metastasectomy in 43 consecutive patients and 110 treated by RFA in 60 patients (median follow up: 22 months). Local recurrence (LR) and hepatic recurrence (HR) rates were compared. Univariate and multivariate stepwise regression analyses for factors favoring recurrence were compared for the 2 groups, including demographics and tumor status as well as tumor size, depth in the liver, proximity of vessels, and R0/R1 status after resection.
Results: Groups were comparable for demographics and tumor characteristics. The metastases median size was smaller for the RFA group than for metastasectomy (15 vs 18mm, p=0.03). LR was

observed in 19% of the metastasectomy group and 13% of the RFA group (delay: 244 days vs 249 days, p=0.21). HR rate was similar for both groups (metastasectomy 78.5%, RFA 66%; p=0.054). Factor associated with recurrence in the RFA group was tumor size (p<0.001), and note tumor depth or vessel proximity, in both uni- and multivariate analyses. For metastasectomy, R1 and lesion depth increased the risk of local recurrence in uni- and multivariate analyses (p=0.02 and p=0.03, respectively). Factors associated with R1 are lesion depth (p=0.04) and vessel proximity (p<0.001).
Conclusion: RFA and liver metastasectomy have similar LR rate. Deeply localized lesions with vessels in the vicinity are at risk for surgery, while tumor size is the only limiting factor in RFA.

1407.3

Radiofrequency ablation versus surgical resection for hepatocellular carcinoma within the Milan criteria: a propensity score-matched study

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Purpose: To compare survival and complication rates after radiofrequency ablation (RFA) versus surgical resection (SR) in patients with hepatocellular carcinoma (HCC) within the Milan criteria.
Material and Methods: We retrospectively and consecutively included all patients with first occurrence of HCC within the Milan criteria receiving SR or RFA as the first-line treatment from January 2004 to December 2013. The cumulative overall survival (OS) and the disease-free survival (DFS) were compared after propensity score matching.
Results: After matching, 128 patients (64 per treatment arm) were retained for analysis. Matching variables were not significantly different between SR and RFA groups. After a median follow-up of 34.1 months (interquartile range: 18.7-60.3), the respective 1-, 3-, and 5-year OS for SR and RFA groups were 92.9%, 79.1%, and 59.9% and 95.2%, 62.3%, and 54.5% (P=0.209). The respective 1-, 3-, and 5-year DFS for SR and RFA group were 69%, 44.1%, and 17% and 64.5%, 40.1%, and 24.5% (P=0.757). Five-year OS and DFS were not significantly different for patients with HCC >30mm across the SR and the RFA groups, 61.1% versus 41.9% (P=0.069) and 16% versus 27 % (P=0.963), respectively. Local tumor progression rates were 2.3% (1/43) of recurrence for the SR group and 12.2% (5/41) for the RFA group (P=0.105). After the first HCC recurrence, 87.8% of RFA patients (36/41) and 74.4% in SR patients (32/43) were still within the Milan criteria (P=0.166).
Conclusion: This propensity score-matched study has shown that RFA and SR had similar OS and DFS for hepatocellular carcinoma within the Milan criteria in a European population.

1407.4

Computed tomography-guided ablation of hepatic lesions: comparing short-term therapeutic efficacy of radiofrequency versus microwave ablation in small lesions

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Purpose: To compare safety and short-term efficacy of CT-guided percutaneous radiofrequency (RFA) versus microwave (MWA) ablation in patients with malignant hepatic lesions (primary or secondary) measuring ≤3cm in diameter
Material and Methods: During the last 24, months we retrospectively compared two groups of patients. RFA Group (48 patients with 66 lesions) and MWA Group (38 patients with 48 lesions) underwent CT-guided ablation (protocol depended on lesion size and location according the manufacturer's guidelines). Contrast-enhanced CT scan was performed immediately post-ablation and Gd-DTPA-enhanced MRI during follow-up. Technical success was defined according to mRECIST criteria. Comparative analyses were performed for short-term therapeutic efficacies.
Results: At month 1, 3, and 6 post-ablation, for MWA Group (mean duration of ablation protocol 7.8 minutes) complete response (CR) rate was 95.9% (46/48) and partial response (PR) rate was 4.1% (2/48). For RFA Group (mean duration of ablation protocol 11.0 minutes), CR rate was 97% (64/66) and PR rate was 3% (2/66). After additional ablation, both lesions were completely treated (CR). No statistical difference in CR rate existed between groups RFA and MWA (p>0.05). No deaths or major complications were encountered. Minor complication (reversible, recovered with no further treatment) rate was 7%.
Conclusion: Both RFA and MWA seem to result in equally high rate of primary effectiveness in lesions smaller than 3cm. Both techniques are safe and effective clinical applications for the treatment of focal liver malignancies with diameter ≤3cm. Protocol characteristics (power/time) should be optimized according to tumor size and location.

1407.5

Applied energy and ablation volume after CT-guided microwave and radiofrequency ablation of colorectal liver metastases

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Purpose: To determine the correlation between the applied energy (E) and ablation volume (V) in radiofrequency ablation (RFA) and microwave ablation (MWA) in the treatment of colorectal liver metastases.
Material and Methods: Fifteen patients treated with CT-guided RFA and 15 with CT-guided MWA were retrospectively selected. The power of the MWA and RFA devices was set according to the protocol provided by the manufacturer, and the amount of applied energy (kJ) was determined. To determine the volume of the ablation zone (mL), a semi-automatic interactive 2D region growing algorithm was used for segmentation on the portal venous phase CT scan acquired 1 week after the ablation. Linear regression analysis was used to determine the correlation between the amount of applied energy and ablation volume.
Results: The mean ablation time for RFA was 73 minutes using 455.2 kJ, resulting in an ablation volume of 69.6 mL. The mean ablation time for MWA was 21 minutes using 182.4 kJ, resulting in an ablation volume of 66.8 mL. The correlation between the amount of applied energy and ablation volume for RFA could be approximated by the linear function $V = 9.53 + 0.13*E$ ($R^2 = 0.84$). The correlation for MWA could be approximated by $V = 8.39 + 0.32*E$ ($R^2 = 0.66$). MWA has a significantly higher correlation coefficient ($p = 0.002$).
Conclusion: The correlation between the applied energy and ablation volume can be approximated by a linear function for both RFA and MWA. RFA ablation, although more time consuming, is associated with a more predictable ablation volume.

1407.6

A new system of microwave ablation at 2450 MHz: preliminary experience at two centers

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Purpose: To assess the feasibility of the application of a new microwave system and to identify its advantages. In particular, the attention was focused on the spherical ablation zone obtained and its usefulness in terms of effectiveness.
Material and Methods: The new system was composed of the following parts: a 2450-MHz generator that delivered a maximum power of 100 W, a fiberglass antenna and a pump for internally cooled antenna. Thirty-five liver nodules (26 hepatocellular carcinomas and 9 metastases) were percutaneously treated [mean diameter, 24.9 mm (range, 16–35 mm)]. Technical success, ablation duration time, overall procedure time, and safety were registered. Clinical success was measured on 1- and 3-month follow-up contrast-enhanced CT. To define the shape of the ablation zone, a CT scan multiplanar reformatting (MPR) was performed. Roundness index transverse was calculated as follows: a value near 1 represented a more spherical ablation zone shape, and a value distant from 1 implied an oval configuration.
Results: Technical success was 100%. Mean ablation time was 3.85 min (range, 3–5 min), and mean overall procedure time was 30.5 min (range, 25–40 min). No major complications were recorded. Clinical success was 100% (no recurrence was observed). Roundness index transverse presented a mean value of 0.94, meaning that a spherical shape of ablation zone was achieved.
Conclusion: One of the most promising innovations of the new MW Thermosphere® technology is the spherical shape of the ablation volume that could be related to an improvement in effectiveness and safety.

Free Paper Session
Vascular: femoro-popliteal

1505.1

A stent featuring true 3D helical geometry significantly reduces restenosis and reintervention in the SFA: 2-year results from the MIMICS trial

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Purpose: Prevalence of both atherosclerosis and restenosis is affected by vessel wall shear stress. The MIMICS RCT investigated the outcome of using the BioMimics 3D helical stent specifically designed to elevate and maintain wall shear stress, following the revascularization of the SFA.
Material and Methods: The BioMimics 3D stent is laser cut from nitinol and heat treated using a forming tool to achieve a true 3D helical geometry. Seventy-six patients were randomized 2:1 against a control stent (Lifestent, CR Bard). All patients received dual antiplatelet therapy. Clinical, X-ray, and ultrasound outcomes were completed in 2 years.
Results: A total of 95% of patients were claudicants, with an average lesion length of 7 cm; 42% had total occlusions and 55% had moderate or severe calcification. The target lesion primary patency of the helical stent at 2 years was significantly higher ($p = 0.05$) than that of the control stent (72% vs. 55%). There was no clinically driven TLR between 12 and 24 months following the helical stent, which again was significantly lower than the control stent (log rank test = 0.03).
Conclusion: 1. This study confirms the beneficial protective effect of swirl flow, producing high vessel wall shear stress.
2. There is a significant reduction in restenosis and clinically driven TLR, following the use of a stent with a true 3D helical geometry when compared with a straight stent in the SFA.
3. These findings should impact the choice of device when managing peripheral arterial disease.

1505.2

Use of 4-French systems for treating fem-pop lesions – advantages and disadvantages: lessons from the 4EVER trial's 36-month results

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Purpose: The 4EVER trial attempts to investigate the long-term results in patients presenting with intermittent claudication or critical limb ischemia by use of 4-French systems.
Material and Methods: The 4EVER trial is a prospective, non-randomized, multi-center, multi-national, controlled trial conducted in 5 sites in Belgium and Germany. Between June 2010 and May 2011, 120 patients were enrolled. The primary endpoint was primary patency at 12 months, defined as freedom from >50% restenosis at 12 months as indicated by an independently verified duplex ultrasound peak systolic velocity ratio (PSVR) <2.5 in the target vessel with no reintervention.
Results: Of the 120 patients enrolled, 83.3% had intermittent claudication and 16.7% presented with critical limb ischemia. The mean lesion length was 43.5mm in the Astron Pulsar group, 105.4mm in the Pulsar-18 group, and 145.0mm in the mixed stent group. The overall mean lesion length was 72.4 mm. Kaplan-Meier estimation reported a 12-month primary patency rate of 81.4% and a 12-month freedom of target lesion revascularization of 89.3%. The 24-month data shows a primary patency rate of 72.3% and freedom of target lesion revascularization of 82.7%. For 103 patients, compression time was recorded with a mean compression time of 8.12 (2.00-15.00) minutes. The data on stent fracture rate at 24 months have been analyzed.
Conclusion: The results demonstrate that the use of 4-French systems is feasible for the majority of endovascular treatments, with equal technical success rate, primary patency, and freedom from TLR as 6-French devices over 2 years, even in calcified lesions.

1505.3

Twelve-month results from the MAJESTIC trial of the Eluvia drug-eluting vascular stent system

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Purpose: The purpose of the MAJESTIC clinical study was to evaluate the performance of the Eluvia drug-eluting vascular stent system (Boston Scientific Corporation, Marlborough, MA, USA) for treating femoropopliteal artery lesions.
Material and Methods: MAJESTIC is a prospective, single-arm, multicenter clinical trial. Eligible patients had chronic lower limb ischemia and de novo or restenotic lesions in the native superficial femoral artery and/or proximal popliteal artery. The primary efficacy endpoint was core laboratory-adjudicated 9-month primary patency (i.e., duplex ultrasound peak systolic velocity ratio of ≤2.5 and the absence of target lesion revascularization [TLR] or bypass). Major adverse events (MAEs) included all-cause death through 1 month, target limb major amputation through 9 months, and TLR through 9 months. Follow-up continues at 1, 2, and 3 years.
Results: Mean age (±SD) of the patients (N=57) was 69±3 years, and 83% were males; 35% had diabetes. Baseline Rutherford category was 2 for 35%, 3 for 61%, and 4 for 4% of patients. Mean lesion length was 70.8±28.1 mm, and 65% had severe calcification. Percent diameter stenosis was 86.3%±16.2%, and 46% had total occlusions. At 9 months, primary patency was 94.4% (90% CI, 86.3% and 98.5%). The MAE rate was 3.6% (2/55), and both MAEs were TLRs. Preliminary 12-month data showed a primary patency of 96.1% (49/51); 12-month follow-up for all patients will be complete by the time of presentation.
Conclusion: MAJESTIC results showed that patients treated with the Eluvia drug-eluting stent sustained a high patency and low MAE rate through 12 months.

1505.4

Zilver PTX postmarket surveillance study of paclitaxel-eluting stents for treating femoropopliteal artery disease in Japan: 24-month results

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Purpose: The paclitaxel-coated Zilver PTX stent is the first drug-eluting stent (DES) approved in Europe, Japan, and the United States for SFA. Previously, the results from a large, randomized study and a complementary, large, single-arm study supported the safety and effectiveness of DES. Currently, a multicenter, prospective, postmarket surveillance study is underway in Japan to further evaluate this stent in real-world patients.
Material and Methods: The first approximately 900 patients in Japan treated with DES were enrolled in the study. Clinically-driven TLR was defined as the reintervention performed for ≥50%-diameter stenosis after recurrent clinical symptoms of PAD.
Results: In this study, 907 patients were enrolled at 95 institutions in Japan. In total, 1,869 stents were placed in 1,091 lesions. Compared with previous randomized and single-arm studies, these patients had significantly more renal disease (p<0.01, 44%) and higher Rutherford classification (p<0.01, 21% CLI). The lesions were also significantly longer (p<0.01; mean, ~15cm) and more complex (p<0.01; 19% in-stent restenosis and fewer patent runoff vessels). Follow-up through 24 months was obtained for >85% of eligible patients. The rate of site-reported total occlusion of suspected thrombotic origin through 24 months remains low. The 24-month Kaplan–Meier estimate for freedom from TLR was 85.0%.
Conclusion: Despite more challenging lesions, the current study continues to show similar outcomes to those from previous Zilver PTX studies, providing further assurance of the benefit of the Zilver PTX stent.

1505.5

Misago RX nitinol stent for treatment of long calcified SFA lesions: results from the e-MISAGO registry

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Purpose: To assess the efficacy of the Misago RX nitinol stent in patients with long calcified atherosclerotic SFA lesions.
Material and Methods: In all, 434 patients with calcified atherosclerotic lesions in the SFA longer than 80 mm were a subset of a total of 3331 patients enrolled in 60 hospitals in 14 countries in the prospective, non-randomized, multicentre e-MISAGO registry and were followed up for up to 12 months after the index procedure. The primary efficacy endpoint was target vessel patency at 1 year. The data were reviewed by an independent clinical event committee with adjudication of all adverse events.
Results: Of 434 patients with long calcified SFA lesions, 71.4% were males, with a mean age of 70.1 years. Hypertension, smoking history and diabetes were present in 76.2%, 54.5% and 41.6%, respectively, with more than 75% of lesions being TASC II B or C. Mean lesion length and RVD were 120 mm and 5.7 mm, respectively; mean diameter stenosis was 93.5 % (38.7% total occlusions).
Symptomatic status changed from 93.6% at baseline to 26.4% at 1 year. Mean ABI increased from 0.6 to 0.8, claudication at walking increased from 80 m to 150 m and 79.9% of patients had improvement of Rutherford Index. Primary patency was 90.3% at 1 year; 2.8% of patients died, most of them due to a cardiac cause, while 1.6% had an amputation at 1 year.
Conclusion: This study confirms the excellent performance of the Misago RX nitinol stent in treating long calcified SFA lesions.

1505.6

Are stent grafts the solution for in-stent restenosis after SFA stenting?

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Purpose: Tackling in-stent restenosis (ISR) in the SFA has some challenges. To date, literature review reveals only very limited data on ISR in peripheral arteries. The Viabahn endoprosthesis with a heparin bioactive surface offers high flexibility when deployed in the SFA, and the coating provides an enhanced hemocompatibility.
Material and Methods: The RELINE trial was a prospective, randomized, multi-center, controlled trial in which enrollment was allowed to continue until 80 patients met the eligibility criteria. Hundred patients were enrolled. The first primary endpoint was primary patency at 12 months, defined as no evidence of restenosis or occlusion within the originally treated lesion based on color-flow duplex ultrasound (CFDU) measuring a peak systolic velocity ratio ≤2.5 and without target lesion revascularization (TLR) within 12 months. The second primary endpoint was the proportion of patients who experienced serious device-related adverse events within 30 days post-procedure.
Results: The analysis was based on the intention-to-treat total of 100 patients. Forty-seven (47.0%) patients were randomized to the VIABAHN ISR group and 53 (53.0%) patients to the POBA group. Demographic data was comparable in both treatment groups. The survival analysis showed a primary patency rate at 12 months of 94.4% for the VIABAHN ISR group and 60.7% for the POBA group (p<0.001). Freedom of TLR at 12 months was 94.3% in the VIABAHN ISR group and 60.4% in the POBA group (p<0.001).
Conclusion: The full 12- and 24-month data analysis shows a clear statistical benefit in the patency outcome for stent grafts as compared to POBA for ISR.

Free Paper Session
Liver TACE: clinical studies

1506.1

Improved stability of lipiodol-drug emulsion for transarterial chemoembolisation of hepatocellular carcinoma results in improved pharmacokinetic profile: proof of concept using idarubicin

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Purpose: To investigate the relationship between improved stability of the anticancer drug-lipiodol emulsion and pharmacokinetic (PK) profile for transarterial chemoembolisation (TACE) of hepatocellular carcinoma (HCC).
Material and Methods: The stability of four doxorubicin- or idarubicin-lipiodol emulsions was evaluated over 7 days. Clinical and PK data were recorded after TACE with the most stable emulsion in eight unresectable HCC patients.
Results: The idarubicin-lipiodol (1:2 v:v) emulsion was the most stable with no phase separation at 5 days, whereas complete phase separation for the doxorubicin-lipiodol emulsions was observed between 4 and 12 hours. Two months after TACE, 1 complete response, 5 partial responses, 1 stabilisation, and 1 progression were observed, with two asymptomatic grade 4 biological adverse events. The most frequent grade 3 TACE-related adverse events were pain and biological abnormalities. Mean idarubicin C_{max} and AUC0-24h were 12.5 ± 9.4 ng/mL and 52 ± 16 ng/mL·h, respectively. Most of the plasma exposure occurred over the 24 hours after the TACE procedure (76% of the estimated total AUC [68 ± 23 ng/mL·h]). The estimated mean bioavailability of idarubicin was 40%, meaning that 60% of idarubicin remained in the liver.
Conclusion: This study demonstrated that improved stability of drug-lipiodol emulsion results in improved PK profile after TACE of HCC. Encouraging data for safety and responses support further clinical studies with the idarubicin-lipiodol (1:2 v:v) emulsion in this indication.

1506.2

Drug-eluting beads transarterial chemoembolization (DEB-TACE) for hepatocellular carcinomas: predictive factors in neoadjuvant therapy

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Purpose: To identify pre-, intra-, and post-procedure factors responsible for determining higher percentage of necrosis and for decreasing the diameter of chemoembolized injuries.
Material and Methods: A prospective, single-center study, which evaluated pre-, intra-, and post-procedure factors that would be related to the success of DEB-TACE, considering the necrosis percentage of outcomes obtained in the pathology and decreased diameter of lesions on magnetic resonance imaging (MRI) after DEB-TACE. Pre-procedure factor evaluated was the diameter of hepatocellular carcinomas (HCC), intra-procedure factors were arterial superselective degree, chemotherapeutic dose used (doxorubicin/mg), and number of vessels nurtured, and post-procedure factors were presence or absence of vascular capsule, microvascular invasion, and degree of Edmondson cell differentiation.
Results: We evaluated 66 HCC receiving DEB-TACE and hepatic transplantation. Diameter reduction percentage of chemoembolized HCC larger than 2 cm had mean percentage reduction of 17.6% (p<001), while smaller than 2 cm showed increase in average diameter by 9.5%. In assessing necrosis percentage for pathology, we found it to be statistically significant (p<001) for lesions larger than 2 cm (mean necrosis, 50.8% and 29.1%; 2 cm higher and 2 cm lower, respectively) and for the presence of vascular capsule (mean necrosis, 69.6% with capsule and 23% without capsule). Doxorubicin dose was correlated with the presence of necrosis, each milligram administered promoted 0.34% increase in the observed necrosis.
Conclusion: The average diameter of HCC, presence of vascular capsule, and dose of chemoembolic used relate to the success of DEB-TACE. These findings may help to better define the criteria used for the indication of chemoembolization using microsphere carriers in the neoadjuvant treatment of HCC.

1506.3

Chemoembolization with DC beads preloaded with irinotecan (DEBIRI) vs. doxorubicin (DEBDOX) as the second-line treatment for liver metastases from cholangiocarcinoma: technical aspects, complications, and efficacy

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Purpose: Transarterial chemoembolization (TACE) with drug-eluting beads is routinely performed using doxorubicin and irinotecan for treating HCC and hepatic metastases from colorectal cancer,

respectively. Conversely, there is no specific drug indication in the treatment of other liver metastases.
The aim of our study is to compare the efficacy of DEBIRI vs. DEBDOX for treating unresectable hepatic metastases from cholangiocarcinoma.
Material and Methods: Ten patients affected by multiple cholangiocarcinoma hepatic metastases, which were resistant to the first-line chemotherapy regimen, were enrolled: 5 underwent lobar/segmental TACE with DEBIRI (100 mg irinotecan/1 vial) and 5, with DEBDOX (50 mg doxorubicin/1 vial) performed every 3 weeks. Patients treated with DEBIRI received analgesic premedication consisting of 30 mg of morphine and 3–4 ml of intra-arterial lidocaine. All procedures were performed with a transfemoral approach using a microcatheter. Complications and efficacy of the two different types of treatment were assessed by contrast-enhanced computed tomography (RECIST and mRECIST criteria).
Results: A total of 32 TACE were performed (mean, 3.2 TACE/patient). All treatments were well tolerated, with only one case of asymptomatic cholecystitis that spontaneously recovered.
Response rates assessed at the end of the treatment cycle of patients treated with DEBDOX were 5/5 PD, whereas the response rates of patients treated with DEBIRI were 2/5 PR, 2/5 SD, and 1/5 PD, with the appearance of a variable necrosis percentage.
Conclusion: In our experience, DEBIRI was more effective than DEBDOX as the second-line treatment of hepatic metastases from cholangiocarcinoma. Analgesic drug administration in patients treated with DEBIRI and microcatheter use led to good treatment tolerability and low complication rate.

1506.4

DEBIRI and cetuximab (DEBIRITUX) as a second-line treatment for unresectable colorectal liver metastases (UCLM): results of a phase II trial exploring a new sequence

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Purpose: DEBIRI has shown manageable toxicities and favorable response rates for UCLM. The modern antiangiogenic therapies can contrast the chemoembolization because they reduce the vessels inside UCLM. We believe that the future development of cure will be the combination of these agents with DEBIRI. No studies exist about the correct sequence of these agents. We investigated the new sequence of DEBIRI followed by cetuximab (DEBIRITUX) as a second-line treatment in patients with UCLM.
Material and Methods: Treatment consisted of two cycles of DEBIRI (100-300 µm; irinotecan total dose 200 mg) followed by 12-weekly cetuximab cycles (first dose 400 mg/m^2, then 250 mg/m^2). Response was evaluated monthly for 6 months, then every 3 months until progression.
Results: Twenty-four patients were enrolled. The median duration of DEBIRITUX was 4.4 months (range 4.0-6.5). All patients received the planned 2 cycles of DEBIRI and a median of 10 cycles (range 8-12) of cetuximab. The overall response rate was 58%, with 6 complete responses (25%) and 8 (33%) partial responses. The most frequent grade 2 adverse events were post-embolization syndrome (30%), diarrhea (25%), skin rashes (38%), and asthenia (35%). After a median follow-up of 29 months (range 8-48), the median progression-free survival (PFS) and overall survival (OS) were 11.2 months and 22.5 months, respectively.
Conclusion: The sequence of DEBIRI followed by cetuximab appears to be effective and feasible as a second-line treatment and confirms our hypothesis.

1506.5

DC-beads M1 doxorubicin drug-loaded chemoembolization (DEBDOX) for liver limited breast cancer metastases

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Purpose: To study the 3-month liver response rate and the progression-free survival after 2 DEBDOX chemoembolizations for patients with liver-dominant breast liver metastases.
Material and Methods: From 04-2011 to 12-2013, all patients with progressive liver dominant breast cancer metastases were screened to be enrolled in the study. Inclusion criteria: liver limited progressive disease, <75% liver involvement by tumor, tumor invasion not suitable for surgery or ablation, OMS status 0-1. Exclusion criteria: liver insufficiency, portal vein thrombosis, biliary injuries, and previously administered dose of doxorubicin > 450mg/m^2. Two sessions of DEBDOX (100mg of doxorubicin) were scheduled at 30-day interval. DEBDOX was administrated in a regional manner for both lobes in the same session. In addition, patients received hormonotherapy, if required.
The primary endpoint was liver response rate at 3 months. The secondary endpoint was progression-free survival from the first DEBDOX.
Results: Twenty-three women (57.5 years [40–78]) were referred for DEBDOX. Two [2–6] chemotherapy lines/patient were previously given. Forty DEBDOX sessions were performed. Seventeen (74%) patients received 2 DEBDOX. Base-line average tumor diameter was 165.3±81.9 mm [82–380]. At 3 months, all the patients were alive and the average tumor diameter change was -4.4%±28 [-55%–48%]. A PR and SD were observed in 6 (26%) and 13 (57%). The progression-free survival was 229 ±28.8 days [188-269].
Conclusion: DEBDOX chemoembolization for limited liver breast cancer metastases offer tumor control in 83% at 3 months with a progression-free survival of 229 days.

1506.6

Is trans-arterial chemoembolization safe in patients with advanced to end-stage HCC and portal vein invasion? Comparison between conventional and drug-eluting beads TACE

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Purpose: To evaluate the toxicity profile of conventional trans-arterial chemoembolization (cTACE) and drug-eluting beads (DEB) TACE in patients with hepatocellular carcinoma and portal vein invasion (PVI).

Material and Methods: This retrospective analysis included a total of 133 HCC patients with PVI who received either cTACE (N=95) or DEB-TACE (N=38). Survival was calculated from first TACE; patients lost to follow-up were censored. Adverse events and liver toxicity grade ≥3 were reported according to common terminology criteria for adverse events (CTCAE) version 4.03 after each TACE. Patients with missing toxicity report were not analyzed.
Results: Between 2000 and 2013, a total of 194 cTACE and 63 DEB-TACE procedures were performed. The median overall survival was 5.0 and 3.3 months for cTACE and DEB-TACE (p=0.156), respectively. The 30-day mortality post-cTACE and -DEB-TACE was observed in 11 (5.7%) and 4 (6.3%), respectively. The most common adverse events after cTACE and DEB-TACE, respectively, were as follows: post-embolization syndrome [N=57 (30.0%) and N=38 (61.3%)], diarrhea [N=3 (1.6%) and N=3 (4.8%)], encephalopathy [N=11 (5.8%) and N=2 (3.2%)], and confusion [N=6 (3.2%) and N=2 (3.2%)]. Liver toxicity grade ≥3 was observed for albumin in 5 (4.7%) and 0 (0%), bilirubin in 22 (20.6%) and 5 (10.6%), alkaline phosphatase in 7 (6.5%) and 5 (10.6%), alanine aminotransferase (ALT) in 12 (11.2%) and 5 (10.6%), and aspartate aminotransferase (AST) in 20 (18.7%) and 11 (23.4%), respectively.
Conclusion: Despite the very poor prognosis of this salvage patient group, cTACE and DEB-TACE are equally safe in advanced to end-stage HCC and PVI.

Free Paper Session
Biliary interventions

1507.1

Percutaneous management of biliary, pancreatic duct and portal vein malignant occlusions by endoluminal RFA and subsequent stenting

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Purpose: Malignant block percutaneous recanalization technique is presented.
Material and Methods: In all, 126 biliary, Wirsung duct and PV recanalization procedures have been performed in 106 patients: unresectable biliary block in 89 (pancreatic cancer 16, cholangiocarcinoma 31, gallbladder cancer 8, hepatocellular carcinoma 6, liver metastatic invasion 19, papilla of Vater tumor 6, tumor blocked metal stent 2, retroperitoneal fibrosis 1); unresectable Wirsung block in 5 (all pancreatic cancer) and symptomatic PV tumor thrombus in 12 (HCC 11, retroperitoneal sarcoma 1).
Ten to 15 Watts for 2 minutes was applied using bipolar endoluminal RF device, positioned using guidewire technique via percutaneous biliary\\Wirsung drainage fistula or direct US-guided percutaneous PV puncture. Procedure finished with metal stent placement. Safety drainage catheter was repositioned in biliary & Wirsung duct cases.
Results: Biliary & Wirsung patency has been restored in 107 (98.2%) of 109 procedures; in 2 (1.8%) cases, guidewire conduction failed; 4 patients had stent occlusion 7 and 8 months after RFA & stenting requiring percutaneous drainage. PV procedures were fulfilled in 8 (66.7%) cases; in 3 (25.0%) cases, guidewire conduction failed; in 1 (8.3%) RF device could not be positioned and only stenting was performed; in 6, PV patency restoration was achieved. There was no 30-day mortality, hemorrhage or pancreatitis following biliary and Wirsung duct RFA & stenting; in 1 PV case, significant intraabdominal bleeding was documented and the patient died because of multiorgan failure.
Conclusion: Endoluminal RFA & stenting is safe and effective in biliary & Wirsung duct block recanalization. Procedure track ablation or coil embolization should be recommended in PV cases to avoid possible bleeding problems.

1507.2

Biliary intervention beyond the drainage: intraductal photodynamic therapy in Klatskin tumor patients

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Purpose: Percutaneous transhepatic biliary drainage (PTBD) is a "gold standard for palliation" in non-surgical Klatskin tumor patients. Impact of additional intraductal photodynamic therapy (PDT) on patient survival and quality of life is an object of this presentation.
Material and Methods: Ninety-three PDT procedures (from one to ten per patient) have been performed in 30 biopsy-confirmed Klatskin tumor patients (12 females, 18 males; age range 34-75 years) with previous PTBD since February 2008. All patients had Bismuth IV type tumors and were not surgical candidates. The second generation chlorin sensitizers, 0.6-2.0 mg/kg, were administrated intravenously 2-4 hours prior the procedure with consecutive wire-guided insertion of optical fiber and intraductal laser irradiation (662-nm laser LAHTA-MILON) at low fluence rate pulse mode regimens (12-50 mW/cm^2, up to 1000 J per liver). The follow-up included clinical examination, lab tests, and abdomen MRI every 3 months.
Results: There was no post-procedural mortality. The only patient who developed post-procedural liver abscess required percutaneous biliary drainage. Intraductal PDT resulted in bile duct recanalization, cholangitis abatement, and improvement of liver function tests. Several MRI findings (post-PDT peritumoral inflammatory infiltration, lymph node reaction, etc.) assumed possible immune system activation. The median survival rate and 1- and 2-year survival rates from the first PDT procedure and from the diagnosis were 13.2 months (range 2-47 months), 65.7%, and 23.5% and 27.6 months (range 5-68 months), 81.8%, and 54.5%, respectively.
Conclusion: The intraductal PDT is a safe and an effective strategy in non-surgical Klatskin tumor patient management, increasing both survival rate and quality of life.

1507.3

Radiofrequency ablation of intrahepatic cholangiocarcinoma: a systematic review of literature

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Purpose: To review the current status of radiofrequency ablation (RFA) in the treatment of primary and recurrent intrahepatic cholangiocarcinoma (IHCC).
Material and Methods: We identified the studies by searching PubMed and EMBASE databases for articles published in English from January 2000 to present using the keywords "radiofrequency", "radiofrequency ablation", "ablation", "cholangiocarcinoma", "cholangiocellular cancer", "liver", "cancer", and "tumor". Additional papers were identified by manually searching the references from selected studies to ensure complete capture of any relevant data. We only considered the treatment of primary or recurrent IHCC with percutaneous image-guided RFA excluding the endoscopic ablation. We excluded case reports and non-human studies. We analyzed 4 aspects of the treatment: technical effectiveness, progression-free survival after RFA, overall survival after RFA, and complications (major and minor).
Results: A total of 11 studies satisfied the inclusion criteria and were included in the review; 197 patients with 64 primary IHCC and 227

recurrent IHCC were treated with ablation. The mean technical effectiveness was 74.2% for primary IHCC and 95.4% for recurrent IHCC. Sufficient data were only available to allow analysis of overall survival: the median overall survival was 26.82 months for primary IHCC and 24.64 months for recurrent IHCC. Eleven major complications (hepatic failure, liver abscess, biliary stricture, hyperpyrexia, massive pleural effusion, bleeding, and pulmonary embolism) and 36 minor complications occurred after RFA.
Conclusion: RFA has been increasingly used for local ablation of IHCC. The evidence in medical literature showed that it is an effective treatment for patients with IHCC, with a low complication rate.

1507.4

Percutaneous treatment of benign biliary strictures with biodegradable biliary stents: midterm outcomes

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Purpose: To evaluate the safety and efficacy of percutaneous insertion of biodegradable (BD) biliary stents in the treatment of benign biliary strictures.
Material and Methods: Over a 4-year period (March 2011 to February 2015), 17 patients with symptomatic benign biliary strictures were prospectively included to be treated by percutaneous insertion of BD polydioxanone biliary stents (ELLA-DV biliary stent; Ella-CS, Czech Republic). All patients had previously undergone multiple (1 to 7, average 3.2) unsuccessful attempts of standard endoscopic and/or percutaneous treatments such as bilioplasty. In all, 20 BD stents were deployed to treat 14 anastomotic/6 non-anastomotic biliary strictures. Safety and technical success were evaluated intraprocedurally, and treatment outcomes and complications were analyzed during the follow-up period (mean 16.4 months [3-47]).
Results: All the stents were successfully deployed with immediate biliary patency restoration. Major complications were as follows: 1 case of frank hemobilia during the procedure, leading to stent occlusion and, after 4 days, stent migration, and 1 case of choleperitoneum.
During follow-up, 1 patient developed stent occlusion due to old clots, requiring percutaneous clearance and 2 patients had episodes of cholangitis, one of them with evidence of restenosis leading to invasive re-treatment. At the end of the follow-up, just 1 patient was still symptomatic due to restenosis.
Conclusion: Percutaneous BD biliary stent placement is safe and effective in the treatment of benign biliary strictures, and compares favorably with standard techniques in terms of patients' quality of life avoiding repeated invasive procedures and thus decreasing overall hospital stay and the risk of potential complications.

1507.5

Fever after percutaneous transhepatic biliary drainage: factors associated with immediate postprocedural and delayed onset

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Purpose: The purpose of this study was to identify factors related to the occurrence of immediate fever (IF) and delayed-onset fever (DOF) after percutaneous transhepatic biliary drainage (PTBD) performed under antibiotic prophylaxis.
Material and Methods: Between February 2013 and February 2014, we prospectively assessed 97 patients with malignant (n=66) or benign (n=31) biliary disease treated with PTBD. Eighty-seven patients had biliary tree dilation, while 10 had no intrahepatic biliary tree dilation. Patients were followed up for 20 days after PTBD and divided in three groups: afebrile-group, IF-group and DOF-group if fever (≥37.5°C) occurred within or after 24h, respectively. Variables associated with fever were subjected to univariable analysis; variables with a P-value ≤0.150 were then subjected to logistic regression analysis.
Results: Sixty-six patients (68%) had no fever. IF occurred in 14 patients (14.4%); DOF was observed in 17 cases (17.6%) (median 4 days after PTBD). After multivariable analysis, we observed the following: IF was associated with non-dilated intrahepatic biliary tree (OR 19.307, 95%CI 1.961-190.051; P=0.011) and low INR values (OR 0.001, 95%CI 0.000-0.526; P=0.032). DOF was associated with further biliary procedures (OR 4.571, 95%CI 1.161-17.992; P=0.030). Other clinical and radiological variables, including the volume of contrast injected during PTBD, were not related to the incidence of fever.
Conclusion: Post-procedural immediate fever was associated with absence of pre-procedural intrahepatic biliary dilation, where technically challenging PTBD procedures are usually needed, in patients without increased bleeding risk, when the operator may feel more confident. Delayed-onset fever was associated with incomplete or unsatisfactory PTBD and the need for further procedures.

1507.6

Percutaneous cholecystostomy for moderate-severe acute cholecystitis in high-risk patients: analysis of the outcome

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Purpose: The aim of this study is to analyze the outcome of patients undergoing percutaneous cholecystotomy (PC) for moderate-severe acute cholecystitis (AC) at our institution.
Material and Methods: We reviewed all patients treated with a PC for moderate-severe AC from 2011 to 2014 in order to analyze the subsequent operative or conservative management, complications, and readmission rates.
Results: Thirty-three patients were analyzed (mean age, 76±12 years). ASA score was III-IV for 90%; estimated mean P-Possum morbidity and mortality rates were 71±19% and 18±19%, respectively. Mean follow-up duration was 12 months. For 25/33 subjects (75.7%), PC was the definitive treatment, with a success rate of 100% (defined as clinical improvement within 48–72 h after PC). Complications after PC were seen in 9/33 patients (27.3%), and no in-hospital death was recorded. Three of 25 patients (12%) had further hospital readmission: 1 for moderate AC; 1, mild acute pancreatitis; and 1, elevation of cholestasis enzymes. Eight of 33 patients (24.2%) had delayed operative treatment; 7/8 and 1/8 patients had a planned open and laparoscopic cholecystectomy, respectively. In the operative group, the complication rate was 87.5%. We observed 1/8 (12.5%) in-hospital death (for cardiac failure), 3 grade IV, 2 grade III, 6 grade II, and 1 grade I adverse events, which were mostly infections (5), cardiac complications (4), and bleeding (3). No further hospital readmission was recorded.
Conclusion: PC is an effective treatment in high-risk patients affected by moderate-severe AC. Further surgical management requires careful consideration due to the high morbidity and mortality rates related to this procedure.

Free Paper Session
Neuro interventions

2205.1

Emergency stenting of the internal carotid artery in combination with anterior circulation thrombectomy in acute ischemic stroke: a retrospective multicenter study

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Purpose: From 10% to 20% of acute ischemic stroke patients suffer from an occlusion or a relevant stenosis of the ipsilateral cervical artery. Promising results have been achieved when emergency stenting of the internal carotid artery (ICA) was carried out in combination with mechanical thrombectomy. Alas, symptomatic intercranial hemorrhages were reported in about 20% cases. We therefore conducted a multicenter study in order to investigate the safety and efficacy of this technique in a large cohort.
Material and Methods: The neurointerventional databases of four German stroke centers were screened for all patients who received emergency stenting of the ICA in combination with mechanical thrombectomy of the anterior circulation between 2007 and 2014. The primary outcome measure was the rate of symptomatic intracranial hemorrhage according to the ECASS III criteria; secondary outcome measures included the angiographic revascularization results and the clinical outcome.
Results: In all, 170 patients with a median age of 64 (25-88) years were treated. The patients presented after a median of 98min (52-160), with a median NIHSS score of 15 (12-19). sICH occurred in 15/170 (9%) cases. There were no statistically significant differences in age, sex, rate of rtPA, procedural timings, and the rate of successful recanalization between the groups with and without sICH. A TICI score ≥2b could be achieved in 77% cases, and the in-hospital mortality rate was 19%; 36% patients had a favorable outcome.
Conclusion: Emergency stenting of the ICA in combination with anterior circulation thrombectomy is not associated with a significantly higher risk of sICH compared to mechanical thrombectomy alone.

2205.2

Efficacy and outcome of mechanical thrombectomy in stroke in relation to occlusion site

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Purpose: In patients with acute ischemic stroke and large vessel occlusion, endovascular mechanical treatment seems to be highly effective. However, the question arises whether there is any difference concerning beneficial outcome depending on the type of vessel affected.
Material and Methods: We retrospectively analyzed data of 110 patients with large vessel occlusion treated between January 2011 and July 2014. All patients received mechanical thrombectomy preferentially by use of a single device (Preset). Primary outcome was classified using the modified Rankin scale after rehabilitation. Acceptable outcome was classified as modified Rankin score of 3 or less. All in all, there were 37 patients (33.6%) suffering from M1 occlusion, 16 patients (14.5%) suffering from tandem occlusion, and 33 patients (30%) suffering from carotid T occlusion.
Results: Baseline NIHSS score was 22.6. Median time from symptom onset to recanalization was 4h 32 min; median needle-to-recanalization time was 2h 3 min. Onset-to-recanalization time was similar: 4h 8min (M1), 4h 8min (tandem occlusions), and 4h 26min (Carotid T).
If the M1 segment was occluded, 20 out of 37 patients (54.1%) had an acceptable outcome. Mortality rate was 10.81%.
In patients with tandem occlusion, 12 out of 16 patients (75%) had an acceptable outcome. Mortality rate was 6.25%.
Highest mortality rate was seen in patients with occlusion of the carotid T [14 out of 33 (42.4%)]. Only 11 out of 33 (33%) had an acceptable outcome.
Conclusion: Even with up-to-date mechanical retriever thrombectomy, outcome in patients with carotid T occlusion remains less beneficial compared to patients with M1 or tandem occlusion.

2205.3

The "black hemisphere" sign in CT angiography: a reliable surrogate for poor clinical outcome in patients with acute ischemic stroke

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Purpose: To assess the role of visual evaluation of the collateral flow on CT angiography (CTA) with special emphasis on the absence of collaterals (black hemisphere) in predicting the clinical outcome in patients with acute ischemic anterior circulation stroke treated with mechanical thrombectomy (MTE).
Material and Methods: In a retrospective analysis from our database (1/2008–8/2014), 168 patients with internal carotid and/or middle cerebral artery stroke were treated with MTE (stent retriever). All patients underwent CT and CTA before treatment and CT or MR within 24 hours after treatment. Nine of 168 (5.3%) patients had a "black hemisphere" sign (complete absence of any vessel enhancement on 5-mm axial CTA MIP images). Recanalization grade (TICI flow) and clinical outcome (mRS after 1 and 3 months) were assessed.
Results: TICI 2b/3 (good angiographic result) was achieved in 131/168 patients (78%) and TICI 0-2a (bad result) in 37/168 (22%). Good clinical outcome (mRS≤3) after 1 and 3 months was seen in 76/168 (45%) and 89/168 (53%) patients, respectively. None of the "black hemisphere" patients had a favourable outcome, even with good angiographic result.
Conclusion: The black hemisphere sign is a strong indicator for poor collateral flow and therefore for a poor clinical outcome.

2205.4

Practical value of the THRIVE score to predict outcome after up-to-date mechanical recanalization in stroke

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Purpose: In patients with acute ischemic stroke, mechanical treatment is becoming increasingly accepted. Information on prediction and prognostic tools are still lacking.
Material and Methods: We retrospectively analyzed data of 110 patients with large vessel occlusion treated by use of retriever thrombectomy between January 2011 and July 2014. Primary outcome

was classified by use of modified Rankin scale after rehabilitation. Retrospectively, the predictive values of the THRIVE score - a score designed to predict good outcome and death after ischemic stroke - were compared to the results actually achieved in our patient cohort.
Results: The mean age was 64 years (range 18-87). Mean NIHSS score was 22.6. Median time from onset to completion was 4 hours and 32 minutes.
Successful recanalization with a TIMI of 2 or higher was achieved in 95 (86.4%) patients; 56.4% also received intravenous alteplase as a bridging therapy.
After rehabilitation (median time 64 days), 37 patients (33.63%) had a modified Rankin score of 2 or lower. Twenty patients had mRS = 3, so a good-to-acceptable result was achieved in 51.8% of patients.
Compared to the results of the original THRIVE score, we found a slightly better rate for acceptable outcome (47% vs 43% in THRIVE 6-9; 18% vs 11% in THRIVE 3-5) but a significant lower mortality than predicted (19% vs. 30% in THRIVE 3-5 and 29% vs. 56% in THRIVE 6-9).
Conclusion: Patients with unfavorable THRIVE scores should not be excluded from rescue treatment as mortality was lower and acceptable outcome was better than predicted.

2205.5

Carotid artery vasoreactivity in patients with peripheral arterial occlusive disease: the CAViPAD study

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Purpose: Endothelial function, measured by flow-mediated dilation, correlates with progression and cardiovascular events in patients with peripheral arterial occlusive disease (PAOD). Measurement of brachial artery flow-mediated dilation is a time-consuming procedure. The carotid artery vasoreactivity test is an endothelial-dependent response of the carotid artery diameter to a sympathetic stimulus. As in coronary vessels, sympathetic activation induces vasodilatation in the carotid artery of healthy individuals and vasoconstriction in patients with cardiovascular disease. In this prospective cohort study, we study the carotid artery vasoreactivity in relation to the severity of PAOD.
Material and Methods: In all, 185 patients with PAOD underwent a duplex ultrasound of the common carotid artery (CCA) for 2 minutes. After 30 seconds, the patients' hand was placed in cold water (+4°C) to induce the sympathetic stimulus. For the following 90 seconds, the CCA diameter was measured. Severity of PAOD (Fontaine) was assessed by an independent vascular surgeon.
Results: No adverse events occurred during or directly after the test. A significant correlation was found between the severity of PAOD and CCA diameter at 60 seconds and the mean CCA diameter change during 90 seconds. Vasoconstriction was observed more frequently in Fontaine IV patients (n=24) than in patients classified as Fontaine I (n=14, p=0.003), IIa (n=65, p=0.016) and IIb (n=83, p=0.025).
Conclusion: The carotid artery vasoreactivity test is a simple and non-invasive tool to measure carotid artery endothelial function. Carotid artery vasoreactivity correlates significantly with the severity of PAOD. Further research will focus on the prognostic value with regard to cardiovascular events and disease progression.

2205.6

The effectiveness of a 5000 IU bolus of heparin in achieving therapeutic anticoagulation in peripheral angioplasty: a real world study

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Purpose: To evaluate the efficacy of a single, intra-arterial bolus of 5000 IU of unfractionated heparin (UFH) to produce adequate anticoagulation in patients undergoing lower limb peripheral angioplasty.
Material and Methods: Activated clotting time (ACT) was measured in 90 consecutive patients undergoing peripheral angioplasty. Patient demographics, medical/drug history and weight were recorded.
ACT was recorded at baseline and following the intra-arterial administration of 5000 IU heparin at 5, 10, 30 and 60 min. The threshold for therapeutic anticoagulation was defined as an ACT of >200 s or the ratio of baseline:recorded ACT (ACT ratio) of >1.5.
Statistical analyses were conducted with Wilcoxon, Chi-square and Fisher's tests.
Results: ACT was >200 s at 5, 10 and 30 min following heparin administration in 53%, 16% and 5% of patients, respectively. ACT ratio was >1.5 at 5, 10 and 30 min in 91%, 62% and 39% of patients, respectively.
Patients in whom the 5000 IU bolus was equivalent to a dose of <60 UI/kg, ACT was significantly lower at 10 min (P=0.01), and none were adequately anticoagulated at 30 min. There was no significant difference between complications in adequately and inadequately anticoagulated patients.
Conclusion: A 5000 IU dose of heparin produces a highly variable anticoagulation effect, as measured by ACT. Patients frequently do not reach a therapeutic threshold (ACT >200 s), but no associated clinical compromise was detected. These findings challenge the current concepts regarding the use and efficacy of a single bolus dose of heparin.

Free Paper Session
Liver: TARE and RT

2206.1

DSM-TACE of advanced HCC: evaluation of tumor response in patients with contraindications to SIRT or cTACE

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Purpose: To analyze tumor response of patients with advanced non-resectable hepatocellular carcinoma (HCC) treated with transcatheter hepatic arterial chemoembolization using degradable starch microspheres (DSM-TACE) combined with doxorubicin who had no local interventional therapy alternative according to an interdisciplinary conference.
Material and Methods: In this retrospective study, 22 patients (19 males, 3 females, median age 67 years) with unresectable multifocal HCC, serum bilirubin levels < 3 mg/dl and contraindications to SIRT or cTACE were included. DSM-TACE was performed using Embocept® S (15 ml) and Doxorubicin (50 mg/25 ml) every 4-6 weeks for three cycles. Patients were initially staged using the Barcelona Clinic Liver Cancer System (BCLC); basic liver function was evaluated with the Child-Pugh (CP) score. Tumor response was assessed using the modified Response Evaluation Criteria in Solid Tumors (mRECIST).

Results: DSM-TACE was technically successful in all 22 patients. At control imaging after three cycles, overall rates of complete response (CR), partial response (PR), stable disease (SD), and progressive disease (PD) were 27%, 27%, 23%, and 18%, respectively, according to mRECIST. With regard to CP scores and BCLC stages, results were as follows: Child A (n=13): 14%, 14%, 18%, and 14%; Child B (n=8): 14%, 9%, 9%, and 5%; Child C (n=1): PR=5% and BCLC A (n=2): 5%, 5%, 0%, and 0%; BCLC B (n=15): 23%, 14%, 23%, and 9%; BCLC C (n=5): 0%, 9%, 5%, and 9%.
Conclusion: DSM-TACE is a safe and promising palliative treatment alternative for patients with advanced HCC who are not eligible for surgery, radioembolization, or cTACE.

2206.2

Hepatopulmonary shunting is an independent prognostic indicator of survival in metastatic colorectal adenocarcinoma patients treated with yttrium-90 radioembolization

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Purpose: To determine if high hepatopulmonary shunt fraction (HSF) is an independent prognostic indicator of biologically aggressive tumors and poor survival in patients who received yttrium-90 radioembolization for unresectable, liver-dominant metastatic colo-rectal adenocarcinoma.
Material and Methods: Data was analyzed from 606 patients who underwent radioembolization to treat liver metastases from colorectal adenocarcinoma between July 2002 and December 2011 in 11 US centers. Overall survival was compared among patients with varying HSF using Kaplan–Meier analysis. A univariate Cox proportional hazards model was constructed to examine the effect of HSF on survival and compare it with other potential prognostic indicators. Multivariate analysis was also performed to determine whether HSF is an independent risk factor for poor survival. Correlation between HSF and other potential indicators of aggressive tumor biology was also assessed.
Results: HSF >10% was predictive of significantly decreased survival (6.9 vs. 10.0 months; hazard ratio 1.60; P<0.001). A progressive decrease in survival was observed as HSF increased from <5% to >20%. HSF did demonstrate a significant correlation to serum CEA levels and T/L ratio. HSF did not correlate with the presence of extrahepatic metastases or prior administration of bevacizumab.
Conclusion: High HSF is an independent prognostic indicator of worse survival in patients undergoing radioembolization for liver-dominant metastatic colorectal adenocarcinoma. High HSF correlates with other potential markers of tumor size, such as T/L ratio or serum CEA level, but does not correlate with the presence of extrahepatic metastases.

2206.3

Computed tomography and magnetic resonance imaging characteristics of novel radiopaque Yttrium-Strontium-Gallium–Silicate oxide glass microspheres: potential materials for radioembolization

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Purpose: To establish in vitro CT radiopacity and MRI contrast from Yttrium-Strontium-Gallium–Silicate oxide glass microspheres.
Material and Methods: Quaternary Y-Sr-Ga-Si oxide glass microsphere compositions (n=10) were developed, based on an initial screening, using a 'design of mixtures' approach and their CT radiopacity was determined (Siemens Definition AS+) and composition-property relationships established. One formulation was then dispersed at 0%, 3%, 6%, 9% and 12% volume fraction (V_f) concentrations (n=3) in 8% porcine gelatin loaded into 5mm NMR tubes and subjected to magnetic stirring, heating (<70°C), horizontal rotation (preventing settling) and rapid cooling on ice to solidify the gel. Measurements of susceptibility, R2*, R2 and R1 were measured for all samples at room temperature using an Agilent 3T preclinical MRI. Values for 100% V_f concentrations were extrapolated from the developed linear regression analyses.
Results: The initial formulation had a CT HU of 5635 (142SD; 70 kVp) and 4645 (8.1SD; 120kVp). The full design space of formulations had CT HU ranging from 3532-6132 (70kVp) and 3243-4955 (120kVp) which can be modulated and predicted based on composition. For MRI, the extrapolated data for 100%V_f microsphere demonstrated -2.825 ppm, 1220 s-1, 83.95 s-1 and 0.726 s-1 for susceptibility, ΔR2*, ΔR2 and ΔR1 respectively. Negligible impact on clinical T1 scans would be expected. There may be some contrast enhancement (signal decrease) on T2 scans. These microsphere formulations may be visible on CT and MRI (100% V_f; T2* of 0.82ms) and quantifiable (V_f=R2*/1220s-1) in vivo using high resolution R2* mapping MRI protocols.
Conclusion: Y-Sr-Ga-Si oxide glass microspheres show in vitro CT radiopacity and diamagnetic susceptibility with low T1 contrast changes, and mild T2 contrast enhancement that should not confound clinical scans with the potential to visualize and quantify the microspheres using R2* mapping protocols.

2206.4

Selective internal radiation therapy (SIRT) with yttrium-90 for unresectable intrahepatic cholangiocarcinoma: survival, efficacy and safety

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Purpose: To present data on safety, survival and tumour response in patients undergoing radioembolisation with yttrium-90 for unresectable intrahepatic cholangiocarcinoma at our institution.
Material and Methods: Patients with intrahepatic cholangiocarcinoma treated with yttrium-90 radioembolisation between 2009 and 2014 were identified. Tumour morphology, tumour distribution, previous chemotherapy or local therapy, biliary obstruction, liver function, extrahepatic disease, ECOG performance status, portal vein involvement, number of treatments and survival period were assessed.

The images were reviewed by an experienced interventional radiologist, and a tumour response was calculated using EASL criteria. The patients were categorised into different groups based on the tumour response (complete response, partial response, partial response with intrahepatic and/or extrahepatic progression and primary disease progression).
The primary end points were overall survival, tumour response and safety.
Results: Twenty-one treatments were performed in 20 patients between 2009 and 2014. Complete response was seen in one patient who received two treatments and remained disease free at 26 months since the last treatment. Partial response was seen in 43% (n=7), partial response of primary tumour with intrahepatic and/or extrahepatic progression was seen in 38% (n=6), and primary tumor progression was seen in 13% (n=2). Mean survival was 7.5 months following treatment.
The procedure was well tolerated, and all patients were discharged home the next day. Two patients had moderate pain during treatment, and one patient had hepatic abscess at 5 months following radioembolisation.
Conclusion: Radioembolisation with yttrium-90 is a safe option in patients with unresectable intrahepatic cholangiocarcinoma, which has shown significant anti-tumour effects, but the mean survival remains low.

2206.5

Increased toxicity following SIR-spheres radioembolization in patients with hypoalbuminemia

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Purpose: SIR-spheres radioembolization (RE) is a liver directed therapy for hepatic metastases. Toxicity from RE is known to be higher in patients with poor hepatic function based on serum bilirubin. In the present study, we explore the association of hypoalbuminemia with RE toxicity.
Material and Methods: Retrospective review of IR database for patients undergoing RE from 2012-3. Patients were divided into two groups based on serum albumin at presentation (abnormal <3.5 g/dL). Post-RE toxicity was categorized based on Common Terminology Criteria for Adverse Events (CTCAEv4). Albumin, total bilirubin, distribution of metastases, systemic therapy, hepatic tumor volume, and RE dose delivered were recorded and analyzed using multivariate regression analysis for association with RE toxicity.
Results: Of the 56 patients identified, 15 (27%) had hypoalbuminemia at presentation. Mean follow up was 346 + 272 days. The most common malignancies were neuroendocrine tumor (n=24) and colon cancer (n=17). 35 patients experience 81 toxicities (44% constitutional, 27% hepatobiliary, 22% gastrointestinal) at a median of 29 days following radioembolization. All variables were similar between groups except frequency of toxicity. Hypoalbuminemic patients were significantly more likely to experience any toxicity and major toxicity (Grade > 3) compared to patients with normal albumin (93.3% vs 51.2%; p= 0.004, power = 0.97 and 35.7% vs 14.6%; p = 0.014 respectively). Only hypoalbuminemia was associated with RE toxicity in multivariate regression analysis [s2] (p = 0.003).
Conclusion: Patients with hypoalbuminemia are significantly more likely to experience toxicity after RE. In multivariate regression analysis, hypoalbuminemia was the only variable significantly associated with post-RE toxicity.

2206.6

Transarterial radioembolization with yttrium-90 microspheres in the treatment of unresectable hepatocellular carcinoma: results from a comprehensive cancer institute in India

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Purpose: To evaluate the safety and efficacy profile of transarterial radioembolization (TARE) using yttrium-90 in the treatment of unresectable HCC.
Material and Methods: Seventy-two patients with unresectable HCC underwent 88 sessions of TARE using yttrium-90 microspheres at our institute during December 2009–December 2014. Patients were staged according to the Barcelona Clinic Liver Cancer (BCLC) staging system. Clinical, biochemical data, and imaging (CT/MRI) were obtained at baseline, 6 weeks and 3 months and every 6 months thereafter. Response evaluation was performed according to European Association for the Study of the Liver (EASL) guidelines. The clinical and laboratory toxicity post-treatment was assessed by the Common Terminology Criteria Adverse Events (CTCAE) version 3.0.
Results: The treatment response (CR + PR) in BCLC-B and BCLC-C groups was 76.3% and 66.7%, respectively; overall response (CR + PR) in the treated patients was 73.2%. Median survival in BCLC-B and BCLC-C groups was 19.6 and 9.1 months, respectively, with overall median survival of 16.3 months. Fatigue was the most common symptom (50%) after TARE, whereas the most common liver toxicity was hyperbilirubinemia (8.7%). There were no cases of radiation gastritis, pneumonitis, or any procedure-related complication.
Conclusion: Transarterial radioembolization using yttrium-90 microspheres is safe and effective for the treatment of unresectable HCC.

Free Paper Session
Portal vein (BRTO) and spleen

2207.1

Clinical outcome of modified BRTO: vascular plug and coil-assisted retrograde transvenous obliteration for treating active bleeding patients with gastric varices

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Purpose: To evaluate the technical feasibility and safety of modified BRTO technique, vascular plug or coil-assisted retrograde transvenous obliteration for gastric varices bleeding, and to describe the mid-term clinical results.
Material and Methods: From April 2012 to January 2015, we retrospectively evaluated a total of nine patients treated by modified BRTO technique as vascular plug (PARTO, n=8) or coil-assisted (CARTO, n=1) for active gastric varices bleeding at a single institution. In the PARTO group, gelatin-sponge embolization of both the gastrorenal shunt and gastric varices was performed after the retrograde transvenous placement of a vascular plug in the gastrorenal shunt. CARTO was performed in one patient who had challenging gastrorenal shunt anatomy for vascular plug placement. Additional embolic materials, such as microcoils and NBCA-lipiodol mixture, were required in three patients to enhance the complete occlusion of gastrorenal shunt or obliteration of competitive collateral vessels. Clinical success was defined as no variceal re-bleeding and the disappearance of gastric varices.

Results: All PARTO and CARTO were performed in emergent clinical settings when endoscopic treatment was insufficient. A 100% technical success, i.e., complete gastrorenal shunt and offending gastric varices embolization, was achieved in all 9 patients with no procedure-related complications. All cases showed successful clinical outcome during mean follow-up period of 17 months (12–32 months) by imaging studies, endoscopy, and clinical data. In four patients, mild worsening of the esophageal varices or transient ascites was noted as portal hypertensive-related change.
Conclusion: The modified BRTO techniques PARTO and CARTO is technically feasible and safe, with excellent clinical outcomes for treating gastric varices bleeding.

2207.2

Short-term comparison of vascular plug-assisted retrograde transvenous obliteration (PARTO) with conventional BRTO for the management of gastric varix

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Purpose: To compare the technical feasibility, effectiveness, and short-term outcomes of PARTO with conventional BRTO using ethanolamine oleate in the management of gastric varix.
Material and Methods: From January 2005 to October 2014, 52 patients with gastric varix with/without bleeding were referred; 38 patients underwent BRTO (23 men, 15 women; mean age 61.3; Child-Pugh class A/B/C = 11/25/2), and 14 patients underwent PARTO (11 men, 3 women; mean age 63.4; Child-Pugh class A/B/C = 9/4/1). The technical success rate, immediate complications, gastric and esophageal varix changes, liver function changes, and incidence of ascites/pleural effusion were evaluated at one and three months after the procedure.
Results: The technical success rates (defined as complete obliteration of gastric varix on fluoroscopy) after BRTO and PARTO were 92.1% and 100%, respectively. There were no immediate complications in PARTO compared with BRTO (8%, n = 3, varix rupture). Follow-up CT showed complete thrombosis of the gastric varix in 94.2% (n = 33) of BRTO and 100% (n = 14) of PARTO. Worsening of the esophageal varix was observed in 18% (n = 6) of BRTO; however, there were no cases of late variceal bleeding. The mean serum albumin level (P = 0.003) and ALT level (P = 0.039) improved significantly in both groups. Worsening of ascites/pleural effusion in BRTO and PARTO was 34.2% (n = 12) and 21.4% (n = 3), respectively.
Conclusion: PARTO is technically feasible, safe, and seems to be equivalent to or better than BRTO for gastric varix management based on early follow-up measures.

2207.3

Comparison of balloon-occluded retrograde transvenous obliteration (BRTO) using ethanolamine oleate Iopamidol (EOI), BRTO using sodium tetradecyl sulphate (STS) foam and modified BRTO (mBRTO)

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Purpose: To compare the clinical outcomes of BRTO using EOI, BRTO using STS foam and mBRTO.
Material and Methods: From April 2004 to February 2015, 83 patients who underwent retrograde transvenous obliteration for gastric varices were analysed retrospectively. BRTO with EOI was performed in 38 patients, BRTO with STS foam in 25 and mBRTO in 20. Among them, we obtained follow-up data in 66 patients. Recurrence of gastric varices was evaluated by follow-up endoscopy or CT. Medical records were reviewed for the clinical and technical efficacy. Statistical analyses were performed using the chi-square test, Fisher's exact test, Kruskal–Wallis test and Mann–Whitney U test.
Results: Technical and clinical success was achieved in 79 patients (95.2%). As major complications, haemoglobinuria occurred in one patient with BRTO using EOI. Recurrence of gastric varices occurred more frequently in the mBRTO group (P<0.05). Recurrence of gastric varices occurred in 1 patient in the BRTO using EOI group and 4 patients in the mBRTO group, with 3.3% and 22.2% expected 1-year recurrence rates, respectively. There was no recurrence of gastric varices in patients who underwent BRTO using STS foam. Abdominal pain occurred more frequently with BRTO using EOI than with BRTO using STS foam and mBRTO (P<0.05). Procedure time of mBRTO was shorter than the other two conventional BRTO groups (P<0.05).
Conclusion: Both BRTO using STS foam and mBRTO are better than BRTO using EOI for the treatment of gastric varices in terms of complication and procedure time. However, mBRTO showed frequent recurrence of gastric varices during the long-term follow-up compared with conventional BRTO.

2207.4

Portal vein recanalization via a percutaneous transsplenic access

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Purpose: To evaluate the feasibility and safety of percutaneous transsplenic portal vein (PV) recanalization.
Material and Methods: Twenty-one patients underwent PV recanalization procedure via a percutaneous transsplenic access. Collapsed intrahepatic PV (n=9) owing to main PV stenosis and early (<30 days) postoperative state (n=6), and unfavorable stenotic PV anatomy via a transhepatic route (n=3) were the main indications of transsplenic access. Eighteen patients had PV stenosis following hepatobiliary surgery; remaining 3 patients had PV stenosis related to inoperable biliary carcinoma. A splenic venous branch was punctured using a 21-G chiba needle and a 0.016″ micro-guide wire under ultrasound and fluoroscopy guidance. PV stenosis was negotiated using a 0.035″ guide wire, and then balloon angioplasty (n=3) or stent placement (n=18) was followed. Following completion of PV recanalization, transsplenic access routes were embolized using coils and/or histoacryl.
Results: Additional transhepatic PV access was needed in two patients owing to failed negotiation of the occluded PV and failed splenic vein puncture, respectively. Brisk PV inflow was obtained in 20 of 21 patients following the procedure. PV flow did not improve in one patient owing to remaining PV thrombosis. Procedural complications occurred in 3 patients: splenic vein tear, perisplenic hematoma, and PV tear following balloon angioplasty. The patient with splenic vein tear needed transfusion. Follow-up CT or US obtained at a mean of 2.3 (range, 1-7) months after the procedure demonstrated brisk PV inflow in all except one patient.
Conclusion: Transsplenic PV recanalization is a safe and feasible alternative technique in patients with an unfavorable transhepatic route.

2207.5

Partial splenic embolization for the treatment of chemotherapy-induced thrombocytopenia

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Purpose: Thrombocytopenia may restrict the administration of chemotherapy. Our purpose is to evaluate partial splenic embolization (PSE) in patients with thrombocytopenia secondary to chemotherapy.
Material and Methods: This is an ongoing prospective, phase II, single-center study for the evaluation of PSE in patients undergoing chemotherapy in which 40 patients will be enrolled. So far, 21 patients underwent PSE to correct thrombocytopenia to facilitate the initiation or resumption of chemotherapy. Primary endpoint is to obtain platelet count above 130,000/µL, and secondary endpoints are the return to chemotherapy and safety. Periprocedural laboratory values, adverse events, and splenic infarct area calculated by CT 2 weeks after PSE were recorded.
Results: Twenty-two PSEs were performed in 21 patients. One patient underwent repeat PSE because of recurrent thrombocytopenia after the successful initiation of chemotherapy. Primary endpoint was achieved in 100% of patients. The continuation of chemotherapy was possible in all patients submitted to PSE. The most common chemotherapy regimen was FOLFOX. Pain was recorded in 15 patients, and 3 needed narcotic therapy. Fever was documented in 6 patients. Seven patients presented with nausea and vomiting with 1 episode of hematemesis. The mean platelet count was 69,000/µL immediately before PSE and peaked at 207,000/µL after PSE. The mean hospital stay was 1.2 days. The mean chemotherapy return time was 12.7 days. The mean splenic infarct area by CT was 43%.
Conclusion: PSE is a safe and effective method of managing thrombocytopenia secondary to chemotherapy, allowing treatment resumption in cancer patients.

2207.6

Iatrogenic portal venous bleeding: what is the role of interventional treatment?

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Purpose: To analyze the clinical outcomes of iatrogenic portal venous bleeding with or without interventional treatment and to explain the role of interventional treatment.
Material and Methods: We performed a 13-year retrospective analysis of six patients (M:F=4:2, median age 61.5 years) who underwent angiography for iatrogenic portal venous bleeding. We analyzed the causes of portal venous bleeding, latency time, angiographic findings, interventional treatment details, treatment-related complications, and clinical outcomes.
Results: The causes of portal venous bleeding were percutaneous liver biopsy (n=3), percutaneous radiofrequency ablation (n=1), percutaneous cholecystostomy (n=1), and transjugular liver biopsy (n=1). The median and mean latency times of angiography following the procedure were 8 and 47.5 hours, respectively (range 4–240 hours). Angiograms, including common hepatic angiograms and indirect portogram on a superior mesenteric angiogram, showed active portal venous bleeding into the peritoneal cavity (n=4) and active portal venous bleeding with an arterioportal shunt with (n=1) or without (n=1) a pseudoaneurysm. Three of the six patients successfully underwent interventional treatment, such as transcatheter arterial embolization (n=2) or percutaneous transhepatic portal vein embolization (n=1). Embolic materials were n-butyl cyanoacrylate alone (n=2) or in combination with gelatin sponge particles and coils (n=1). There were no major treatment-related complications or any patient mortality. The other three patients who did not undergo interventional treatment died of multiorgan failure with disseminated intravascular coagulation after massive blood transfusions.
Conclusion: Transcatheter angiography with indirect portography is necessary in order to identify portal venous bleeding. Interventional treatment is safe and effective for managing significant iatrogenic portal venous bleeding.

Free Paper Session
Vascular: iliac arteries

2304.1

Fusion of CT angiography or MR angiography with unenhanced CBCT and fluoroscopy guidance in endovascular treatments of aorto-iliac steno-occlusion: technical note on a preliminary experience

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Purpose: To evaluate the feasibility of image fusion (IF) of pre-procedural arterial-phase CT angiography or MR angiography with intra-procedural fluoroscopy for road-mapping in endovascular treatment of aorto-iliac steno-occlusive disease.
Material and Methods: Between September and November 2014, we prospectively evaluated 5 patients with chronic aorto-iliac steno-occlusive disease who underwent endovascular treatment in the angiography suite. Fusion image road-mapping was performed using angiographic phase CT images or MR images acquired before and intra-procedural unenhanced cone-beam CT (CBCT). Radiation dose of the procedure, volume of intraprocedural iodinated contrast medium, fluoroscopy time and overall procedural time were recorded. Reasons for potential fusion imaging inaccuracies were also evaluated.
Results: Image co-registration and fusion guidance were feasible in all procedures. Mean radiation dose of the procedure was 60.21 Gycm^2 (range 55.02- 63.75 Gycm^2). The mean total procedure time was 32.2 minutes (range 27-38 minutes). The mean fluoroscopy time was 12 minutes and 3 seconds. The mean procedural iodinated contrast medium dose was 24 mL (range 20-40 mL).
Conclusion: Image fusion gives interventional radiologists the opportunity to use new technologies in order to improve outcomes with a significant reduction of contrast medium administration.

2304.2

Transradial and transulnar access for iliac artery intervention using sheathless guiding: feasibility study

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Purpose: The purpose of this pilot study was to evaluate the acute success and complication rate of the transradial and transulnar access for iliac artery stenting using sheathless guiding.
Material and Methods: The clinical and angiographic data of 95 consecutive patients with symptomatic iliac artery stenosis treated via transradial or transulnar access using 6 and 8.5F sheathless

guiding between 2013 and 2014 were evaluated in a pilot study. Primary endpoints were as follows: major adverse events (MAE) and rate of major and minor access site complications. Secondary endpoints were as follows: procedural results and hospitalisation in days.

Results: Technical success was achieved in 94 patients (99%) and the cross-over rate was 5.3%. Radial and ulnar artery access was applied in 90 (94.7%) and 6 (6.3%) patients. Major access site complication was not detected, but minor access site complication was encountered in 4 patients (4.2%). Incidence of two-month MAE was 1%. Hospitalisation was 1.57±1.92 day in the radial and 1.90±1.40 day in the cross-over group (p=ns). During the learning curve at 1–2 years, procedure time was 28.2±33.6 and 22.1±13.5 min (p=ns), X-ray dose was 481±390.8 and 407.8±339.3 Gycm^2 (p=ns), fluoroscopy time was 1696±3051 and 1320±1193 sec (p=ns) and contrast consumption was 108.8±92.6 and 77.41±46.45 ml (p<0.05), respectively.

Conclusion: Iliac artery stenting can be safely and effectively performed using radial and ulnar artery access via sheathless guiding with high technical success. The learning curve plays an important role in decreasing contrast consumption.

2304.3

Iliac chronic total occlusions treatment using the Outback LTD re-entry catheter: single-center experience and midterm results

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Purpose: To present the midterm results of endovascular stent reconstruction of iliac chronic total occlusion iliac with use of the Outback LTD re-entry catheter.

Material and Methods: Between April 2009 and December 2013, 180 patients (mean age: 69.6±9.01 years, range: 56-89 years) with chronic total occlusion of the common or external iliac arteries underwent endovascular revascularization (TASC C: 73%; TASC D: 27%). Indications for treatment were moderate-severe claudication (Rutherford 2-3) in 64% of patients, rest pain (Rutherford 4) in 22% and ulceration (Rutherford 5-6) in 14%. In 29 patients (16.1%), the true lumen could not be re-entered by using standard catheter and wire techniques, and fluoroscopic-guided true lumen re-entry using the Outback catheter was attempted.

Results: The procedure was successful in achieving true lumen re-entry in all cases (100%). All occlusions were stented. No cases were converted to open repair. Bleeding from the recanalization and angioplasty site occurred in 1 patient (3.4%) and successfully treated with a covered stent deployment. All occlusions treated with true lumen re-entry devices remain clinically patent at a mean follow-up of 12.8 months. The clinical status improved in all patients with an improvement of at least two Rutherford categories in 26 patients (89.6%). The primary patency was 100% with no secondary interventions.

Conclusion: Endovascular treatment of chronic total occlusions is often limited by the inability to re-enter the true lumen. The use of the Outback LTD re-entry catheter was feasible and safe, facilitating technical success and endovascular stenting of chronic total occlusions with high rates of patency at the midterm follow-up.

2304.4

AGIR study: a prospective randomized control trial comparing efficacy of Angio-Seal™ vascular closure device vs manual compression in interventional radiology

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Purpose: To demonstrate the efficacy/superiority of Angio-Seal™ vascular closure device vs. manual compression in interventional radiology procedures to control hemostasis at the access site, without increasing the risk for the patients.

Material and Methods: AGIR is a multicentric, international, prospective, open, parallel study, with stratified randomization in which patients had their arterial puncture closure randomly performed by Angio-Seal™ vascular closure device or manual compression.

The mobilization time, complications related to the closure, the time to hemostasis, the immediate hemostasis success, Angio-Seal™vascular closure device deployment success and time to discharge were collected for this population of patients.

Results: A total of 123 patients were included in the study during 18 months of enrollment. All of them were discharged and 111 were followed up for 2 weeks (±1week). The mobilization time in 85,3% of patients randomized to the Angio-Seal™ device group was less than 4 hours versus in 22,6% of patients randomized to the manual compression group (p<0.0001).

The proportion of complications at any time of the study duration was 9.8% in the Angio-Seal™ device group and 9.7% in the manual compression group (p=0.24). In the Angio-Seal™ device group, there were 7 complications (2 hematomas <6cm, 2 significant bleedings, and 3 minor complications) in 5 patients (8.20%) and in the manual compression group, there were 8 complications (2 hematomas <6cm, 4 hematomas >6cm, and 2 significant bleedings) in 6 patients (9.68%).

Conclusion: The Angio-Seal™ is a safe vascular closure device that significantly reduces the mobilization time. Regarding complications, there were no significant differences between the two groups of treatment.

2304.5

Clinical outcomes of the BIOFLEX-I study: utilization of self-expanding stents in the iliac arteries

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Purpose: The BIOFLEX-I study evaluates the safety and efficacy of the Astron self-expanding, nitinol stent for the treatment of atherosclerotic lesions in the iliac arteries.

Material and Methods: BIOFLEX-I was a prospective, multicenter, non-randomized, single arm, investigational device exemption (IDE) study performed in the United States, Canada, and Europe. Thirty study centers enrolled 161 evaluable subjects with de novo or restenotic lesions (≤140mm length) or occlusions (≤100mm length) in the common or external iliac arteries. The primary endpoint was major adverse events (MAEs), the composite of 30-day mortality, clinically-indicated target lesion revascularization (TLR) and index limb amputation at 12 months, adjudicated by an independent Clinical Events

Committee. Results were compared to a pre-specified performance goal based on prior studies. Angiography and duplex ultrasound findings were assessed by independent core laboratories.
Results: For the BIOFLEX-I study of patients with iliac disease treated with the Astron stent, the primary 12-month composite endpoint of MAE was met with a rate of 2.1% (p<0.001), 95% CI [0.4%, 5.9%]. Thirty-day mortality was 0.7%, 95% CI [0.0%, 3.8%]. TLR at 12 months was 1.4%, 95% CI [0.2%, 4.5%], and 12-month index limb amputation was 0.0%, 95% CI [0.0%, 2.5%]. The secondary endpoint of primary patency was 89.8%, 95% CI [83.3%, 94.5%] at 12 months.
Conclusion: The 12-month outcomes of the BIOFLEX-I study for the Astron stent in iliac indications demonstrate a low MAE rate, high primary patency, and a low rate of TLR. This supports the safety and efficacy of the self-expanding, nitinol stent for treatment of atherosclerotic lesions in the iliac arteries.

2304.6

Outcomes following endovascular treatment of the internal iliac artery for buttock claudication

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Purpose: Internal iliac artery (IIA) stenosis is one of the many causes of the buttock, hip, or thigh pain. This study reviews our experience of endovascular treatment for buttock claudication.
Material and Methods: All patients undergoing endovascular IIA intervention for buttock claudication over a 9-year period were identified retrospectively. Patients with additional intervention of the common iliac arteries were excluded. Imaging and follow-up documents were reviewed via electronic patient records.
Results: Thirty-one IIAs (26 patients) fulfilled the inclusion criteria (24 males and 2 females; mean age, 66 years). Primary transluminal balloon angioplasty (PTA) was performed in 20 limbs (15 patients). Eleven IIAs (9 patients) underwent stenting. Fifteen IIAs (12 patients) were followed up with CTA/MRA [2 IIAs underwent stenting, and 13 IIAs (10 patients) underwent PTA). Widely patent vessels were demonstrated in 5 IIAs (5 patients). Of these, 2 IIAs (2 patients) had undergone stenting, and 3 IIAs (3 patients) had undergone PTA. Occlusion was present in one IIA, whilst the remainder had recurrent stenoses. Two patients from the PTA group underwent subsequent stenting for restenosis. On clinical follow-up, 14 IIAs (12 patients) reported improvement in symptoms, and 7 IIAs (6 patients) reported persistent symptoms. Ten IIAs (8 patients) were lost to follow-up. The only procedure-related complication was a case of external iliac artery dissection.
Conclusion: IIA intervention is technically feasible with low rates of complication. However, a larger scale prospective study is needed to prove its effectiveness in the treatment of buttock claudication.

Free Paper Session Prostate

2305.1

The safety and efficacy of prostatic arterial re-embolization for benign prostatic hyperplasia: preliminary results

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Purpose: To evaluate the short-term outcomes of prostatic arterial re-embolization (PArE) for benign prostatic hyperplasia (BPH).
Material and Methods: This prospective study included 32 patients diagnosed with BPH who did not respond to medical treatment and after clinical failure of previous prostatic embolization using non-spherical polyvinyl alcohol particles (PVA). Between 2012 and 2014, we performed PArE. Technical success was achieved after embolization of at least one prostatic artery. Clinical success was defined as improving symptoms (IPSS reduction at least 25% of the total score and lower than 18 points) and quality of life (reduction of QoL of at least 1 point or equal to or below 3 points) after PArE. The evaluation was performed before and after (6 months) re-embolization using International Prostate Symptom Score (IPSS), quality of life (QoL), International Index of Erectile Function (IIEF), uroflowmetry, prostate-specific antigen (PSA), and prostatic volume. We used non-spherical PVA, embospheres, and compressible hydrogel microspheres (bead block).
Results: PArE was technically successful in 30 patients (93.75%). At 6 months after re-embolization, the clinical success rate was 80%, with a mean 29.1% decrease in QoL and 31% in IPSS (average reduction of 6.5 points). We used PVA in all PArE except in 5 patients: 4 embolizations with bead block and 1 with embospheres. Those 5 cases were technical and clinical success. In 3 of the 4 patients embolized with bead block, we noted a small increase in prostate size and PSA at 6 months.
Conclusion: PArE is a safe procedure with good short-term results for BHP.

2305.2

Prostate artery embolisation: initial experience and outcome for treatment of benign prostate hyperplasia at a single institution

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Purpose: Report interim results of single-centre prospective study investigating prostate artery embolization (PAE) in a tertiary referral urology centre.
Material and Methods: A single-tertiary-centre prospective study was conducted from January 2014 to January 2015. Inclusion criteria were as follows: symptomatic benign prostatic hypertrophy with lower urinary tract symptoms (LUTS) refractory to medical therapy, age 50-75 years, prostate volume >40ml, maximum urinary flow rate <12ml/s, International Prostate Symptom Score (IPSS) ≥19 and/or overall quality of life (QOL) >3 and/or Qmax <12ml/s, or urinary retention. Exclusion criteria: bladder diverticula or calculi, urethral stenosis, neurogenic bladder, eGFR <45ml/min, and prostatic malignancy. Outcome measures: IPSS, quality of life (QOL), post-void residual (PVR), QMAX, International Index of Erectile Function (IIEF) scores pre- and post-procedure, all measured at 1 week and 1 and 3 months post-PAE. PSA and prostate volume were measured pre- and post-procedure.
Results: An ongoing study. From January 2014 to January 2015, 35 patients (median age 67) have undergone PAE. Technical and procedural success was 90%. Clinical success was 80%. IPSS decreased from mean of 22.3 pre-PAE to 8.7 at 3 months (p<0.05). Prostate volume reduced from mean of 134.8ml pre-operatively to 75.6ml at 3 months (p<0.05). Pre-PAE PSA of 9.89ng/ml decreased to 5.89ng/ml at 3 months. QOL score improved from 4.9 pre-operatively to 1.8 at 3 months (p<0.05). PVR decreased from 179.7ml to 117.7ml at 3 months (p<0.05). Interim 6-month cumulative outcomes of pre-specified end points will also be presented.
Conclusion: PAE appears to be safe with promising initial results.

2305.3

Prostatic artery embolization in benign prostatic hyperplasia: preliminary results in 28 patients

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Purpose: Aim of the study is to report clinical outcome after prostatic artery embolization (PAE) in 28 consecutive patients with benign prostatic hyperplasia (BPH) and lower urinary tract symptoms (LUTS).
Material and Methods: From May 2012 to December 2014, we performed PAE in 28 consecutive patients (mean age, 75.9 years) with BPH and LUTS who were refractory to medical therapy.
Follow-up (mean time, 244 days) was performed using the International Prostate Symptoms Score (IPSS), Quality of Life (QOL), International Index of Erectile Function (IIEF-5), PSA, and transrectal prostatic US-scan with volume and weight calculation at 3, 6, and 12 months.
Preprocedural angio-CT was performed in order to obtain a vascular map. Embolization was performed using Embosphere® (300–500 µm). Technical success was defined when selective prostatic arterial embolization was completed in at least one pelvic side. Clinical success was defined when symptoms and quality of life improved.
Results: PAE was technically successful in 27/28 patients (97%).
PAE was bilaterally completed in 22/27 (81.5%) patients and monolaterally in 5 (18.5%).
All patients removed bladder catheter from 4 days to 4 weeks after PAE.
We obtained an IPSS reduction (mean, 21.7 points), an IIEF-5 increase (mean, 2.7 points), a QOL improvement (mean, 2.3 points), and a volume reduction (mean, 17.4 cm^3) at 12-month follow-up.
Conclusion: Our experience showed the feasibility, safety, and efficacy of PAE in the management of patients with LUTS related to BPH. PAE may play an important role in patients for whom medical therapy has failed or in those who are not amenable to surgery or refuse any surgical treatment.

2305.4

Long-term results of prostatic artery embolization for patients with benign prostatic hyperplasia: 240 cases

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Purpose: To evaluate the long-term clinical results of prostatic artery embolization (PAE) in 240 patients with benign prostatic hyperplasia (BPH) and moderate-to-severe lower urinary tract symptoms (LUTS).
Material and Methods: PAE was performed in 240 patients with BPH and moderate-to-severe LUTS with non-spherical polyvinyl alcohol (PVA) particles of 100 µm and 200 µm. PAE results were evaluated based on International Prostate Symptom Score (IPSS), Quality of life (Qol) and International Index Erectile Function (IIEF) questionnaires, prostate volume (PV), prostate-specific antigen (PSA) and peak urinary flow rate (Qmax) changes from baseline. Clinical success was considered when there was reduction of the total IPSS score at least 25% and ≤15, Qol reduction of at least one point, and no need of medical therapy or any other treatment.
Results: There were 7 (2.9%) technical failures, and 26 patients were lost to follow-up. All 207 controlled patients were followed up at 1, 3, and 6 months (short term) and thereafter every year for over 3 years (long term); 77 patients have been followed up for over 4 years. There was relief of LUTS at the time of discharge in 168/233 (72.1%) patients. Cumulative rate of improvement was shown in 145/207 (70.0 %) patients at long term. There was a major complication: a small bladder wall ischemia treated by surgery and without sequela. No was sexual dysfunction or urinary incontinence was reported.
Conclusion: PAE is a safe and efficient outpatient procedure, with almost immediate relief of LUTS and with good long-term results, low morbidity, and no sexual dysfunction.

2305.5

The short- and medium-term results of prostatic artery embolization with bead block for patients with benign prostatic hyperplasia

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Purpose: Evaluate the short- and medium-term results of prostatic artery embolization (PAE) with bead block in patients with benign prostatic hyperplasia (BPH) and moderate-to-severe lower urinary tract symptoms (LUTS).
Material and Methods: Two hundred patients with BPH and moderate-to-severe LUTS refractory to medical therapy for at least 6 months underwent PAE with spherical polyvinyl alcohol (PVA) particles, bead block 300–500µm, between October 2012 and November 2014. The clinical success was evaluated by clinical improvement of International Prostate Symptoms Score (IPSS), Quality of Life (Qol), and International Index Erectile Function (IIEF) questionnaires, and by changes from baseline of prostate volume (PV), peak urinary flow rate (Qmax), PSA, and post-void residual volume (PVR) at 1 and 6 months after PAE and every 6 months thereafter.
Results: Six patients were lost to follow-up. Mean values: procedure time 78.8 min; fluoroscopy time 19.3 min; radiation 3641.2 dGycm; IPSS/Qol improvement of 11.6 ± 6.12/1.67 ± 1.12 points (33.1%/21.5%). IIEF improvement 1.4 ± 3.2 (21.4%) points; PV reduction 28.6 ± 21.4 mL (29.3%); Qmax improvement 4.9 ± 5.6 mL/s (36.1%); PSA reduction 3.4 ± 4.5 ng/ml (29.9%); and PVR reduction of 40 ± 21 mL (40.3%). There were 14 (7.2 %) clinical failures at 3 months. There was clinical success over 1 year in 53/60 patients (88.3%).
Conclusion: PAE with bead block for patients with BPH is an efficient and safe procedure with very good short- and medium-term clinical results, without sexual dysfunction.

2305.6

Embolization for patients with benign prostatic hyperplasia, very large prostate and moderate-to-severe lower urinary tract symptoms (LUTS) as an alternative to open surgery

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Purpose: To evaluate the results of prostatic arterial embolization (PAE) for patients with benign prostatic hyperplasia (BPH), prostate larger than 100cc and moderate-to-severe lower urinary tract symptoms (LUTS).
Material and Methods: A single-center cohort study was conducted in 152 consecutive patients with a diagnosis of BPH, prostate larger than 100cc, moderate-to-severe LUTS or with acute urinary retention (AUR). Twenty-five patients had AUR. Embolizing agents were PVA (94/152), bead block in (43 /152) and Embozene (12/152). International Prostate Symptom Score (IPSS), Quality of Life (Qol), International Index Erectile Function (IIEF), uroflowmetry, (Qmax: peak urinary flow and PVR: post voiding residual volume), prostate-specific antigen (PSA) and prostate volume, were assessed before and after PAE, at 1, 3 and 6 months, followed by every 6 months up to 3 years, then yearly.
Results: PAE was technically successful in 149 of 152 patients (98.6%). Mean follow-up of 32 months (range, 3–66 months). One hundred and twenty-six patients were evaluated for between 1 and 3 years, at 1, 3 and/or 6 months; and 12 patients were evaluated for

more than 3 years (long term). There were 39 (28.3%) clinical failures, 22 (15.9%) at short term and 17 at medium term. Mean IPSS/QOL reduction was 12.5 ± 7.2/1.8 ± 1.2 and mean prostate volume reduction was 45 ± 85 mL.
Conclusion: PAE is a safe, minimally invasive procedure with good short-, medium- and long-term results for BPH patients with prostate larger than 100cc and moderate-to-severe LUTS refractory to medical therapy.

Free Paper Session
Thyroid and patient care

2306.1
Mid-term clinical results of larynx-preserving approach for advanced laryngeal cancer using modified RADPLAT

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Purpose: Laryngeal cancer is the most common in head and neck cancers, and larynx preservation has a social impact. The ASCO guideline recommends that a larynx-preservation approach is an appropriate, standard treatment option, and concurrent chemoradiation is the most widely applicable approach for most patients with T3 and T4 disease. RADPLAT using super-selective catheterized infusion technique has been used for the treatment of advanced head and neck cancers. However, there have been a few reports of RADPLAT in advanced laryngeal cancer. The purpose of our study was to prospectively determine the feasibility and efficacy of our organ-preserving therapy using modified RADPLAT method.
Material and Methods: Eligibility criteria were untreated and pathologically proved squamous cell carcinoma of the larynx staged as T3, T4, and transglottic T2. Our treatment protocol was four times weekly cisplatin infusion of 75 mg per kg body weight concurrently with radiation therapy. Super-selective infusion of cisplatin was performed by coaxial catheterization into the superior thyroid artery or superior laryngeal artery through the femoral artery. Primary endpoint was the local control rate.
Results: Forty-five patients were treated by our protocol. Sublocations were 19 supraglottic, 22 glottic, and 4 subglottic laryngeal cancers. Larynx preservation rate was 94% with a median follow-up of 52 months. No thromboembolic event was observed. Grade 3 adverse events were observed in 18% of the patients.
Conclusion: Our modified RADPLAT protocol for advanced laryngeal cancer was feasible, and vocal function had been preserved in 94% of the treated patients without compromising survival.

2306.2
Radiofrequency ablation: new perspectives in the treatment of malignant and benign thyroid diseases

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Purpose: The aim of this study was to evaluate the safety and efficacy of ultrasound-guided percutaneous radiofrequency ablation (RFA) in the treatment of benign thyroid nodules and in selected cases of recurrent thyroid cancers (RTC).
Material and Methods: This study included 40 patients: 30/40 were affected by nodular goiter contraindicated to surgery; 10/40 were affected by RTC and excluded from surgery/radiometabolic therapy. Pretreatment diagnostic protocol included CT and US examinations performed within 1 month in order to evaluate lesion volumes.
All RFA procedures were performed under US guidance using an 18-gauge electrode, with a single 1-cm active, internally cooled tip.
Response to therapy was evaluated by means of contrast-enhanced ultrasound in benign goiters (follow-up ranging from 6 to 18 months) and by means of CT in RTCs (follow-up ranging from 3 to 12 months).
Mean volume reduction rate (MVRR) was evaluated with respect to the pretreatment lesion volumes.
Results: RFA was well tolerated by all patients; only in one case, a permanent paralysis of the recurrent nerve was recorded.
MVRR in goiters at 6, 12, and 18 months resulted to be 71.9±13.3%, 75. 8±14.3%, and 83.0±6.5%, respectively; MVRR of RTC at 3, 6, and 12 months were 57.2±27.5%, 82.4±13.0%, and 75.4±6.6%, respectively.
Conclusion: RFA is a reliable alternative to surgery in patients affected by benign goiter; moreover, RFA might be considered as a valid approach for the debulking of RTC in nonsurgical cases.

2306.3
Radiofrequency versus ethanol ablation for treating predominantly cystic thyroid nodules: a randomized clinical trial

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Purpose: To compare single-session radiofrequency ablation (RFA) and ethanol ablation (EA) for treating predominantly cystic thyroid nodules (PCTNs).
Material and Methods: In this single-blind, randomized trial, 50 patients with a single PCTN were randomly assigned to be treated by either RFA (25 patients) or EA (25 patients). The primary endpoint was the tumor volume reduction ratio (%) at the six-month follow-up; the superiority margin was chosen as 13% (RFA minus EA). Analysis was performed primarily in an intention-to-treat manner. The secondary endpoints were therapeutic success rate, improvement of symptomatic and cosmetic problems, and the number of major complications. The analysis was performed in an intention-to-treat manner.
Results: The mean volume reduction was 87.5% ± 11.5 for RFA (n = 22) and 82.4% ± 28.6 for EA (n = 24) (P = .710; mean difference [95% CI], 5.1% [-8.0 to 18.2]), indicating no significant difference. Regarding the secondary endpoints, therapeutic success (P = .490), mean symptom (P = .205), and cosmetic scores (P = .710) showed no difference. There were no major complications in both groups (P > .99).
Conclusion: The therapeutic efficacy of RFA is not superior to that of EA; therefore, EA might be preferable as the first-line treatment for PCTNs.

2306.4
Complications following US-guided core-needle biopsy for thyroid lesions: a retrospective study of 6175 consecutive patients and systematic review

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Purpose: To present the spectrum of clinical adverse events of core needle biopsy (CNB) for thyroid lesions and to make performers aware of the potential complications and provide useful preventive measures

Material and Methods: Between January 2008 and March 2013, US-guided CNB was performed in 6175 patients with 6406 thyroid nodules. We assessed the numbers and types of major and minor complications, and evaluated the factors associated with complications during the thyroid CNB.
Results: The authors observed 59 complications (0.9%), 7 major and 52 minor. The major complications were massive hematoma (n=2), pseudoaneurysm (n=1), CCA injury (n=1), voice change (n=2), and tracheal puncture (n=1). The minor complications were small hematoma (n=41), edema (n=6), vertebral puncture (n=3), vasovagal reaction (n=1), and dysphagia (n=1). All patients recovered spontaneously except for two with large hematoma who underwent surgery.
Conclusion: Although the complication rate of CNB for thyroid lesions is low, various complications may occur; comprehension of complications and suggested technical tips may prevent complications or properly manage those that occur.

2306.5

Labeling interventional radiology drains to prevent medical errors and improve patient care

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Purpose: To evaluate errors in charting and in patient care before and after establishing a drain labeling system.
Material and Methods: A total of 55 nurses and 51 house staff were anonymously surveyed regarding the accuracy of medical charting and subsequent errors in patient care, involving percutaneous drains prior to creating a consistent method for drain labeling. Statistical analysis of the results was performed. An initiative was then undertaken to label all drains placed by interventional radiology at the time of placement based on the location of drain termination within the body. Tyvek, a brand of synthetic material, was selected for its strength and chemical/liquid resistance.
Results: Nurses reported that labeling errors rarely or never (80%) impacted care. They perceived outputs were usually (67%) or always (15%) charted correctly. Compared with nursing staff, physicians were less likely to perceive drain output as usually (57%) or always (2%) charted correctly and more likely to think that drain labeling errors impacted patient care.
Conclusion: Surveys showed a discrepancy between nurses and physicians regarding the accuracy of drain output charting and the subsequent effect on patient care. However, both groups acknowledge some degree of inaccuracy and subsequent errors. This demonstrates an opportunity to improve patient care by the institution of a formalized method of drain labeling at the time of placement in the Interventional Radiology Department. This system is now in place, and we expect repeat surveys to show a measureable decrease in charting errors and an improvement in patient care.

2306.6

Patient-controlled sedation in interventional radiology

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Purpose: To investigate the efficacy, safety, and patient satisfaction of patient-controlled sedation (PCS) in interventional radiology. We have performed a pilot/feasibility study and are commencing a controlled trial of patient- vs. radiologist-controlled sedation.
Material and Methods:
1. Pilot study
Ten patients aged 18–75 years, receiving Hickman line placement, tunneled dialysis catheter, or port implantation were enrolled into a pilot study in which 1 mg midazolam and 25 mcg fentanyl bolus was administered over 3 minutes after the patient presses a button. A further successful button request for sedation is not possible until the 3-minute administration is completed. Complete physiological monitoring as well as subjective tests of patient satisfaction and well-being were performed, and some novel tests for the amnestic effect of sedation were also performed.
2. Controlled trial
We intend to enroll 100 subjects for a controlled trial; 50 assigned to PCS and 50 to traditional radiologist-controlled sedation. The study is intended to show noninferiority of PCS, with endpoints of the number of adverse events, patient satisfaction, and amnesia.
Results:
1. Pilot study
Attempted the enrolment of 13 patients, but three declined to take part
Ten patients enrolled
Zero adverse events
High-overall patient satisfaction
Satisfactory inducement of amnesia
2. Controlled trial: in progress. Enrolment should be complete and results available by mid-2015.
Conclusion: PCS is a safe and effective alternative to radiologist-controlled sedation. The inherent safety profile of patient control and matching the dose to patient requirements may make PCS a useful innovation in interventional radiology practice.

Free Paper Session
Vascular: aorta

3005.1

A multi-institutional survey of transcatheter arterial embolization for type II endoleak after endovascular aortic repair: a retrospective study of technical aspects and outcomes

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Purpose: The purpose of the present study was to determine the status of transcatheter arterial embolization (TAE) for type II endoleak (T2EL) in Japan and investigate the technical aspects that affect TAE results and patient outcomes.
Material and Methods: This was a retrospective analysis of a multi-institutional survey of endovascular aortic repair (EVAR) using commercial stent grafts and TAE for T2EL conducted in 25 hospitals. The investigation included 139 cases of initial therapy.
Results: The patients (104 men, 35 women) ranged in age from 55 to 95 (mean age, 76.9) years. The largest minor axis of the aneurysm ranged from 30 to 88 (mean, 53.8) mm. With transcatheter arterial embolization, the technical success rate was 84.2%. The imaging

success rate was 47.1%. Aneurysm diameter enlarged in 11 cases (9.0%), showed no change in 105 cases (86.1%), and shrunk in 6 cases (4.9%). The clinical success rate was 83.6%. Remaining EL was significantly more common with the embolization of branch only (P=0.0006) and significantly less common with the embolization of branch and sac (P=0.034).
Conclusion: Clinical success was achieved in >80% of cases. To obtain EL resolution, it is important to select an approach allowing both branch and sac to be embolized and use an embolic material suited to the case. We would like to investigate long-term results with a longer follow-up period.

3005.2

Outcomes following Onyx embolisation of type 1 endoleak in 20 cases

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Purpose: To assess the technical success and outcomes following Onyx embolisation of type 1 endoleak (EL1).
Material and Methods: A single-centre retrospective review of all transarterial type 1 Onyx embolisations was performed at a tertiary referral vascular centre. Results of CT and duplex imaging and clinical records were reviewed. Immediate technical success, complications and long-term outcomes were assessed.
Results: Twenty cases of EL1 embolisation was performed on 19 patients, 1 requiring two embolisations (average, 82 years; range, 64–91). These consisted of 17 proximal (type 1a) and 2 distal (type 1b) endoleaks. Eight patients showed aneurysm sac enlargement, and one had a contained rupture prior to embolisation. None of the patients were suitable for conventional EL1 therapy.
Average time from endoleak diagnosis to embolisation was 32 days (range, 1–172 days). Detachable coils in addition to Onyx were used in seven cases, and Onyx was solely used in 13 cases.
Immediate technical success was achieved in all 20 cases. Two adverse events with Onyx reflux into the Nellix graft was successfully alleviated by placing a stent within the Nellix graft. Mean imaging follow-up post-embolisation was 12 months (range 0–44 months). Of the 19 patients, 10 showed stable sac size; 3, reduction in sac size and 5, increasing sac size. All the latter 5 cases were associated with a recurrence/persistence of the type 1a endoleak. No sac size or endoleak recurrence was seen among the seven Nellix graft embolisations.
Conclusion: Transarterial embolisation is a viable option in the management of EL1 when conventional therapy is not feasible. Careful case selection is necessary to ensure optimum outcomes.

3005.3

Long-term follow-up results of endovascular repair in the management of arterial stenosis caused by Takayasu arteritis

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Purpose: The purpose of this retrospective study was to report our long-term follow-up results of endovascular repair in the management of arterial stenosis caused by Takayasu arteritis (TA).
Material and Methods: We retrospectively analyzed the outcome of endovascular interventions, including angioplasty and angioplasty with stenting, in patients with arterial stenosis caused by TA. The mean follow-up interval after endovascular procedure was 81 months (range, 12–144 months). The patients who were not available for the follow-up protocol after endovascular intervention and those who were not under adequate medical treatment were excluded from the study.
Results: A total of 67 endovascular procedures were performed for 49 arterial stenotic lesions of 35 patients included in the study. Treatment of recurrent stenosis with a second endovascular procedure was performed in 11 (22.5%) lesions. Twenty-two (33%) of 67 endovascular interventions resulted in restenosis or occlusion. Among all 49 arterial lesions, only four (8%) lesions (one common iliac, one renal, one celiac, and one thoracic aortic) were occluded at the time of final evaluation. Kaplan-Meier survival analyses of the renal arterial lesions showed that the overall 1- and 8-year restenosis-free survival rates of renal arterial interventions were 74% and 57%, respectively.
Conclusion: This study emphasizes that long-term patency of TA lesions is related with control of the disease activity by optimal immunosuppressive therapy before and after an initial endovascular procedure. Performing reinterventions with a close monitoring of the arterial lesions should not be avoided in order to obtain better outcomes.

3005.4

Failure of periarterial and controlled delivery of doxycycline from biodegradable poly(lactide-co-glycolide) (PLGA) film to preserve elastin or collagen in a novel rabbit AAA model

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Purpose: The systemic administration of doxycycline has been shown to suppress experimental AAA but brings a series of adverse side effects. We demonstrated the possibility of local administration of doxycycline from biodegradable poly(lactide-co-glycolide) (PLGA) film for AAA in a novel enlarging rabbit model.
Material and Methods: Doxycycline (10 mg) and PLGA (90 mg) were dissolved in 1 ml of dichloromethane, and 100 µl of solution was dropped to Polyester films (3×5 mm). Novel enlarging AAAs were induced in 12 rabbits, four pieces of film with doxycycline (Dox+AAA) or without doxycycline (Nor+AAA) were wrapped onto aneurysms; four unwrapped aneurysms served as the aneurysm group. Four aorta incubated with saline solution with no treatment was used as the sham control. Inner diameter was studied by IVDSA after 1 and 4 weeks, and pathological analysis was performed after 4 weeks.
Results: Aneurysm was seen in the Nor+AAA group and AAA groups, and their diameters enlarged significantly compared to the Dox+AAA group ($P < 0.01$) and progressed further 4 weeks later. All aneurysms showed intimal hyperplasia, and their elastin content decreased significantly after 4 weeks when compared to the sham group ($P < 0.0001$). However, there was no significant difference of elastin or collagen content, including type Ⅰ and type Ⅲ in Dox+AAA, Nor+AAA, and AAA groups ($P > 0.05$). MMP2 and MMP9 expression were dramatically increased in the aneurysm groups compared to the sham group ($P < 0.0001$).
Conclusion: Local administration of doxycycline in our experimental condition fails to preserve elastin or collagen in novel enlarging rabbit AAA model.

3005.5

Endovascular repair of acute and chronic aortic type B dissections: procedural factors influencing the aortic remodeling

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Purpose: To assess factors influencing the clinical outcome and morphologic changes of acute and chronic type B aortic dissection after endovascular repair (TEVAR).

Material and Methods: We retrospectively reviewed 60 patients who underwent TEVAR for complicated acute aortic dissection (AAD, n=29) and chronic aortic dissection (CAD, n=31) with a minimum follow-up of three years. True lumen, false lumen, and total aortic short axis diameter were recorded above, at the level, and below the stent-graft. Six procedural factors were analyzed in relation to aortic remodeling and other clinical outcomes. Comparison between continuous variables was made by Student's t test. Analysis of variance (ANOVA) was utilized to compare short axis, false lumen, and true lumen diameters during the follow-up period. Univariate/multivariate analysis was used to assess relationship between procedural factors and multiple outcomes.
Results: A total of 100 stent-grafts were implanted in 60 consecutive patients with complicated AAD and CAD. Aorta remodeling consisting in false lumen thrombosis and shrinkage was more prominent in AAD than in CAD especially within the first 18 months. Of note, whole aortic size increased significantly above the stent-graft in AAD. Only in the AAD group increased aortic remodeling was related to post-dilatation of the stent-graft. Type I and II endoleaks occurred in 17 patients (28%) and were inversely related to the LSA embolization after stent-graft deployment in the AAD, but not in the CAD.
Conclusion: Aorta remodeling and occurrence of endoleaks after TEVAR may be influenced by some procedural factors in patients with AAD, but not in patients with CAD.

3005.6

Semiconversion with graft salvage as a safe treatment for persistent type II endoleak

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Purpose: To present our large series of semiconversions as a feasible and safe treatment for untreatable and type II endoleak.
Material and Methods: Between January 2001 and December 2014, a total of 25 patients out of 1623 EVAR were selected as candidates for open semiconversion. The indication was persistent type II endoleak in 10, type I and II endoleak in 5, and endotension in 10. The technique consisted of performing proximal banding with Teflon, sacotomy to remove the thrombus and hygroma, and then suturing all the feeding vessels. Proximal and distal fenestrations were left to avoid sac repressurization.
Results: The semiconversion was performed after a medium period of 74 months from the EVAR. The mean aneurysm size at the time of the EVAR in these 25 patients was 6.0 cm, while the mean aneurysm size at the time of the semiconversion was 7.2 cm. Only one patient had a stable aneurysm size; the remaining 24 had a mean percentage diameter increase of 38% and an average increasing rate of 6.4% per year. The 10 patients with endotension and the 5 with associated type I and II endoleak did not undergo any other treatment but sacotomy; the 10 patients with type II endoleak previously underwent unsuccessful embolization. We had technical success in 100% of the cases without perioperative mortality. Four cardiac deaths were registered during follow-up.
Conclusion: This large case series shows that semiconversion is a safe and effective treatment for otherwise untreatable type II endoleak.

Free Paper Session
Liver TACE: experimental/new frontier

3006.1

Ginsenoside Rg3 improves transarterial chemoembolization treatment in Chinese patients with advanced hepatocellular carcinoma

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Purpose: This single-center, open-label, randomized, controlled trial aimed to evaluate the efficacy and safety of ginsenoside Rg3, a low-toxicity vascular-endothelial growth factor (VEGF) inhibitor, when used to supplement transarterial chemoembolization (TACE).
Material and Methods: Advanced hepatocellular carcinoma (HCC) patients with no prior systemic therapy were randomly divided to receive two daily oral Rg3 doses at 20 mg in combination with TACE (n=152) or TACE alone (n=76). The primary end-point was overall survival (OS). Secondary end points included time to progression (TTP), time to untreatable progression (TTUP), disease control rate (DCR), and safety.
Results: Median overall survival was 13.2 months (95%CI 11.15-15.26) in the TACE+Rg3 group and 10.1 months (95%CI 9.14-11.06) in the TACE group (HR 0.63 [95%CI 0.46-0.85], p=0.002). Median TTP values were 4.3 (95%CI 3.32-5.28) and 3.2 (95%CI 2.51-3.89) months for TACE+Rg3 and TACE patients, respectively (HR 0.82 [95%CI 0.62-1.08], p=0.151). TACE+Rg3 patients had greater median TTUP (8.3 months [95%CI 7.05-9.55]) compared with 7.3 months [95%CI 6.40-8.20] obtained for the TACE group (HR 0.76 [95%CI 0.57-1.02], p=0.063). The most frequently reported Rg3-related grade 3/4 adverse events (constipation, 1.3%; hypertension, 3.9%) were alleviated by symptomatic treatment. Importantly, Rg3 alleviated some TACE-related adverse syndromes (ascites [23.7 vs 48.7%], anorexia [12.5 vs 44.7%], and fatigue [9.9 vs 50.0%], all p<0.01) and blood anomalies (anemia [36.8 vs 51.3%], leukopenia [46.7 vs 76.3%], thrombocytopenia [32.9 vs 50.0%], and hyperbilirubinemia [17.8 vs 34.2%], all p<0.05).
Conclusion: In patients with advanced HCC and sufficient liver function, ginsenoside Rg3 improves TACE treatment.

3006.2

UGT1A1 mutation status and exposure of target tumor and remote tissue to irinotecan and SN38 following hepatic DEBIRI

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Purpose: To analyze the relative distribution of irinotecan and SN38 in tumor and remote liver tissue following DEBIRI.
Material and Methods: Five consecutive patients with inoperable hepatic metastases from colon, rectal, or anal primaries received lobar chemoembolization to near-flow stasis with 2ml of 100–300-µm DC® beads loaded with 100-mg irinotecan (CPT-11). All treatments received the complete dose of DEBIRI. Two patients received two cycles of treatment. Serum samples were obtained at fixed time intervals following DEBIRI. Tissue sampling of treated tumor and untreated contralateral lobe was performed immediately, 90 minutes, and 24 hours post-DEBIRI. Plasma and tissue concentrations of CPT-11, the active metabolite SN38, and the inactive metabolite

SN38-G were measured using an LC-MS/MS assay. Tissue half-lives of CPT-11 and SN38 were calculated based on linear regression through the terminal elimination on a log-normalized concentration vs time curve. All patients were tested for UGTA1A mutation. Statistical analyses were performed using GraphPad Prism.
Results: There was no statistically significant difference in C_{MAX} or AUC for CPT-11 or SN38 between normal and tumor tissue following DEBIRI.
Three patients had wild-type UGT1A1 genotypes (6/6, WT), while two had variants (VAR). Higher plasma CPT-11 C_{max} (p=0.0006), lower SN38 C_{max} (p=0.03), and lower SN38 AUC (p<0.001) were observed for WT. No significant difference in AUC for SN38 AUC or SN-38G in normal and tumor tissue was noted with VAR vs. WT.
Conclusion: Lobar DEBIRI results in similar exposure of target tumor and remote normal tissue to CPT-11 and active metabolite, regardless of UGT1A1 mutation status.

3006.3

Evaluation of embolic effect, tumor selectivity, and anti-tumor efficacy of 3 doxorubicin/ Lipiodol® formulations in a rabbit VX2 model

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Purpose: To compare embolic effect, tumor selectivity, and anti-tumor efficacy of 3 doxorubicin/ Lipiodol® formulations.
Material and Methods: Twenty-four New Zealand rabbits implanted with VX2 tumor in left liver lobe received selective hepatic artery infusion of 3 doxorubicin/Lipiodol® preparations: 1:1 ratio non-stabilized oil-in-water (group 1, n=7); 1:3 ratio stabilized water-in-oil (group 2, n=8); and 1:1 ratio stabilized oil-in-water (group 3, n=9). Lipiodol® deposition in tumor, healthy peritumoral liver and in peritumoral portal branches was evaluated by measuring density with sequential 3D-CBCT after incremental injection of the 3 formulations. The embolic effect of the tumor's feeder arteries was evaluated with 2D-angiogram and the tumor necrosis on Day 7 by dynamic contrast-enhanced MRI.
Results: After injection of 0.4 mL of each preparation, the mean ratio of Lipiodol® deposition in tumor versus healthy peritumoral liver was significantly higher (p≤0.03) in group 2 (10.2) than in groups 1 (3.3) and 3 (2.4). The mean Lipiodol® tumor enhancement was higher in group 2 (100±27) than in groups 1 (44±14, p=0.04) and 3 (90±15, NS). It was lower in group 2 (13±6) than in groups 3 (38±7, p≤0.04) and 1 (16±10, NS) in healthy peritumoral liver. The arterial embolic effect (p=0.02) and the grade of visualization of peritumoral portal vessels (p≤0.001) were higher in group 2. MRI-based tumor response at day 7 was 100% in both groups 1 and 2 and 50% in group 3, but results have been hampered by conditions of the experiment and small sample size.
Conclusion: Stabilized water-in-oil doxorubicin/Lipiodol® formulation allows better tumor targeting, higher embolic effect and complete tumor necrosis.

3006.4

Does DEB-TACE enhance the local effect of IRE? Imaging and histopathological evaluation in a porcine model

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Purpose: Irreversible electroporation (IRE) is associated with a hypervascular penumbra of vital temporarily damaged tissue due to reversible electroporation. Transarterial treatment of this penumbra could increase local efficacy of IRE. We conducted an in-vivo trial on swine to compare the ablation volumes of an IRE/DEB-TACE combination vs. IRE-only.
Material and Methods: Nine swine underwent IRE in one liver lobe and DEB-TACE immediately followed by IRE in a different liver lobe. For DEB-TACE, 100-300 µm beads (DC-Beads®) were loaded with 50-mg doxorubicin. For IRE, the NanoKnife® was used with two IRE electrodes according to the manufacturer's recommended protocol. After one day (n=3), three days (n=3) and seven days (n=3), animals were sacrificed, and ablation volumes were evaluated histopathologically. Imaging follow-up was performed using contrast-enhanced CT and MRI. Lesion volumes were measured one day (n=9), three days (n=6) and seven days (n=3) after the procedure.
Results: Mean histopathological ablation volume of IRE/DEB-TACE combination lesions after one, three and seven days were 15.7 ± 11.1 ml, 11.8 ± 9.3 ml and 4.2 ± 1.4 ml, respectively. Mean histopathological ablation volumes of IRE-only lesions after one, three and seven days were 7.2 ± 4.5 ml, 4.0 ± 1.0 ml and 1.7 ± 1.5 ml, respectively. In intra-individual comparison the ablation volumes of the IRE/DEB-TACE combination group were on average 199.6%, 163.4% and 98.5% larger than IRE-only lesions after one, three and seven days, respectively.
Conclusion: Combination of IRE followed by DEB-TACE resulted in larger ablation volumes compared to IRE alone, suggesting that local efficacy of IRE can be enhanced by post-IRE DEB-TACE.

3006.5

Characterisation of a novel drug-eluting radiopaque bead embolic

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Purpose: A novel drug-eluting radiopaque bead (ROB) based on the DC Bead® has been developed to be visible in vivo under clinical X-ray imaging. ROB was developed to maintain equivalent performance to DC Bead®, whilst providing clinicians with intra- and post-procedural visualisation for TACE procedures. This study presents the in vitro characterisation of ROB.
Material and Methods: ROB loaded with doxorubicin at equivalent doses to those used clinically for DC Bead® was tested for size, usability and in-vitro performance. Commonly available micro-catheters were selected to evaluate the deliverability, and a proprietary penetration model was used to characterise the particle depth of embolisation. Elution profiles for ROB were generated using a novel elution model. Elution data was evaluated against DC Bead® prepared in accordance with clinical guidelines.
Results: The drug loading times were equivalent to DC Bead®, and no significant change in bead diameter was measured between preloaded, loaded and eluted conditions. Good handling and deliverability of ROB was achieved using standard materials and techniques. Predictable depth of penetration was achieved in an in vitro model. Elution profiles for doxorubicin fall within a clinically established elution window.
Conclusion: ROB has been successfully developed showing equivalence to DC Bead®, whilst offering intra- and post- procedural visualisation. This combination will enable physicians to accelerate the development of treatments to achieve improved and optimised clinical outcomes.

3006.6

Repeated transarterial chemoocclusion with degradable starch microspheres (DSMs-TACO) of unresectable hepatocellular carcinoma: a prospective pilot study

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Purpose: To evaluate the efficacy and safety of trans-arterialchemo-occlusion (TACO) using degradable starch microspheres (DSMs) for unresectable hepatocellular carcinoma (HCC) treatment.
Material and Methods: We prospectively enrolled 24 HCC cirrhotic patients (21/3 M/F, mean age 66.3±10.5 years), to be treated with three repeated DSMs-TACO procedures (225 mg of DSMs, Embocept®S, PharmaCept and doxorubicin cloridrate, 50 mg/m^2), performed at 4-6 week intervals. Patients were clinically evaluated before and after each procedure and disease severity scored according to Child-Pugh and MELD scores. Treatment response was assessed by CT-scan 4 weeks after each procedure, according to mRECIST criteria.
Results: Complete response (CR) was observed in 5 (20.8%), 9 (37.5%) and 14 (58.3%) patients after the first, second and third procedures, respectively. At the end of the treatment course, all patients experienced at least a partial response. Patients with monolobar disease (14/24: 58.3%) showed higher CR rates after the first procedure compared to those with bilobar HCC (6 vs 0, p=0.017). No differences between mono- or bilobar disease were observed in CR (64.2% vs 50%; p=ns). Eight patients (33.3%) did not complete the planned repeated procedures. In most cases, treatment discontinuation was due to worsening liver function, mainly in patients with more advanced liver disease.
Conclusion: DSMs-TACO offers a valid therapeutic option in patients with unresecable HCC. A careful patient selection is required in order to avoid worsening liver function in patients with borderline liver compensation. Further investigations to establish the best treatment schedule and to define the effect of DSMs-TACO on survival are required.

Free Paper Session
IVC filters

3007.1

Prevention of pulmonary embolism in patients with severe trauma: role of IVC filters

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Purpose: Traumatic injury is a significant risk factor for venous thromboembolism. IVC filters are widely used in the United States to prevent pulmonary embolism (PE). In Norway, low-molecular-weight heparin forms the mainstay of prophylaxis. The goal of this study was to evaluate the effect on mortality, PE, and lower extremity deep vein thrombosis (LE-DVT).
Material and Methods: Trauma patients admitted to two large tertiary medical centers (Mayo Clinic, MN, US and Oslo University Hospital Ullevål, Norway) between 2008 and 2013 were considered for inclusion. The centers represented the two approaches to prevent PE. US patients (n=305), who met the EAST criteria received IVC filters in addition to prophylactic anticoagulation, were matched to Norwegian patients (n=669), who received anticoagulation alone.
Results: In the US cohort, the mean age was 46.6 years, 67.2% men, and median ISS score 27. In the Norwegian cohort, the mean age was 47.2 years, 72.8% men, and median ISS score 25. At Mayo, the incidence of PE during hospital stay was 25 (8.2%), before IVC filter 16 (5.2%), and after IVC filter 9 (3%). At Oslo, the incidence was 8 (1.2%). Mortality rate was 22 (7.2%) and 58 (8.7%), respectively. At Mayo, LE-DVT was 42 (13.8%) during hospital stay, 18 (5.9%) before IVC filter, and 24 (7.9%) after IVC filter. At Oslo, the incidence was 4 (0.6%).
Conclusion: Unadjusted data showed a trend towards higher incidence of LE-DVT and PE in the US cohort. Further analyses are needed. The data forms a background for a matched prospective study.

3007.2

Are pre-operative retrievable inferior vena cava filters ever actually retrieved?

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Purpose: Pulmonary embolism following surgery is a major cause of morbidity and mortality. There has been an increasing trend in the use of retrievable IVC filters for patients unable to be coagulated. No timeframe has been defined for the time of removal. We reviewed our practice of retrievable IVC filter use as an adjunct to surgery.
Material and Methods: Data collection was performed for all retrievable filters implanted between November 2004 and October 2014. Patients were identified from the hospital's radiology information system. Data is presented as mean±SEM (range).
Results: In total, 393 retrievable filters were inserted during the study period. The indication of pre-operative thromboembolic prophylaxis was 64.6%; 4 patients underwent two filters. Age 58.7±16.0 years (18.9-86.8), 55% female. The specialties requested include orthopaedics 20.5%, pulmonary endarterectomy 15.4%, gynaecology 13.8%, upper GI 13.8%, colorectal 13%, urology 6.7%, hepatobiliary 6.3% and others 10.6%. Of the 254 filters inserted, attempted retrieval was made in 65.7%; time to attempt was 78.8±77.5 days (3-537) with no difference for those that failed retrieval (t-test). In total, 59% filters were retrieved. Reasons for failure included thrombus (n=13), angled (n=7), legs outside wall (n=2) and inability to snare (n=2). Where no attempt at retrieval was made, cover for cancer surgery was associated with increased mortality (log-rank p<0.0001).
Conclusion: Time was not a factor in failure to retrieve. The majority of filters were retrieved within 3 months. Strikingly, only 59% of those filters placed temporarily were ever retrieved. We now utilise a departmental registry to ensure patients are not lost to follow-up without attempted filter removal.

3007.3

The impact of a prospectively maintained IR database on IVC filter retrieval rates

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Purpose: Retrievable IVC filters are intended to avoid long-term complications of permanent filters, such as IVC occlusion/penetration, filter/strut migration, and recurrent venous thromboembolism (VTE). SIR guidelines advise "100% of patients should have attempted retrieval, unless a change in clinical circumstances contraindicates removal."

We aimed to determine the impact of a prospectively maintained database on retrieval rates of IVC filters at our institution over a 3-year period.
Material and Methods: All patients undergoing retrievable IVC filter insertions from 1st May 2011 to 31st April 2014 were identified. Each patient had been allocated a routine retrieval appointment at time of insertion. Non-retrieval prompted discussion with the referring clinician regarding permanency.
Results: In all, 111 patients had retrievable IVC filters: 73 Celect™ and 38 Gunther Tulip® (Cook Medical). The most common indications were VTE despite or with contraindication to anticoagulation (43.2%), perioperative prophylaxis (37.8%), pre-thrombolysis of extensive VTE (6.3%), VTE with poor cardiopulmonary reserve (5.4%), and massive pulmonary embolism (4.5%).
The filter was deemed permanent in 36 patients (32.4%) due to either change in clinical status or ongoing unsuitability for anticoagulation. Nine patients (8%) were deceased. Of the remaining 66 patients, 61 underwent attempted retrieval (92.4%), successfully in 58 (95%). Five of the 66 patients (10.3%) did not undergo retrieval, all due to inadequate follow-up. Patients with perioperative indications were most likely to have retrieval.
Conclusion: Our 92.4% attempted retrieval rate and 95% success rate at retrieval are among the highest published to date. A prospective database and routine retrieval appointments to prompt discussion with referring clinicians can significantly improve retrieval rates.

3007.4

Two-year results of the prospective, multicenter Denali retrievable IVC filter trial

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Purpose: To assess the safety and effectiveness of an optional inferior vena cava (IVC) filter in patients requiring caval filtration to protect against pulmonary embolism (PE).
Material and Methods: A prospective multicenter trial was performed on 200 patients with temporary indications for an IVC filter. Patients were followed up for 2 years or for 30 days after filter retrieval. Technical and clinical success of filter placement and retrieval were the primary endpoints. Evaluation for recurrent PE, new or worsening deep vein thrombosis, and filter migration, fracture, penetration, and tilt was also performed.
Results: Final results of this clinical trial with the 2-year follow-up will be available by the time of CIRSE meeting, and, if accepted, will be presented at CIRSE. An interim analysis of the study results has shown a technical success of filter placement of 99.5%, with a clinical success of placement achieved in 94.5% of patients. There was a technical success rate of retrieval of 97.3% (108 of 111). Mean dwell time for filter retrievals was 165 days (range, 5–632 days). There were no instances of filter fracture, migration, or tilt greater than 15° at the time of retrieval or 6-month follow-up. Final data will be available for presentation at CIRSE 2015.

3007.5

Safety and efficacy of the Celect versus Denali retrievable IVC filter

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Purpose: To compare the safety and efficacy of the Celect (Cook, Bloomington, IN) to those of the Denali (Bard, Tempe, AZ) retrievable IVC filters.
Material and Methods: A retrospective review was performed of Denali and Celect filter placements. Data related to filter placement and retrieval were reviewed. Outcomes including complications and breakthrough PE were evaluated.
Results: Two hundred consecutive Celect filter and 100 consecutive Denali filter placements were enrolled into the study. Overall, primary indications were DVT or PE disease (89%) or prophylaxis (11%). Technical success rate for placement was 100% for both cohorts. The mean follow-up was 197 days. There were 3 breakthrough pulmonary emboli (1%) over the study period, with 2 occurring in the Celect group and 1 in the Denali group. In all, 146 patients had imaging follow-up by either CT or fluoroscopy. For this group, complications from indwelling filters included IVC strut penetration (12% in the Celect group, 8% in the Denali group), filter tilt (3% in the Celect group, 2% in the Denali group), and filter thrombus (0.5% in the Celect group, 0% in the Denali group).
There were a total of 100 patients who returned for retrieval (30%) with mean indwelling time of 127 days. The technical success rate was 99.5% for the Celect group and 100% for the Denali group.
Conclusion: Both filters were efficacious in preventing PE. There was a trend toward more strut penetration in the Celect group, though this did not result in an increase in clinical symptoms. Safe retrieval was performed in both cohorts.

3007.6

Multicenter trial of the VenaTech Convertible Filter: a novel approach to IVC filtration

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Purpose: Existing retrievable filter platforms have limited points of contact with the dynamic IVC wall which can potentially lead to complications. The convertible filter is a new concept based on a durable permanent IVC filter design in which the filter is not retrieved but converted into a stent configuration. The primary objective is to demonstrate that the successful filter conversion rate is no lower than the reported IVC filter retrieval success. The secondary objective is the 6-month major device-related adverse event rate with a converted filter.
Material and Methods: This is an IDE multicenter, prospective, single-arm, historically controlled study with a total of 148 patients. Patients were enrolled for standard indications for retrievable filter placement. Evaluation of safety and performance in 61 subjects in whom the filter has been implanted, converted, and followed up for 6 months has been completed to date.
Results: All filter implants were successful. The technical success rate for filter conversion to date is 93% (77/83). No serious conversion-related events have been reported. To date, 61 patients whose filter was converted have completed at least 6 months of follow-up with no delayed complications such as migration or penetration of the legs through the wall of the vena cava.

Conclusion: Preliminary data suggests the VenaTech Convertible Filter is a safe and effective temporary filter with favorable conversion rates compared to reported IVC filter retrieval rates. Early results show decreased incidence of IVC wall perforation vs current retrievable filter designs and no serious adverse events at 6 months related to filter conversion.

Free Paper Session
Lung ablation

3008.1

Percutaneous thermal ablation of colorectal cancer lung metastases in nonsurgical patients: our experience

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Purpose: The purpose of our work is to compare the effectiveness of percutaneous radiofrequency ablation (RFA) and microwave ablation (MWA) procedures to treat nonsurgical patients with colorectal cancer lung metastases that are smaller than 3 cm in the absence of extrapulmonary disease at ablation time.
Material and Methods: At our center, between January 2009 and February 2015, 21 patients underwent percutaneous RFA of colorectal cancer lung metastases (37 nodules treated), while 23 patients underwent percutaneous MWA of colorectal cancer lung metastases (39 nodules treated). Follow-up computed tomography (CT) scans were performed 1, 3, and 6 months after treatment and then at every 6 months.
Results: In the MWA group, residual disease was observed 1 month after treatment in 1 nodule (2.7%); no residual disease was observed in the RFA group. We evaluated disease-free survival rates (DFS) and overall survival rates (OS), respectively, at 12, 24, and 36 months in both RFA (DFS, 83.2%, 61.7%, and 45.7%; OS, 96.7%, 74.3%, and 67.1%) and MWA (DFS, 85.7%, 57.9%, and 44.5%; OS, 100%, 78.6%, and 66.7%) groups. No major complications were seen in both groups. The only complication observed was pneumothorax, with an incidence rate of about 10% in both groups.
Conclusion: We can assess that the RFA and MWA are good alternatives to surgery for nonsurgical patients with colorectal cancer lung metastases, with comparable results in terms of DFS and OS and low incidence of complications.

3008.2

Radiofrequency ablation (RFA) of advanced lung tumors: imaging features, local control, and survival analysis

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Purpose: To prospectively observe the imaging features and local control of the advanced lung tumors after RFA and to analyze PFS and OS of the patients.
Material and Methods: Between February 2012 and December 2013, 58 advanced-stage patients (100 lung lesions) were enrolled in our study. In each lesion, ablation was performed once, then a 12-33-month follow-up was given. The contrast-enhanced CT images at preablation and 1 and 3 months post-ablation and every 3 months thereafter were obtained. PET was performed preablation, 3 months after ablation, and every 6 months thereafter. The CT appearance, size, enhancement, and PET metabolic activity of the ablation zone were recorded to describe the imaging evolution and to assess the local control of the lesion.
Results: There were significant differences in lesion size between preablation and 1-month post-ablation (P=0.000), 1- and 3-month post-ablation (P=0.000), and 3- and 6-month post-ablation (P=0.006); while no significant difference was found between 6- and 12-month post-ablation (P=0.300). The local control rate was 52%. In definite recurrent or residual lesions, 63% showed increase more than 20% compared with minimum size, 27% showed nodular enhancement measuring more than 10 mm, 10% showed central enhancement greater than 15HU. The time to local control, PFS, and OS was 15.4±7.5, 9.6±5.8, and 18.0±7.0 months, respectively. No death related to the operation occurred.
Conclusion: It was more suitable to take lesion size at 1-month post-ablation as the baseline and assess efficacy at or after 6-month post-ablation. RFA was a safe and effective approach for local control of lung tumors of advanced stage patients, and indicated an improved OS.

3008.3

Radiofrequency ablation versus surgery for the treatment of lung metastases: a comparative study

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Purpose: To compare efficacy and tolerance of radiofrequency ablation (RFA) and surgery for the treatment of lung metastases
Material and Methods: This IRB approved study, included patients treated for lung metastases from extra-pulmonary cancer: up to 5 tumors, with à maximal diameter of 4cm, without pleural or lymph node involvement on preoperative CT-scan.
Seventy-eight patients (130 metastases) were enrolled in the surgery group and 126 (223 metastases) in the RFA group.
Patient and treatment characteristics were reported and compared. Efficacy was assessed using overall survival, progression free survival, pulmonary progression and local recurrence rates.
Results: Patients were significantly older in the RFA group (p<0.0001), with more extra-thoracic locations requiring additional treatments (p=0.015). Metastases were larger in the surgery group (mean size: 17.4 vs. 15.4 mm, p=0.05) but more frequently unilateral (94% vs. 76%, p=0.0014).
Overall survival at 1 and 3 years was 94.8 and 67.2% for the surgery group versus 94 and 72.1% for the RFA group, p=0.46. There was no statistically significant difference in terms of PFS (49.4 and 26.2 vs. 38.9 and 14.8, p=0.18), pulmonary progression (39.1 and 56% vs. 41.2 and 65.3%, p=0.99), or local recurrence (5.4 and 10.6 vs. 14.8 and 18.6, p=0.07), rates when comparing surgery and RFA, respectively.
Complication rate was 29% for surgery and 32% for RFA (p=0.8), with a significantly lower hospital stay for RFA patients (p<0.0001).
Conclusion: RFA seems efficient and safe and has to be considered as an alternative to surgery for the treatment of lung metastases.

3008.4

Robot-assisted navigation system for CT-guided percutaneous lung tumor procedures: our experience in Hong Kong

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Purpose: To evaluate the new robot-assisted navigation system for CT-guided percutaneous lung lesions procedures
Material and Methods: Imaging-guided lung procedures are usually challenging due to patient breathing, especially during local

anaesthesia procedures. This was prospective study in a university-based hospital. This was assessment of efficacy involving total 89 patients with lung lesions underwent CT-guided percutaneous lung interventions utilizing robot-assisted navigation system (Maxio, Perfint Healthcare, USA). Targeted needle pathway was planned on Maxio Robotic system based on pre-procedural CT-scans. Primary endpoint was satisfactory instrument position for intended intervention. Lesion size and depth from skin were noted. Performance level was documented on five-point scale (5-1: excellent-poor). Total radiation doses were recorded and compared against 20 patients with conventional CT guidance and CT-fluoroscopy lung procedures (ratio 1:1).
Results: There were 59 males and 30 females patients in the robotic group. Average age was 66.7 years (range 38-85). 84 patients underwent lung biopsy while rest had thermal ablation, fiducial marker insertion or lung abscess drainage. Average lesion size was 3.1cm (range 0.8-7.8cm). Average lesion depth was 5.6cm (range 2.8-9.5cm). All interventions met primary endpoint of satisfactory instrument positioning. Average performance levels were 4.71. Average radiation dose (dose linear product) was 440.1mGycm (range 83.7-2012.7), whereas conventional CT guidance was 645.4mGycm (range 285.1-1043.5) and CT-fluoroscopy was 460.1mGycm (range 214.2-1157.0).
Conclusion: Our experience demonstrated effectiveness of robot-assisted navigation system for CT-guided lung tumor interventions with lower radiation dose compared with conventional CT-guided procedures. Radiation doses were similar to CT-fluoroscopy without radiation exposure to interventional radiologists. Targeting success rate for satisfactory intervention was 100%.

3008.5

Diffusion-weighted imaging guidance to CT-guided transthoracic biopsy

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Purpose: To establish the feasibility of performing CT-guided transthoracic biopsy by using previously acquired diffusion-weighted imaging (DWI).The purpose of this study is to establish the feasibility of performing CT-guided transthoracic biopsy by using previously acquired DWI.
Material and Methods: CT-guided transthoracic biopsy decision was made according to patients' previously acquired CT or PET-CT scans. Magnetic resonance imaging (MRI) (including T1, T2, and STIR images) and DWI with ADC map were acquired. The matching of the most hypointense area of the lesion on the ADC map with CT images was checked. If there was no match, then biopsy site was replanned according to the most hypointense area on the ADC map.
Results: From March 2013 to October 2014, 83 of 116 patients were eligible for inclusion. Out of 83, 11 patients were excluded because of deformation of DWI images due to severe artifacts. Seventy-two patients (16 females, 56 males) had 74 lesions, all of which were diagnosed histopathologically. Sixty-three lesions were malignant and 11 were benign. Malignant lesions were more hypointense (p=0.001) and showed more diffusion restriction (p=0.002) on the ADC map compared with the benign ones. However, there was no statistically significant difference between malignant and benign groups with respect to ADC values (p=0.147).
Conclusion: To our knowledge, this is the first study using ADC maps as a guidance to CT-guided transthoracic biopsy in the English language literature. Determining the most hypointense areas in ADC maps qualitatively, as biopsy targets, is a simple and less time-consuming method than ADC value measurement, which is sometimes even conflicting.

3008.6

Utility of C-arm cone beam computed tomography and ablation software for planning and predicting thermal ablation of lung malignancies

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Purpose: To evaluate the utility of C-arm cone beam computed tomography (CBCT) and ablation software for planning thermal ablation of lung malignancies with an adequate safety margin.
Material and Methods: Between January 2012 and January 2015, 35 patients (19 men, 16 women; mean age 73.5 years) underwent thermal ablations of lung malignancies (22 non-small cell lung cancers; 13 metastasis) under CBCT guidance. Pre-procedural CBCT was performed, and the ablation was planned determining optimal approach to the lesion, using a dedicated software. Under fluoroscopy, with navigation system, ablation devices were positioned into the lung lesion and intra-procedural CBCT was performed to check device position within the lesion. CBCT lesion detection accuracy and ablation device positioning accuracy on the basis of CBCT and software information were recorded. Moreover, 1-month follow-up CT and intra-procedural CBCT were retrospectively registered to evaluate the accuracy of CBCT ablation software to predict the safe margins of ablation area.
Results: All procedures were completed without major complications. C-arm CBCT detected all lesions (100%). In 14 cases (41.6%), the ablation devices were repositioned on the basis of CBCT. At the 1-month follow-up CECT, we obtained complete ablation in 23 cases. In the other cases, the residual disease was seen at lesion periphery, where the CBCT software showed lack of safe margins of planned ablation area.
Conclusion: Planning and monitoring of percutaneous lung malignancies thermal ablation using CBCT and ablation software is feasible and can be used for safe needle positioning within target lesion.

Free Paper Session
Venous intervention

3104.1

Impact of endovascular treatment for extensive veno-occlusive deep vein thrombosis in the pediatric population

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Purpose: To evaluate our experience and impact of using endovascular treatment (ET) strategies in a cohort of children with acute deep vein thrombosis (DVT) of a limb.
Material and Methods: This was a retrospective study of 29 patients referred for ET using pharmacomechanical strategies (thrombolysis, thrombectomy or a combination) for management of acute DVT in a pediatric hospital. Data included the clinical presentation, medical treatment, endovascular procedure, postprocedural course and long term follow up including clinical evaluation and imaging.
Results: There were 29 patients (16 girls and 13 boys) with a median age of 16 years (range 12 -17). Each patient had only one limb involved. Of the 17 patients with lower limb involvement, 7 (41%) underwent angioplasty of which 2 required stenting. Of the 12 patients with upper limb involvement, 7 (58.3%) underwent angioplasty and none underwent stenting. Two patients developed transient bradycardia and hypertension during thrombectomy, which resolved

spontaneously. These patients also developed hematuria which cleared after a day. Extravasation was seen in one patient while traversing an occlusion. No patient had severe bleeding during the treatment period. The extent of recanalisation ranged from 60 to 96%. When seen on follow-up visits, 18 patients (62%) had complete resolution of deep venous thrombosis, 6 patients (20%) had residual thrombosis, and 5 patients (17.2%) had re-occluded veins.
Conclusion: Endovascular treatment is beneficial in children with acute deep vein thrombosis of a limb. Over the long term, majority of the patients have relief of symptoms and a lower incidence of post thrombotic syndrome.

3104.2

Predicting re-thrombosis and clinical failure in the endovascular management of May-Thurner syndrome

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Purpose: To identify features predictive of re-thrombosis or clinical failure in patients undergoing treatment for May-Thurner syndrome (MTS).
Material and Methods: All patients (n=123) undergoing initial iliac vein stenting for suspected MTS conducted between 1996 and 2014 were reviewed. Sixty-four patients were excluded for poor (<30 day) follow-up, malignant obstruction, or prior stenting. Re-thrombosis was defined as in-stent thrombosis that necessitated repeat intervention. Clinical failure was recorded as subjective worsening or no interval change in the presenting symptoms. Baseline, procedural, and outcome parameters in addition to complications were recorded as per CIRSE standards of practice guidelines on iliocaval stenting. The average time to follow-up was 1061 days (median, 228; range, 30–6050).
Results: During follow-up of 59 patients with treated MTS, 14 (24%) experienced thrombotic complications and 10 (17%) reported no clinical improvement. Analysis of the data found that patients who had thrombotic complications had more stents placed, on average, for treating MTS than those who did not have thrombotic complications (2.6 vs. 1.8, p=0.042). Additionally, patients with chronic DVTs were less likely to report clinical improvement (p=0.037). These relationships held true when controlling patient demographics, clinical presentation, venous access point, stent diameter, stent composition, and pre-procedural anticoagulation use.
Conclusion: Endovascular stenting for MTS is an effective treatment with a high rate of clinical improvement and low incidence of re-thrombosis. Our experience suggests that patients treated with more stents or evidence of chronic DVT appear to be at a higher risk of thrombotic complication and clinical failure, respectively.

3104.3

Five-year outcome after catheter-directed thrombolysis for upper femoral and/or iliac vein thrombosis: results of a randomized controlled trial (the CaVenT study)

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Purpose: To examine whether an additional catheter-directed thrombolysis (CDT) reduces the frequency of post-thrombotic syndrome (PTS) after high-proximal deep vein thrombosis (DVT).
Material and Methods: Patients with a first-time objectively verified DVT affecting the upper half of the femoral vein and/or the iliac vein and with symptoms up to 21 days were randomized to the conventional therapy, with anticoagulation and compression stockings alone or to an additional CDT. PTS at a 5-year follow-up period was assessed using the Villalta scale.
Results: A total of 209 patients were randomized during 2006–2009. Mean age was 51.6 years (SD, 16.8 years), and 66 patients (38%) were females; the mean duration of symptoms was 6.5 days (SD, 16.8 days). Eighty-seven patients (49.4%) had an involvement of the pelvic veins. After a 60-month follow-up, data on clinical status were available for 176 patients (89 controls, 87 CDT). Thirty-seven patients (43%; 95% CI, 33–53%) recruited for additional CDT developed PTS as compared with 63 (71%; 95% CI, 61–79%) in the control group (p<0.001), including 4 in the CDT and 1 in the control group with severe PTS. This corresponded to an absolute risk reduction of 28% (95% CI, 14–42%) and a number needed to treat of 4 (95% CI, 2–7).
Conclusion: Follow-up after 60 months showed a continued and increased benefit of CDT from 2- to 5-year follow-up, which underpins the importance of recanalization of occluded veins. Two additional ongoing studies may provide final evidence for the utility of CDT in the treatment of severe proximal DVT.

3104.4

Venous chimney graft technique in the endovascular treatment of central vein stenosis in hemodialysis patients

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Purpose: One major concern in the deployment of stent-grafts for central vein stenosis is the need to avoid bridging of the internal jugular or brachiocephalic vein confluence. We report the feasibility and safety of the chimney graft technique in the endovascular treatment of central vein stenosis in hemodialysis patients.
Material and Methods: Six patients (mean age, 67 years; 4 males; mean dialytic age, 13 years) presented indications for the stent-grafting of symptomatic central vein stenosis after multiple conventional treatment failures. All were carriers of ipsilateral AVF with arm edema and had malfunctioning vascular access. Double access was engaged from arm and femoral approaches. After unsuccessful PTA of lesions, a self-expandable PTFE stent-graft was transfemorally released with a safety wire in the jugular or brachiocephalic vein. A similar stent-graft was then released in the distal jugular or in the contralateral brachiocephalic vein with distal ends parallel to the other stent-graft (double barrel chimney graft). The procedure was completed with an intrastent low-pressure kissing ballooning.
Results: All procedures were successful. Symptoms cleared in all patients (mean follow-up, 12 months). Ten Viabahns (5–10 cm long) were released. A staged procedure was accomplished in two cases. In four patients, stent-grafts remained patent to the end of follow-up and until death in two patients at 8 and 18 months. Reintervention was required in one patient at 6-month follow-up (primary patency of 80% and 75% at 6 and 12 months, respectively).
Conclusion: The venous chimney graft technique may extend the limits of central vein stent-grafting by preserving the patency of residual veins.

3104.5

An endovascular approach to the entrapped central venous catheter after cardiac surgery

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Purpose: Entrapment of central venous catheters (CVC) at the superior vena cava (SVC) cardiopulmonary bypass cannulation site by closing purse-string sutures is a rare complication of cardiac surgery. Historically, resternotomy has been required for suture release. An endovascular catheter release approach was developed.
Material and Methods: Four cases of characteristic CVC angulation against the SVC wall and associated resistance to removal, suggestive of catheter entrapment were encountered. In each case, catheter removal was achieved using a reverse catheter fluoroscopically guided over the suture fixation point between CVC and SVC wall, followed by the placement of a 0.35-inch guidewire through the catheter. The guidewire was snared and externalized to create a through-and-through access with the apex of the loop around the suture. A snare placed from the femoral venous access provided concurrent downward traction on the distal CVC during suture release maneuvers.
Results: In the initial attempt, gentle traction freed the CVC, which fractured and was removed in two sections. In the subsequent three cases, traction alone did not release the CVC. Therefore, a cutting balloon was introduced and inflated. Gentle back-and-forth motion of the cutting balloon atherotomes successfully incised the suture in all three attempts. An asymptomatic self-limited arrhythmia was observed immediately after suture release in one patient. No other complications were encountered. During all cases, a cardiovascular surgeon was present in the interventional suite and prepared for emergent resternotomy, if necessary.
Conclusion: An endovascular approach to the "entrapped CVC" is proposed, which may reduce risks posed by resternotomy to cardiac surgery patients in the postoperative period.

3104.6

Translumbar tunneled inferior vena cava catheter placement: single-centre 6-year experience

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Purpose: To describe the technique, review the literature and communicate our single-centre 6-year experience in performing this procedure.
Material and Methods: From September 2008 until December 2014, 105 translumbar haemodialysis catheters were placed in 92 patients, 51 men and 41 women. All procedures were performed in an angio-suite with sterile surgical technique under both general plus local anesthesia. Ultrasound and angiography imaging guidance were available at all times. Informed consent for anesthesia and the procedure were previously signed. After the procedure, all patients were observed at our recovery section before returning to the ward or home or going to the haemodialysis unit or discharged to the referring centre.
Search of the available literature about translumbar catheter placement was performed in MEDLINE, OVID and LILIACS. A database for the translumbar catheter placement at our institution during the 2008–2014 period was developed on the basis of the electronic clinical history records. Peri-procedural results and procedure-related complications were studied and compared with those published.
Results: Technical success was achieved in all procedures. All catheters could be placed appropriately and used in a satisfactory way after placement.
The incidence of complications up to 72 hours post-procedure was observed, identifying 4 complications (3.8%; 1 haematoma, 1 bacteraemia, 1 catheter migration and 1 tunnel bleeding), all of them were minor complications.
Conclusion: Translumbar catheter placement is a feasible, safe and effective alternative for central venous access in haemodialysis patients who have exhausted other conventional access ways. This technique can be performed on an outpatient basis. Our results are according to the available literature.

3104.7

An update on VIVO-EU, a prospective study of the Zilver vena venous stent in the treatment of symptomatic iliofemoral venous outflow obstruction

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Purpose: To evaluate the performance of the Zilver vena venous stent in the treatment of symptomatic iliofemoral venous outflow obstruction.
Material and Methods: This prospective, multicenter study is enrolling patients with symptomatic iliofemoral obstruction in up to two limbs. Patients may undergo thrombolysis, thrombectomy, and/or IVC filter placement prior to stent placement, depending on their underlying medical conditions. Patients undergo follow-up at 1, 6, and 12 months, including ultrasound examination. Assessments include procedure success measures, adverse events, clinical symptoms of venous insufficiency, and reinterventions. As of April 2015, 27 patients (77.8% female; mean age of 45±17 years) have been enrolled.
Results: A mean of 1.3 stents were placed per patient. Lesions were on the left side in 26 patients (96.3%), and the common iliac vein was most frequently stented (n=26; 96.3%), though the external iliac and/or common femoral vein was also involved in some patients. One major adverse event has occurred, a symptomatic pulmonary embolism one day post-procedure, and one patient has undergone a reintervention for a symptomatic occlusion of the study lesion. Clinical symptoms improved after stent placement, as measured by VDS, CIVIQ, and VCSS.
Conclusion: The VIVO-EU study is evaluating the Zilver vena venous stent in patients with symptomatic iliofemoral obstruction, and to date has demonstrated a low complication rate and favorable performance.

Free Paper Session
IR in liver transplant

3105.1

Locoregional therapies in hepatocellular carcinoma before liver transplant: a retrospective study

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Purpose: Liver transplant (LT) is the best treatment for cirrhosis and hepatocellular carcinoma (HCC). Locoregional therapies are used to bridge or downstage LT candidates to within LT criteria. Tumor necrosis (TN) on the explant has been shown to improve outcomes. Currently, TACE or percutaneous ablation (PA), alone or in combination, is the most widely used. The purpose of this study is to review the results of locoregional therapies in LT patients with cirrhosis and HCC.

Material and Methods: A retrospective study of all patients who underwent LT at our institution in 2013-2014 due to cirrhosis and HCC was undertaken to compare the %TN in those treated with single vs combined locoregional treatments and in those who underwent bridging vs downstaging. The Milan criteria were considered in this study.
Results: During 2013 and 2014, 206 patients underwent LT at our institution, 58 of those due to cirrhosis with HCC (28%). Fifty-three patients (26%), with a mean age of 58±6.4 years, 48 males and 5 females, had been previously submitted to TACE (n=37), PA (n=4), or to combined treatments (n=12). These patients waited 274 days on the LT list, on average. Combined locoregional therapies achieved a significantly higher average %TN than did single treatments, with 88% and 67%, respectively (p=0.0258). Patients being downstaged had a trend towards a lower %TN than those being bridged (p=0.531).
Conclusion: Combined locoregional treatments, with TACE and PA, achieve superior tumor necrosis in liver explants, compared to single treatments, in patients awaiting LT and may be the best option for downstaging.

3105.2

Comparison of software-assisted volumetry with conventional CT volumetry in pre-operative calculation of future liver remnant (FLR) in patients undergoing liver resection: is it a reliable tool?

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Purpose: To evaluate the correlation between the estimated resection volume calculated pre-operatively using semi-automated method and conventional CT volumetry with post-operative resection volume in hepatectomy patients.
Material and Methods: Forty-six patients who had undergone hepatectomy at our institute from August 2012 to November 2014 were analysed. Patients underwent triphasic CT according to the software protocol, and volumetry was performed using the semi-automated software as well as conventional CT volumetry. The parameters evaluated included the estimated resection volume, post-hepatectomy specimen volume and tumour size. A retrospective analysis has been performed comparing actual specimen weight with estimated resection volumes calculated using both volumetry methods.
Results: Significant correlation was noted between the estimated resection volume calculated using the software and the actual specimen weight ($p<0.005$). Mean resected volume post-surgery was 1121 g, while mean estimated volume using the semi-automated method and CT volumetry was 1203 cc and 1260 cc, respectively. Resection volume calculated using the semi-automated method correlated more closely than the CT volumetry a Pearson correlation value of 97.5% vs. 93.7%, respectively.
Conclusion: Liver volumetry using semi-automated software is faster, and the resected volumes more closely correlate with the semi-automated method than with the CT volumetry method, and it can be a valuable tool in selecting the potential surgical candidate.

3105.3

Identification of cofactors influencing hypertrophy of the future liver remnant after portal vein embolization: the effect of newly developing portal collaterals on embolized liver volume

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Purpose: The purpose of this study was to monitor hypertrophy of the future liver remnant (FLR) following portal vein embolism (PVE) before planned extended right hepatectomy (ERH). However, because individual responses to PVE are highly variable, our focus was to identify cofactors of successful hypertrophy.
Material and Methods: Twenty-eight patients (10 females, 18 males), mean age 64.1 ± 12.9 years, were nominated in our center for ERH of primary or secondary liver tumors. They were prepared by PVE and volumetric analysis for hypertrophy before and after PVE (median 52.0 ± 26.3 days) was performed. The embolized liver segments were investigated for occurrence of reperfusion of their portal branches.
Results: Patients were divided into responders and non-responders by post-PVE standardized FLR being above or below 25%, respectively. No significant differences between the groups were found regarding biometric and volumetric parameters before PVE. In the entire group, after PVE, the mean absolute increase of segments 2 and 3 was 196.0 ± 84.7 cm^3 and the mean relative increase was 82.5 ± 98.8%. The formation of left-right collaterals exhibited a negative correlation to successful hypertrophy ($p=0.004$) as well as low plasma total protein ($p=0.019$). A successful embolization of segment IV seemed to favor sufficient hypertrophy but showed only a tendency ($p=0.098$).
Conclusion: Cofactors associated with a favorable outcome regarding hypertrophy were absence of collaterals in the control CT scans and higher plasma total protein. Successful embolization of segment IV might favor higher hypertrophy, but significance was not reached in our cohort.

3105.4

Long-term outcomes of percutaneous transhepatic balloon angioplasty with stent deployment for portal vein stenosis after liver transplantation

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Purpose: To retrospectively evaluate long-term outcomes of percutaneous transhepatic balloon angioplasty and stent placement for portal vein stenosis (PVS) after liver transplantation (LT).
Material and Methods: Between January 2004 and December 2014, of 1494 patients (LDLT: 924, DDLT: 570) who underwent LT, 54 patients (male 43, female 11; mean age 57.7 years) were confirmed to have portal vein stenosis or thrombosis at follow-up CT or ultrasonography. All patents with PV stenosis underwent percutaneous transhepatic interventions, including direct portography with manometry and balloon angioplasty with/without stent placement. Technical success, clinical success, laboratory findings, manometry findings, patency rates, and major complications were evaluated. Follow-up periods after initial balloon angioplasty ranged from 14 days to 110.6 months (mean 38.2 months).

Results: Technical success was achieved in all patients, and clinical success was achieved in 50 of 54 patients (92.6%). Of 50 patients undergoing manometry, 46 patients showed significant improvement of pressure gradient across the stenosis after percutaneous transhepatic balloon angioplasty and stent deployment with changing of mean pressure gradient from 11.2 mmHg to 2.04 mmHg. At 1, 3, 6, and 12 months and the last follow-up after balloon angioplasty with stent deployment, the rates of primary patency were 100%, 98%, 98%, 98%, and 98%, respectively. One major complication subsequent to balloon angioplasty with stent deployment was noted: portal vein thrombosis with hepatic infarction.
Conclusion: Percutaneous transhepatic balloon angioplasty and stent placement is a safe and effective treatment with long-term patency for PVS after LT.

3105.5

Efficacy and patency of primary hepatic vein stenting for hepatic venous outflow obstruction after living donor liver transplantation

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Purpose: To retrospectively evaluate the efficacy and patency of primary hepatic vein stenting for hepatic venous outflow obstruction (HVOO) after living donor liver transplantation (LDLT).
Material and Methods: Percutaneous interventions, including hepatic vein stent placement with or without balloon angioplasty, were performed in 21 patients who had undergone LDLT and had HVOO confirmed through hepatic venography or manometry, including the patients who have structural abnormality. Two stents were inserted in four patients; therefore, the number of treated anastomoses was 25. Technical success, patency rates, and pressure gradients between the hepatic veins and the right atrium were evaluated in 19 patients each.
Results: Technical success was achieved in 25 of 25 vessels (100%). The mean interval between operation and stenting was 43 days. After the procedure, the mean follow-up period was 530 days. The mean pressure gradient decreased from 8.5 mmHg to 2.1 mmHg before and after treatment, respectively ($P < .01$). The patency rates of 25 vessels at 1, 2, and 3 years after stent placement were all 80%. However, middle hepatic vein stenting revealed a low patency rate. Three of seven (43%) stents in the middle hepatic vein were occluded during follow-up.
Conclusion: Percutaneous primary hepatic vein stent replacement was an effective treatment for HVOO after LDLT.

3105.6

Transjugular and percutaneous liver biopsy in a liver transplant unit: assessment of practice and financial implications

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Purpose:
1. To describe TJLB and PLB experience in our liver transplant unit.
2. To assess preoperative assessment, case documentation, technical success, complications and histological adequacy and to compare with published standards.
3. To identify potential cost savings.

Material and Methods: Twelve-month retrospective data collection using computerised patient records.
Data analysed using SPSS and relevant statistical tests.
Results: In all, 570 liver biopsies were performed; 22 operators performed 330 transjugular biopsies (TJLB) (median 10, 1-60): hepatologists 90, IRs 76 and IR trainees 164. Of 240 percutaneous biopsies (PLB), 97 were lesional. TJLB and PLB technical success were 96% and 100%, respectively. Technical failures included failure to cannulate hepatic veins (54%), unstable sheath position (30%) and jugular access difficulties (15%). Technical failure was more common in IR trainees ($p=0.02$). 7% of cases had inadequate coagulation assessment prior to biopsy. Hepatic venogram was documented in 93%. Histological adequacy for diagnosis was achieved in 98% of TJLB and 98% of PLBs (4x19G and 1x18G cores). IR trainee samples were less likely to be adequate ($p=0.002$). Transjugular complication rates 2.7% major and 1.2% minor. There was no significant difference in complication rates between PLB and TJLB. Mortality 0.18%, haemorrhage 1% and post-biopsy embolisation 0.3%. 130 TJLBs had no clear indication, performing these as PLB would bring a consumables cost saving of £26000/annum.
Conclusion: TJLB and PLB experience in our unit is significant with exceptional histological adequacy and low complication rates. TJLB complication rates are similar to PLB. PLB is less expensive and should be considered when there is no clear TJLB indication.

Free Paper Session
Kidney and ureter

3106.1

Primary aldosteronism: what is the value of adrenal venous sampling when the right adrenal vein samplings are missing?

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Purpose: Bilateral adrenal vein samplings (AVS) are essential to determine aldosterone hypersecretion lateralization (AHL) in primary aldosteronism before adrenalectomy. However, it is often difficult to position the catheter's tip into the right adrenal vein. The objective of this study is to assess the accuracy of AVS to detect AHL when the right adrenal vein sampling is missing.
Material and Methods: All consecutive AVS from November 1990 to December 2014 were included. Non selective AVS, repeated AVS, and AVS with missing data were excluded. Cortisol and aldosterone levels were measured from the adrenal veins and the left iliac vein before (basal) and after intravenous cosyntropin injection. Reference standard for AHL was a basal adrenal vein aldosterone/cortisol ratio (A/C) >4 the opposite side. A multinomial regression model was built to predict AHL (right, left, or no lateralization) using only the left adrenal and peripheral veins basal cortisol and aldosterone concentration. AHL detection accuracy was assessed with receiver operating characteristic (ROC) curves.
Results: AVS of 171/186 (91.9%) patients (60 women, 126 men; mean age 53.3 years) met the inclusion/exclusion criteria. AHL was found in 106 (62%) patients. Areas under the ROC curves for right and left AHL detection were 0.91 (95%CI; 0.86-0.95) and 0.92 (95%CI; 0.88-0.960), respectively. With a specificity of 95%, sensitivities to detect right and left AHL were respectively 52.7% (95%CI; 38.9%-66.1%) and

52.9% (95%CI; 38.6%-66.8%), with no false positive showing contralateral AHL.
Conclusion: Even without right adrenal vein samplings, AVS can still determine AHL in the majority of patients.

3106.2

Lowering iodinated contrast concentration in infrainguinal endovascular interventions: a three-armed randomized controlled non-inferiority trial

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Purpose: To determine the influence of iodinated contrast concentration on the confidence of interventional radiologists in diagnosing and treating lesions during endovascular intervention in patients with symptomatic peripheral arterial disease (PAD).
Material and Methods: Institutional ethics committee approval and written informed consent was obtained. We did a randomized controlled non-inferiority trial in 60 patients (mean age, 71 years; 38 men) in whom endovascular intervention was performed with iodinated contrast concentration of 300, 240, or 140 mgI/mL. Standardized lower limb acquisitions were obtained. Primary outcome was confidence (score 0-100%) of interventional radiologists in diagnosing and treating arterial lesions. Secondary outcomes were procedural iodine load, image quality of standardized angiographies, and interobserver agreement in assessing arterial lesions.
Results: Median confidence scores in diagnosing arterial lesions were 100% (range 81-100%) for the 300-group, 100% (range 82-100%) for the 240-group, and 100% (range 91-100%) for the 140-group (both p=1.00 compared to the 300-group). Median confidence score for treating arterial lesions was 100% (range 78-100%) for the 300-group. The median scores in the 240- and 140-groups, 100% (range 79-100%, p=0.40) and 100% (range 63-100%, p=0.25), respectively, were not significantly lower compared to the 300-group. Secondary outcomes showed adequate image quality and excellent interobserver agreement (κ>0.8) in diagnosing arterial lesions for all groups. Procedural iodine load was lower in the 240- (24.3±7.6g, p=0.022) and 140-groups (17.8±5.6g, p<0.001) compared to the 300-group (29.7±6.3g).
Conclusion: Using iodine contrast of 140 mgI/mL for diagnosis and interventions in PAD patients reduces administered iodine load significantly without compromising image quality. Future use of lower iodine dose is recommended.

3106.3

Remote ischemic preconditioning to reduce contrast-induced nephropathy: a randomized controlled trial

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Purpose: Despite the increasing use of pre- and posthydration protocols and low-osmolar iodine-containing contrast media, the incidence of contrast-induced nephropathy (CIN) is still significant. There is evidence that contrast media cause ischemia reperfusion injury of the renal medulla. Remote ischemic preconditioning (RIPC) is a noninvasive, safe, and low-cost method to reduce ischemia–reperfusion injury. The aim of this study is to investigate whether RIPC, as an adjunct to standard preventive measures, reduces CI-AKI.
Material and Methods: The RIPCIN study is a multicenter, single-blinded, RCT in which 76 patients at risk of CIN received standard hydration combined with RIPC or hydration with sham preconditioning. RIPC was applied by four cycles of 5-min ischemia and 5-min reperfusion of the forearm. The primary outcome measure was the change in serum creatinine from baseline to 48 to 72 hours after contrast administration.
Results: With regard to the primary endpoint, no significant effect of RIPC was found. CIN occurred in 4 patients (2 sham and 2 RIPC). A pre-defined subgroup analysis of patients with a Mehran risk score ≥ 11, showed a significantly reduced change in serum creatinine from baseline to 48 to 72 hours in patients allocated to the RIPC group (Δcreatinine -3.3±9.8 µmol/L) as compared to the sham group (Δcreatinine +17.8±20.1 µmol/L).
Conclusion: RIPC, as an adjunct to standard preventive measures, does not improve serum creatinine levels after contrast administration in patients at risk of CIN. Our data indicate that RIPC might have beneficial effects in patients with a high or very high risk of CIN (Mehran risk score ≥ 11).

3106.4

The use of covered self-expanding metallic stents in recurrent ureteric stenosis in renal transplant patients: initial experience

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Purpose: Urological complications following transplantation occur in up to 13 % of patients. Ureteral stenosis, particularly at the ureterovesical junction, is the most frequent (0.5–10%). Treatment options include percutaneous nephrostomy, antegrade balloon dilatation and antegrade double J(DJ) stenting. This series sought to evaluate the efficacy of covered self-expanding metal stents in the treatment of recurrent transplant ureteral strictures.
Material and Methods: Between 2013 and 2014, six transplant kidney patients presenting with ureteral stricture were treated with covered metal stents. Patients were initially treated by percutaneous nephrostomy, followed by ureteroplasty and DJ insertion. After 4 weeks, if renal function and degree of collecting system dilatation were stable, the DJ was removed cystoscopically. If obstruction recurred, a new DJ was inserted. Strictures still present after two ureteroplasties and DJ removals were treated with covered self-expanding metal stents (Niti-S, TaeWoong Medical).
Results: The procedures were technically successful and were performed as an out-patient, without hospital admission. All patients remained well without migration, re-intervention or recurrence at a mean follow-up interval of 12 months (1-22). Renal function of the treated patients remained stable or improved (eGFR/creatinine) from baseline after nephrostomy insertion to the latest follow-up. The degree of renal collecting system prominence also remained stable.
Conclusion: Covered self-expanding metal stent insertion is an effective treatment for recurrent/refractory strictures in transplant ureters. Up to now the accepted treatment was surgery, which is technically challenging and has a variable organ loss rate. Added advantages of this technique include reduced rates of re-intervention, option to remove the stent and patients being 'tube free', improving quality of life.

3106.5

Retrospective review of outcomes in 491 consecutive patients undergoing percutaneous nephrolithotomy for staghorn calculi

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Purpose: In all, 491 consecutive percutaneous nephrolithotomies for staghorn calculi were retrospectively reviewed for number and type of complications.
Material and Methods: In all, 491 adult patients underwent percutaneous nephrolithotomy (PCNL) for staghorn calculi from January 2006 to August 2014. The posterosuperior calyx above rib 12 but below rib 11 was chosen in the majority of cases. Each patient had a ureteral catheter in place through which a double contrast pelvocalycealagram was done. The targeted calyx was accessed in a coaxial manner using a 18-gauge Cook Needle and Accustick System set. Once access to the bladder was achieved, a second Amplatz wire was inserted as a safety wire. Each patient underwent tract dilatation with 30-French working sheath insertion. Combination rigid and flexible nephroscopy in conjunction with ultrasonic and laser lithotripsy were used. At completion of the procedure, either a 24-French or 16-French re-entry Malecot catheter was placed.
Results: The overall major complication rate was 7.53%. Complications included hydrothorax requiring chest tube in 12 patients (2.44%), pneumothorax in 11 patients requiring chest tube (2.24%), bleeding requiring transfusion in 9 patients (1.83%), bleeding requiring arterial embolization of a renal artery pseudoaneurysm in 2 patients (0.4%), pulmonary emboli in 1 patient (0.2%), cecal volvulus requiring surgery in 1 (0.2%), and puncture of the gall bladder requiring laparoscopic cholecystectomy in 1 patient (0.2%).
Conclusion: A posterosuperior calyceal approach for PCNL in patients with staghorn calculi is a safe and effective method for stone eradication with acceptable complication rate below that reported in the literature.

3106.6

Safety and efficacy of renal cryoablation for small renal masses: midterm follow-up

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Purpose: The purpose of this study is to report midterm outcomes following percutaneous renal cryoablation.
Material and Methods: An IRB-approved, retrospective review of patients undergoing percutaneous cryoablation for renal tumors from 2006 to 2012 was performed. Patient and tumor characteristics, cryoablation technique, complications, renal function, and pattern of recurrence were evaluated.
Results: In all, 139 ablations were performed on 126 patients. Mean patient age was 67 years (range 36-88). Mean tumor size was 2.3 cm (range 0.8-6.8), treated a median of 2 probes (range 1-6) with a technical success rate of 97.8%. There were 13 major complications (9%), including perinephric hemorrhage (5), hematuria with clot retention (3), acute kidney injury and/or dehydration (2), persistent arrhythmia (1), nerve injury (1), and post-operative pain (1). No renal collecting system injuries were observed. Retrograde pyeloperfusion was used in 4 cases to avoid such injury. There was no significant decline in renal function 3 months after ablation (p=0.86). Among 116 patients with clinical T1 disease, mean follow-up was 32.9 months with 20% of the cohort having follow-up beyond 5 years. Local recurrence was observed in 10 (9%). Delayed, local recurrence was observed in 6 (5%), occurring between 16 and 44 months after ablation despite the appearance of adequate margins. Finally, 1 patient (0.8%) developed distant metastases to the lung 37 months after initial renal cryoablation, and died of disease approximately 2 years later.
Conclusion: Percutaneous cryoablation is a safe and effective option for the management of small renal tumors, with a low complication rate, preservation of renal function, and infrequent local recurrence.

Free Paper Session
Portal vein (TIPS)

3107.1

A real-time three-dimensional ultrasound user interface for TIPS: lessons learned

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Purpose: We present an improved user interface (UI) with real-time three-dimensional ultrasound (3D US) guidance for TIPS as well as an improved testing phantom. The setup design was improved based on the results and feedback from the CIRSE 2013 test. Results will be presented for a planned test in our local hospital, and the setup is also present at CIRSE 2015 for testing.
Material and Methods: An improved UI with real-time 3D US image guidance and a new testing phantom were developed. The design was an iterative process with many test sessions accompanied by interventional radiologists. Their feedback was used during the design iterations. A validation test is planned in our local hospital before CIRSE 2015 in which participants will be asked to perform two intra-hepatic punctures in the phantom using a Rösch-Uchida Transjugular Liver Access Set (Cook Medical). The total number of punctures per attempt will be measured as well as the needed time. A questionnaire and interview will be performed afterwards. This test setup will also be present at CIRSE 2015, where we hope to find many more participants.
Results: We present the insights gained from our trans-disciplinary design process. Furthermore, we will present the results from our validation test in our local hospital.
Conclusion: Our UI combined with testing phantom are a result of a trans-disciplinary design process in which many insights were gained. These could be beneficiary for other similar research groups as well. Results from our planned validation test will hopefully substantiate our design strategy.

3107.2

Transjugular intrahepatic portosystemic shunt (TIPS) creation in patients with partial portal vein thrombosis is well tolerated: a retrospective, multi-center analysis

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Purpose: Non-occlusive portal vein thrombosis (PVT) develops in patients with cirrhosis due to impaired portal blood flow. Shunting (TIPS) has been proposed as a treatment for PVT due to its ability to restore portal blood flow. In this study, we analyzed outcomes in patients undergoing TIPS, stratified by presence of PVT and MELD score.
Material and Methods: A multi-center, retrospective chart review was conducted of 269 patients, consisting of 68 patients with non-occlusive PVT and 201 patients without PVT, who received TIPS from 2005 to 2014. The primary endpoint was 90-day survival. Secondary outcomes included survival at 30 days, change in MELD score, post-TIPS hospitalizations for overt hepatic encephalopathy (HE), and variceal bleeding or persistent ascites.
Results: Baseline MELD scores were 14.8 ± 0.7 and 15.5 ± 0.4 among groups with and without non-occlusive PVT, respectively (p=0.38). Patients with PVT had significantly improved 90-day survival compared to those without PVT (89.7% vs. 77.1%, p=0.02). Among patients with MELD scores ≥18, there was an observed trend towards improved 90-day survival for the PVT group compared to the non-PVT group (84.6% vs. 57.4%, p=0.06), though this was accompanied by a higher incidence of hepatic encephalopathy (53.8% vs. 23.5%, p=0.03). Similar reduction in ascites and variceal bleeding was noted in both groups.
Conclusion: Survival in patients with non-occlusive PVT was greater than in those without PVT. We speculate that the improved ability of patients with PVT to tolerate TIPS is due to a decreased dependence of the liver on portal blood circulation in these patients.

3107.3

Single-centre experience of extending indications for percutaneous intra-portal islet auto-transplantation (PIPIAT) after pancreatic surgery to prevent type 1 diabetes (T1D): feasibility, technical aspects, complications, and clinical outcome

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Purpose: Percutaneous islet allo-transplantation, needing immunosuppression, is a traditional less-invasive alternative to surgical pancreas transplantation for brittle type 1 diabetes, while PIPIAT, not needing immunosuppression, is usually performed after pancreatic surgery for chronic pancreatitis to prevent diabetes. Our aim was to assess feasibility, technical aspects, complications, and clinical outcome of PIPIAT following pancreatic surgery, not only for chronic pancreatitis but also for benign and malignant nodules.
Material and Methods: From 2008 to 2012, 41 patients were enrolled for PIPIAT 24/48 hours after pancreatic surgery (total pancreatectomy, distal pancreatectomy for benign/borderline neoplasms of pancreatic body-neck). PIPIAT was performed using a combined US and fluoroscopy-guided technique (4-F catheter): portography PIPIAT feasibility, complications, median follow-up, metabolic (insulin independence rate, graft function based on β score and marker of islet function) and oncologic (malignant and metastatic diseases) outcomes were recorded.
Results: PIPIAT was not performed in 7/41 patients (4 due to inadequate islet mass, 2 due to hemodynamic instability and 1 due to islet culture contamination), while it was successfully performed in 34 patients. PIPIAT-related complications occurred in 8 patients (23.5%): 3 bleedings (2 requiring transfusions), 1 partial portal thrombosis, and 1 sepsis. Median follow-up duration was 546 days. Insulin independence was achieved in 15/34 patients (44%), partial graft function in 16/34 patients (47%), and no function in 3/34 patients (6%). Seventeen patients had malignancy; none of them developed liver metastases during follow-up.
Conclusion: PIPIAT, performed under a combined US and fluoroscopy guidance and not requiring immunosuppression, is feasible, with a relatively low complication rate and a better metabolic outcome than allo-transplantation.

3107.4

TIPS in uncontrolled variceal haemorrhage: place for a parallel approach?

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Purpose: This review highlights another option for treatment of variceal haemorrhage in patients who have ongoing bleeding despite endoscopic therapy and TIPS. When patients rebleed despite TIPS, insertion of another stent in parallel to the original to reduce the PPG further can be a successful intervention in specialist centres.
Material and Methods:
- Assess the efficacy of parallel TIPS in a large UK tertiary referral liver centre
- Retrospective study
- 1st TIPS (index) and parallel TIPS were performed over a 19-year period
- Index TIPS was done as 'rescue' therapy for refractory variceal bleed or for ascites
- A total of 550 TIPS were done in our centre in 19 years

Results:
- Mean PPG pre-TIPS was 16.6 (±7.71) mmHg.
- Mean PPG post-TIPS was 10.8 (±7.35) mmHg.
- Median time between index TIPS and parallel TIPS insertion was 72 days.
- Clinical indications:
- Eight variceal re-bleeds & 2 ascites re-accumulation.
- Five index TIPS were blocked/narrowed on imaging.
- 67% had covered stent as the parallel TIPS.
- Median follow-up was 30 months (range 0.5-120) post-parallel TIPS.
- 1 patient had transient encephalopathy.
- 10 patients (83%) had a resolution in symptoms.
- Secondary patency was 82% with a median number of interventions of 1.5.
- 92% patients were alive at 1 month with 86% 1-year survival.
- Two patients were transplanted during follow-up.

Conclusion:
- Parallel TIPS is a safe and effective method to treat TIPS insufficiency.
- The majority of patients had a good haemodynamic result and also resolution of symptoms.
- Role in reducing portal pressure should be considered if any clinical or haemodynamic evidence of primary TIPS shunt failure unresponsive to dilatation.
- Small, select group of patients.

3107.5

Passive expansion of submaximally dilated transjugular intrahepatic portosystemic shunts and assessment of clinical outcomes

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Purpose: To assess for passive expansion of submaximally dilated transjugular intrahepatic portosystemic shunts (TIPS) and compare clinical outcomes with maximally dilated TIPS.
Material and Methods: PTFE-covered TIPS were created in 313 patients from July 2002 to December 2013. In all, 230 patients had TIPS maximally dilated to 10 mm, while 43 patients had 10-mm TIPS submaximally dilated to 8 mm. Group characteristics (age, gender, MELD score, post-TIPS portosystemic gradient) and clinical outcomes (primary patency, assisted primary patency, clinical success, TIPS reduction for hepatic encephalopathy) for these patient populations were compared. Fourteen patients with submaximally dilated TIPS (VIATORR®) underwent follow-up computed tomography (CT) imaging, which was used to evaluate for passive expansion with 3D imaging software (TeraRecon).
Results: The two groups demonstrated no statistically significant difference in group characteristics or clinical outcomes. For the 14 patients with CT imaging, the median imaging follow-up was 373 days. There was an increase in median TIPS diameter, median percent diameter change, median area, and median percent area change in patients with CT follow-up greater than 6 months after TIPS placement compared to follow-up within 6 months (8.45 mm and 8.05 mm, 5.58% and 0.67%, 56.04 mm^2 and 50.94 mm^2, 11.48% and 1.34%, respectively; $P < 0.01$).
Conclusion: While there was passive expansion of submaximally dilated TIPS after 6 months, there was no difference in clinical outcomes compared to maximally dilated TIPS. Submaximal dilation may be an acceptable method to prevent complications related to overshunting in select patients, although our study found no difference in hepatic encephalopathy requiring TIPS reduction.

3107.6

Patient radiation dose reduction during transjugular intrahepatic portosystemic shunt (TIPS) implantation using Philips Allura Clarity

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Purpose: To compare the patient radiation doses during transjugular intrahepatic portosystemic shunt (TIPS) implantation performed with Philips Allura Xper versus Philips Allura Clarity imaging acquisition and processing platform.
Material and Methods: In a single-center-study cumulative air kerma (AK), cumulative dose area (DAP), total fluoroscopy time, number of exposure frames, age and BMI were retrospectively collected from 190 patients during TIPS implantation. All procedures were performed on the identical Philips Allura FD20 system by a matched group of operators. 163 procedures were performed using Philips Allura Xper, 27 were performed after the Philips Allura Clarity upgrade. Mean values were compared using a two-tailed t-test.
Results: After the Philips Allura Clarity upgrade a 53% reduction in mean DAP (324.1 $Gycm^2$ vs. 153.2 $Gycm^2$, p=0.005) and a 51% reduction in mean AK (1.3 Gy vs. 0.7 Gy, p=0.010) could be observed compared to procedures performed under Philips Allura Xper. The number of exposure frames was significantly reduced by 33% in the Allura Clarity group (144 vs. 96, p=0.003). Fluoroscopy times were equivalent in the two groups of patients (p=0.680) reflecting similar degree of intervention-complexity at matched operator's experience. Both patient groups showed no significant difference regarding BMI (p=0.125) or age (p=0.513).
Conclusion: The Philips Allura Clarity imaging acquisition and processing platform significantly reduces patient radiation dose compared to Philips Allura Xper undergoing TIPS implantation at equal procedure duration without compromising image quality.

Free Paper Session Miscellaneous

3108.1

Comparison of rate of secondary procedures for "push"- versus "pull"-type gastrostomy tubes

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Purpose: Interventional radiologists place gastrostomy tubes via two primary methods: the "push" method and the "pull" method. In this study, we investigated whether one method was associated with a higher need for secondary procedures for replacement after accidental dislodgement or clogging.
Material and Methods: Forty-eight consecutive gastrostomy tubes placed at a single institution were reviewed. Of these, 33 were placed via the push method and 15 were placed via the pull method. Follow-up time (placement until death, removal, or last follow-up) was determined. The number of repeat IR procedures and their indications during this time were determined. All transgastric jejunal feeding tubes whether placed primarily or with subsequent conversion were eliminated from the analysis to avoid confounding variables.
Results: For the 33 push-type tubes, there was a total follow-up time of 570 weeks, with 33 secondary procedures needed for these tubes during this time. For the 15 pull-type tubes, there was a total follow-up time of 423 weeks, with 5 total secondary procedures necessary. Per time period of follow-up, push-type gastrostomy tubes necessitated 4.8 times more secondary procedures than did pull-type tubes ($p<0.05$).
Conclusion: Compared with push-type tubes, pull-type gastrostomy tubes are associated with a lower rate of dislodgement and clogging and necessitate fewer follow-up IR procedures such as replacement or exchange. These tubes are a more durable method of enteral feeding and are our preferred method for gastrostomy tube placement.

3108.2

Radiological removal of "buried bumper" flanged gastrostomy tubes

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Purpose: Flanged gastrostomy catheters can become buried in the gastric wall in spite of good nursing, and removal of a "buried bumper" may be difficult with associated morbidity and mortality. We review our experience of treatment in interventional radiology, describing our technique and specific problems and complications.
Material and Methods: In our centre, gastrostomy tubes are inserted radiologically or endoscopically. Cases were collected prospectively from 01/11/2003 to 01/02/2015 by the senior author. Follow-up was obtained by review of electronic hospital notes.

Results: Nineteen cases were identified. Average age of the group was 70.7 years (median 79.4, range 22.3-97.3) at the time of procedure, with 13 males and 6 females. All patients required gastrostomy for long-term neurological conditions. In 17/19 cases, the tubes could be removed after placement of an oro-cutaneous wire through the catheter by a combination of balloon dilatation from above after inflation in the gastrostomy tube and pushing from below with a large-bore dilator. Of the two failures, one succumbed at 11 days post-procedure from infection and one required surgical removal. Time to bury varied from 283 days to 1805 days, with an average of 912 days. Three cases buried a second time.
Conclusion: Impaction of flanged catheters is a relatively unusual clinical problem. In our unit, previous attempts at removal endoscopically have been unsuccessful. Surgical removal in these high-risk cases has been associated with increased morbidity. Radiological removal has a high rate of success in our practice. We discuss relevant clinical and technical issues.

3108.3

Severe gastrointestinal bleeding: a national confidential enquiry into the quality of care in patients requiring blood transfusion of 4 or more units

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Purpose: A study of the quality of clinical care and organisation of services for patients with severe gastrointestinal bleeding (GIB) from admission to discharge or death.
Material and Methods: This was an NCEPOD (National Confidential Enquiry into Patient Outcome and Death) Study. Complying with Confidential Enquiries is a statutory requirement for all UK doctors and hospitals. NCEPOD is funded by the NHS and is part of NHS England's Health Quality Improvement Programme (HQIP).
All acute hospital trusts in England, Wales and Northern Ireland submitted an organisational questionnaire which included details of gastroenterology, interventional radiology (IR) and surgical on-call rotas and competencies and local guidelines for upper and lower GIB. Where any aspect of a hospital's service were not comprehensive details of the alternative arrangements were sought. Further information on equipment, facilities, high-cost equipment replacement planning and learning from adverse outcomes was provided.
A list of all patients coded for a GIB over 4 months in early 2013 were filtered by the local NCEPOD reporter by those receiving a blood transfusion of 4 or more units. New admissions and GIB in established in-patients were included. Cases for review were randomly selected with a maximum of 5 cases per hospital. A clinical questionnaire was completed by the consultant primarily responsible for the patient's care along with a copy of the case notes.
In all, 618 clinical questionnaires were received.
Case notes were reviewed by a panel of gastroenterologists, IRs, surgeons, general physicians and anaesthetists using a detailed structured questionnaire which assessed the quality of care.
Results: Report published 3rd July, 2015.

3108.4

World's first interventional technique to restore vein valve function

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Purpose: Today's treatments of epifascial vein insufficiency are destructive, using surgical extraction or endovenous closure. A new vein-preserving modality is based on the idea of shaping vein valve zones by extraluminal injection of crosslinked hyaluronan.
Material and Methods: In a pilot study, 23 patients (15 f, 8 m; 38-67y.) with proximal valve incompetence of the GSV (diameter 7.0-11.5 mm, mean 8.6) were selected to receive a diameter reduction by circumferential injection of a NASHA gel, 2% solution, crosslink degree: 2%. Injections were performed with a safety system consisting of a relocatable sharp cannula and a flexible blunt outer metal catheter (IntraShape®) under continuous ultrasound monitoring until absence of reflux. Clinical and ultrasound examinations were performed after 2, 12, 26, and 52 weeks.
Results: An orthograde flow could be established in 22/23 cases (95.6%), using a gel volume of 12-35 ml (mean: 19.4 ml). After 12 weeks, orthograde flow was present in 19/22 cases (86.4%); after 26 weeks, in 18/22 cases (81.8%); and after 52 weeks, in 15/22 cases (68.2%). All cases with remaining reflux (n=7) received a second gel injection of 4-7 ml, with hemodynamic success up to week 52 or beyond. There were no adverse reactions or complications.
Conclusion: External valvuloplasty by perivenous hyaluronan injection is feasible, safe, and effective, providing a genuine vein-preserving modality. Placement technique and gel durability and will have to be improved. In future, even treatments of (so far incurable) deep vein insufficiency may be an option.

3108.5

Hysterographic IR IUCD retrieval ± reinsertion procedure is an effective alternative outpatient procedure for women whose IUCD strings are retracted

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Purpose: To develop an IR procedure to retrieve lost IUCDs whose strings have retracted conferring all the advantages of minimally invasive IR practice. To develop an IR method to obviate the blind push element of conventional IUCD insertion when reinserting.
Material and Methods: Twenty-one women with IUCD issues from 2011 to 2015 reluctant to undergo GA formed the study group. IUCD string retraction and inability to retrieve was the primary referral issue. IR principles and techniques were employed to address this clinical need on an outpatient basis as per patient preference. IR IUCD retrieval reinsertion methodology evolved and was refined as a process over this period.
Results: Twenty-one patients were referred from primary care following failed attempted IUCD retrieval insertion, specifically for the facility of IR review as outpatients. Fluoroscopic HSG-guided retrieval was performed in 16. Fourteen required Mirena reinsertion. Two had tight cervical stenosis requiring over-the-wire dilatation. When strings retract, they appear to retract completely into the endometrial cavity and fluoroscopic-guided trial forceps engagement along the cervical canal is not effective. Snare retrieval is also ineffective. The refined retrieval method is the use of an 8-Fr guiding catheter and rat tooth forceps grasper. Insertion control is optimally achieved by use of a 14-Fr peel-away sheath after over-the-wire serial cervical dilatation.
Conclusion: IR techniques are optimally placed for patients whose IUCD strings have retracted. IUCD retrieval and reinsertion is quick and reliable and performed on an outpatient basis. IR is a very feasible alternative to primary referrers when IUCD issues beyond their capacity arise.

3108.6

Percutaneous long bone cementoplasty for palliation of malignant lesions of the limbs: a systematic review

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Purpose: Percutaneous cementoplasty (PC) is rarely applied to long bone tumours since cement is not considered to be sufficiently resistant to torsional forces. We reviewed the literature to understand the effects of percutaneous long bone cementoplasty (PLBC) in terms of analgesia, limb function and complications.
Material and Methods: This study followed the Cochrane's guidelines for Systematic Reviews of Interventions. Inclusion criteria were as follows: (1) prospective/retrospective studies concerning PC; (2) cohort including at least 10 patients; (3) at least 1 patient in the cohort undergoing PLBC; (5) published in English; (6) results not published by the same author more than once.
Results: A total of 1598 articles were screened, and 13 matched the inclusion criteria covering 196 PLBC patients. Pain improvement was high in 68.2% patients (σ=0.2) and mild in 27.4% (σ=0.2). Functional improvement was high in 71.9% patients (σ=0.1) and mild in 6% (σ=0.1).
Use of PLBC correlated with pain reduction ($P < 0.001$). Secondary fractures occurred in 16 cases (8%, σ=2.5); other complications occurred in 2% of cases. Percutaneous stabilisation (PS) was coupled with PLBC in 17% of cases without any subsequent fracture. PS was not associated with the absence of secondary fracture (P=0.08).
Conclusion: PLBC is safe, offering good pain relief and impaired limb function recovery. Secondary fractures are uncommon, and PS may reduce their occurrence. However, no evidence is currently available to support PS plus PLBC as compared with PLBC alone.

Lisbon, Portugal
September 26-30

CIRSE 2015

PART 3

Abstracts of
Posters
sorted by presentation numbers

Cardiovascular and Interventional Radiological Society of Europe

CIRSE

Aortic intervention

P-1

Standardized approach of aortic dissection endovascular treatment based on a new aortic dissection classification

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Purpose: Endovascular treatment of aortic dissection consists of implanting thoracic stent grafts to cover the proximal entry tear and redirect flow into the true lumen. A large range of adjunctive procedures are needed in more than 50% of cases in order to obtain complete exclusion of the thoracic false lumen. Unfortunately, there are numerous mechanisms of failure and the therapeutic strategies are not standardized. Therefore, with this study, we propose a standardized approach of endovascular treatment based on a new aortic dissection classification.
Material and Methods: Between 1998 and 2014, 271 patients with thoracic dissections underwent endovascular treatment. Different techniques were used to achieve complete false lumen thrombosis on 45 patients (11 females) (aged 29–88 years). We categorized each case based on embolization technique and a new aortic dissection classification.
Results: Thirty-two cases were embolized with coils or plugs, and in 18 cases, covered stents were implanted on supra-aortic or visceral branches. Thrombosis of the false lumen was obtained in 80% of cases (36/45), with no early or late mortality rate in any of the followed-up patients, except one case of aortic perforation at 12 months after a thoracic plug procedure.
Conclusion: False lumen obstruction by various techniques is feasible. However, it requires highly trained and experienced operators. A new aortic dissection classification could help operators' therapeutic choices and facilitate comparison of different strategies in further publications.

P-2

Thoracic abdominal endovascular aneurysm repair (TEVAR) with chimney grafts, hybrid techniques, and multilayer stenting in the management of thoracoabdominal aortic pathologies: evolving endovascular solutions

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Purpose: We aimed to assess minimally invasive and adaptive surgical techniques for thoracoabdominal aortic (TAA) disease.
Material and Methods: From October 2008 to October 2014, 46 patients presented with TAA pathology. Sixty-one percent (28) of patients were males, and 80% were ASA Grade III or higher, with a mean age of 66.4 years. Two were acute complicated type B dissection, three were traumatic aortic transection, and two were ruptured.
Five patients underwent hybrid visceral debranching followed by thoracic endovascular aortic repair (TEVAR). Twenty patients underwent chimney or snorkel stent placement in the subclavian or renal vessels. Twelve patients underwent multilayered stenting.
Results: Thirty-day mortality was 10.8%, and 30-day morbidity was 6.25%. No patient developed rupture, paraplegia, or stroke. Five-year aneurysm-related survival was 89.1% (95% CI=75.6%–95.9%). All-cause survival was 64% (95% CI=48.5%–77.2%) at 1 year and 58.1% (96% CI=42.8%–72.2%) at 5 years. No aneurysm expansion was observed. Two patients required reintervention for graft migration.
Conclusion: Data presented demonstrates that minimally invasive techniques for TAA pathologies are safe, prudent, and viable for the nonelective treatment of thoracic aortic pathologies.

P-3

Risk factors for stent graft-induced new entry (SINE) tear after thoracic endovascular aortic repair (TEVAR) for Stanford type B aortic dissection

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Purpose: To investigate risk factors of stent graft-induced new entry (SINE) tear after TEVAR.
Material and Methods: From July 2001 to June 2013, 79 patients who underwent TEVAR for Stanford type B aortic dissection were retrospectively analyzed. Seventeen patients underwent TEVAR in 2 weeks (acute) after the diagnosis of aortic dissection, and the other 62 patients underwent TEVAR after 2 weeks (chronic).
Factors of SINE development after TEVAR were compared in terms of chronicity, taper ratio of true lumen of aortic dissection in which longitudinal and short diameter, circumferential length, and area were analysed.
Results: SINE occurred in 21 patients (26.6%), and 10 patients (12.7%) required reintervention with graft replacement surgery or stent graft. SINE occurred more frequently in cases of chronic dissection rather than in cases of acute dissection (32.3% vs. 5.9%, respectively; p=0.032). Longitudinal diameter of the true lumen was significantly greater in SINE group than that in non-SINE group (p<0.05).
Conclusion: SINE was significantly more frequent in chronic aortic dissection than that in acute dissection. Longitudinal diameter of the true lumen of aortic dissection was signficantly greater in SINE group.

P-4

Intramural hematoma and penetrating ulcers: treatment indications and timing

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Learning Objectives: To describe treatment (medical, endovascular, and surgical) indication and timing in patients with intramural hematoma (IMH) alone and associated with penetrating ulcers (PAU).
Background: Acute thoracic aortic syndrome contributes significantly to the high overall mortality of cardiovascular disease. Clinical features of IMH may be very similar to those of classic dissection, and patients cannot be reliably distinguished by clinical presentation alone.
IMH may involve just the ascending thoracic to entire thoracic aorta (similar to classic aortic dissection). So far, the natural history of IMH is not fully understood.
Patients may, however, show spontaneous reabsorption of IMH to evolution of complications such as PAU formation with possible progression to rupture. There is currently increasing evidence that the two entities may not be distinct diseases but that there may be considerable overlap in their pathophysiology.
Clinical Findings/Procedure: The aim of this poster is to illustrate a) IMH classification, b) association of IMH and PAU, and c) general

principles of the management of aortic IMH, with emphasis on endovascular therapy in complicated IMH.
Conclusion: Clinical and imaging grading of IMH is essential for accurate and efficacious medical, endovascular, or surgical treatment. Endovascular therapy represents a feasible therapeutic option in complicated IMH, especially for elderly patients with comorbidities.

P-5

The art of catheter insertion and manipulation in the aorta

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Learning Objectives: It is absolutely paramount that a competent interventionalist be able to safely insert and manipulate a catheter within the aorta and its branches without complications, which can be catastrophic. We aim to provide some tips and tricks on how to safely insert and manipulate various catheter configurations to aid in catheterising target vessels.
Background: Given the large variety of catheter configurations, their size and design, it can often become a game of trial and error for an inexperienced practitioner to establish the art of choosing and forming the appropriate catheter for the target vessel.
Catheter details, such as size, shape, materials used, diameter, length and stiffness, all play a vital role in the procedural success.
Clinical Findings/Procedure: Most technical failures and complications are due to lack of experience in or knowledge of correct catheter selection and its safe manipulation. For example, avoiding the formation of reversed angled catheters in a diseased aortic arch, which risks devastating complications such as stroke.
Cautious pre-interventional imaging is paramount in identifying the anatomical challenges, potential difficulties in catheterising the target vessels and predicting technical limitations in the entire pathway, from the puncture site to the desired destination.
Conclusion: This poster will aim to provide guidance on how to insert and manipulate the commonly used catheters within the abdominal aorta, whilst avoiding frequently encountered complications due to poor catheter technique.

P-6

Hand arteriography and interventional radiology: the forgotten procedure revisited

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Learning Objectives: Numerous vascular diseases affect the upper extremities, particularly the hands. There is an inherent fear or lack of interest of radiologists to acquire information and knowledge about the vascular anatomy and the many vascular diseases affecting the hands. There exist certain myths and misconceptions that the vascular anatomy of the hands is too complicated and difficult to learn and master. Moreover, the hands are one of the most important organs of the body and a catastrophic handicapped life may result from neglected or missed diagnoses of vascular diseases of the hands. Therefore, the vascular anatomy and pathology of entities affecting the hands must be revised.
Background: We have more than four decades of experience in this topic. Therefore, we present the diagnostic and interventional radiologic (IR) management of most vascular diseases of the hands. We review the conventional vascular anatomy, congenital vascular anomalies, traumatic injuries, inflammatory diseases, malignancies, and occlusions. Most IR procedures in the hands such as thrombolysis, vasodilatation, PTA, stenting, and drug infusion are illustrated.
Clinical Findings/Procedure: Complete or partial successful IR procedures prevent serious amputations. No major complications related to these IR procedures have occurred.
Conclusion: Diagnostic and IR procedures in the hands need to be done and are being done with increasing frequency. Therefore, a review of the vascular anatomy and pathology of the hands is in order.

P-7

A tailor-made approach

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Learning Objectives: We provide a pictorial review of infrarenal EVAR where there have been unforeseen challenges or where there has been unusual and rare features that required a non-standard approach for a standard procedure.
Background: Although infrarenal EVAR has become a standard non-complex procedure, there are still cases which present challenges either due to the aortic anatomy and unexpected events during the procedure or due to particular features unique to the case.
Clinical Findings/Procedure: We present a series of cases, each providing unique learning point peculiar to each case.
Through these cases, we demonstrate how each aspect of standard EVAR can pose its own challenges and ways of overcoming these.
This series also demonstrates how familiarity with various graft properties allows a tailor-made approach to each case and, in some cases, using two different grafts for various components of the same case.
Conclusion: A tailor-made approach with a good understanding of the various stent grafts enables the treatment of peculiar challenges within what is regarded as a standard procedure.

P-8

The resuscitative balloon occlusion of the aorta (REBOA): experience in a UK major-trauma centre

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Learning Objectives: To understand the key indications, imaging appearances and complications related to the resuscitative balloon occlusion of the aorta (REBOA) in major trauma.
Background: The REBOA is a novel balloon inflation technique, inserted endovascularly and sited in the thoracic or abdominal aorta (zones I or III) to reduce distal haemorrhage. The indication for its use is life-threatening haemorrhage and haemodynamic instability, despite haemostatic resuscitation. Our major-trauma centre recently saw the first pre-hospital REBOA worldwide. We discuss our experience from radiological and interventional perspectives.
Clinical Findings/Procedure: The REBOA is inserted at the trauma scene or on arrival at the Emergency Department. In our institution, the REBOA is subsequently removed in the operating room or in the Interventional Radiology Department. Therefore, the REBOA may be in situ on the initial CT scan. Knowledge of the device, its imaging characteristics and possible sequelae/complications is therefore important.
The REBOA is inserted via the common femoral artery. Its appearance is that of a balloon inflated within the thoracic or infrarenal abdominal aorta, attached to a catheter extending down to the femoral artery. With it inflated, the appearance of distal contrast extravasation and enhancement of viscera may be affected depending on its position, which must be considered.

Considerations for interventional radiology, potentially unknown findings and complications, namely vascular injury and distal embolus, will be discussed based on our experience.
Conclusion: The REBOA is a novel haemorrhage control device in trauma. Whilst undoubtedly lifesaving, knowledge of imaging appearances and possible complications is of utmost importance.

P-9

Double D technique for saccular aortic aneurysm: a solution to challenging anatomy for bifurcated stent-graft placement

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Three patients with saccular AAA having challenging anatomy for bifurcated stent-graft placement were successfully treated with parallel placement of stent-graft legs inside the aortic cuff (the double D technique).

P-10

Hybrid treatment of a type II symptomatic Crawford aneurysm

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A 68-year-old patient presented with a symptomatic type II Crawford aneurysm. We planned a hybrid repair, which included the Vortec technique for the vessels, TEVAR, and a car-sub bypass.

Biliary intervention

P-11

Long-term outcome of percutaneous biliary interventions for biliary anastomotic stricture in pediatric patients after LDLT with Roux-en-Y hepaticojejunostomy

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Purpose: To retrospectively evaluate the long-term outcomes of percutaneous transhepatic biliary drainage (PTBD) followed by balloon dilatation and placement of an internal drainage tube for anastomotic stricture in pediatric patients who underwent living donor liver transplantation with Roux-en-Y hepaticojejunostomy (RYHJ).
Material and Methods: We studied 52 patients (23 boys, 29 girls; median age, 5 years) with anastomotic biliary stricture who were treated with PTBD followed by balloon catheter dilatation and long-term placement of an internal drainage tube. The internal drainage tube was removed upon confirmation of anastomotic stricture alleviation. Median follow-up was 48 months (range 6–150 months). Clinical success, tube independent rate, risk factors of recurrent biliary stricture, and patency rates were evaluated.
Results: Of 52 patients, 39 (75%) had no stricture recurrence. Of 13 patients (25%) with recurrence, 6 were treated again with the same percutaneous biliary interventions and developed no further recurrence. Clinical success was noted in 43 of 52 patients (82.7 %). Drainage tubes were removed from 47 (90.4%) of 52 patients. Multivariate logistic regression analysis indicated that postoperative serum alanine aminotransferase > 50 IU/L was a significant risk factor of recurrent biliary stricture after the initial series of percutaneous biliary interventions ($p < 0.005$). Kaplan–Meier analysis showed that the rates of primary and primary-assisted patency at 1, 3, 5, and 10 years were 75%, 70%, 70%, and 68% and 94%, 92%, 88%, and 88%, respectively.
Conclusion: PTBD followed by balloon dilatation and internal drainage was an effective treatment for anastomotic biliary stricture at RYHJ after pediatric LDLT.

P-12

Differences in percutaneous cholecystostomy outcomes between calculous and acalculous cholecystitis

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Purpose: To compare the outcome of percutaneous cholecystostomy (PC) placement between patients with acute acalculous cholecystitis (AC) and acute calculous cholecystitis (CC).
Material and Methods: A retrospective review of the PCs placed was performed (2005–2014). Patients were categorized as CC or AC cholecystitis based on preprocedural imaging. Medical records were reviewed for technical success, complications, duration of PC placement, and outcome according to the method of PC removal. Differences between groups were compared using chi-square test.
Results: In total, 244 PCs were placed in 116 CC and 128 AC patients. Five complications occurred during placement (AC, 2; CC, 3). The median length of time when PC remained in place was similar (AC, 97 days; CC, 72 days; p=0.33).
Removal during cholecystectomy occurred in 56 CC patients (48%) and 23 AC patients (18%; p<0.001). Two AC patients had their tubes removed during a different surgery. PCs were removed after nonoperative management in 9 CC (8%) and 31 AC (24%, p<0.001) patients. PC remained in place at the time of death in 29 CC patients (25%) and 53 AC patients (41%; p=0.01).
Unintentional PC dislodgement occurred in 6 CC patients and 4 AC patients. One CC patient had PC in place at the time of data collection. Fifteen patients in each group were lost to follow-up.
Conclusion: AC patients are less likely to have PC removed and significantly more likely to die with PC in place compared with CC patients. If an AC patient has PC removed, it is more likely to occur electively after nonoperative management as opposed to cholecystectomy.

P-13

Efficacy of short-term percutaneous cholecystostomy for acute cholecystitis in critically ill patients

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Purpose: The aim of this study was to assess the success rate of percutaneous cholecystostomy (PC) for acute cholecystitis (AC) in high-risk patients when the catheter is left in place for a shorter period.
Material and Methods: We retrospectively analyzed all patients undergoing PC as definitive treatment for moderate-severe AC in our surgical department from 2011 to 2014 in order to establish the temporal length of catheter maintenance and the success rate.
Results: Twenty-five patients were included in the study, with a mean follow-up of 12 months. The mean age was 79±10 years. Patients were mostly ASA III (48%) and IV (44%). Mean estimated P-Possum morbidity and mortality were respectively 70±19% and 18±15%. PC catheter was left in place for a mean of 9±4 days, with a success rate of 100%

(defined as clinical improvement within 48-72 h after insertion of PC). Thirty-day overall mortality was 13% (comparable to 15.4% reported in literature), and 12% of the patients needed further hospital readmission for recurrent biliary disease within 6 months.
Conclusion: In high-risk patients affected by moderate-severe AC, PC results to be an effective procedure to improve the outcome, even if the maintenance of the PC catheter is limited to a short-term period of less than 2 weeks.

P-14

Percutaneous intraductal radiofrequency ablation plus biliary stenting for malignant biliary jaundice

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Purpose: To evaluate the safety and feasibility of percutaneous intraductal radiofrequency ablation (RFA) for the treatment of malignant obstructive jaundice.
Material and Methods: Sixteen patients unable to undergo resection of an obstructive malignant tumor in the biliary tract underwent percutaneous RFA within the ducts of the biliary tract. After RFA, a metal stent was inserted and an external drainage tube applied. Patients were observed closely during and after the procedure.
Results: Intraductal RFA was achieved in all patients successfully, as was insertion of a metal stent and placement of an external drainage tube. Complications such as bleeding and perforation of the biliary tract were not observed. Cholangitis occurred in two cases, both of which were cured by conservative treatment. Prevalence of remission of jaundice in seven days was 75% (12/16). Eight patients died because their tumors were at an advanced stage, but the remaining eight survived. Jaundice recurrence was observed in three patients 3–6 months after the procedure but was resolved with identical interventional treatment. Patency at 1, 3, and 6 months was 100%, 92.5%, and 81.3%, respectively.
Conclusion: As a new type of palliative treatment, percutaneous intraductal RFA is safe and feasible for malignant biliary obstruction. Short-term outcome is acceptable, but randomized controlled trials and prospective studies are needed to ascertain long-term efficacy.

P-15

Percutaneous implantation of iodine-125 seed strips combined with biliary stents for treatment of malignant biliary obstruction: analysis of 26 cases

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Purpose: To investigate the clinical efficacy of percutaneous transhepatic insertion of a biliary stent (PTIBS) combined with the implantation of radioactive seed strips for the treatment of malignant biliary obstruction.
Material and Methods: Twenty-six patients suffering from malignant biliary obstruction were enrolled. Iodine-125 (125I) seeds were placed in a catheter to prepare 125I-seed strips. Percutaneous transhepatic cholangiodrainage was carried out. Then, percutaneous catheterization was undertaken, and a guidewire wa inserted through the catheter until it passed the obstructed biliary segment. The latter was dilated using a balloon catheter and PTIBS was carried out. An 8–10-F drainage catheter was placed in the biliary duct through the stent. Finally, under fluoroscopic guidance, a catheter with a 125I-seed strip was inserted via the drainage catheter into the area to be radiated. The external drainage catheter was wrapped and fixed to the skin or was imbedded under the skin.
Results: PTIBS combined with the implantation of radioactive seeds was accomplished successfully in 25 patients (96%). After treatment, serum levels of bilirubin decreased to normal/near normal in all patients ($p<0.05$). Obvious side effects were not observed.
Conclusion: PTIBS combined with the implantation of radioactive 125I-seed strips is a safe and effective method for the treatment of malignant biliary obstruction.

P-16

Antireflux effect of a novel dual stent system for the palliative treatment of malignant extrahepatic biliary obstructions: prospective and pilot study

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Purpose: To investigate the antireflux effect and clinical efficacy of a novel dual stent system in patients with malignant extrahepatic biliary obstruction.
Material and Methods: This is a prospective, pilot study that enrolled 39 consecutive patients with malignant extrahepatic biliary obstructions from May 2013 to May 2014. All patients were treated with a novel dual stent system (covered stent-in-uncovered stent). To prevent food reflux, the inner covered stent has a long duodenal extension (16 cm or 21 cm in length).
Results: The stents were successfully placed in all 39 patients. Successful internal drainage was achieved in 34 (87.2%) of the 39 patients. In the remaining five patients, their drainage catheters could not be removed due to either recurrent food reflux (n=3) or persistent high-serum bilirubin level without stent dysfunction (n=2). Complications including procedure-related hemobilia (n=1) and acute cholecystitis (n=2) occurred in three (7.7%) patients. Median patient survival time and stent patency time was 83 days (95% confidence interval [CI], 38–128 days) and 69 days (95% CI, 45–93 days), respectively. Five (14.7%) of the 34 patients presented with stent dysfunction due to food reflux (n=2) or sludge incrustation (n=3), and they required repeat intervention. Therefore, the overall rate of stent dysfunction caused by food reflux or sludge incrustation after stenting was 20.5% (8 of 39 patients).
Conclusion: Percutaneous placement of a novel dual stent system is feasible, safe, and effective in achieving internal biliary drainage. The stent system has the potential benefit of reducing duodenobiliary reflux and stent dysfunction with fewer complications.

P-17

Percutaneous endobiliary radiofrequency ablation and metallic stenting in malignant biliary obstructions

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Purpose: Endobiliary radiofrequency ablation (RFA) is a promising palliative treatment of malignant biliary obstruction. Most of the recently published studies of this treatment involved endoscopically applied RFA. We report a retrospective study of patients with percutaneously applied endobiliary RFA and metallic stenting to evaluate clinical feasibility and safety of this technique.
Material and Methods: Intraluminal RFA with a Habib™ Percutaneous HPB catheter was performed in 31 patients. After the RFA procedure metallic stenting was performed in 30 patients. Complications related with procedure, stent patency, laboratory findings, and patient survival were evaluated from the hospital database or via phone call, if needed.
Results: The main pathological diagnosis was pancreatic cancer (n=24) in our patient group. All the interventions were performed successfully. From the postprocedural cholangiograms, an

additional stenting in two patients was decided. Ten patients died in the first 30 days after this procedure without any sign of biliary obstruction. Two patients were lost to follow-up. There were no procedure-related complications. Stent occlusion occurred in two patients after 89 and 181 days. Luminal patency was restored with a repeated percutaneous intraluminal RFA in the first patient.
Conclusion: Percutaneous endobiliary RFA and metallic stenting is a safe and feasible palliation method for unresectable, malignant biliary obstruction. Prospective controlled trials are necessary to prove its superiority over metallic stenting alone.

P-18

Treatment of benign post-surgery biliary strictures with a 3-fold repeated percutaneous balloon dilatation regimen without long-term indwelling catheters

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Purpose: To determine primary and primary-assisted patency rate at 1.5 years of 3-fold repeated percutaneous balloon dilatation in benign biliary strictures without long-term indwelling catheters.
Material and Methods: Patients with benign biliary anastomotic strictures after liver transplantation, resection and biliary surgery (N=59, N=6 respectively N=10 consisting of biliodigestive N=59 and duct-to-duct anastomoses N=16) were prospectively included to receive a 1-week therapy session consisting of 20-minute balloon dilatation on day 1, repeated on days 3 and 5. No indwelling catheters were left in place afterwards. Technical and thirty days clinical success as well as complications were analyzed. Primary and primary-assisted patency rates were determined at 18 months. Patients with a clinical/technical failure or an observation time less than 18 months were excluded from patency rate analysis.
Results: Seventy-five patients underwent 135 dilatation sessions. Forty patients underwent one dilatation session, 19 were treated with two, 10 with three and 6 with more than three dilatation sessions. Technical success was achieved in 130/135 (96%) sessions. We noted 59/135 (43%) minor and 10/135 (7%) major (septic and haemorrhagic shock requiring intervention, death) complications. Eight patients were excluded from patency rate analysis because of clinical/technical failure (N=4) or lost to follow-up (< 18 months, N=4).
At 1.5 years, primary patency rate (N=67) was 42.7% and primary-assisted patency rate (N=67) 66.2%.
Conclusion: In benign biliary strictures, repeated percutaneous dilatation is effective. As long-term indwelling catheters were avoided, patients' comfort was improved.

P-19

First look: feasibility of percutaneous intraductal radiofrequency ablation for malignant biliary strictures

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Purpose: Radiofrequency ablation (RFA) is well established in malignant liver tumour treatment. A percutaneous catheter is available for the intraductal ablation of malignant biliary strictures. We report an initial assessment and technical feasibility during routine percutaneous biliary cholangiography (PTC).
Material and Methods: Patients referred for the PTC of malignant biliary obstruction in a supraregional cancer centre had an additional intraductal RFA with an 8-Fr bipolar catheter (EndoHabib, Carefusion, Sheffield, UK) prior to stent insertion, if strictures were deemed too tight to allow adequate stent expansion or for the obstruction of existing uncovered stents.
Ninety-second ablations at 10 W were performed. For strictures of >1 cm, multiple overlapping burns were applied. All transhepatic tracts were embolised with powdered collagen.
Data collected included length of stricture, number of burns, post-procedure complications, in particular, evidence of sepsis. IRB approval was granted.
Results: Eleven patients had 12 episodes of RFA; median, 2 burns (range, 2–10); median stricture length, 4 cm (2–10 cm); median diameter, 0 mm (0–1 mm). Ablations were technically easy. In one patient, the electrodes sheared off the 8-Fr catheter on withdrawal through an 8-Fr sheath used in error. Five patients had a preprocedure evidence of infection, and 4 became septic despite iv antibiotics. No haemorrhage, perforation or bile leak occurred, but ablations were painful.
Conclusion: Intraductal RFA of biliary strictures is quick and easy, only requiring an additional ablation catheter and a larger sheath, but carries an increased risk of biliary sepsis. Its exact role needs to be determined as the additional cost is approximately €800.

P-20

Long-term (>5 years) clinical and histological follow-up of successful radiological percutaneous treatment of biliary strictures in pediatric liver transplant recipients

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Purpose: The aim of this study was to retrospectively evaluate long-term follow-up (>5 years) of successful percutaneous treatment (PT) of biliary strictures (BS) in children underwent liver transplantation (LT).
Material and Methods: From 1/2004 to 12/2014, 70 pediatric LT recipients underwent PT of BS in our hospital; 35/70 had a follow-up longer than 5 years and represent our study cohort. Mean recipient age at the time of PT was 5 years (range, 8 months-16 years).
Results: In all patients, percutaneous stenting and bilioplasty were successfully performed without major complications. Mean number of balloon dilatations performed was 4 (range, 3-8). Mean duration of catheter placement was 5 months (range, 2-10). In 10/35 patients (28%), two courses of PT were necessary; the mean time to recurrence was 19 months (range, 3-61 months). One patient had repeat LT 91 months after PT for chronic rejection; one patient is with a biliary catheter in place for portal biliopaty secondary to portal cavernoma and is on waiting list for redo LT. Thirty-three patients are symptom-free with respect to BS at a mean follow-up of 95 months (range, 65-131 months). Thirty-two out of 35 patients underwent liver biopsy at a mean follow-up of 5 years (range, 3-8 years) after last PT with evidence of mild cholestasis [N=7 (22%)], moderate/severe cholestasis [N=3 (10%)], chronic rejection [N= 2 (6%)], and no cholestasis [N=20 (62%)].
Conclusion: Clinically and histologically good response can be maintained in a long-term follow-up in more than half of pediatric LT recipients with BS treated with the percutaneous approach.

P-21

Reduced radiation exposure for patients treated with percutaneous biliary drainage

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Purpose: Percutaneous biliary drainage (PTCD) involves repeated follow-up procedures, increasing the cumulative radiation exposure of patients. The purpose of this study was to quantify the radiation exposure reduction of a new C-arm imaging platform for patients being treated with PTCD.
Material and Methods: Hundred consecutive patients [60 males; mean age, 55 years (19–86)] were treated with PTCD either on a new or ON a standard C-arm imaging platform (n=65 vs. 35). The new system includes optimized acquisition parameters and real-time image processing algorithms, such as noise reduction, temporal averaging, and automatic pixel shift. Air kerma (AK), dose-area product (DAP), and acquisition time for digital fluoroscopy (DF) and cholangiograms (XA) were recorded. Because PTCD procedure time varies a lot, DF and XA-DAP were normalized by DF time and XA images, respectively. Statistical analysis was performed using the Wilcoxon rank sum test.
Results: There was no significant difference in median DF time or XA images acquired between the new and old platforms (6.0 vs. 5.3 minutes; 4 images for both; $p<0.001$). The new platform significantly reduced both the cumulative AK and DAP by 77% compared with those reduced by the standard platform (median, 46 mGy and 10.3 Gy·cm^2 vs. 199 mGy and 44.4 Gy·cm^2, respectively; $p<0.001$ for both). Specifically, DAP per DF minute and per XA image decreased by 42% (median, 3.1 vs. 1.8 Gy·cm^2/min; $p<0.001$) and 80% (median, 918.0 vs. 187.5 mGy·cm^2/image; $p<0.001$), respectively.
Conclusion: The new imaging platform significantly reduced radiation exposure for patients being treated with PTCD.

P-22

Safety and effectiveness of percutaneous bilateral side-by-side biliary covered stent placement

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Learning Objectives: To investigate the technical and clinical safety and effectiveness of percutaneous bilateral side-by-side biliary covered stent placement in patients with malignant hilar biliary obstruction.
Background: Biliary obstruction resulting from advanced hepatic hilar malignancy is difficult to treat, and bilateral biliary drainage may be a reasonable option to preserve the functional volume of the liver during the course of chemotherapy and to prevent procedure-related cholangitis of a contaminated undrained lobe. We hypothesize that side-by-side biliary stent placement is more physiologic than T-configured stent and that covered stent could prevent tumor ingrowth.
Clinical Findings/Procedure: From January 2013 to January 2015, biliary stent placement was performed in 9 patients using partially expanded polytetrafluoroethylene (ePTFE)-covered stents. Biliary stents were placed by bilateral percutaneous approach with side-by-side placement. The diameter of the stents was 8mm; the length depended on the extent of malignant invasion. Bilateral side-by-side biliary covered stent placement was technically successful in all 9 patients. Mean serum bilirubin level was 11.98±6.0mg/dL before drainage and 3.22±3.4mg/dL 2 weeks after stent placement. Mean patient survival and stent patency periods were 234±237days. Two patients required maintenance of percutaneous transhepatic biliary drainage (PTBD) catheter after biliary stent placement. Stent migration or tumor ingrowth was not observed in any patient. Complications related to cystic duct obstruction was not observed in any patient.
Conclusion: This preliminary study suggests that side-by-side biliary stent placement was a physiologic treatment method for effective bilateral biliary internal drainage, and that percutaneous bilateral side-by-side biliary covered stent placement was safe and effective in patients with malignant hilar biliary obstruction.

P-23

Percutaneous "T" and "Y" stenting for palliation of malignant biliary hilar obstruction

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Learning Objectives: The aim of this educational poster is to present tips on biliary "T" and/or "Y" conformation stenting with self-expandable metal stents (SEMS) for the palliation of malignant biliary hilar obstruction.
Background: Malignant biliary bifurcation/hilar obstruction is often inoperable at presentation and has a poor prognosis. Open biliodigestive bypass surgery is not possible in most of these patients or has high perioperative mortality rates. Therefore, percutaneous biliary hilar stenting is a less invasive, or occasionally the only possible, method for palliative relief of cholestasis.
Clinical Findings/Procedure: At our tertiary care hospital, approximately 20 biliary bilobar bifrucation stenting procedures are performed every year.
In our practice, we found that parallel "Y" stenting is connected to higher occlusion rate. Stent-in-sidestent "Y" or "T" conformation bifurcational cholangioplasty offers longer SEMS patency if using a 9- or 10-mm SEMS; these data positively correlate with those of the MOZART study.
We also found that "T" stenting decreases procedure time as only a single biliary puncture is required, but it is not advisable in a sharp-angled biliary bifurcation; therefore, preprocedural imaging is crucial. Comparing laser-cut nitinol SEMS (Zilver 635 biliary; Cook) and closed-cell SEMS (Wallstent endoprosthesis; BostonScientific), we found that stent in-sidestent implantation of laser-cut nitinol SEMS was more precise and quick; but with Wallstent, there was less often need for postdilatation, although the patency rates of both stent types were similar.
Conclusion: Percutaneous "T" and "Y" biliary stenting for hilar obstruction achieves satisfactory palliation of cholestasis and improves quality of life, with a low complication rate.

P-24

Cholecystoduodenal stent placement through a pre-existing biliary–enteric fistula

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An 83-year-old male underwent percutaneous cholecystostomy. A cholecystoduodenal fistula was identified on cholangiography. A double-flanged covered-stent was subsequently placed percutaneously across the fistula for internal drainage. Using a cholangioscope, the gallstones were passed through the stent to the duodenum.

P-25

Biliary papillomatosis causing bile duct confluence stricture: a case report

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A case of biliary papillomatosis differentiated from Klatskin tumor by interventional intraductal biopsy is presented. The therapy consisting of systemic and local prospidine application resulted in stricture resolution. Patient has been in a good condition without biliary drainage during the five-year follow-up.

P-26

Percutaneous and endoscopic transhepatic biliojejunal recanalization for iatrogenic biliary obstruction

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We describe a case of a 92-year-old male who underwent surgery for gastric cancer and cholecystectomy for gallstones. He had iatrogenic common bile duct occlusion. He was treated by the rendezvous technique with transhepatic biliojejunal recanalization.

P-27

Percutaneous glue injection for the treatment of bile leak from cystic duct stump

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A 25-year-old woman underwent laparoscopic cholecystectomy, complicated by bile leak from the stump, confirmed by HIDA. PBD was performed; the stump was embolized with n-butyl cyanoacrylate. The external biliary tube was left in place. After 5 days, cholangiogram confirmed absence of leak; the tube was removed and patient was discharged.

P-28

All in one: percutaneous transhepatic benign and palliative techniques in a single patient

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We describe a case of a 77-year-old female with malignant hilar biliary obstruction and extrahepatic bile duct stones who underwent percutaneous transhepatic biliary drainage, brush and forceps biliary biopsy, sphincteroplasty and occlusion balloon, and hilar stent-in-stent T-shape.

P-29

Percutaneous irreversible electroporation of an unresectable hilar cholangiocarcinoma (Klatskin tumor) – a case report

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We report a case of a successful percutaneous irreversible electroporation of an unresectable hilar cholangiocarcinoma (Klatskin tumor) with the presence of a metal Wallstent in the common bile duct in a 66-year-old patient.

P-30

Percutaneous management of post-laparoscopic cholecystectomy residual CBD stones and iatrogenic proximal biliary stricture by balloon-assisted percutaneous descending litholapaxy (BAPDL) and bilateral biliary stenting

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A patient with jaundice and cholangitis underwent bilateral percutaneous biliary drainage, BAPDL (2 stones evacuated from CBD to duodenum using biliary drainage fistula), followed by bilateral biliary stenting; biliary patency was completely restored.

P-31

Selective ethanol ablation using balloon catheter for isolated draining & Intrahepatic biliary ducts after hepatic resection: two cases

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Isolated draining intrahepatic biliary ducts after hepatic resection were subjected to selective ethanol ablation (n=3) with a microballoon catheter connected to a 10-Fr drainage tube. The procedure was effective, and the bile duct leakage disappeared. There were no major complications.

P-32

Biliary drainage catheter-related pneumoperitoneum: something you must not forget when dealing with a suspicion of bowel perforation

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Biliary drainage catheter-related pneumoperitoneum is unusual. However, you must know and consider this diagnosis when dealing with a patient with suspected bowel perforation. We present a case in which we show the importance of this diagnosis.

P-33

Non-vascular indications of the Colapinto needle: a case report

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We report a case of percutaneous recanalization of hepaticojejunostomy using a Colapinto needle and percutaneous jejunostomy in a post-operative patient with occlusive anastomotic biliary stricture non-crossable with conventional interventional radiology techniques. The procedure was successfully performed, followed by biliary trans-anastomotic stent graft placement.

P-34

An uncommon case of percutaneous treatment of biliary obstruction and associated blind loop syndrome with the T-stenting technique

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A 50-year-old woman underwent Roux-en-Y choledocho-jejunostomy for distal common bile duct cancer. After relapse, which caused biliary obstruction and blind loop syndrome, biliary T-stent was placed between the choledocho and blind loop through the stent mesh, achieving complete resolution of the patient's clinical features.

Biopsy and drainage

P-35

Tissue acquisition by interventionist for oncologist

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Purpose: Histological and molecular examinations are prerequisites to understand cancer, determine individualized care, and identify targets for novel therapies. For almost every suspect lesion or type of cancer, there is a distinct diagnostic work-up to offer an appropriate tissue to the pathologist and to comply further with the increasing needs of the oncologist. An Interventionist's responsibility is to provide the highest tissue quality, i.e., enough pure and fresh target tissues with best comfort to the patient.
Material and Methods: We studied Spirotome macrobiopsy procedures for investigating optimal tissue acquisition in various organs with regard to efficacy in molecular biology diagnostics, comfort, and safety. All 909 patients gave informed consents, according to institutional requirements. Only when pathological and molecular data were considered complete and satisfactory by the oncologist and comparable to diagnostic surgery or in line with follow-up along with sufficient patient comfort, the procedure was defined as successful.
Results: In less than 2% of the procedures, the tissue was considered non-contributive to complete diagnosis. Sample sizes were between 100 and 300 mg. Patient comfort was excellent as less than 5% of patients experienced side effects. Pneumothorax for lung applications was less than 10%. Fifty-three cases had diagnosis when surgery was not possible.
Conclusion: Improvement of tissue acquisition in the diagnostic work-up by the interventionist drastically affects quality of care in pathology and oncology. Tru-cut systems are gradually replaced by next generation tools in providing appropriate tissue volumes from different organs, making molecular biology at reach for every cancer patient.

P-36

Value of percutaneous transhepatic cholangiobiopsy for the pathologic diagnosis of obstructive jaundice: analysis of 826 cases

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Purpose: To investigate the value of percutaneous transhepatic cholangiobiopsy (PTCB) for the pathologic diagnosis of causes of obstructive jaundice (OJ).
Material and Methods: From April 2001 to December 2011, PTCB was performed in 826 consecutive patients. Data on pathologic diagnosis, true positive rate, and complications were analyzed retrospectively. Patients with negative pathologic findings were diagnosed using clinical, imaging, laboratory, and prognostic data. The feasibility and safety of PTCB for OJ were evaluated, and the true positive rates for biliary carcinoma and non-biliary carcinoma were compared.
Results: PTCB was successful in all cases. Of 740 patients clinically diagnosed with malignant biliary stricture and 86 with benign biliary stricture, 727 had a positive pathologic diagnosis; in 99 patients, the pathologic findings were considered false negative. Theoverall true positive rate for PTCB was 88.01%, differing significantly for biliary and non-biliary carcinoma (χ^2=12.87, P<0.05). Malignancy accounted for 89.59% of OJ cases; well-, moderately, and poorly differentiated carcinoma represented 57.88%, 19.97%, and 22.15%, respectively. Biliary adenocarcinoma was the predominant malignant pathologic type (96.41%). Transient bilemia/bile leakage/temporary hemobilia occurred in 47/11/28 cases, respectively, with no serious complications.
Conclusion: PTCB is safe, feasible, and simple, with a high-true positive rate for the definitive diagnosis of OJ causes. Well differentiated adenocarcinoma was the predominant pathologic type.

P-37

The isocenter puncture (ISOP) method in various situations

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Purpose: To evaluate feasibility and safety of the isocenter puncture (ISOP) method in various situations other than for PVP (percutaneous vertebroplasty).
Material and Methods: The ISOP method was developed for PVP and makes use of the isocenter marker (ICM) displayed on the center of the fluoroscopy monitor screen. After positioning the target to the ICM, the C-arm can be rotated to any direction without losing the target as it remains at the center of the monitor. Then, the operator can puncture with a "bull's eye" method from a favorable angle and confirm puncture depth by lateral projection. We applied this method for situations other than for PVP.
Fifty-one puncture cases [median age, 68 (10-86) years] were detected retrospectively between July 2006 and January 2014 in which the ISOP method was employed. Puncture target, indication, technical success rate, median fluoroscopy time, median time needed to puncture, conversion to CT-guided puncture, and complications were evaluated.
Results: Puncture targets were as follows: pelvic bone: 11, pelvic abscess: 10, vertebral disk: 8, iliolumbar muscle: 6, vertebral body: 5, aortic aneurysm sac: 3, and others: 8. Indications were as follows: drainage: 29 cases, biopsy: 10, embolization of endoleak after EVAR/TEVAR: 3, and others: 9. Technical success was 98%. Median

fluoroscopy time and median time needed to puncture were 9 (2-47) minutes and 11 (2-32) minutes, respectively. There was no conversion to CT-guided puncture. Unexpected external iliac vein puncture occurred in one case but did not lead to any serious consequence.
Conclusion: The ISOP method is technically feasible and safe for various purposes under only fluoroscopic guidance.

P-38

CT-guided percutaneous biopsy is an accurate and effective diagnostic tool for pulmonary nodules under 20mm in diameter

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Purpose: To determine the accuracy, diagnostic yield, and pneumothorax rates of CT-guided percutaneous biopsy for pulmonary nodules ≤20mm in diameter.
Material and Methods: Between 2012 and 2014, 219 biopsies from 217 patients were retrospectively reviewed. Patients were divided into two groups: nodules ≤20mm (G1; 85 nodules) and nodules >20 mm (G2; 134 nodules). Patient and procedural variables, diagnostic yield, and pneumothorax rates were compared. Sensitivity and specificity were calculated from surgical pathology specimens (n=49; G1=26, G2=23).
Results: A total of 163 (74%) nodules were diagnosed as malignant, and 39 (18%) as non-malignant; 17 (8%) were non-diagnostic samples. More malignancies were discovered in G2 (n=107, 80%) than in G1 (n=56, 66%; p=0.021). There were more non-malignant nodules in G1 (n=21, 25%) than in G2 (n=18, 13%; p=0.049). The rate of non-diagnostic samples was comparable (G1=8, 9%; G2=9, 7%; p=0.340). The sensitivity and specificity for a diagnosis of malignancy was 100% and 100% in G1 and 100% and 33% in G2, respectively. There was a higher rate of pneumothorax in G1 (n=30, 35%) compared to G2 (n=29, 22%; p=0.026). However, the rate of clinically significant pneumothorax requiring aspiration (G1=6, 7%; G2=5, 4%; p=0.345) or placement of a chest tube (G1=5, 6%; G2=5, 4%; p=0.516) was similar between groups.
Conclusion: While fewer malignancies were discovered among pulmonary nodules under 20mm, CT-guided percutaneous biopsy remains an accurate and effective diagnostic tool with high sensitivity, high specificity, and equivalent rates of non-diagnostic samples in this subgroup. The rate of clinically significant pneumothorax is comparable in smaller and larger pulmonary nodules.

P-39

Percutaneous trans-subinguinal drainage (PTSD) for psoas muscle abscess

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Purpose: To retrospectively evaluate the safety and efficacy of PTSD for psoas muscle abscesses.
Material and Methods: Four patients with psoas muscle abscesses (3 females and 1 male; mean age, 77.5 years) received PTSD during the past one year. Three patients had a unilateral lesion, and one had bilateral lesions in the psoas major muscle. Previous antibiotic therapies were not effective in all patients. Conventional transgluteal route was not acceptable since the patients general condition was too poor to keep lying in the prone or decubitus position. Trans-subinguinal psoas muscle route was created as follows. After groin puncture below the femoral head, a biliary needle reached the psoas muscle via the iliac muscle under CT guidance, avoiding the femoral vessels or adjacent injury of the vital organs. The needle was exchanged to an angiographic catheter over the guidewire to confirm that it is located within the abscess by contrast injection or pus aspiration. Under X-ray fluoroscopic guidance, a trans-subinguinal drainage catheter was inserted into the cavity. Clinical data were retrospectively reviewed to assess the safety and efficacy.
Results: The procedures were completed and pus was well drained in all lesions. No major complications were seen. Postprocedural management of the wounds or drainage catheters was comparatively easy because there was no need for postural change of the patients.
Conclusion: PTSD seems a safe and effective procedure for conventionally inaccessible psoas muscle abscess in patients who cannot keep lying in the prone or decubitus positions.

P-40

A pilot study of real-time MR overlay technique for pediatric percutaneous extremity bone biopsies in interventional radiology suite

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Purpose: Bone marrow abnormalities are often better visualized on MRI than on CT/fluoroscopy, but biopsies are typically performed under conventional CT/C-arm CT guidance. CT-negative lesions are challenging and require the MRI to be reviewed separately during the biopsy. This pilot study describes our initial experience with a novel technique of overlaying 3D MR images on real-time fluoroscopy during pediatric percutaneous bone biopsy procedures on CT-negative lesions.
Material and Methods: In this IRB-approved prospective study, patients undergoing extremity bone biopsies were included. Pre-procedural MRI maximizing lesion visualization was overlaid on live fluoroscopy using syngo InSpace 3D/3D fusion and iPilot dynamic software (Siemens Healthcare). Age-/anatomically matched retrospective conventional CT-guided extremity bone biopsies were reviewed for the comparison of radiation dose and procedure time. Effective doses for MR overlay and CT-guided biopsies were estimated using the PCXMC program (v2.0.1.3, STUK, Finland) and dose-length products/age-appropriate K-factors based on AAPM reports.
Results: Three MR overlay patients were included (2 females, 1 males; mean age 7.55 years). Diagnostic accuracy was 100% (neuroblastoma, acute leukemia, malignant adrenal neoplasm), and average fluoroscopy time was 7.8min.
Four patients (3 males, 1 female; mean age 7.73 years) underwent conventional CT-guided extremity bone biopsies. The average procedure time for MR overlay cases (80min) was shorter than that for the CT-guided cases (119.8min). MR overlay biopsies had a lower mean radiation dose (0.09±0.12mSv) than CT-guided biopsies (0.47±0.6mSv).
Conclusion: This early experience demonstrates that MR overlay technology in IR suite provides diagnostic bone biopsies in CT-negative lesions while reducing the procedure time and radiation dose. Further validation with increased patient recruitment is required.

P-41

Does sclerotherapy have benefit in the treatment of infected postoperative lymphocele?

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Purpose: To evaluate the efficacy and safety of sclerotherapy compared with simple percutaneous drainage (PCD) in the treatment of infected postoperative lymphocele in gynecologic malignancy patients.
Material and Methods: From March 2002 to December 2014, percutaneous drainage with or without sclerotherapy for postoperative lymphocele was performed in 85 patients. Among them, 40 infected lymphoceles in 38 patients were included. There were 12 patients (mean age, 46.71 years) in the sclerotherapy group and 26 (mean age, 50.5 years) in the PCD group. Ovary cancer, cervical cancer, and endometrial cancer were the causes of operation (2, 7, and 3 patients, respectively, in the sclerotherapy group vs. 11, 11, and 4 patients, respectively, in the PCD group). Absolute ethanol was used as the sclerosant in 13 lesions, and povidone iodine was used in one lesion. Mean follow-up period was 32.6 months (range, 1–154).
Results: There was no statistically significant difference in the mean duration of catheter placement (17.0±20.84 days in the sclerotherapy group vs. 13.09±10.92 in the PCD group, p>.05). Total drained volume between the two groups also showed no statistically significant difference (mean; 702.66 cc in the sclerotherapy group vs. 797.19 cc in the PCD group, p>.05). Mean interval of initial PCD to sclerotherapy was 8.2 days (range, 0–30). However, fluid volume before and after sclerotherapy significantly decreased from 606.41±1257.31 to 96.25±176.91 (p=.019). Recurrence occurred in two patients in each group. There was no major complication.
Conclusion: Sclerotherapy following infection control seemed to be as safe and effective as PCD in infected postoperative lymphocele.

P-42

Percutaneous CT-guided coaxial core needle biopsies of pulmonary lesions: analysis of outcomes of 1290 procedures from a tertiary cancer care center

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Purpose: CT-guided lung biopsy is a well-established diagnostic method for pulmonary lesions. The aim of our study was to evaluate the diagnostic outcomes and safety profile of coaxial CT-guided lung biopsies.
Material and Methods: We retrospectively analyzed the results of CT-guided core biopsies data from December 2013 to December 2014 for 1290 procedures in 1222 patients to determine the diagnostic accuracy, complication rates, and independent risk factors for diagnostic failure and pneumothorax.
Results: Final diagnoses were established in 1220 procedures of 1290 lesions (94.5%). Twenty-seven patients were lost to follow-up. Nondiagnostic biopsy results were obtained for 43 of the 1263 lesions (3.4%). The overall sensitivity, specificity, positive predictive value, and negative predictive value for the diagnosis of malignancy were 99.2% (1147/1156 lesions), 95.3% (61/64), 99.7% (1147/1150), and 90.0% (63/70), respectively; diagnostic accuracy was 99.0 % (1208/1220).
Complications: pneumothorax (14.6% of biopsies), pneumothorax requiring a chest drain (3.0%), hemoptysis (1.4%), and death (0%).
Conclusion: CT-guided lung biopsy has a high diagnostic yield with a good accuracy. Complication rates were acceptable and comparable to those of previous studies.

P-43

Can PET-CT imaging improve the diagnostic results in CT-guided lung biopsy? Impact on diagnostic accuracy and comparison with conventional procedure

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Purpose: CT-guided lung biopsies are subject to sampling errors. Current study assesses whether information provided by FDG-PET/CT will decrease the false negative rate and thus improve the accuracy and of CT-guided lung biopsies.
Material and Methods: From Jan 2011 to Feb 2015, we included 200 patients with lung nodules who underwent FDG-PET/CT and CT-guided biopsy with a true-cut full-core 18G needle within an interval of less than 30 days. An experienced interventional radiologist prior to the procedure has carefully studied the PET-CT imaging, and during the biopsies, we decided to put the tip needle as close as possible at the level of the area with the highest SUV measured. In each patient was performed a single step biopsy, and we compared our results with the data of accuracy reported in the literature.
Results: From each biopsy was obtained a sufficient quantity of material that has allowed a histologic typing of the lesion. No major complications during procedures.The preliminary study of the PET-CT imaging has influenced the choice of location of access needle biopsy.
Conclusion: The data collected during our study allowed us to demonstrate greater accuracy in the diagnosis with lung biopsy performed after a study of PET-CT images with a significant difference compared to data reported in the literature of traditional lung biopsies. The role of PET-CT now being clearly defined within diagnostic protocols for the characterization of lung nodules, it is essential to reduce the rate of false-negative patients biopsied, by a careful study of PET-CT before performing a lung biopsy.

P-44

Robot-assisted liver biopsy using a respiratory monitoring device: first experience

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Purpose: Patient breathing during intervention planning and device insertion often cannot be reliably reproduced, which makes the exact placement of the biopsy device challenging. A respiratory monitoring device enables patients to self-monitor their breathing. Our study compares liver biopsies using robotic assistance in combination with a respiratory monitoring device versus a manual approach under CT-fluoroscopy.
Material and Methods: We retrospectively analyzed 28 biopsies of focal liver lesions (16 males and 12 females; mean age, 56 years) between January 2014 and February 2015. Fifteen biopsies were performed manually under CT control, 13 using robotic guidance (MAXIO, Perfint Healthcare, India) combined with a respiratory monitoring device (Breath Hold ES; Medspira, MN, USA).
Results: Six of the 13 (38%) robot-assisted liver biopsies required manual position correction of the biopsy device by a mean distance of 4.2 mm. Total procedure time was 12.4 minutes under robotic assistance and 10.8 minutes using manual approach (p = 0.24). The total dose-length product was 382.8 mGy·cm under robotic assistance and 413.2 mGy·cm using the manual approach (p = 0.32). Biopsy results were inconclusive in 3 cases, 1 in the robot-assisted group. No complications occurred.
Conclusion: Robot-assisted biopsy of liver lesions using a respiratory monitoring device is safe and has a high accuracy.

P-45

C-arm cone beam CT fusion imaging with CT-PET: impact on results of CNB of lung lesions

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Purpose: CNB biopsy of the lung is subject to sampling errors. Modern angiographic systems allow to perform C-arm cone beam computed tomography (CBCT) to obtain cross-sectional imaging, which allows a precise planning of the sampling area and an accurate approach planning. A new software allows the image fusion between CBCT imaging and CT-PET scans. The purpose of this study is to evaluate the influence of the fusion imaging on the accuracy of CNB.
Material and Methods: From January 2014, 68 patients underwent CNB lung biopsy for lung lesions with CBCT guidance after CT-PET assessment of their pathology. For each patient, during the procedure, we performed a CBCT scan to check the right position of the needle inside the lesion. A manual, or automatic, fusion imaging between CBCT and CT-PET imaging were performed. Retrospectively, we evaluated the needle position compared to the higher standard uptake value (SUV) area. The data was correlated with histopathological results.
Results: Of the 68 patients, 42 were true positive (61.8%), 2 false positive (4.4%), 15 true negative (22.1%), and 8 false negative (11.7%). In the false-negative group, the needle position was outside the higher SUV area. In the true-positive group, the position was inside the area.
Conclusion: Present results demonstrate the capability of CBCT and CT-PET fusion imaging to increase the accuracy of CNB lung biopsy, thus allowing a more accurate choice of the sampling area and a better planning for the procedure.

P-46

Percutaneous image-guided biopsy in the era of personalized oncology

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Learning Objectives:
1. To highlight the impact of personalized oncology on interventional radiology practice related to percutaneous image-guided biopsies.
2. To overview percutaneous image-guided biopsies, including tissue acquisition and analysis, image-guided techniques, ex-panded indications, expectations, and future directions relevant to interventional radiology.

Background: Personalized oncology, a new evidence-based trend in treating cancer, relies on molecular understanding of the disease, use of advanced diagnostic techniques, and tailoring of the treatment based on a patient's molecular profile. This patient-specific management has influenced the interventional radiology practice. The recent advances in specific chemotherapy and novel targeted therapy and the increasing need for specific molecular analysis and diagnosis of tumor histopathologic subtypes have had a direct impact on biopsy techniques due to the expanded indications of and expectations from the biopsy.
Clinical Findings/Procedure: Molecular profiling is an integral part of the histopathologic tests, and it is based on the availability of sufficient and appropriate tissue. Tissue acquisition often requires needle biopsy under available imaging guidance. The most dramatic change has been to obtain biopsy within timely fashion or sequentially under newly developed functional and molecular imaging to provide sufficient tissue for clinical and research purposes.
Conclusion: Percutaneous image-guided biopsy has an established role in the diagnosis and management of a patient with cancer, and interventional radiologists are key members of the multidisciplinary tumor boards. Interventional radiologists must be aware of the expanded indications, tissue yield, and expectations related to biopsy in order to adapt to the new changes, alleviate the possible challenges, and continue their efficient role in patient care.

P-47

Complications following US-guided core-needle biopsy for thyroid lesions: anatomic considerations and adjunctive techniques

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Learning Objectives: To present the spectrum of complications following US-guided core needle biopsy (CNB) for thyroid lesions and to make performers aware of the potential complications and provide useful preventive techniques.
Background: CNB presents an alternative to FNA to obtain tissue for diagnosis. Knowledge of various complications following US-guided CNB and understanding of US-based neck anatomy, particularly that of the nerves, vessels, and other critical structures, are important to prevent complications. Inadvertent injuries of the neck nerves and vessels may be a cause of significant morbidity and medico-legal problems.
Clinical Findings/Procedure: The broad spectrum of the complications will be presented based on the actual data obtained from the authors' hospital (period: 2008-2013, number of cases: 6175 patients with 6406 thyroid nodules) and published articles. Next, we will thoroughly review the US-based thyroid and peri-thyroid anatomy, as well as its clinical significance for reducing iatrogenic injuries. Useful anatomic landmarks and prevention techniques for complications will lastly be discussed to help reader comprehension. It will include basic and advanced techniques of thyroid CNB (i.e., selection of cutting needle, approach route, and techniques for difficult cases).
Conclusion: Knowledge of various complications and US-based neck anatomy may be helpful for maximizing the adequacy and minimizing the complications that can result from US-guided CNB for thyroid lesions.

P-48

An axial puncture approach for draining deep pelvic abscess under fluoroscopy guidance

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The authors have devised a new approach for fluoroscopy-guided axial puncture through the perirectal space for percutaneous catheter drainage of deep pelvic abscess. The puncture avoids transgluteal and transpiriformis approaches, which may reduce intra- and postprocedural pain and hemorrhage risk.

P-49

Percutaneous needle aspiration of paraspinal lesions using XperGuide cone-beam CT: initial experience

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The aim is to report our initial experience using XperGuide cone-beam CT for percutaneous needle aspiration of paraspinal lesions. Percutaneous needle aspiration of paraspinal lesions using XperGuide cone-beam CT is easy, accurate, safe, and useful in determining treatment approach.

P-50

Bronchobiliary fistula (BBF) as a complication of drug-eluting beads transarterial chemoembolization (DEB-TACE) for hepatocellular carcinoma (HCC): first reported case

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The day after DEB-TACE was performed through the right IPA for recurrent HCC in segments 7/8, the patient had dyspnea with severe biliptysis. CT revealed pleural effusion and biloma. Immediate percutaneous drainage was performed, and BBF was confirmed under fluoroscopy.

Bone, spine and soft tissue intervention

P-51

Preoperative embolization for reducing perioperative blood loss in patients with spinal hypervascular tumors

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Purpose: To evaluate the efficiency of preoperative embolization for reducing perioperative blood loss in patients with spinal hypervascular tumors.
Material and Methods: We analyzed the results of hypervascular spinal tumor treatment with patients who were treated in 2011–2014. The group included 53 patients aged 27–77 years (average, 58): 10 (18.9%) patients with primary tumors and 43 (81.1%) patients with metastatic disease. Endovascular intervention was performed in all cases with superselective catheterization of feeding vessels and embolization of hypervascular focus. We used embolic agents and various combinations (microparticles, coils, and liquid agents). Then, in a period of 1–10 days, all patients underwent open surgery. We calculated the average intraoperative blood loss in these cases and performed a comparison of the data with the literature data.
Results: According to the literature, blood loss in patients undergoing surgery for spine tumors average up to 5500 ml, and in the case of metastases of renal cell cancer surgery, it can be up to 8000 ml. All patients who underwent embolization had intraoperative blood loss (average, 632.4 ± 99.7 ml). In patients with RCC, the values of blood loss with embolization (840.6 ± 208.7 ml) are several times smaller than those without embolization. There have been no in-hospital mortality associated with the volume of intraoperative blood loss. Neurological deficit after endovascular intervention occurred in three (7.7%) patients; 15 patients (38.5%) manifested postembolization syndrome.
Conclusion: Considering the data, it can be said that the preoperative embolization is safe and greatly reduces intraoperative blood loss, which allows improved surgical treatment stage.

P-52

Anterior screw fixation of traumatic type 2 odontoid fractures with Xper-CT guidance in angiographical suite: our preliminary experience

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Purpose: We aim to present our preliminary experience in the treatment of traumatic type 2 odontoid fractures with anterior screw fixation under Xper-CT guidance in the angiography suite.
Material and Methods: We considered 5 patients (2 females and 3 males) in the period of June 2012-December 2014 presenting with traumatic type 2 odontoid fractures. All patients had fragment displaced posteriorly with no spinal cord injury; one of them was in extracorporeal membrane oxygenation due to ARDS secondary to the traumatic accident and received a high-dose anticoagulant therapy. Procedures were performed in the angiography suite with a minimally invasive approach by a neurosurgeon and an interventional radiologist under fluoroscopic control and Xper-CT guidance, under general anaesthesia. Xper-CT guidance was used for planning the path of the Kirschner wire, to control its positioning, and to assess the correct position of the screw. Other surgical maneuvers were performed under fluoroscopic guidance. Length of surgery, complications, and clinical outcomes were evaluated.
Results: Screw fixation was performed without any complication in four patients. In one case, we had a rupture of Kirschner wire, whose fragment remained inside the odontoid body without any clinical complications. Length of surgical procedures lasted from about 60 minutes to about 100 minutes (patient in ECMO). The patient in ECMO remained 40 days in the ICU due to ARDS; the other patients had a rapid recovery.
Conclusion: Anterior screw fixation under Xper-CT guidance in the angiography suite is a safe procedure and can be proposed as a valid alternative to surgical approach in the operating room with simple fluoroscopic guidance.

P-53

Percutaneous cryoablation for the treatment of osteoid osteoma

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Purpose: The purpose of this study was to evaluate the feasibility and efficacy of percutaneous cryoablation for the treatment of osteoid osteoma in adults.
Material and Methods: Thirteen consecutive adult patients (six male and seven female patients; mean age, 23.6 years; age range, 17–37 years) who underwent CT-guided percutaneous cryoablation for the treatment of osteoid osteoma were retrospectively evaluated. Lesions were located in the spine (n=5), femur (n=3), cuboid (n=2), talus (n=1), fibula (n=1), and humerus (n=1). The procedures were carried out under local anesthesia and conscious sedation in ten patients and general anesthesia in three patients. Technical success was evaluated with post-procedure MRI at 6 weeks. Clinical outcome was assessed using a visual analog scale (VAS) to evaluate the severity of pain before and immediately after the procedure as well as at primary (6 weeks) and secondary (6–24 months) follow-ups.
Results: All procedures were considered technically successful. For each patient, the post-procedure MRI examination demonstrated an area of signal alteration corresponding to the cryoablation zone that included the nidus, and it showed no complications that resulted from the procedure. All patients experienced complete resolution of the symptomatology at the primary and secondary follow-ups ($p<0.05$). No minor or major complications were noted during the procedure, recovery period, or at the primary and secondary follow-ups.

Conclusion: CT-guided percutaneous cryoablation is safe and effective in the treatment of osteoid osteoma in adults, and it can be accomplished without general anesthesia in selected cases.

P-54

A review of the safety and efficacy of CT-guided sacroplasty for sacral insufficiency fractures

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WITHDRAWN

P-55

Evaluation of a new prophylactic device for bone malignant lesions in the hip

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Purpose: Percutaneous cement augmentation using viscous cement can be performed safely, by minimally invasive procedure, to treat malignant bone lesions. Although easy to use, cement is not biomechanically relevant to prevent hip fracture (no bending resistance) because it creates microcracks and bone fracture. Standard osteosynthesis fixation is also performed to prevent fracture in malignant lesions. The purpose of this study is to evaluate the impact of a new prevention-dedicated osteosynthesis device (PDOI) made of polymer and combined with cement, implanted using a minimally invasive approach for treating malignant bone lesions of the proximal femur.
Material and Methods: This study is a prospective series of 10 PDOIs. To date, all 10 patients have been implanted. Clinical evaluation includes Oxford hip score during a 1-year follow-up.
Results: Mean age and BMI of patients were 60.0±5.3 years and 23.6±3.2 kg/m^2, respectively. The Mirel score was 9.1 (8–12), and the ECOG functional status was 1.3 (0–3). Mean duration of implantation was 92 (60–155) minutes. Six patients were positioned supine and four were in the lateral decubitus position. Mean cement quantity combined with the osteosynthesis device was 9.5 (3–15 cc). At 2 months, visual analog scale (VAS) was 2.8 (2–3), and OHS-12 score was 23.5 (3–42).
Conclusion: Results of this prospective study demonstrate the feasibility of the implantation of this new PDOI. This new treatment for pathological fracture prevention seems to be a promising alternative as it allows to continue radiotherapy and not to discontinue chemotherapy. Patients' follow-up data are expected to confirm the efficacy of this technique.

P-56

Role of percutaneous radiofrequency in athletic pubalgia

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Purpose: Role of pulse-dose radiofrequency (PDRF) in management of chronic pain in high-performance athletes with pubalgia.
Material and Methods: Between January 2013 and May 2014, 40 high-performance athletes with pubalgia refractory to conservative therapies during the last 3 months were enrolled. The sensitive ramus of the ilioinguinal nerve and the obturator nerve were the goals of treatment. A 20-gauge cannula with a 10 cm length was introduced with a percutaneous access on the upper and lower edge of the superior ramus of the pubis. After the spindle was removed, a radiofrequency needle with a 10-mm "active tip" was introduced. PDRF was performed with 1200 pulses at 45 V and 20-ms duration, followed by a 480-ms silent phase. The purpose was to reach a tissue temperature under 45-50°C in order to arouse a modulatory effect on nerve fibers.
Results: All patients completed the treatment. Mean VAS scores before PDRF was 7.9±0.8. Pain intensity decreased up to 6-8 months in 34 patients (mean VAS scores 3.2±0.5 at 6 months and 3.7±0.3 at 9 months). They followed an adequate physiotherapy program and started training 3 months after PDRF. Two patients had no pain relief; 4 had pain relief up to 3 months and then underwent again PDRF with similar results. No complications were observed.
Conclusion: Our preliminary results showed the potential role of PDRF in the management of chronic pubalgia in high-performance athletes. PDRF could be offered to athletes with chronic painful conditions, which limit their trainings. A prospective, double-bind, randomized clinical trial needs to confirm our results.

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Efficacy of quantic molecular resonance in the treatment of contained disc herniations: preliminary experience

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Purpose: The aim of this study is to prove the efficacy of quantic molecular resonance in the treatment of disc protrusions by means of pain relief and functions.
Material and Methods: Twenty-eight patients (12 males and16 females; average age, 51.2 years) with sciatic pain due to contained disc herniation (Pfirrmann grade, 1–3) were selected for treatment with percutaneous disc decompression by means of quantic molecular resonance. Diagnosis was confirmed by MRI and EMG in all patients. All procedures were performed under fluoroscopic guidance with local anesthesia. Seventeen-gauge Crawford needles were used to insert the probe. Clinical evaluation by the assessment of pain by means of a 11-point visual analogue scale (VAS, 0–10) and of functions by means of the Oswestry Disability Index (ODI, 0–50) was performed at baseline and at 1 and 3 months after the procedure. RM checks have been performed at 3 months after the procedure.
Results: A total of 28 intervertebral discs were treated. Baseline pain was 8.2±1.5 and baseline ODI was 58.4%. At 1 month, pain was 2.8±2.3 ($p<0.01$), while ODI was 19.3%. At 3 months, pain was 3±2.5 ($p<0.01$), while ODI was 19.8%. No complications arose.
Conclusion: From our preliminary study, the treatment of contained disc herniation with quantic molecular resonance is an optimal therapy for symptomatic patients, showing good reduction in pain and good increase in functions.

P-58

Factors affecting time to pain relief in patients with osteoid osteoma treated by CT-guided percutaneous radiofrequency ablation

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Purpose: To prospectively analyze the factors that may affect time to pain relief post CT-guided percutaneous radiofrequency ablation (RFA) of osteoid osteoma. These factors include patient's age, sex, amount of sclerosis surrounding the nidus, the relation to nearby joint, and the number of muscles that have to be traversed.
Material and Methods: Thirty patients diagnosed to have osteoid osteoma on the basis of clinical and radiological criteria were treated

by CT-guided percutaneous RFA. Pain was evaluated after the procedure daily for one week using a visual analogue scale, with 0 denoting no pain and 10 denoting the worst pain imaginable. Moreover, time to pain relief was analyzed in relation to age, sex, the amount of sclerosis surrounding the nidus, the relation to nearby joint, and the number of muscles that have to be traversed to reach the lesion.
Results: There was a highly significant positive correlation (p=0.0001 and r=0.636) between the amount of sclerosis surrounding the nidus and time to pain relief. On the contrary, there was no significant statistical difference in sex (p=0.654), relation to nearby joint (p=1.0), or the number of muscles that have to be traversed (p=0.108) in relation to time to pain relief. Considering age, there was a significant positive correlation (p=0.013 and r=0.446) between age and time to pain relief.
Conclusion: The amount of sclerosis surrounding the nidus of osteoid osteoma is the most effectual factor for time to pain relief post-CT-guided percutaneous radiofrequency ablation treatment.

P-59

Cryoablation of vascular malformations: a phase I clinical trial

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Purpose: To evaluate the safety of cryoablation for vascular malformations.
Material and Methods: A phase I clinical trial of cryoablation for vascular malformations started from December 2013 at our institute. On the date of submitting this subject, 7 patients were included in this study (3 men, 4 women). This study was scheduled to enroll 9 patients and will finish until the presentation. Inclusion criteria were as follows: patients with limited vascular malformations, age more than 10 years, and some symptoms and without severe comorbidities or severe anticoagulopathy. Cryohit (Galil Medical, Yokneam, Israel) was used to ablate the lesion. Cryoprobe puncture was performed mainly under US guidance or CT fluoroscopic guidance. Two freeze cycles were performed in each ablation. The affected skin was warmed using warm water. The size and distribution of ice ball were checked on CT after each freeze cycle. Overlapping ablation was performed if needed. VAS score was used to evaluate the efficacy of cryoablation.
Results: All procedures were completed in the out-patient clinic. Pain was well tolerated under local anesthesia. Ice ball was well recognized by US or CT. Adverse events were post-procedural pain, disturbance in walking, swelling, and edema. Severe adverse events did not occur. In one buttock case, leg nerve disturbance appeared during a freeze cycle; we immediately stopped freezing, and the nerve symptom quickly recovered. VAS score decreased from 6.2 ± 1.6 to 2.0 ± 2.4 at one month.
Conclusion: Cryoablation of soft tissue vascular malformation was safe and effective to control pain.

P-60

The injectability, viscosity, and mechanical characteristics of a novel adhesive bone cement for vertebroplasty

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Purpose: It is desirable, at a minimum, that vertebroplasty cements possess (i) prolonged injection windows for extended delivery, (ii) constant injection consistencies for improved control, and (iii) lower elastic moduli to eliminate stiffness concerns, in order to enhance patient safety and clinical utility. We have developed a glass ionomer cement (GIC) that may meet all of these critical requirements. This study examines the injectability, viscosity, and mechanical characteristics of this experimental GIC versus SpinePlex™.
Material and Methods: Glass powder (0.36ZnO/0.04SrO/0.206SiO_2/0.269GeO_2/0.09CaO/ 0.0175ZrO_2/0.0175Na_2O molar-fraction) was combined with polyacrylic acid (M_w=12,700g/mol, 50wt%-aqueous) to produce a GIC (powder-liquid ratio=2.0/1.5). Spineplex™ was used as the control. Viscosity was measured using rotational rheometry (500Pa shear stress, 1Hz). An Instron-3344 was used to determine injection forces (F_{inj}; 12G cannula; extruding rate=10mm/min), strength and modulus (cylindrical samples: d=4mm, h=6mm; crosshead speed=1 and 20mm/min).
Results: F_{inj} for the GIC were between 6.085N±0.2984N to 12.33N ±3.125N; significantly lower than SpinePlex™ (39.87±8.398N to >200N). GIC viscosity was largely consistent, not exceeding 20% of the maximum obtained. The viscous-to-elastic transition of the GIC (*gelation*) occurred at 6-7min; relatively constant F_{inj} were maintained during this transition. The GIC had significantly lower moduli (589.7MPa±22.29MPa and 768.2MPa±21.03MPa for 1 and 20mm/min, respectively) in comparison to SpinePlex™ (822.7MPa±38.19MPa and 894.1MPa±102.6MPa for 1 and 20 mm/min, respectively) irrespective of loading rate. Finally, the GIC provided strengths bordering those accepted in the vertebroplasty literature: 28.33MPa±1.677MPa and 59.46MPa±1.961MPa for 1 and 20mm/min respectively.
Conclusion: The considerably lower, more consistent F_{inj} paired with superior mechanical data of the GIC present an exciting advancement in vertebroplasty materials.

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Effects on pain medication following percutaneous spinal augmentation: sustained significant decrease

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Purpose: To determine if percutaneous spinal augmentation and cementoplasty (pSAC) had a measurable effect on long-term analgesic use.
Material and Methods: All patients who attended the pre-assessment vertebroplasty clinic at a tertiary referral centre in the United Kingdom over a 1-year period (2011) were identified retrospectively using electronic hospital clinic records. Repeat prescription documentation was obtained from the patient's general practitioner or inpatient hospital records and compared with pre-assessment analgesic documentation. End points were set at early 2015 or natural death. Fisher's exact test (GraphPad software) was used to analyse the results.
Results: Forty-six patients (65% female; age range, 25–87 years; median 71) were assessed. Twenty-one patients (46%) had a diagnosis of osteoporosis, and 25 (54%) had a cancer-related diagnosis. Twenty-seven (59%) had a pSAC procedure performed over the next 2 years, with 19 (41%) deemed unsuitable. Of the 27 patients who underwent a pSAC procedure, a statistically significant (p=0.0188) decrease in analgesic use, as defined by the WHO pain ladder was noted in 17 patients (63%) when compared with those who did not undergo the procedure. There was no significant relationship to age, sex or diagnosis.
Conclusion: The pSAC led to a significant long-term reduction in analgesic use, suggesting a decrease in pain and an improvement in the quality of life.

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Outcome study after RFA in 105 patients with osteoid osteomas

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Purpose: To assess the outcome of patients treated by computed tomography-guided radiofrequency ablation (CT-guided RFA) for osteoid osteomas (OO).
Material and Methods: A monocentric, retrospective study was conducted. Patients with clinical suspicion and imaging diagnosis of OO were treated with CT-guided RFA, using the same device with either a 7-mm or a 10-mm active tip electrode. Specific precautions were applied in case of articular or spinal OO. Patients were contacted by phone to evaluate long-term outcome in terms of pain and ability to perform daily activities (including sports) and long-term complications. Success was defined as no residual pain and the ability to perform daily activities normally.
Results: From 2007 to 2014, 105 patients were treated by CT-guided RFA for OO at our institution. Mean patient age was 24.7 years (SD=11.3; range, 1–53), and mean delay to diagnosis was 15.5 months (SD=9.9; range, 3–48). Among patients who answered the follow-up call (n=56), the overall success rate was 89.3%: 49/56 (87.5%) had primary success of the procedure, and 1/56 (1.8%) had secondary success (repeat-RFA after pain recurrence). Mean follow-up time was 34.6 months (SD=24.6; range, 3–81). Few complications occurred as follows: 2 mild reversible peripheral nerve injuries, 1 brachial plexus neuropathy, and 1 broken electrode tip fragment.
Conclusion: Osteoid osteoma can be effectively and safely treated by CT-guided RFA. Beneficial effects of the percutaneous treatment persist at long-term follow-up.

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Sciatica-like syndrome: differential diagnosis and percutaneous CT-guided and US treatments

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Purpose: To present our experience in imaging-guided treatment of sciatic pain of non-disc origin.
Material and Methods: From July 2009 to September 2014, we studied 2300 patients with chronic sciatic pain with MRI of the lumbar spine and pelvis: 1461 patients showed a nerve compression caused by disc herniation; 389 patients had lumbar apophyseal arthritis; 98 patients had sacroiliac joint inflammation; 31 patients had insertional tendinopathy of hamstring tendons; 12 patients had piriformis syndrome; and in 309 patients, the cause of pain was unidentified. We performed TC-guided injections with O2-O3 and corticosteroids on 367 patients with lumbar apophyseal arthritis, 87 patients with sacroiliac joint, and 10 patients with piriformis syndrome. We performed US-guided injections of platelet-rich plasma (PRP) on 27 patients with insertional tendinopathy of hamstring tendons. Six months later, we repeated the MRI studies of the treated patients. All patients were also evaluated by VAS scale (before and 6 months after the treatment).
Results: The mean VAS values after percutaneous CT-guided infiltration dropped overall by 80% (from 8 to 1.6) and after PRP percutaneous infiltration by 70% (from 6 to 1.8). The MRI controls showed a reduction of reactive edema of the sacroiliac joints and of the piriformis muscle. We also observed a recovery of morphological signal intensity in patients with insertional tendinosis of hamstring tendons. No major complications occurred after therapy.
Conclusion: MRI is the gold standard for identification of sciatica-like pain (of non-disc origin). The imaging-guided treatment is a very effective and safe solution to treat these symptoms.

P-64

Interlaminar epidural infiltrations in patients with severe degenerative lumbar spine: how often is the needle properly placed inside the epidural space without imaging guidance?

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Purpose: The purpose of this study is to assess technical efficacy, accuracy, and safety of epidural (interlaminar) infiltrations performed blindly in a series of consecutive patients with severely degenerated lumbar spine.
Material and Methods: During the last year, 138 patients with severe degenerative lumbar spine underwent epidural (interlaminar) infiltration either as therapy for low back pain and neuralgia or as anesthesia prior to percutaneous vertebroplasty. Patients included in the study had already undergone a blind epidural infiltration with minimum or no pain reduction. The session was repeated in the angiography suite. Patients were placed in the lateral decubitus position. Anesthesiologist performed blindly, with no imaging guidance, the needle placement stating the level of target from the beginning of the procedure. Once the anesthesiologist felt loss of air resistance and stated that needle was inside the epidural space, verification was performed by injection of 1-3 cc of iodinated contrast medium under fluoroscopy in the true lateral projection.
Results: Proper needle placement inside the epidural space was illustrated in 82/138 cases (59.4%), while extra-epidural location was verified post-contrast medium injection in 56/138 cases (40.6%). Target level was accurately defined in 96/138 cases (69.6%), whereas in 42/138 cases (30.4%), needle was advanced in a different than the stated level. In 5/138 (3.6%) cases, there was puncture of the dura matter.
Conclusion: Blind interlaminar epidural infiltrations lack the accuracy of exact needle location that imaging guidance offers in ~40%. Imaging guidance for interlaminar epidural infiltrations ensures accurate needle placement and enhances the safety and efficacy of the technique.

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Comparison between the radiation doses associated with 3D rotational angiography and CT utilized for vertebroplasty verification procedures

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Purpose: This study aims to quantify and compare the radiation burden in terms of effective dose (ED), associated with three-dimensional otational x-ray angiography (3D-RX) and multi-slice computed tomography (MSCT) utilized for verification purpose after vertebroplasty.
Material and Methods: Thermoluminescent dosimeters (TLDs) were placed at the RANDO male phantom which was irradiated at the 3D-RX fluoroscopy unit, under conditions simulating the procedure, to estimate the dose-area product (DAP) to ED conversion factor. Data from 16 patients who underwent vertebroplasty over the last 2 years were collected, and ED was assessed by using the

defined conversion factor. For the patient cohort (n=24) who underwent the confirmation procedure with an abdomen and pelvis CT scan protocol, appropriate 'K' factors from literature were used to convert registered dose-length product (DLP) values to ED.
Results: The ED estimated from the phantom irradiation was equal 6.989mSv, resulting in DAP to ED conversion factor of 0.225mSv/Gy·cm^2. The radiation burden for the 16 patients who underwent 3D-RX imaging was 8.8±3.1mSv and for the 24 patients who underwent CT scanning was 5.1±2.0mSv.
Conclusion: Obtained results indicate that significantly higher radiation burden is associated with the 3D-RX technique than with CT exposure ($p<0.05$) used for confirming vertebroplasty outcomes. The verification procedure with the 3D-RX unit appears to be more practical since it is performed immediately after vertebroplasty at the same modality while CT scan is usually performed on the day after vertebroplasty.

P-66

Cryoablation of breast cancer sternal metastases: preliminary outcomes of a new treatment approach

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Purpose: The purpose of this study is to review the safety, clinical effectiveness, and imaging response of cryoablation for sternal metastases in patients with breast cancer.
Material and Methods: A retrospective analysis of all patients with breast cancer and solitary bone sternal metastases or oligometastatic disease treated with cryoablation was performed. The major goal was local tumor control and pain palliation, if present.
Results: Between September 2013 and February 2015, a total of seven patients, all females with a mean age of 53±14 years underwent cryoablation of breast cancer sternal metastases. Four patients had the procedure performed for pain palliation (4/7), with resolution of symptoms in all of them (4/4) and without pain recurrence during follow-up between 3 and 21 months. Three patients were treated for local tumor control (3/7), with two having complete response (2/3) and one having partial response (1/3). Follow-up with scintigraphy in five patients showed no recurrence in two (2/5) and persistent disease in three (3/5). The major complication was a skin burn (second degree), with resolution in 1 month.
Conclusion: There is no consensus regarding the treatment of isolated sternal metastases in breast cancer; although it is currently regarded as stage IV (AJCC) disease, they appear to have a good distant disease-free survival. Cryoablation is a safe and palliative treatment, which is effective for pain relief and likely to be effective for local tumor in sternal metastases. The procedure becomes safer and more effective, as experience increases and if some technical aspects are considered.

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Ultrasound-guided removal of foreign bodies: personal experience

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Purpose: To describe a technique for the ultrasound-guided removal of a foreign body (FB) and to demonstrate its advantages over the standard surgical procedure.
Material and Methods: One hundred fifty-five patients (107 males and 48 females aged 9–65 years; median age, 31 years) presented at our institution between June 2009 and December 2014 with suspected foreign bodies retained in the soft tissues of various body districts. Radiographic and/or ultrasound diagnosis was established by a radiologist expert in musculoskeletal sonography. The FB ultrasound-guided removal was performed in outpatients using high-frequency linear-array probes, sterile material, local anaesthetic (lidocaine 2%), scapels and surgical forceps. Antibiotic prophylaxis with amoxicillin and clavulanic acid were prescribed to all patients for 7 days after the procedure.
Results: Technical success was 100%, and 155 FBs (59 glass, 50 metal, 27 vegetable, 10 plastic and 9 stone) were successfully removed under ultrasound guidance in all patients. The procedure took between 15 and 30 min. No complications arose either during or after the procedure. Skin sutures were used in 4/155 cases.
Conclusion: Ultrasound-guided removal of an FB retained in the soft tissues is a good alternative to surgery as it is relatively straightforward, inexpensive and repeatable and carries a low risk of complications. These encouraging results suggest ultrasound-guided removal as the first-choice of procedure for the extraction of foreign bodies.

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Percutaneous screw fixation plus cementoplasty in the treatment of painful bone metastases: preliminary experience

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Purpose: To retrospectively evaluate the feasibility and effectiveness of CT-guided percutaneous screw fixation plus cementoplasty (PSFPC) in patients with painful bone metastases.
Material and Methods: Twenty-five patients (10 men and 15 women, median age 57 years) with 27 metastatic bone lesions from breast cancer (12), NSCLC (5), multiple myeloma (7), thymoma (1) and renal cell carcinoma (2) with painful pathological fractures or high risk of fracture underwent CT–guided PSFPC. Twelve metastases were located in the vertebrae, 12 in the pelvis and 3 in the femurs. Nine patients underwent to tumor ablation before the osteosynthesis. We analyzed the feasibility and complications of the procedure, the decrease in pain using VAS score, the walking ability classified in worse, unchanged and improved and length of hospital stay.
Results: All sessions were completed and all procedures were well tolerated. PSFPC was performed under local anesthesia and conscious sedation in all patients. There were no complications related to incorrect positioning of the screws or leakage of cement. All patients were able to walk within 6 hours after the procedure. The average length of hospital stay was 2 days. VAS score decreased from 7.1 (range, 4-9) before treatment to 1.6 (range, 0–5) 6 months after. No new bone fracture occurred during a median follow-up of 6 months (range, 2-9).
Conclusion: Our results suggest that PSFPC is a safe and effective procedure which allows to stabilize the fracture and prevent the pathological fractures with a significant pain relief and good recovery of walking ability. PSFPC seems to be a promising alternative to surgery.

P-69

Transfacet infiltrations: a new concept that opens new horizons...

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Learning Objectives:
1. To demonstrate the relevance of facet joint infiltrations under CT guidance for the management of radicular pain.
2. To explain how to optimize such facet joint infiltrations at cervical, thoracic, or lumbar levels in order to reach the spinal nerve root target.

Background: Facet joint infiltrations often constitute the first minimally invasive option for treating facet joint conditions. Such approaches may also be used in epidural or foraminal infiltrations aiming to treat discoradicular conflicts, as well as in foraminal or spinal canal stenosis, avoiding the use of epidural or foraminal spaces access.

Clinical Findings/Procedure: During facet joint infiltrations procedures, a leak of contrast media is often seen in periarticular spaces (in the epidural area, in the ipsilateral foramen, in the spinous joint recess, or sometimes in the controlateral facet joint); and exceptionally, contrast leaks have been observed in the intrathecal space (this raises other issues limiting injection of some types of corticosteroids). These "extravasations" of contrast media are most often concomitant with the intended intra-articular contrast injection. Thus, these extra-articular passages may technically be produced on purpose to obtain close contact with the targeted nerve roots. These facet joint infiltrations become therefore "transfacet infiltrations."

Conclusion: Facet joints constitute avascular sanctuaries and may also offer a safe approach to infiltrations for sciatic, crural, intercostal, and cervicobrachial neuralgias by using "facet joint plus infiltrations," namely "transfacet infiltrations." They may also be used as the first-choice treatment for periradicular spinal infiltrations, and can be performed on patients under antiplatelet treatment without increased spinal canal bleeding risk.

P-70

Specific approach to imaging criteria and vertebroplasty procedure in patients with multiple myeloma

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Learning Objectives:
1. How to evaluate MRI findings in patients with multiple myeloma (MM) and how to avoid usual mistakes in analysis?
2. What should be the inclusion criteria for vertebroplasty in patients with MM?
3. Specific approach to and complications of vertebroplasty procedures in MM.

Background: Percutaneous vertebroplasty is used for the treatment of painful benign vertebral compression fractures and also for patients with MM who are at a high risk for vertebral compression fracture due to osteoporosis. Many restrictions have prevented larger studies in this population; therefore, this specific area of intervention lacks diagnostic, inclusion, and procedure guidelines. The main drawback of MRI is the lack of specificity. Focal or diffuse patterns may exist at diagnosis and may be a variation of the norm or reflect an alternative pathological or physiological process. Also, procedural complications tend to appear more often and require specific approach and care.

Clinical Findings/Procedure: Compression fractures in patients with MM are almost equally often in vertebrae affected directly by myelomatous lesions and vertebrae that show no direct signs of involvement on MRI. Acute compression fractures in osteoporosis and MM generally mount a reparative response with edema. However, edema with MM may be decreased or even absent. Outcomes after vertebroplasty in MM show similar, yet different, results than after the same procedure in benign fractures.

Conclusion: Vertebroplasty is an effective method of pain treatment that allows reduction of narcotic use in patients with MM, but due to its specific nature and variable appearance, it requires additional diagnostic and procedural attention.

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Imaging-guided hip viscosupplementation: what an interventional radiologist should know

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Learning Objectives:
1. To briefly review the indications for hip viscosupplementation (VS) as a local treatment for symptomatic osteoarthritis (OA).
2. To review the action of intra-articular hyaluronic acid (HA) injection and also which forms of HA are available.
3. To illustrate the intra-articular hip joint injection technique with fluoroscopy and ultrasound used in our center.
4. To discuss the role of interventional radiology (IR) on hip VS.

Background: VS is the intra-articular administration of preparations containing HA, intended to restore the normal biological properties of HA normally found in the synovial fluid. It has been used in humans for more than 30 years, mainly for knee OA but increasingly for other joints. Its use for hip OA is a more recent technique than that for knee OA due to the greater technical difficulty of infiltration in the hip, which requires imaging guidance.

Clinical Findings/Procedure: Describing our institution's experience, we will present several selected cases of hip VS, explaining our technique protocol step by step. We will also demonstrate the utility of imaging not only as guidance to the correct articular injection but also in selecting the right patients by radiographic criteria.

Conclusion: Imaging-guided intra-articular VS is a feasible and safe procedure, providing significant relief from pain in patients suffering from hip OA. Imaging guidance allows knowing the precise anatomic location of the HA, an important factor in both investigation and interpretation of patient response. Based on our experience, IR should be part of an integrated multidisciplinary team in the management of hip pain control.

P-72

Percutaneous epidural adhesiolysis for cervical radiculopathy

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Learning Objectives: To describe useful techniques of effective percutaneous epidural adhesiolysis (PEA) for cervical radiculopathy.

Background: Since the Racz catheter was developed in 1982, PEA using the Racz catheter is sometimes much more effective than conventional epidural steroid injection for cervical disorders causing neck pain and/or radiculopathy. But placing a catheter tip at the accurate site is still a problem because the catheter is thin and flexible. For successful treatment, approaching techniques are necessary.

Clinical Findings/Procedure: The patient lies in the prone position. After checking the cervical levels with C-arm, the needle insertion site is marked. For cervical PEA, the contralateral approach has been used but the ipsilateral approach is an easier way to reach the target area based on my experience of 115 cases. The entry point depends on the targeted cervical level. If the target area is C6-7, the entry point is approximately T2 lamina. For the C5-6 level, T1 lamina on C-arm view is marked. The entry point for the C4-5 level is same as for the C5-6 level but slightly closer to the midline. An RX-2 epidural needle is introduced with the needle tip facing down. After touching the lamina, the needle tip slides into the C6-7 or C7-T1 space. After confirmation with epidurography, a Racz epidural catheter is advanced through the needle into the targeted region. Contrast medium is injected to confirm the nerve root and the filling defect; then, hyaluronidase and dexamethasone are injected.
Conclusion: The ipsilateral approach and different entry points are helpful techniques to improve the success rate of cervical PEA.

P-73

The role of IR in the treatment of benign bone and soft tissue tumours: current status

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Learning Objectives:
1. To describe the percutaneous techniques that can be used in cases of benign bone and soft tissue tumours.
2. To specify the indications for each technique and report their advantages, limitations and clinical success.

Background: Despite their benign characteristics, these tumours can cause significant pain and pressure on adjacent structures and impair patients' everyday activities. Imaging-guided techniques, as an alternative to surgery, are minimally invasive with excellent treatment outcomes and less associated morbidity, especially for difficult cases near vital structures where surgery may not be an option.
Clinical Findings/Procedure: We retrospectively reviewed the benign bone and soft tissue tumours treated in our department during the last decade. These tumours include osteoid osteomas (OO), chondroblastomas, osteoblastomas, aneurysmal bone cysts, aggressive vertebral hemangiomas (AVH) and neurinomas.
- Small-sized OO were treated with laser photocoagulation.
- Radiofrequency, microwave or cryoablation was used for larger-sized lesions.
- Cryoablation has the advantage of visualisation of the ablation zone with CT or MR imaging, thus reassuring complete lesion coverage and permitting safe ablation of lesions in proximity to nerves.
- We reserved sclerotherapy for cases of AVH with paravertebral extension.
- Thermal insulation, temperature monitoring and functional control/electrostimulation of the neural structures at risk was applied when the distance of the lesion structure at risk was <2cm.
- In cases of lesions on load-bearing bones, cementoplasty was used alone or in combination with the ablation technique.

Conclusion: Percutaneous techniques can be considered as the first or alternative treatment choice in cases of benign bone and soft tissue tumours.

P-73a

Various approaches for coaxial CT-guided percutaneous biopsy of vertebral lesions: review of anatomic and technical considerations

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Learning Objectives: The study aims to discuss appropriate access route planning with various approaches for coaxial CT-guided biopsy of vertebral lesions to maximize patient safety and optimize diagnostic yield as well as to recognize the advantages of using different coaxial needles for the same.
Background: Percutaneous CT-guided biopsy of vertebral lesions remains challenging because of the risk of injury to major neurovascular structures and the spinal cord.
Clinical Findings/Procedure: The classical transpedicular approach is usually preferred for thoracic and lumbar vertebral lesions. For cervical spine lesions with complex cervical spine anatomy, we usually prefer anterolateral approaches. Lateral or parapedicular approaches are also used depending upon the location of vertebral lesions with advantage of avoiding injury to the cord and exiting nerve roots. For lytic lesions or lesions with paravertebral soft tissue, Cook's Trucut core biopsy needle is used; sclerotic lesions are biopsied with Murphy's bone biopsy needle; and Ackerman bone biopsy needle is used when more tissue is required for diagnosis.
Conclusion: Familiarity with normal cross-sectional anatomy of the spine facilitates the planning of a safe access route to avoid injury to major adjacent neurovascular structures. Overall thorough understanding of the advantages and disadvantages of each approach helps us in targeting the inaccessible-looking lesions with great accuracy and achieving a greater positive rate of diagnosis.

P-74

Retrograde transpubic (RTP) approach for percutaneous acetabular radiofrequency ablation and cementoplasty

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We report a case of disabling acetabular metastasis treated with thermoablation and cementoplasty. We used the RTP approach under dual guidance. We describe this technique, detailing its indications, advantages, and the technical tips to achieve a safe and satisfactory procedure.

P-75

Percutaneous CT-guided cryoablation as an alternative treatment for an extensive pelvic bone giant cell tumor: a case report

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A 45-year-old man presented with a large giant cell tumor of the pelvic bone refractory to clinical treatment (denosumab) and who refused surgery (hemipelvectomy) underwent percutaneous CT-guided cryoablation with successful results, as observed in almost 3 years of follow-up.

P-76

A rare case report: percutaneous vertebroplasty for a patient with traumatic cervical vertebral body fractures

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A 75-year-old male presented with severe neck pain due to post-traumatic C6 compression fracture with pseudoarthrosis. His comorbidities contraindicated surgical fixation. We performed percutaneous vertebroplasty with local anesthesia subacutely, resulting in excellent pain relief and long-term stability.

P-77

Successful treatment of a cerebral spinal fluid (CSF) leak by the injection of NBCA through a 4-F vertebral catheter placed in the epidural space

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We report a case of a female who presented with postural headache. Imaging showed a CSF leak at C7-T1 with intracranial hypotension. The leak was successfully treated by NBCA injection through a 4-F vertebral catheter placed in the epidural space.

Clinical practice development

P-78

Safety and efficacy of capnography monitoring during procedural sedation for percutaneous hepatobiliary procedures

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Purpose: To evaluate the efficacy of capnography (measure of partial pressure of CO_2 in the exhaled breath) in addition to standard monitoring for detection of hypoxic events during procedural sedoanalgesia (PSA) for percutaneous hepatobiliary procedures (PHP).
Material and Methods: Patients aged 18-80 after excluding those with ASA IV, cardiovascular instability, hypoxemia, pre-existing need for supplemental O_2, undergoing PHP under IV fentanyl+propofol PSA with standard monitoring (SpO_2, BP, HR, and EKG) were retrospectively compared with a group in which capnography was added, for detection of intraprocedural hypoxic events (SaO_2<90%, $EtCO_2$>10% baseline). HR, SpO_2, NIBP, and EKG changes were examined for both groups. Capnography was recorded in the study group. O_2 with a nasal cannula (with a CO_2 sampling line) was administered at 3L/min. Incidence of respiratory depression (SaO_2<90%), bradycardia (HR<50/min), and hypotension (systolic blood pressure <90mmHg) were recorded for both groups. Reduction of end-tidal CO_2>10% of baseline and absence of exhaled CO_2 were classified as respiratory depression.
Results: A group of 117 patients with similar demographics, clinical, and procedural characteristics, with capnography added to standard monitoring during PSA for PHP, were retrospectively compared to a preexisting cohort (n=123) of similar cases who received standard monitoring only. Sedation-related respiratory depression occurred at similar rates in both groups (35 vs 32.5%). Capnography-detected respiratory depression significantly (>60 sec) preceded clinical hypoxia (SpO_2<90%) in 28% (n=33) patients, allowing early interventions (O_2 increase and/or assisted ventilation) that significantly reduced the incidence of desaturation in the capnography group (P<0.001).
Conclusion: Capnography enhances early detection of hypoxic events during propofol-fentanyl PSA for PHP, allowing a safer and effective timeline for ventilatory interventions.

P-79

Interventional radiology day ward: the experience of a tertiary centre

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Purpose: A dedicated interventional radiology day unit (IRDU) was recently established at our hospital to improve patient care. This study aimed to assess the cost-effectivenes of this approach.
Material and Methods: Data regarding unit utilisation, discharge times and complications were retrospectively collected (01.03.2013 to 31.03.2014). By monitoring the activity going through the IRDU and applying a contribution margin to the freed-up beds, the financial performance was measured. Satisfaction survey questionnaires were sent randomly by post to 100 patients, previously admitted to the IRDU.
Results: During the studied period, 1513 patients were admitted to the unit. The mean utilisation of the IRDU was 80% and ranged between 68% and 92%. Given this utilisation rate of the IRDUs, seven beds from a total of 1400 inpatient bed days were freed over 1 year. From the obtained financial data, it was estimated that for the financial year 2013–2014, the IRDU managed to achieve a total of £470k as savings for the Trust. The return rate to our patient satisfaction survey was 40%. All patients were satisfied with their overall IRDU experience. The majority of the patients (79%–100%) were satisfied with various aspects of the service. No cancellations or breeches were reported.
Conclusion: The IRDU has brought significant benefits for the patients and hospital without compromising the quality of care. The unit brings the diagnosis and treatment of the IR patients under the same roof, offering more efficient patient management and reduction in costs.

P-80

Preliminary experience of using an intelligent needle planning device for CT-guided non-vascular interventions

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Purpose: CT-guided interventional procedures have been widely performed by interventional radiologists in the past decades. In order to elevate the accuracy of needle puncture and reduce scanning times, an intelligent needle planning device was used to help CT-guided puncture for interventional diagnosis and treatment.
Material and Methods: Totally, 60 non-vascular procedures were performed under CT guidance using the needle planning device ROBIO from Dec 2012 to Dec 2013 including 31 patients for biopsy, 15 for liver radiofrequency ablation, 9 for cyst drainage and 5 for liver radioactive seed implantation. The aiming accuracy, puncture and localisation times and complications were recorded.
Results: We achieved successful puncture of 58 patients with only one design; however, two procedures failed while using ROBIO, including one case of lung biopsy and one case of cyst drainage. Mean localisation time of lung biopsy was 13.8±4.1 min, and mean puncture times were 1.1±0.2. Puncture accuracy was less than 5 mm in 16 punctures, 5–10 mm in 3 punctures and 12 mm in 1 puncture.

The mean puncture times were 1.6±0.8, 1.7±0.7, 1.1±0.4 and 1.9±0.8 in liver biopsy, liver radiofrequency ablation, liver cyst drainage and liver radioactive seed implantation, respectively. Complications occurred in 7 cases: pneumothorax in 2 (1 severe pneumothorax needed thoracic tube insertion), haemothorax in 1 and liver bleeding in 4.
Conclusion: ROBIO-assisted CT-guided interventional procedure is a convenient and safe method due to high accuracy and reduced scanning times. More clinical data should be collected for the purpose of obtaining a comprehensive evaluation of the intelligent guiding device in our further work.

P-81

Block balloon technique for superselective catheterization of hardly accessible arterial branches

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Purpose: Block balloon technique (BBT) is applied for superselective catheterization of hardly accessible arterial branches under temporary balloon occlusion of the parent arteries. This retrospective study is to evaluate the safety and efficacy of the newly developed technique.
Material and Methods: BBT was conducted for selective catheterization of five targeting arteries (right inferior phrenic artery in two and inferior pancreaticoduodenal, accessory middle colic, and left hepatic artery in one each) in five adult patients. The procedures were intended for embolizing hepatic tumors in two, arterial hemorrhage in two, and type II endoleak in one. Preceding conventional manners, including the side-hole technique, failed to select targeting arteries arising steeply from the parent arteries. The procedure of BBT was as follows: manipulating balloon and microcatheter from individual transfemoral control; positioning balloon catheter in the distal side, where the parent artery delivers the targeting artery; inflating balloon to block the parent artery until introducing a microcatheter toward the targeting artery; and executing superselective embolization. Detail procedures, technical feasibility, and procedure-related complications were evaluated retrospectively.
Results: A 5-F, 9-mm-φ balloon catheter was employed for the celiac artery in two and for the superior mesenteric artery (SMA) in two; and a 2-F, 5-mm-φ balloon catheter was employed for the right hepatic artery in one. Interventional procedures were successful in all patients. Vasovagal reflex occurred during balloon occlusion of the SMA in one, and it disappeared after the balloon deflated. Arterial injury or other complications were not seen.
Conclusion: BBT seems safe and efficacious for superselective catheterization of hardly accessible arterial branches.

P-82

Evaluating embolic agent administration using a novel vascular flow simulation model

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Learning Objectives: Use of a novel vascular flow simulation (VFS) model as a tool for the IR to evaluate handling, administration, and flow characteristics of different particulate and liquid embolic agent formulations.

Background: We have developed a VFS that has a transparent vascular phantom, which is directly visualized by the operator. The vascular network bifurcates into 6 vascular subunits that can act as separate embolizable target sites that become occluded with the embolic agent, resulting in concurrent flow changes in the vascular subunit.
Clinical Findings/Procedure: Catheterization is via a hemostatic valve and allows for proximal or selective catheterization using commercial microcatheters. The VFS allows the IR to explore such parameters as the effect of catheter tip placement, blood flow rate, injection rate, embolic concentration, and desirable "end points." The viewing window allows the physician to observe first-hand the effects of embolization on the flow in the targeted subunit, as well as reflux and non-target embolization. Lipiodol® and microspherical embolic agents have been evaluated on the VFS and compared to fluoroscopic recordings of the same formulations delivered in various in-vivo models of hepatic artery embolization. There was an excellent correlation between the observed flow dynamics of the embolic formulations in the VFS and that captured on fluoroscopy.
Conclusion: The VFS provides the IR with a tool to observe directly the effects of administration technique and formulation variation on the flow behavior of embolic agents predictive of the in vivo situation.

P-83

Magnetic resonance imaging-guided prostate biopsy versus systematic transrectal ultrasound-guided prostate biopsy in men with elevated prostate-specific antigen

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Learning Objectives: Low ADC values increase the probability for precise sampling and detection of clinically significant cancer.
In borderline cases, such as highly elevated PSA and negative TRUS biopsy, multiparametric MRI has an important role.
Background: Prostate MRI offers an alternative to the elevated PSA/negative TRUS biopsy dilemma. The apparent diffusion coefficient (ADC) value is a quantitative parameter of DWI, representing water diffusion in extracellular and extravascular spaces and capillary perfusion. Recent studies concluded that ADC measurement can differentiate malignant prostate lesions from benign prostatic tissue. The diagnosis of prostate cancer has been mainly based on TRUS-guided biopsy. However, TRUS-guided biopsy is reported to have a false negative rate of 40%.
Clinical Findings/Procedure: This study included 50 patients with high serum PSA who underwent prostatic MRI examination with ADC mapping. After 1.5-T MRI, patients were referred for standard systematic TRUS biopsy (12 cores), followed by MRI-directed biopsy of prostate lesions (maximum 4). Targets were chosen based on ADC values, measured on fused axial T2 images and ADC maps. The physician performing ultrasound-guided biopsy reviewed the lesions seen on MRI and used this knowledge to direct the biopsies. MRI-guided biopsies provided higher detection rate (82.1%) for significant prostate cancer than TRUS biopsies (74.1%). Subsequent MRI-guided biopsy required significantly fewer cores and revealed a higher percent of cancer per biopsy core ($p < 0.05$).
Conclusion: The use of the ADC map for guiding prostate biopsies could improve prostate cancer detection rate and has the potential to reduce the sampling error associated with conventional biopsy.

P-84

Biliary intervention: analgesia and sedation – is it good enough?

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Learning Objectives: Percutaneous biliary interventions are high-risk procedures. Are we providing adequate analgesia and sedation? We have performed a regional survey of interventional radiologists' practice for biliary IR across South West UK, and we discuss the importance of anaesthetist-administered analgesia and sedation.
Background: This is a regional survey of 20 independent acute NHS trusts across SW UK. Both interventional radiologists and IR nurses were contacted initially by telephone and then with an automated electronic survey system. Questions were asked concerning patient pain and movement and whether anaesthetic support would be of value or was available. Data from interventional radiologists and IR nurses were analysed separately.
Forty-nine interventional radiologists and 20 IR nurses replied.
Clinical Findings/Procedure: Among the interventional radiologists, 84% claimed a preference for an anaesthetist to be present (36% claimed this never occurred, and 42% had an anaesthetist for only specific patients). Only 2 institutions had routine cover. Further, 63% felt that patients experienced moderate to severe pain; 41% claimed pain and significant movement during the procedure. Of the IR nurses, a similar percentage (56%) thought that patients experienced moderate to severe pain. Only 25% interventional radiologists and 57% IR nurses felt analgesia and sedation were good or satisfactory. Half of both IR nurses and interventional radiologists denied having formal training for sedation or powerful analgesic use.
Conclusion: Pain and, to a lesser extent, movement are suboptimal aspects of patient care in biliary IR. There is a need for increased anaesthetist-supported IR lists and for structured training in analgesia and sedation for both interventional radiologists and IR nurses.

P-84a

The FIRST checklist for learning procedures

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Learning Objectives: Despite the rapid progression of the speciality, training in IR has remained largely unchanged, relying on the apprenticeship model of 'see one, do one, teach one'. However, the increasing complexity and range of procedures, along with the increasing emphasis on patient safety, demand a more efficient and less risky training approach. We review the literature and propose a new structured method for teaching procedures.
Background: Recently published IR curricula from the UK's RCR and Europe's CIRSE specify practitioner competencies but do not specify how they are best delivered. In the absence of guidance, there remains a wide range of approaches and effectiveness in the teaching of procedures.
Clinical Findings/Procedure: We have reviewed the models that have been described in the teaching of technical skills and have developed the Five-step IR Structured Training (FIRST) checklist: 1 Overview; 2 Demonstration; 3 Explanation; 4 Rehearsal and 5 Performance. This provides a structured, goal-orientated approach to learning procedures that aims to optimise efficiency and patient safety. We have used the FIRST checklist to train a cohort of six nurses in PICC line placement and assessed their perception of the training structure via self-reported questionnaire. We compared the results with those of radiology residents who have undergone traditional PICC line training.
Conclusion: Our results demonstrate that trainees find the FIRST checklist to be a safer, more efficient and preferable alternative to the traditional apprenticeship approach. We envision that the structured procedural training will become the standard of care to best look after the needs of trainees and patients.

P-85

Successful hybrid interventional radiology for complications after pancreaticoduodenectomy

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A 63-year-old woman with portal vein thrombosis and ruptured pseudoaneurysm of a gastroduodenal stump after pancreaticoduodenectomy successfully underwent stent placement in the portal vein via ileocecal approach and percutaneous coil embolization for the pseudoaneurysm at a hybrid operating room.

P-86

Percutaneous transpancreatic endoprosthesis (PTE) for a malignant pancreatic duct obstruction

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PTE was efficacious for managing an intractable pancreatitis caused by cancerous pancreatic duct obstruction. Percutaneous transpancreatic catheter traversed the obstruction to make a pull-through route via transduodenal access. Then, a 6-F, 10-cm endoprosthetic catheter was implanted successfully in the pancreatic duct through the duodenum.

P-87

Mechanical recanalization of bilateral fulminant pulmonary embolisms under ECMO using the aspiration technique

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We present the case of a patient who underwent removal of a large petrous bone meningioma and subsequently developed fulminant bilateral pulmonary embolism. She was treated interdisciplinarily under ECMO using the endovascular aspiration technique. Alternatives and pitfalls will be discussed.

Clinical practice development

P-88

Percutaneous irreversible electroporation of locally advanced pancreatic carcinoma using the dorsal approach

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A 76-year-old patient was referred for percutaneous irreversible electroporation (IRE) of an unresectable pancreatic tumor. Because ventral electrode placement was dangerous due to collateral vessels, electrodes were placed paravertebrally alongside the aorta and inferior vena cava. IRE was successfully performed.

P-89

Percutaneous irreversible electroporation (IRE) for recurrent thyroid cancer

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A 74-year-old patient presented with a third local recurrence of follicular thyroidal carcinoma after extensive surgical resection and radiation therapy. Since all established focal therapies were contraindicated, irreversible electroporation was successfully performed. At 7 months, there was no residual vitality.

Dialysis intervention and venous access

P-90

Endovascular treatment of previously untreated dysfunctional radial-cephalic fistulas

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Purpose: To show our experience in a study of the treatment of dysfunctional radial-cephalic fistulas in patients referred to the vascular department for the first time.
Material and Methods: Over a 15-year period, we performed 411 percutaneous transluminal angioplasties (397 patients) in radial-cephalic fistulas that had never previously been treated by radiological or surgical means. Fifty-three percent of these fistulas were less than 1-year old at the time of angioplasty. Low-flow was the most frequent etiology of fistula dysfunction (63%). There were 33 thrombosed fistulas (8%) in which clots were removed by manual catheter-directed aspiration. There were 50 immature fistulas (12.2%). High-pressure balloons (81%), cutting balloons (5%), and cryoplasty balloons (11%) were used to dilate stenoses.
Results: Eighty-four percent of stenoses were located in the anastomotic area. In 1.5% cases, some stenoses in the radial artery were dilated. Nine percent of the lesions dilated were occluded. The initial success rate was 96.6%. Primary and secondary patency rates were 57% and 76% at 1 year and 35% and 55% at 2 years, respectively. Better patencies were achieved with high-pressure balloons. At least one more dilatation was performed in 46% of the fistulas during follow-up.
Conclusion: Surgery is the traditional treatment for perianastomotic stenoses in radial-cephalic fistulas. However, endovascular treatment of perianastomotic stenoses in radial-cephalic fistulas is a better option for increasing the average functional life of an access.

P-91

Ultrasound-guided angioplasty of dysfunctional vascular access: the pros and cons

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Purpose: To report the final results of a prospective study on 189 duplex scan-guided balloon angioplasty cases for failing or nonmaturing arteriovenous access.
Material and Methods: One hundred thirty-two failing or nonmaturing arteriovenous access (106 radial, 1 ulnar, 21 brachial, and 4 PTFE) underwent 189 ultrasound scan-guided balloon angioplasties. Access site puncture and cannulation with short sheath, wire, and balloon advancement and inflation were guided by duplex scan only. A success criterion was the non-use of fluoroscopy during the procedure.
Results: One hundred twenty-seven procedures (67%) were successfully completed without fluoroscopy and contrast material. Most failures were due to a difficulty to traverse aneurysmal and tortuous segments by ultrasound control as well as anastomotic stenoses. The primary patency rate at 6 and 12 months and two years was 75 ± 3%, 41 ± 3%, and 14 ± 2%, respectively. The secondary patency rate at 6 and 12 months and two years was 85 ± 3%, 62 ± 4%, and 27 ± 4%, respectively.
Conclusion: This experience suggests that the endovascular repair of AV access under duplex scan guidance is feasible and safe. The superficial location of AV access facilitates duplex scan visualization. This proposed approach averts contrast material use and radiation exposure. Despite this, technical problems that appeared during the procedures force us to be more cautious in advising this mode of treatment.

P-92

Is prostatic artery embolization (PAE) an effective treatment to remove indwelling bladder catheters (IBC) in patients with benign prostatic hyperplasia (BPH) unsuitable for surgery?

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Purpose: Assess the efficacy and safety of PAE as an alternative treatment to remove IBC in patients with BPH.
Material and Methods: A prospective study was conducted from November 2013 to May 2014. Inclusion criteria: patients unfit for surgery, IBC (for at least 3 months), and BPH. Exclusion criteria: bladder or prostatic cancer. Superselective PAE was performed according to Carnevale's technique. Technical success: bilateral embolization. Clinical success: IBC removal.
Results: We performed PAE in 18 patients (mean age 77.2). Mean procedure time: 51min. Mean dose-area product (DAP): 818.5mGy/cm^2 (range 439-2023mGy/cm^2). All patients were discharged the day after procedure. There were no intraoperative or peri-procedural complications. Technical success: 16 patients (88.8%); primary bilateral embolization was possible in 15 patients. PAE was performed unilaterally because of anatomical problems. Mean follow-up was 6.4 months (range 4.5-11.6 months). Five patients (27.7%) complained urethral burning 48 hours after the procedure; 2 (11.1%) had urinary tract infection first month after catheter removal; 4 (22.2%) acute urinary retention episodes were treated with catheter

positioning, definitively and successfully removed after 15 days. Clinical success: 17 patients (94.4%). Catheter was removed 17 days after PAE (range 15-31 days). The medium prostate volume before procedure was 80.18cc (range 34-165cc). Post-PAE imaging is available for 10 patients (55.5%); prostate volume reduction was statistically significant 62.53cc (range 38-123cc), p=0.0078. Also, PSA was significantly reduced (2.25ng/ml to 0.89ng/ml, p=0.0156).
Conclusion: PAE is feasible, safe, and efficacious in patients with IBC and severe comorbidities. PAE may play an important role in patients in whom medical therapy has failed and who are not candidates for surgery.

P-93

Long-term outcomes of percutaneous transluminal angioplasty in immature autogenous arteriovenous fistula patients

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Purpose: To evaluate the technical feasibility, long-term clinical outcomes of immature arteriovenous fistula (AVF) after percutaneous transluminal angioplasty (PTA) and to analyze the risk factors affecting patency.
Material and Methods: Between October 2003 and April 2013, a total of 40 patients (M:F=20:20; mean, 62 years) with immature AVF were referred for PTA at our institute. Fistulography and ultrasonography were performed to evaluate the stenosis or occlusion of immature AVF. Thereafter, PTA was performed with the retrograde transvenous approach and balloon catheter. Technical/clinical success rate was evaluated and primary/secondary patency of AVF was estimated using Kaplan–Meier analysis. Risk factors (immature time, stenotic portion, balloon size, rupture of vein, and accessory vein) for patency was analyzed with the log-rank test. All medical records were retrospectively reviewed.
Results: Technical and clinical success rates were achieved in 100% (40/40) and 95% (38/40), respectively, without any significant complication. Vascular ruptures occurred in 10% (4/40), but hemostasis was achieved by the balloon catheter tamponade. One-year primary and secondary patency rates of the 40 patients were 57% and 81%, and the estimated average and median patency were 1165 and 1038 days. There were no significant predisposing factors for patency by the log-rank test.
Conclusion: PTA of immature AVF has good clinical results and patency, even in rupture cases. Also, there was no significant risk factor affecting patency in our study.

P-94

How to stay sharp: the who, how, and why of sharp recanalization for venous occlusions

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Learning Objectives:
1. Describe the spectrum of central venous occlusions (CVOs) and the indications for sharp recanalization (SR).
2. Describe the technique of and materials required for SR. Discuss innovative/emerging ways of performing SR.
3. Discuss the pearls/pitfalls of SR.

Background: CVOs are commonly seen in patients on hemodialysis and with certain malignancies. Dialysis-related trauma to veins and repetitive line insertions often lead to CVOs, which can interfere with hemodialysis and central venous access. Obstruction by tumors and strictures from their treatments can also lead to CVOs. CVOs may cause serious symptoms, including swelling, headaches, and visual problems. Although standard recanalization methods have a high success rate, crossing CVOs may require the use of an SR technique.
Clinical Findings/Procedure: Once standard techniques have failed, SR is considered. Two venous access points are achieved, allowing catheter placement on each side of the occlusion, which is mapped by simultaneously injecting both catheters. The downstream catheter is then replaced with an SR set. Use of a TIPS set, 20–22-G puncture needles, back of a stiff wire, re-entry, and radiofrequency catheters has been described. Puncturing from the low- to high-pressure vessel is recommended. The set is advanced towards an upstream target, including catheters, snares, inflated balloons, and guidewires. Once the target is reached, intraluminal positioning is confirmed. Through-and-through access is achieved, allowing for angioplasty and stenting.
Conclusion: When routine techniques fail, SR, using tools in the angiography suite, is an effective way of restoring flow through CVOs, allowing for relief of associated symptoms and improvement of dialysis access function.

P-95

Peritoneal dialysis: the role of the radiologist from the placement of the catheter to complications

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Learning Objectives:
1. Review the technical implementation of the peritoneal catheter by the interventional radiologist at our center.
2. Learn to recognize the imaging characteristics of the peritoneal dialysis catheter: it is important for the radiologist to be familiar with common findings.
3. Recognize and review the types of complications using different imaging techniques.

Background: A retrospective study of 25 patients was performed in 2014. We reviewed the peritoneal dialysis catheters placed by the interventional radiology unit for the technique implementation for its proper functioning and possible complications with the different imaging techniques such as ultrasound and CT.
Clinical Findings/Procedure: Of the 25 patients reviewed, we identified multiple complications related to the following:
- Infection of both the entry point and the tunnel
- Malpositioning, kinking, and entrapment of the catheter by peritoneal adhesions
- Dialysate leak around the catheter
- Incisional hernias

Conclusion: Ultrasound allows a reliable assessment of the state of the tunnel. It has a good concordance between clinical findings and radiological images and is the method of choice for the start of the study of possible infectious complications. Therefore, it allows us to differentiate between deep and superficial complications, such as leaks and malpositioning, thus allowing dynamic studies without subjecting patients to invasive or ionizing techniques.

P-96

Sharp recanalization of a debilitating left subclavian vein occlusion using a TIPS needle

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A 34-year-old hemodialysis patient presented with recurrent debilitating left arm swelling. A 1-cm left subclavian vein occlusion failed routine recanalization techniques. Sharp recanalization with a Rösch-Uchida TIPS set crossing the lesion was performed, allowing for serial angioplasty, stenting, and rapid symptom improvement.

P-97

A rare successful treatment with the rendez-vous technique of complete efferent vein thrombosis of AVF after failure of traditional revascularization techniques

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We successfully treated using the rendez-vous technique a 70-year-old male with complete efferent vein thrombosis for 5 cm using double-access with a 4-Fr introducer sheath from above and 20-G cannula needle into the patent portion beyond the anastomosis, an 0.018-inch guidewire and a balloon-catheter.

P-98

A rare complication of indwelling haemodialysis catheters implanted in haemodialysis patients using a transhepatic approach: dislodgment of the catheter into the peritoneum

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Main complications of indwelling haemodialysis catheters implanted by a transhepatic approach are bleeding, infections and thrombosis. We present a rare complication of indwelling haemodialysis catheter implanted by a transhepatic approach in a patient with fistulas and central venous occlusion.

P-99

Implantation of indwelling haemodialysis catheters in the inferior vena cava using a balloon in a haemodialysis patient: a rare case

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We describe translumbar catheterisation of the inferior vena cava (IVC) by inflating a balloon in the IVC lumen for increased safety in a patient with chronic renal failure. This is the first article in literature which presents this technique.

P-100

Life-threatening complication after percutaneous transhepatic access for hemodialysis treated by embolization using the percutaneous transhepatic approach

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A hemodialysis patient who had exhausted all usable veins for vascular access underwent percutaneous transhepatic catheter placement. Ultrasound revealed blood in the abdominal cavity. Portography showed active portal vein bleeding. Embolization of the portal vein branch using direct puncture was successfully performed.

P-101

Management of misplaced central venous catheter

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We present a case of misplaced (anterior mediastinum) central venous catheter (CVC). With this case, we review the diagnosis and interventional management of such cases.

Embolotherapy (excluding oncology)

P-102

Clinical significance of pulmonary arteriovenous malformation reperfusion

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Purpose: To assess the clinical significance of reperfused pulmonary arteriovenous malformations (rPAVM) after embolization.
Material and Methods: This retrospective review examined patients who underwent PAVM embolization between January 1, 2006 and December 30, 2007, excluding patients with diffuse PAVMs. Clinical history, symptoms, and imaging findings were reviewed at the time of embolization as well as during follow-up through December 30, 2013, including note of any reperfused PAVMs. Symptoms were graded as mild (hypoxia-related events, anemia, migraine) and severe (TIA/stroke, septic emboli, hemoptysis, hemothorax).
Results: During the treatment period, 101 patients underwent PAVM embolization. Twenty seven underwent repeat embolization for reperfusion of previously embolized PAVM. None of these developed recurrent rPAVM during follow-up, but three other patients developed a new rPAVM, giving a total of 30 patients with rPAVMs. Eighteen patients were found to be symptomatic at the time of presentation with rPAVM. Three were excluded on the basis of respiratory manifestations felt not to be PAVM-related. Of the 15 remaining, 13 had at least one other significant PAVM at the time of diagnosis of reperfusion. Only 2 symptomatic patients had only rPAVM, both with mild manifestations. A Fisher exact test showed a statistically significant difference ($p=0.004$) between symptomatic patients with only rPAVM and those with rPAVM and other new PAVMs.
Conclusion: The majority of symptomatic patients with rPAVM had additional PAVMs requiring embolization. None of the symptomatic patients with only rPAVM had severe manifestations. This suggests that rPAVM plays a small role in patients with recurrent symptoms after embolization.

P-103

Transcatheter arterial embolization for hepatocellular carcinoma via collateral vessels using microspheres

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Purpose: Transcatheter arterial embolization (TAE) for hepatocellular carcinoma (HCC) using microspheres is commonly performed. However, the safety of TAE via collateral vessels (e.g., the right inferior phrenic artery) remains unknown. Therefore, we evaluated the safety of TAE for HCC via collateral vessels using microspheres.

Material and Methods: Microspheres were approved for clinical use in our country beginning in February 2014. Therefore, the patient inclusion criteria were as follows: 1) treatment between February 2014 and December 2014, 2) TAE performed for the management of HCC nodules, 3) TAE performed using microspheres, 4) TAE performed via collateral vessels, and 5) Eastern Cooperative Oncology Group (ECOG) performance status was 0 or 1. The safety was evaluated using Common Terminology Criteria for Adverse Events (CTCAE) ver. 4.0.
Results: Between February 2014 and December 2014, we performed 363 sessions of TAE. We performed TAE using microspheres in 76 sessions and TAE for HCC via collateral vessels in 22 sessions (18 patients). Collateral vessels utilized for treatment included 20 right inferior phrenic arteries, two left inferior phrenic arteries, two renal capsular arteries, one epicholedochal arterial plexus, one right adrenal artery, one right intrathoracic artery, one right intercostal artery, and one right gonadal artery. TAE was performed using DC beads in 17 sessions, hepasphere in four sessions, and embosphere in one session without major complications.
Conclusion: TAE for HCC using microspheres via collateral vessels was as safe as that performed via the hepatic artery.

P-104

Safety, technical success, and short-term outcomes of the microvascular plug for embolization of pulmonary arteriovenous malformations

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Purpose: To evaluate the safety, technical success, and short-term outcomes of the previously unreported use of the MicroVascular Plug (MVP) for embolization of pulmonary arteriovenous malformations (PAVM).
Material and Methods: Patients with PAVMs embolized with MVPs (Covidien, Irvine, CA) between September 2014 and February 2015 were reviewed. Technical success was defined as immediate intraprocedural angiographic occlusion of the feeding artery. Follow-up post-procedure angiography or contrast-enhanced computed tomography was obtained in all patients to assess for PAVM reperfusion or migration.
Results: The MVP was used in 6 patients to embolize the feeding arteries of 18 PAVMs. Two patients had neurologic symptoms and 2 had cardiopulmonary symptoms prior to treatment. Fifteen AVMs were simple and 1 was complex. The average feeding artery size was 3.0 mm. Two sizes were used (12 MVP-3 and 6 MVP-5). Technical success was 94%. One patient required immediate coil deposition proximal to the plug to achieve post-deployment angiographic stasis due to feeding artery tortuosity. There was no reperfusion noted on follow-up imaging. The average length of follow-up was 3 months. One patient had a symptomatic microembolus to the toe that resolved. There were no other complications.
Conclusion: The use of MVP for embolization of PAVMs has not been reported. MVP appears to be safe and results in a high rate of immediate angiographic occlusion and low rate of reperfusion. MVP is advantageous due to its resheathability, superselective distal microcatheter deployment, lack of need for proximal coil deposition, and immediate occlusion despite anticoagulation.

P-105

Geniculate artery embolization for the management of recurrent hemarthrosis: a single-center experience

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Purpose: The purpose of this study is to validate small-particle geniculate artery embolization (GAE) as a safe and effective technique for the management of recurrent hemarthrosis of the knee following total knee arthroplasty (TKA).
Material and Methods: IRB approval was obtained for this retrospective review of patients who underwent small-particle GAE. Patient charts were reviewed for a history of bleeding diatheses, use of anticoagulants, response to conservative therapy, and the threshold at which patients were referred to IR for GAE. Lower extremity angiography performed during GAE procedures were analyzed for consistency of technique. Procedural outcomes were evaluated for patients' improvement in pain, range of motion (ROM), and quality of life (QOL). The incidence of intra-procedural and post-procedural morbidity and mortality was also evaluated.
Results: Five patients aged 70-84 were treated with GAE because of development of pain, swelling, and loss of mobility following TKA. GAE using polyvinyl alcohol (PVA) particles (45-355 microns) was performed after a mean of 31 months following TKA. No bleeding diatheses were documented. All patients were referred to IR after a trial of failed conservative management, which involved repeated knee aspiration. Four of 5 patients (80%) responded after a single GAE, reporting decreased pain and improved ROM and mobility. One patient required an additional GAE and achieved satisfactory results after the second procedure. Patients universally reported a high degree of post-procedural satisfaction and improved QOL. There were no procedure-related complications.
Conclusion: Small-particle GAE is a safe and effective treatment for recurrent hemarthrosis of the knee following TKA.

P-106

Feasibility of "squashing deployment" of Amplatzer vascular plug II in short segment embolization

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Purpose: The Amplatzer vascular plug (AVP) II has three segments, including the central lobe and two discs on each side of the lobe. Each disc can be shortened and inverted by compression during deployment (squashing deployment), allowing for short segment embolization.
The purpose of this study is to evaluate the safety and efficacy of squashing deployment of AVP II.
Material and Methods: Between November 2013 and December 2014, 29 AVPs II were used in 23 patients to embolize the internal iliac artery (21) and the subclavian artery (8). The in vivo length of AVP II was compared with the in vitro length measured using the corresponding tube model. Further, the change of shape of AVP II by volume rendering image on follow-up CT was performed.
Results: Complete embolization was achieved in all sessions, although an additional metallic coil was used simultaneously in one session. Mean diameter of the selected AVP II was 80% larger than that of the target vessel (range, 33%–100%). Bilateral sides of discs were stuffed in 5 AVPs II (group 1), one side in 14 (group 2), and neither side in 10 (group 3). Mean shortening rates of AVP II in group 1, group 2, and group 3 were 42.1±9.7%, 30.2±7.5%, and 9.0±8.4%, respectively. No shape transformation of group 1 or 2 to 3 was observed on follow-up CT.

Conclusion: Squashing deployment was safe, and it could enable short segment embolization.

P-107

An exploratory study of transcatheter arterial embolization with microspheres for symptomatic enlarged polycystic liver

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Purpose: To assess the safety and effectiveness of transcatheter arterial embolization (TAE) with microspheres for patients with symptomatic polycystic liver (PCL).
Material and Methods: This prospective study was approved by the institutional review board of our hospital. Five patients (1 man, 4 women; mean age, 52.6±10.2 years) were enrolled. The chief complaints were markedly distended abdomen and gastrointestinal obstruction caused by an enlarged PCL. Hemihepatic embolization with tris-acryl gelatin microspheres was performed in the hepatic artery supplying the hepatic lobe that showed predominant presence of cysts. Each patient underwent assessment of liver function, questionnaire survey about symptoms, measurement of the estimated volume of whole liver and liver cysts before and at 3, 6, and 12 months after TAE, and assessment of complications associated with TAE.
Results: All five patients successfully underwent TAE. The left lobe was treated in three patients and the right in two. After TAE, post-embolization syndromes and transient elevation of white blood cells, aspartate aminotransferase, and alanine aminotransferase occurred in all patients, but none developed hepatic insufficiency or severe complications. The mean estimated whole liver volume was 7406±2323 mL and cyst volume was 6006±2443 mL before TAE, and changed to 90.8±12.9% and 93.3±9.8% of the pre-therapeutic value at 12 months after TAE, respectively. Three of five patients in whom contraction of the liver had been obrained reported significant improvement of clinical symptoms within 3 months after TAE.
Conclusion: These results suggest that TAE with microspheres might be a safe and effective treatment for symptomatic enlarged PCL.

P-108

Radiological diagnosis and interventional embolization of hemoptysis associated with peripheral pulmonary artery pseudoaneurysms

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Purpose: Hemoptysis could be a life-threatening emergency with high mortality rate. In rare cases, the source of bleeding is from pulmonary circulation. The aim of this study is to determine incidence, etiology, radiological diagnosis, and interventional embolization treatment outcome of peripheral pulmonary artery pseudoaneurysms (PAPs) in patients with hemoptysis.
Material and Methods: A retrospective review of all consecutive patients who underwent interventional embolization for massive hemoptysis between January 2009 and September 2014 was performed. Clinical and radiologic reviews of all patients with PAPs detected by multidetector row CT angiography (MDCTA), bronchial and non-bronchial systemic arterial angiography, and pulmonary angiography were analyzed.
Results: Among 104 patients, 8 PAPs (6.7%) were found in 7 patients (7 men; mean age, 49 years). The underlying pulmonary diseases were inactive pulmonary tuberculosis (n=3), prior thoracic trauma (n=2), pulmonary actinomycosis (n=1), and Hodgkin's lymphoma (n=1). Detection rate of PAPs on MDCTA, bronchial and non-bronchial systemic arterial angiography, and pulmonary angiography were 100%, 71.4%, and 50%, respectively. A total of 12 sessions of endovascular treatment, including transcatheter embolizations, percutaneous direct thrombin, and NBCA injections were performed with a successful rate of 85.7%. Rate of recurrent hemoptysis was 14.3%. Procedure-related complications, including rupture of pseudoaneurysm during treatment (n=1) and hematoma at puncture site (n=1), were detected.
Conclusion: MDCTA is an effective diagnostic tool, and it is useful for the treatment planning of PAPs, while catheterized bronchial and non-bronchial systemic arterial angiography and pulmonary angiography is not always promising for diagnosis. Interventional embolization is a safe and effective treatment for PAPs.

P-109

Long-term outcome of embolotherapy for pancreatitis-induced pseudoaneurysms

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Purpose: To assess the safety and long-term efficacy of catheter-directed embolization of pancreatitis-induced pseudoaneurysms and to analyze overall survival of these embolized patients.
Material and Methods: Patients referred for the endovascular treatment of a pancreatitis-induced pseudo-aneurysm between January 1998 and January 2014 were analyzed. All embolization procedures were performed by transcatheter techniques using different types of embolics. Demographic, technical-radiological, and clinical data were collected.
Results: Thirty-four patients were identified, with acute (n=13; 38%) or chronic (n=21; 62%) pancreatitis as underlying disease. 7 patients (20.6%) had an active bleeding when diagnosed, while in 27 patients (79.4%) the diagnosed pseudoaneurysm was not bleeding. In all 34 patients, successful endovascular exclusion of the pseudo-aneurysm was obtained after the first attempt without complication. The splenic artery was the most frequently affected vessel (n=12; 35%). A new pseudoaneurysm on a different vessel arose during follow-up in 3 patients (9%). In 1 patient (3%), the initially excluded pseudoaneurysm reopened during follow-up. All 4 recurrences occurred in the first 5 months after treatment. Long-term follow up (mean 6.6 years; range 4 months–16 years) depicted estimated survival rates of 94%, 89%, and 75% after 2, 5, and 10 years respectively. None of the 5 deaths were related to a complication of the pseudoaneurysm.
Conclusion: Catheter-directed embolization of pancreatitis-induced pseudoaneurysms is very safe and effective. Recurrence is low and seems only to occur within the first 6 months after embolization, which is a critical time interval where clinical and radiological follow-up is needed. Overall survival is high, without pseudoaneurysm-related deaths.

P-110

Pulmonary arteriovenous malformations: percutaneous embolization using Amplatzer plug IV

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Purpose: The aim of our study is to illustrate the benefits of percutaneous treatment by embolization of high-flow pulmonary arteriovenous malformations (PAVMs) in patients suffering from hereditary haemorrhagic telangiectasia (HHT; Rendu-Osler-Weber disease) using Amplatzer plug IV.

Material and Methods: From December 2001 to February 2015, we embolized 279 PAVMs in 124 procedures performed on 98 patients, all referred by the HHT centre in Crema, and enrolled in a screening programme of HHT families. All patients underwent clinical evaluation, contrast-enhanced ultrasound (CEUS) and spiral computed tomography (CT). Eighty-four of 279 PAVMs (30%) were treated using Amplatzer plug IV (from April 2010 to February 2015).
Results: All 84 embolizations using Amplatzer plug IV were performed without difficulty in obtaining immediate exclusions of PAVMs. Only one patient developed hemiparesis, which resolved in 12 hours. At 6-month spiral-CT follow-up, we demonstrated exclusion from circulation of treated PAVMs.
Conclusion: Percutaneous embolization has recently become the initial treatment option in PAVMs owing to its good results and minimal invasiveness compared with thoracotomy. From 2009, Amplatzer plug IV is available that can be deployed using 4- or 5-French catheters. This device seems to facilitate saving of time and money compared to coils with the same invasiveness.

P-111

Effectiveness and safety of balloon-assisted sclero-embolotherapy for subcutaneous arteriovenous malformations

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Purpose: Sclero-embolotherapy using N-butyl cyanoacrylate (NBCA) might be effective for high-flow arteriovenous malformations (AVMs) but shows problems, such as cast migration through accompanying high-flow arteriovenous shunting, sticking of casts to the catheter, and unexpected embolization of normal vessels. We have developed a new sclero-embolotherapy technique, balloon-assisted sclero-embolotherapy (BAST), using a microballoon catheter to control blood flow. By controlling blood flow, the sclero-embolic agent can remain within the lesion for longer period. In addition, because NBCA is not used in BAST, BAST is free from the risks associated with that chemical. The purpose of this study was to evaluate the effects and safety of BAST.
Material and Methods: Fifteen patients with AVM underwent this procedure. The microballoon catheter (2.7 Fr, φ 4.0 mmx10 mm) was inserted and advanced as close as possible to the lesion and arteriography was performed both before and after balloon inflation to confirm the blood flow control. After confirming blood flow control, absolute ethanol, polidocanol or monoethanolamine oleate foam was injected. Decreased contrast enhancement on arteriography, changes in clinical symptoms (pain, skin ulceration, and cosmetic problems), and complications were assessed.
Results: Adequately decreased contrast enhancement on arteriography after treatment was confirmed in all patients. Thirteen patients (87%) experienced clinical symptom improvement. No major complications, requiring surgical treatment occurred. Minor complications, such as blistering and skin necrosis, occurred in only one patient and healed within a month.
Conclusion: BAST for high-flow AVMs was effective in this cohort and might be safer than the conventional procedures.

P-112

Onyx (ethylene vinyl copolymer) liquid embolic for the treatment of low-flow venous vascular malformations: clinical and histologic findings

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Purpose: To describe our long-term experience with the use of Onyx liquid embolic for the treatment of venous vascular malformations.
Material and Methods: Forty-nine patients with slow-flow venous vascular malformations underwent treatment using Onyx. There were 31 females and 18 males with ages ranging from 7.5 to 62 years (mean 25 years). Forty of the malformations involved the extremities, and 9 involved the chest, abdominal wall, or pelvis. All patients were evaluated with MRI/MRA pretreatment and ultrasound, if necessary, to document lesion visibility. Onyx 18 or Onyx 18 plus Onyx 34 (5 cases) was delivered by direct injection under ultrasound and fluoroscopic guidance. In several cases, Onyx was also delivered via microcatheter placed into larger feeding or draining vessels. In 6 cases, Sotradecol foam was injected in adjacent sites.
Results: In all patients, Onyx was delivered into the targeted sites in the malformation. Minimal post-procedure pain occurred. Forty-two patients returned for follow-up ranging from 1 month to 85 months (median 22 months). Follow-up imaging showed persistence of Onyx. Histologic sections were obtained on patients who underwent operation. There were two complications: in one patient, there was extrusion of Onyx from a lesion on the sole of the foot, which healed without sequelae and in the other, embolization of a small Onyx fragment to the lung occurred, without sequelae.
Conclusion: Use of Onyx liquid embolic allows controlled delivery of the embolic agent with visualization of the malformation interstices during delivery. Onyx is a safe, durable agent for the treatment of venous vascular malformations.

P-113

Transcatheter arterial embolization for traumatic gastrointestinal bleeding

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Purpose: To assess the safety and efficacy of transcatheter arterial embolization (TAE) for gastrointestinal (GI) bleeding following trauma.
Material and Methods: From 2001 to 2014, 17 patients were referred to our interventional unit for GI bleeding following trauma, based on clinical decisions and CT images. After excluding five patients with no bleeding focus and one patient who underwent emergency surgery for massive bleeding detected on angiography, a total of 11 patients (M:F = 10:1; mean age, 51.4 years) who underwent super-selective TAE of visceral vessels were included in this study. Technical and clinical success, complications, and 30-day mortality rate were analyzed.

Results: In 11 patients who underwent TAE, the type of trauma was a traffic accident (n=7), fall (n=3), and assault (n=1) and the bleeding focus was in the small bowel (n=5), duodenum (n=4), stomach (n=1), and colon (n=1). NBCA (n=4), microcoils (n=2), and combinations of NBCA, microcoils or gelatin sponge particles (n=5) were used as embolic agents. Technical success was achieved in all 11 patients, with immediate cessation of bleeding. Clinical success rate was 91% (10/11), and all of these patients were discharged with no further treatment required for the GI bleeding. However, one patient showed rebleeding 10 days later and underwent repeated TAE with successful results. There were no procedure-related complications such as bowel ischemic change. The 30-day mortality rate was 0%.
Conclusion: Our clinical experience suggests that TAE used to control GI bleeding after trauma is safe and effective as a minimally-invasive alternative to surgery.

P-114

Prostate artery embolization: tips for easy understanding of relevant anatomy

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Purpose: Prostatic arterial supply is variable, and defining the angiographic anatomy is integral to safe and effective embolization. We sought to define the arterial patterns encountered in our prostate artery embolization (PAE) practice in order to depict them on a simple diagrammatic template.
Material and Methods: We performed a retrospective review of 55 patients (110 pelvic sides) who underwent CT angiography (CTA) and selective DSA before embolization. Each side was reviewed regarding the prostatic arterial supply, and PA origin, number of prostatic arteries, tortuosity, and any evidence of an arterial anastomosis were assessed. Following analysis, we developed a template to simplify PAE case planning.
Results: Key angiographic patterns encountered include the common gluteal trunk (CGT), gluteal-pudendal trunk (GPT), or replaced obturator artery in approximately one third of the patients. Seventy-two percent of pelvic sides had one PA, 24% had two independent PAs identified, and 4%, no convincing PA was identified. On CTA, PA origin was detected primarily from the internal pudendal artery (n=43), GPT (n= 25), obturator or superior vesical artery (n=22 each). Anastomoses between the PA and other arteries were identified in 11%. The number and origin of PA detected on CT was confirmed by angiography in 96%. In 24%, angiography detected an anastomosis not evident on CTA.
Conclusion: Analysis of PAE performed at our institution has demonstrated recurring angiographic patterns. This has facilitated the development of an arterial template, which we present for use during CTA case planning, to ensure DSA pattern recognition and efficient and direct embolization.

P-115

Impact of PAE on the median lobes of the prostate

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Purpose: Intravesical prostate protrusion (IVPP) in BPH patients correlates with post-voiding residual volume, peak flow urinary rate, incidence of detrusor overactivity and low urinary compliance. We undertook a retrospective imaging analysis of our PAE patients to evaluate the evolution of IVPP after PAE.
Material and Methods: Between 12-2013 and 11-2014, we performed PAE on 25 consecutive patients (mean age 64.8 years). Because of too short follow-up in 10 patients, we were able to assess 15 patients, 11 of them having a protruding median lobe on the pre-embolisation MRI. We retrospectively evaluated the morphological effect of PAE by measuring the greatest distance of IVPP on sagittal T2W images and searched for ischemic changes on axial T2W images before and after PAE in these 11 patients. We used paired t-test for statistical analysis ($p<.05$ was set as significant).
Results: Mean IVPP was 1.46±0.5cm [0.8-2.5] pre-PAE and 1.15±0.3cm [0.7-1.8] post-PAE ($p=.02$) (mean follow-up 137 days). We observed a significant decrease of IVPP after PAE in 9 patients (81.8%). In two patients, there was no change in IVPP. We also found a significant reduction in IPSS after PAE (pre-PAE IPSS: 15.2 ±8.1 [6-31] and post-PAE IPSS: 4.9±5.1 [0-13]) ($p<0.01$). Significant ischaemic changes on the median lobes with decreased signal intensity on T2WI were observed in 6 patients (54.5%).
Conclusion: PAE results in significant reduction of median lobes in most cases, with reduction in IVPP contributing to clinical success. Ischaemic changes in the median lobes can be directly visualised in 54.5% of patients.

P-116

Transcatheter arterial embolization for treating iatrogenic bleeding after EUS-guided pancreaticobiliary drainage procedure

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Purpose: With increasing cases of endoscopic ultrasound (EUS)-guided drainage procedure, bleeding complications have been rising. We report our experiences of transcatheter arterial embolization (TAE) for treating iatrogenic bleeding after EUS-guided pancreaticobiliary drainage procedure.
Material and Methods: We performed a 5-year retrospective analysis of 363 patients with 415 EUS-guided pancreaticobiliary drainage procedures (excluding gallbladder). Among them, seven (1.7%) patients (M:F=4:3, mean age, 67.6-years) were referred for TAE to manage active bleeding around the pancreaticobiliary drainage sites.
Results: One patient underwent two TAE for two different bleeding foci, therefore, a total of eight TAE procedures were performed in seven patients. Eight EUS-guided drainage procedures related to bleeding were pancreaticogastrostomy (n=1), choledochoduodenostomy (n=2), hepaticogastrostomy (n=4), and hepaticoesophagostomy (n=1). Median latency time of bleeding after the procedures was 14 days (range 0-480 days). The bleeding sites were left hepatic artery (n=6), right hepatic artery (n=1), and left gastric artery (n=1). Bleeding focus was seen in all patients; pseudoaneurysm (n=5), extravasation (n=1), both pseudoaneurysm and extravasation (n=1), and arterial irregularity (n=1). TAE was performed with gelatin sponge particles (n=1) and NBCA with/without coils (n=7) with technical and clinical success rates of 100% (8/8) and 75% (6/8), respectively. Rebleeding following gelatin sponge particle embolization occurred in one patient and was treated with TAE with coil/NBCA. Procedure-related ischemic hepatitis was observed as a major complication in another patient with pancreatic cancer with portal vein invasion.
Conclusion: TAE using NBCA seems safe and effective for bleeding after EUS-guided procedures. When portal vein is compromised, TAE of hepatic artery can cause severe liver damage.

P-117

Angiographic detection and treatment of nonvariceal upper and lower gastrointestinal hemorrhage

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Purpose: To investigate the sensitivity of mesenteric angiography, technical success of hemostasis, clinical success rate, and complications of transcatheter embolization for the treatment of nonvariceal gastrointestinal hemorrhage.
Material and Methods: A retrospective review of 200 consecutive patients who underwent mesenteric arteriography for nonvariceal gastrointestinal hemorrhage between February 2004 and February 2011 was conducted. Of these patients, selective embolization was attempted in 114 patients to obtain hemostasis with the help of microcoils, polyvinyl alcohol particles, and gelfoam. Main outcomes measured were to determine the sensitivity of mesenteric angiography (positive cases on mesenteric angiography), technical success rate (target vessel devascularization), clinical success rate (cessation of bleeding without further endoscopic, radiologic, or surgical intervention), and complications in terms of rebleeding and ischemia.
Results: Of 200 angiographic studies, 114 (57%) correctly revealed the bleeding site, and the rest were negative. Forty-seven patients had upper gastrointestinal bleeding, and 67 had lower gastrointestinal bleeding. In 112 patients (98%), technical success was achieved, with immediate cessation of bleeding. Clinical success was achieved in 71 out of 81 patients (86%) who were followed up for one month. Thirteen patients rebled, and two developed bowel ischemia. Six patients underwent surgery for complications.
Conclusion: The use of mesenteric embolization for the treatment of gastrointestinal hemorrhage is highly successful and relatively safe, with 98% of technical success and 1.7% of post embolization ischemia in our series. In 86% of cases, it was definitive without any further intervention.

P-118

Prostatic artery embolization for lower urinary tract symptoms due to benign prostatic hyperplasia: early clinical experience

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Purpose: To evaluate the technical aspects and report the clinical outcome of prostatic artery embolization (PAE) in 25 patients with lower urinary tract symptoms (LUTS) due to benign prostatic hyperplasia (BPH).
Material and Methods: From November 2013 to November 2014, twenty-five patients (mean age 66.04 years) underwent PAE for BPH. The selection criteria included the presence of LUTS and the absence of clinical response with medical therapy. Fluoroscopy time, air kerma dose, and pelvic vascularization patterns were evaluated. Embozene microspheres (400 micron) were used in all cases. Technical success was considered when at least one of the prostatic arteries could be embolized. Clinical success was considered in the presence of improved quality of life and relieved symptoms.
Results: The mean fluoroscopy time was 27.16 minutes. For pelvic vascularization pattern, we used the Yamaki classification, resulting in type A pattern in 68% of the pelvic sides. The mean air kerma dose was 7185 mGy. There was one technical failure due to extreme tortuosity of the prostatic artery. During and post-PAE there were no major complications. All patients were treated on an outpatient basis.
Conclusion: Prostatic artery embolization is a new, feasible, and minimally invasive technique for BPH treatment. PAE is an effective alternative to surgery due to symptomatic relief and the absence of major complications. Despite the good clinical results, a larger multicenter study is necessary to assess the long-term outcome of this procedure.

P-119

N-butyl-2-cyanoacrylate embolization for emergency treatment of traumatic arterial hemorrhage

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Purpose: To evaluate the effectiveness of N-butyl-2-cyanoacrylate (NBCA) embolization for emergency treatment of traumatic arterial hemorrhage.
Material and Methods: We retrospectively analyzed 34 trauma patients (24 males; mean age 59.1 years; mean ISS 30.1) with arterial hemorrhage who underwent emergency embolization with NBCA alone (n=33 arteries; NBCA-ethiodized oil mixture concentration of 1:3 to 1:9) or combined with microcoils/gelatin sponge (n=11 arteries) from December 2007 to January 2015 in two hospitals. Hemorrhage sites were the thorax (n=4), the abdomen (n=13: 4 livers, 3 kidneys, 3 mesenteries, 2 spleens and 1 ovary), the spine and pelvis (n=24), the face (n=2) and the extremity (n=1). The indications for using NBCA were unstable hemodynamics (n=15), coagulopathy (n=12), massive extravasation (n=8), pseudoaneurysm (n=5) and difficult superselective catheterization (n=4). Technical success rate, recurrence rate, procedure-related complications, and clinical outcomes were evaluated.
Results: The initial technical success rate was 93% (41 of 44). In the remaining 3 arteries, second injection of NBCA (n=2) and gelatin sponge stopped the hemorrhage. No recurrent bleeding occurred, but one patient underwent surgery for ileus caused by adhesion of NBCA cast. During hospitalization (mean period 36.9 days), 9 patients (26%) died due to severe brain damage (n=4), multiple organ failure (n=2), disseminated intravascular coagulation (n=2) and thoracic injury (n=1).
Conclusion: The off-label use of NBCA embolization by experienced physician is safe and effective for managing arterial hemorrhage in severe trauma patients.

P-120

Clinical outcome and efficiency of mechanical and combined mechanical/chemical embolization in patients with pelvic venous congestion syndrome

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Purpose: To compare the clinical outcome and efficiency of mechanical and combined mechanical/chemical embolization in patients with pelvic venous congestion syndrome (PVCS).
Material and Methods: Between October 2012 and December 2013, 91 consecutive patients with PVCS were treated by endovascular ovarian vein embolization using mechanical (coil and/or vascular plug) or by combined mechanical/chemical (sclerotherapy) embolization. A visual analog scale (VAS), questioning nine items according to SIR recommendations was used to evaluate the clinical outcome. VAS scores were recorded before procedure and 3, 6, and 12 months after procedure.
Results: Ovarian vein embolization was performed bilaterally in 41 (45%), in the left side in 38 (42%), and in the right side in 12 (13%) patients. Total VAS median value decreased from 35 to 8 ($p<0.0001$). Clinical improvement was detected in 97.9% of the patients, and the rest (2.1%) of them were clinically stable during the follow-up period. There was no significant difference between mechanical and mechanical/chemical embolization with respect to clinical

improvement (p=0.87). Additionally, significant reduction in all disease-specific symptoms was determined (p<0.0001). No major complications related to the procedure occurred.
Conclusion: Endovascular embolization in patients with PVCS is a safe and effective treatment method with respect to clinical outcome. Despite the absence of superiority, when compared with combined mechanical/chemical method, mechanical embolization should be the preferred technique among endovascular treatment options due to the lower radiation dose and shorter procedure duration.

P-121

Experience from the ACE study in treating peripheral vessel embolization using large-volume Ruby coils

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Purpose: The Penumbra Ruby™ Coil system is a generation of novel large-volume platinum detachable coils designed for arterial and venous embolization in the peripheral vasculature. Recent literature describes the impact of packing density on the stability of recanalization.[1] Herein, initial data from the multicenter Aneurysm Coiling Efficiency (ACE) registry aims to validate the system's safety and efficacy in relation to high packing density and sustainable occlusion in the periphery.
Material and Methods: Patients were treated at 13 centers using the Ruby Coil system between March 2012 and January 2015. Data compiled from the first 68 cases included 7 splenic, 11 renal, 3 mesenteric, 1 iliac, and 1 hepatic artery aneurysms; 7 AVMs; 6 fistulae; 4 varices; and 28 vessel sacrifices.
Results: For aneurysms only, median number of coils placed was 6 and mean packing density was 28% (N=40). Post-treatment distribution of Raymond occlusion scores were Class I (91.3%), II (4.3%), and III (4.3%). At 6 months, scores were Class I (92.9%) and II (7.1%).
For vessel sacrifices, all 28 had successful coil embolization. Median number of coils placed was 2.5, and mean fluoroscopy time was 21 min. Thirteen patients with 6-month follow-up demonstrated stable or ongoing occlusion. For all 68 patients, no procedural SAEs were recorded. Follow-up is ongoing.
Conclusion: Using Ruby resulted in a high mean packing density and complete post-procedure occlusion, which remained stable at the 6-month follow-up.
[1]JVIR 2013;24:1798

P-122

Management of blunt splenic trauma: retrospective study and review of current practice in a major trauma centre

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Purpose: A study of splenic traumas from admissions in the last two years at our major trauma centre was undertaken to elucidate whether patients' treatment pathways adhere to guidance on non-operative management.
Material and Methods: EAST guidelines state that in stable patients, non-operative management including splenic artery embolisation is preferable regardless of the grade of injury. Literature supports that high-grade injuries and splenic vascular injuries should be managed by embolisation if the patient is stable.
A retrospective audit of all splenic traumas from February 2012 to March 2014 was undertaken. CT imaging was reviewed for all patients. Splenic injuries were regraded using both the established AAST grading system and the newer CT grading system that had the benefit of taking into account vascular injury. Patient outcomes were documented. Following the presentation of data to the emergency and trauma teams, a repeat audit was performed.
Results: Of the 86 patients reviewed, 70 sustained blunt splenic trauma. Forty-five patients were managed non-operatively. Of these, 27 had high-grade injuries (III–V), and 12 had evidence of vascular injury. Only 6 were referred for splenic artery embolisation. Of the remainder, two required late salvage splenectomy.
After increasing awareness with the emergency and trauma teams, a repeat audit has been undertaken. Initial figures suggest an increase in splenic embolisations in appropriately risk-stratified patients.
Conclusion: Fewer than expected embolisations were performed in one of the UK's busiest, major trauma centres. Education and increased awareness of guidelines have resulted in an increase in the number of splenic embolisation at our major trauma centre.

P-123

Perfusion of the spleen after mid-splenic artery embolization

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Learning Objectives:
1. Understand indications for mid-splenic artery embolization and the mechanism by which it works.
2. Understand the ideal embolization is distal to the dorsal pancreatic artery and proximal to the pancreatica magna artery.
3. Know the collateral routes by which the spleen continues to be perfused after mid-splenic artery embolization.
4. Understand that this continued collateral perfusion results in lowered rates of infarction and ischemia compared to distal embolization.

Background: Splenic artery embolization plays a central role in the treatment of trauma patients with blunt splenic injury. Proximal splenic artery embolization leads to hemostasis by decreasing splenic

arterial blood flow and pressure, allowing clot formation to occur. It is often preferred to supra-selective distal embolization because of its equivalent efficacy but faster procedure times with lower incidence of splenic infarction and abscess because of continued splenic parenchymal perfusion via numerous collaterals.
Clinical Findings/Procedure: Images after mid-splenic artery embolization will be shown, highlighting these essential collateral pathways. These include a) right to left gastroepiploic artery, b) left gastric to short gastric arteries, and c) dorsal pancreatic artery to transverse pancreatic artery, with retrograde flow in the pancreatica magna artery to the splenic artery.
Conclusion: Performing and understanding proximal splenic artery embolization is essential for all IR physicians. It works by decreasing splenic artery pressure but allows continued splenic parenchymal perfusion via numerous collaterals. These collateral pathways are highlighted here.

P-124

Prostate artery embolisation (PAE): the tricks to success

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Learning Objectives:
1. Understanding of standard pelvic arterial anatomy and common normal variants encountered during prostate artery embolisation (PAE).
2. Role of cross-sectional imaging in pre-procedural planning and post-procedural follow-up.
3. Techniques employed to avoid non-targeted embolisation and achieve a successful procedural outcome.

Background: PAE has historically been used to manage intractable haematuria and has only recently been used to manage lower urinary tract symptoms (LUTS) related to BPH. Many men over 50 years of age experience debilitating LUTS caused by obstruction of the bladder outlet by an enlarged prostate. PAE offers these patients a minimally invasive treatment option; however, a sound understanding of arterial anatomy is essential in order to achieve a successful result and avoid non-targeted embolisation.
Clinical Findings/Procedure: We describe our technique of PAE and tricks employed to achieve a successful procedural outcome. Meticulous pre-procedural planning is essential, and a drawing of the arterial configuration of each internal iliac artery, based on CT images, can be used as an aid to interpret angiographic images. The prostatic arteries are cannulated using a combination of Progreat microcatheter and Fathom guidewire, prior to which glyceryl trinitrate is administered to avoid spasm. Due to stasis in the vessel, road map can be used to identify the end point of embolisation and prevent non-targeted embolisation.
Conclusion: PAE is a safe and minimally invasive treatment option for patients with BPH, avoiding the complications associated with surgery. The procedure is challenging; however, we present techniques, which in our experience have resulted in a successful procedural outcome, to minimise the risk of non-targeted embolisation.

P-125

Catheterization of the difficult internal mammary artery using a side-hole catheter

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Learning Objectives: To evaluate the safety and efficiency of a new side-hole catheter for the catheterization of a difficult internal mammary artery (IMA) in patients with hemoptysis.
Background: During the recent 4 years from January 2011 to August 2014, a total of 96 transarterial embolization procedures required exact evaluation of the IMA due to chronic lung disease involving the anterior thorax. Of these 96 procedures, 17 (17.7%) failed for selective IMA angiography using the conventional catheter and thus underwent catheterization using our side-hole catheter. The side-hole catheter was developed as a modification of a cobra-type curved catheter, which is currently in clinical use. A side hole allows passage of a microcatheter and thus to perform IMA arteriography more directly.
Clinical Findings/Procedure: The causes of the failed catheterization were severe vascular tortuosity, acutely angulated subclavian artery, or abnormal take-off of the IMA from the subclavian artery. In failed cases with the conventional catheter, superselection with the microcatheter through the side-hole catheter yielded a technical success rate of 100%. More time (longer than 5 min) was required to catheterize the IMA with the conventional than with the side-hole catheter (17 vs 2 min, $p<0.05$). There were no procedure-related complications, such as cerebrovascular events, arterial dissection, or thromboembolism, after catheterization with the side-hole catheter.
Conclusion: Side-hole catheter technique may be safe and effective with short procedural time in patients in whom IMA is difficult to access. Further design revisions are needed to improve the ease and speed of IMA catheterization and angiography.

P-126

Complications of portal vein embolization: evaluation with cross-sectional imaging

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Learning Objectives:
1. Major complications following portal vein embolization (PVE) can be categorized as puncture related, i.e., vascular injury, biloma, and abscess, and embolization related, i.e., migration of embolic material, parenchymal infarction, non-targeted embolization, and proximal venous thrombosis.
2. Significant hemodynamic changes or hepatic infarction following PVE can lead to delayed surgery, or non-resectability.
3. Familiarity with the radiologic findings of post-PVE complications will facilitate making an accurate diagnosis and conducting prompt management in these situations.

Background: PVE is a relatively safe procedure, and most patients experience no significant procedure-related complications. To date, there are, however, only a few studies focusing on the major complications that can lead to non-resectability.
Clinical Findings/Procedure: We categorized major complications that can be evaluated on CT as puncture related, i.e., vascular injury, biloma, and abscess, and embolization related, i.e., migration of embolic material, parenchymal infarction, non-targeted embolization, and proximal venous thrombosis. We present the CT findings of these major complications, together with their clinical significance and treatment options.

Conclusion: Although major complications are rare, familiarity with radiologic findings of post-procedural complications will facilitate making an accurate diagnosis and conducting prompt management in these situations.

P-127

Hepatic arterioportal communications (fistulas and malformations): cross-sectional imaging spectrum and interventions

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Learning Objectives:
1. Common causes and clinical manifestations of arterioportal communications (APCs) – arterioportal fistulas (APFs) and arterioportal vascular malformations (APVMs)
2. Cross sectional imaging findings of APCs
3. Evidence-based classification of APCs
4. Recommended interventional treatments of APCs – including embolization techniques, materials, contraindications, possible complications, and post-intervention management

Background: Arterioportal communications are infrequently seen during abdominal three-phase contrast-enhanced imaging (CT, MR, and angio), and both the diagnostic radiologist and interventionalist are often not fully aware of the significance of the findings, etiologies, and possible treatment options. Their incidence is increasing with the exponential increase of liver imaging and hepatic oncologic interventions.

Clinical Findings/Procedure:
A. Common causes of APCs
B. Clinical manifestations related to APCs
C. Diagnostic imaging findings of APCs
D. Classifications of APCs
E. Recommended treatment and follow-up of different types of APCs
1. Angiographic findings
2. Embolization techniques
3. Embolization materials
4. Contraindications to endovascular management
5. Possible complications
6. Post-intervention follow-up

Conclusion: This poster aims to educate the diagnostician and the interventionalist about arterioportal communications, their significance, their etiologies, and their imaging features and to provide a primer for their management.

P-128

Spontaneous subcapsular rupture of adenoma in pregnancy in a case of multiple hepatic adenomas

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A 32-year-old pregnant female at 32 weeks of gestation presented with right hypochondrial pain and shock. Imaging revealed multiple liver tumors with subcapsular tumor rupture. She was managed with emergency embolisation of the right hepatic artery with fetus in situ and subsequent caesarean.

P-129

Traumatic presacral pseudoaneurysms/vascular channels

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We present a case of traumatic presacral pseudoaneurysm/dilated vasculature formation with diverse arterial inflow recruitment simulating an arteriovenous malformation. Repeated episodes of clinical instability necessitated multiple endovascular procedures to successfully stabilise the patient. Multi-modality imaging is also presented.

P-130

Arterial embolization for severe hemorrhage complicating 2 cases of giant lymphatic malformations

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Severe hemorrhage complicating giant multi-macrocystic lymphatic malformation is rare and needs special care. In a newborn boy and a 4-year-old girl, arterial embolization was necessary to complement percutaneous sclerosis for bleeding control.

P-131

Management considerations in ruptured pancreaticoduodenal aneurysms: a report of 3 cases

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Massive peritoneal bleeding of ruptured pancreaticoduodenal aneurysm needs urgent and precise diagnosis and treatment.
Aneurysm embolization in 3 cases was effective, but associated celiac trunk occlusion in 2 of them necessitated specific anatomic considerations to prevent ischemic complications.

P-132

Balloon-assisted coil embolization of an arteriovenous fistula associated with lumbar discectomy

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A left proximal internal iliac artery to left common iliac vein fistula occurred following lumbar disc surgery. The AV fistula was completely occluded by Guglielmi detachable coil embolization under the neck reconstruction and flow control using two balloon catheters.

P-133

Massive perirectal arteriovenous malformation treated by transcatheter coil

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This 40-year-old woman had lower gastrointestinal bleeding due to a massive perirectal arteriovenous malformation. Coil embolization of the drainer and the inferior mesenteric vein via the transhepatic approach and occlusion of the feeders via the transarterial approach was effective.

P-134

Sphenoid wing epithelioid hemangioendothelioma presenting with carotid cavernous fistula symptoms

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A patient with a left sphenoid wing epithelioid hemangioendothelioma presented with venous hypertension in the eye, proptosis, chemosis, and loss of vision. The patient was successfully treated with Onyx embolization via the middle meningeal arteries, followed by resection.

P-135

Balloon-assisted guiding sheath advancement for embolization using the Amplatzer vascular plug: the anchor technique

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We describe the novel technique to advance a guiding sheath through the tortuous iliac artery by using the balloon as the anchor. This technique could be useful during internal iliac artery embolization using the Amplatzer vascular plug.

P-136

Successful embolization of high-flow priapism unusually originated in the bulbar artery of the penis using gelatin sponge "torpedoes"

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High-flow priapism is usually caused by a traumatic communication between the cavernous artery and the corpus cavernosum. Rarely, other arteries are involved. We present one of these rare cases and the way we successfully treated it.

P-137

Migration of hepatic artery pseudoaneurysm embolization coils after pregnancy

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Coil embolization of a large iatrogenic hepatic artery pseudoaneurysm was performed in a 35-year-old woman. Two years later, she had a successful pregnancy with incidental discovery of short-interval enteral migration of the entire coil pack.

P-138

Transcatheter and percutaneous procedures for huge pelvic arteriovenous malformations causing high-output heart failure

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We describe the case of a 63-year-old woman presenting with a huge pelvic and retroperitoneal high-flow arteriovenous malformation causing high-output heart failure who was treated with combined therapies, including transarterial embolization with n-butyl cyanoacrylate-iodized oil mixture and coil.

EVAR and TEVAR

P-139

Outcome of internal iliac artery aneurysm repair using iliac branch device

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Purpose: Iliac branch grafts (IBGs) are used to treat iliac aneurysms and preserve internal iliac artery (IIA) flow. IIA aneurysm (IIAA) is a relative contraindication to IBG placement. To overcome this limitation and treat IIAAs, an extension of the IIA branch stent-graft to the superior gluteal artery (SGA) was performed.
Material and Methods: This retrospective cohort study included consecutive patients who underwent the placement of an IBG (Zenith, Cook®), with an extension of the branch stent-graft to the SGA secondary to aneurysmal IIA (>15 mm) from May 2009 to August 2014. Stent-grafts such as Viabahn (Gore®), Fluency (Bard®), or +/- iCast (Atrium®) were used proximally. Imaging follow-up was with CT angiography at 1 and 6 months and annually.
Results: The procedure was performed on 15 patients (all males), with a mean age of 76.8 years (range: 69.8–85.7 years). Twenty IIAAs were treated for a mean IIA and CIA diameter of 33 mm (range: 15–57 mm) and 34.6 (range: 15–58 mm), respectively. Technical success rate was 100%. A total of 66.7% of patients had patent IIA on both sides postprocedure. There was no IBG-related 30-day complication or reintervention. Mean imaging follow-up was 19.7 months (range: 3–65 months). Primary patency of SGA stent-grafts was 100%. A small type II endoleak was seen in one case (5%), but no additional intervention was needed. All patients were free from buttock claudication at clinical follow-up.
Conclusion: Extension of the internal iliac component of IBGs to the SGA for distal sealing is feasible. This technique is useful for preventing buttock claudication, and its branch patency is excellent.

P-140

Embo-EVAR: a technique to prevent type II endoleak? An Italian single-centre experience

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Purpose: To evaluate the role of intraprocedural aneurysm sac embolisation (embo-EVAR) during endovascular abdominal aneurysm repair (EVAR) using coils and fibrin glue for preventing type II endoleak (EII).
Material and Methods: A retrospective clinical case analysis of 72 patients who underwent EVAR during 2011-2014 was conducted. Two groups were compared at 6- and 12-month follow-ups with MDCT scan and contrast-enhanced ultrasound (CEUS) imaging: 36 patients (group A) treated with classic EVAR and 36 patients (group B) treated with embo-EVAR. Coils were released filling the aneurysm sac as well as possible; the embolisation was completed by injecting fibrin glue. Device and materials used, differential systemic and sac pressures and presence of any endoleak and complications were registered.
Results: In our experience, we had 100% technical success without surgical conversion. Embo-EVAR was performed, after endograft deployment, in group B patients, all with ratio of Δ-pressures (obtained from Δ-sac pressure/Δ-differential pressure) >0.16. No early or late complications occurred, and mortality was nil. Follow-up, performed with CT-angiography and CEUS at 6 and 12 months, revealed

the following: 6 EIIs and 1 endoleak type IA in group A and 1 EII and 1 endoleak type IB in group B. Mean radiation exposure time was 30.3 min in group A and 43.3 min in group B. Average cost of EVAR procedure was 9000 € and of sac embolisation was 1500 €.
Conclusion: Although a randomised study is necessary, embo-EVAR may be a valid approach for preventing EII and further complications; it is inexpensive and safe and, in our experience, could be routinely performed when Δ-pressures ratio is >0.16, with excellent results.

P-141

Percutaneous AAA-EVAR can be safely undertaken with an ultra-low profile endograft and a double-wire 'post-close' approach

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A 65-year-old male underwent percutaneous EVAR using an Ovation endograft system via DrySeal sheaths. Femoral arterial punctures were closed using an 8F Angioseal (left; 12F sheath) and combined 8F/6F Angioseals (right; 14F sheath) via a double-wire technique, achieving successful haemostasis.

P-142

EVAR for AAA in Marfan's syndrome: the first endostapled case

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A 59-year-old male with Marfan's syndrome presented with an abdominal aortic aneurysm with a highly angulated, dilated neck. This was successfully excluded by an endostapled bifurcated stent graft with a telescoped thoracic stent graft, with no changes in aneurysm morphology at 6 months.

P-143

A case of AUI-EVAR using Excluder legs with both upside-down technique and endowedge technique

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We performed AUI-EVAR for a case with abdominal aortic and bilateral common iliac artery aneurysms. Its proximal neck was narrow, short and angulated. Using Excluder legs with both upside-down and endowedge techniques, aneurysms were successfully excluded, except for a small type 2 endoleak.

P-144

Inexplicably late type Ia endoleak post-EVAR with low-profile endograft in a patient with a favourable neck anatomy finally treated with transcaval coil embolization

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CT 7 months post-EVAR with Ovation™ endograft showed type Ia endoleak at the level of the collapsed sealing rings. A Rösch-Uchida set was inserted to puncture the aneurysmal sac through the IVC wall. We catheterized the inflow channel to release coils and thrombin. After 12 months, normal endograft patency and no endoleaks were observed.

P-145

Preliminary experience with a modified candy plug using an excluder aortic cuff (mCP-Ex) to occlude distal false lumen backflow in chronic aortic dissection

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The placement of a modified candy plug using an excluder aortic cuff (mCP-Ex) in the false lumen is a safe and simple technique to occlude distal false lumen backflow in chronic aortic dissection.

Experimental work in IR

P-146

In-vitro flow distribution characterisation of Y90 surrogates: density and gravitational effects

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Purpose: The objective of this study was to investigate the influence of radio-embolic microsphere density on flow distribution through a vascular flow simulator (VFS).
Material and Methods: Distribution of "cold" surrogates (Glass, TheraSphere® [yttrium aluminosilicate, density = 3.6 g/ml] and Resin, SIR-Spheres® [Aminex 50, density = 1.6 g/ml]) were investigated in the VFS under various injection and blood-mimicking fluid (BMF) flow rates. The injection solution was 0.9% saline (dyed for UV quantification). Conditions were designed to determine the distribution of injection solution (dye), microspheres and total volumetric flow following injection of surrogates. Injection of surrogates in equal volumes was performed at standard and reduced rates. The influence of gravity was investigated by orientating the VFS vertically and horizontally.
Results: Distribution of microspheres and injection solution were correlated (R^2= 0.5712); however, microsphere distribution did not correlate with total flow (R^2=0.0104). Although not significant (P=0.052), VFS orientation appeared to affect the distribution of BMF with higher flow favouring lower posterior channels in the vertical orientation. Importantly, there was no statistical difference between the distribution of glass and resin microspheres in the vertical or horizontal orientation (P>0.05).
Conclusion: Distributions of radio-embolic microspheres appear to be mostly determined by vascular geometry, not the density of microspheres. No significant differences in distributions were observed between glass and resin surrogates under a variety of flow and injection rates.

P-147

Microsphere penetration using a balloon-occlusion microcatheter in a renal artery embolization model

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Purpose: To compare arterial penetration of microspheres using a microballoon catheter vs. flow-directed embolization.
Material and Methods: Twelve porcine kidneys were embolized with 100–300 µm trisacryl gelatin microspheres (Embosphere). Branch arteries were embolized to stasis using a 1.8-F microballoon catheter (Terumo), with the balloon either inflated or deflated. Histology of explants was performed to assess the arterial distribution of microspheres: segmental, arcuate, interlobular, and preglomerular. Microspheres were counted in contiguous 8-µm thickness slices, 100-µm apart for each embolized segment (110 slices in 22 segments). The ratios of the number of microspheres in interlobular or smaller arteries relative to arcuate arteries were statistically analyzed by comparing segments embolized with the microballoon inflated vs. segments embolized with the microballoon deflated.
Results: Microballoon embolization resulted in a statistically significant higher mean ratio of particles in smaller interlobular arteries compared with arcuate arteries (ratio, 0.61±0.77 vs. 0.38±0.24; p=0.039). More particles were seen in larger arcuate arteries with flow-directed embolization compared with those seen in microballoon occlusion (36.3±18.8 vs. 28.2±18.5; p=0.025). Fewer total particles were needed for embolization with microballoon occlusion compared with those for flow-directed embolization (39.0±24.4 vs. 49.3±25.0; p=0.031). Minimal arterial spasm was seen in two vessels embolized with the microballoon inflated. No reflux was noted using the balloon-occlusion microcatheter.
Conclusion: Embolization with balloon-occlusion microcatheter enabled deeper penetration of microspheres with fewer particles in swine renal arteries compared with flow-directed embolization. This may prove to be useful for improving delivery efficiency, achieving greater ischemia, and preventing reflux during transarterial embolization procedures.

P-148

Investigating the dissipation of thermal energy during irreversible electroporation: hot or not?

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Purpose: With irreversible electroporation (IRE), malignant tissue is exposed to a series of high-voltage electrical pulses, which permanently damages the cellular membrane. Although the mechanism of cell death is believed to be primarily nonthermal, it is known that the development of some heat is inevitable. The purpose of our study was to investigate the dissipation of thermal energy during IRE.
Material and Methods: IRE was performed in a transparent polyacrylamide gel, resembling soft-tissue properties. Temperature gradient and absolute temperature changes were measured using high-speed color schlieren imaging with an infrared thermocamera. Parameters studied were voltage, pulse length, unequal active tip length, interelectrode distance, and the angle between the electrodes. The effect of sequential pulsing was also investigated.
Results: With standard ablation settings (90 pulses, 1500 V/cm, 1.5-cm interelectrode distance, 1.5-cm active tip length), high-speed color schlieren imaging showed instant gas formation ascribed to electrolysis. Thermal imaging showed an average increase of the temperature of 12°C around both electrodes, persisting for several minutes. Temperatures were highest around the negative electrode and increased with voltage, pulse length, and shorter interelectrode distance. Sequential pulsing significantly reduced the temperature increase.
Conclusion: IRE causes a substantial temperature increase that can be controlled by varying the ablation settings. Whether the working mechanism of IRE is partly ascribed to this thermal component is unclear and warrants further studies. Sequential pulsing minimizes the temperature increase. Future in vivo studies are needed to observe the thermal effects in perfused tissues.

P-149

The influence of metallic implants on the dissipation of thermal energy during irreversible electroporation

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Purpose: Irreversible electroporation (IRE) uses high-voltage electrical pulses to induce cell death. The presence of metallic objects, such as stents and coils, in the vicinity of the electrodes is considered a contraindication due to the risk of thermal damage by the heating of metal. We investigated whether metal-induced tissue heating occurs during IRE.
Material and Methods: IRE around a nitinol and stainless steel stent, platinum coils, and titanium brachyseeds was performed in a transparent tissue phantom, delivering 90 pulses using clinical ablation settings. Absolute and relative temperature changes were measured using an infrared thermocamera and color schlieren imaging. Next, IRE was performed in vivo in the periphery of a porcine liver with and without a nitinol stent using similar settings, delivering 1x90 and 3x90 pulses. Temperatures were measured internally with fiberoptic temperature probes and superficially using the thermocamera. The tissue was investigated macroscopically using 3D gross pathology.
Results: In the tissue phantom, thermal imaging showed a substantial symmetrical temperature increase around the electrodes ranging from 13–30°C, without an additional heating of the metallic objects. In the porcine liver, with 1x90 versus 3x90 pulses, temperature increased, respectively, 4.4 versus 11.0°C with stent and 5.6 versus 13.0°C without stent. Tissue examination showed white coagulation around the electrodes but not around the stent.
Conclusion: IRE in the vicinity of metallic objects does not cause additional heating of the metal or surrounding tissues. The contraindication to perform IRE in the vicinity of metallic objects may be unsubstantiated.

P-150

Feasibility of percutaneous soft tissue interventions using a multiaxis interventional C-arm CT system with a 3D laser guidance: phantom study

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Purpose: Aim of this phantom study was to compare the precision of needle placement using a multiaxis interventional C-arm cone-beam computed tomography system (CBCT guidance) with that under multidetector computed tomography guidance (MDCT guidance).
Material and Methods: In an abdominal phantom, eight lesions (six liver lesions, both renal pelvises) were each punctured in- and off-plane with a 20G needle under CBCT (Artis zeego, Siemens Healthcare Sector, Germany) and under MDCT guidance (Somatom Definition Flash, Siemens Healthcare Sector, Germany). In the follow-up CBCT and MDCTs, angular deviation, absolute deviation, and longitudinal deviation were measured. Procedural times were calculated.
Results: The respective lesions were hit in all 32 interventions. There was no significant difference in absolute, angular, and longitudinal deviation for either in- or off-plane interventions between MDCT and CBCT guidance. For CBCT interventions, absolute deviation from the needle tip to the lesion center ranged from 1.6 to 4.3 mm (mean, 3.0 mm±0.9 mm); angular deviation, 0° to 4.2° (mean, 1.9°±1.1°); and longitudinal deviation, 0 mm to 2.8 mm (mean, 1.1 mm±1 mm). Using MDCT guidance, off-plane interventions took significantly longer than in-plane interventions (701 vs. 527 sec; p=0.03). In-plane interventions took significantly longer under CBCT than under MDCT guidance (888 vs. 527 sec, p=0.00005); for off-plane procedures, there was no statistically significant difference.
Conclusion: Under CBCT guidance, percutaneous soft-tissue interventions can be conducted with a precision comparable with that under MDCT guidance. Although associated with longer procedural duration, CBCT-guided interventions offer the advantage of more degrees of freedom, which can be of particular importance for off-plane interventions.

P-151

New percutaneous vertebral fusion with flexible bone screws: bench experiments

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Purpose: For the treatment of vertebral instability causing lower back pain, a new, less invasive percutaneous method for vertebral fusion has been developed.
Material and Methods: A superelastic nitinol guide with a distal curved end was inserted into a straight cannula having been placed transpedicularily in the vertebral body (polyurethane model). While entering into the vertebral body, the guide, corresponding to its inherent memory shape, took a curve through the vertebral body and the end plate into the disc space and subsequently into the next vertebral body. Based on this principle, three types of fusions were evaluated:
- A flexible hollow screw was introduced over the curved guide to create a firm connection of vertebral bodies.
- Instead of a screw, a mesh tube was inserted vertically through the vertebrae and filled with bone material to induce an osseous formation.
- The facet joints were fused bilaterally by flexible screws inserted percutaneously over the curved guides.

The fusions created with the flexible screws were evaluated in acute tests for maximum resisting pressures.
Results: This new technique with curvilinear screws allowed a new, less invasive access and guaranteed firm connections of osseous structures. Unilateral fusion with a single screw through the vertebral bodies resisted a maximum force upto 350 N, and bilateral facet joint fusions resisted upto 700 N.
Conclusion: According to our bench experiments, flexible bendable screws promise new, less invasive access routes to create firm connections of osseous and articular structures.

P-152

A new technique for therapeutic arthrography for frozen shoulder: a review of 20 cases

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Purpose: Describe a new technique for performing therapeutic arthrography for patients with frozen shoulder and evaluate the outcome for 20 patients.
Material and Methods: The conventional technique punctures anteriorly between the joint capsule and the anterior humeral head or posteriorly between the labrum and the humeral head. These are peripheral recesses that do not allow efficient spread of the medication or the pressure induced by hydrodilatation. We inject centrally into the joint space with the help of the needle, microwire, and introducer of the kit, which is more efficient. First, 8cc of Omnipaque (GEHealthcareInc, Princeton, NJ, USA) to confirm the diagnosis of FS. Subsequently, 4cc Linisol 2% (Braun Medical, Puurs, Belgium), 4cc Marcaine (AstraZeneca, Ukkel, Belgium), and 1ml containing 40-mg depomedrol (Pfizer, Brussels, Belgium) were injected centrally into the joint space. This was followed by hydrodistention with saline (up to 40cc). All patients had physiotherapy as soon as possible. All patients received follow-up at 2 days and 1, 3, 6, and 12 months and were asked to rate improvement in pain and mobility on a percentage scale from 0 to 100%.
Results: The average age was 54.4 years (39 to 67) with 13 men and 7 women.
We report following improvements in pain and mobility:
At 2 days: 57.7% (CI 37.6-65.9), 46.8% (CI 33.3-60.1)
At 3 months: 77.7% (CI 64.7-90.6), 75.0% (CI 60.9-89.0)
At 6 months: 82.9% (CI 71.9-93.9), 82.9% (CI 72.3-93.5)
At 12 months: 95% (CI 79.1-100), 98.8% (CI 94.8-100)
Conclusion: The results of our modified central technique are encouraging and at least comparable with typically reported data of pain relief and mobility in other studies, which seems logical according to hydrodynamics.

P-153

In vitro and in vivo feasibility study of a glass-fibre-based MR-compatible guidewire

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Purpose: Evaluation of a dedicated MR-compatible glass-/aramid-fibre-based guidewire (GW).
Material and Methods: The tested GWs (MaRVis, Hannover/Germany) are based on micropultruded glass-/aramid-fibres, which are embedded in resin doped with metal particles and a PTFE shrink tube. The 10-cm hydrophilic tip is made of flexible nitinol. The diameters tested were 0.89 mm (0.035") (standard/stiff) and 0.36 mm (0.014") in 260/300-cm length. After in vitro testing for visualisation

and handling in an abdominal aorta model, all GWs were used in 9 pigs (mean weight, 65±5 kg). Under MR guidance, catheterisation was performed for iliac arteries, abdominal/thoracic aorta, renal arteries, iliac and inferior cava vein using fast real-time GRE sequences (temporal resolution, 0.2 s; FOV, 150 mm; matrix, 128x128) in a 1.5T scanner (Siemens Magnetom Aera, Erlangen/Germany). Additionally, balloon dilatation and stent implantation were performed using GWs. Visualisation and handling and time for catheterisation of vessel regions were assessed.
Results: MRI clearly visualised GWs with a continuous artifact along the shaft of 2 mm and 4.5 mm at the tip. Exact handling combined with sufficient stiffness and adequate transfer of traction and torsion allowed a precise and exact navigation to the target vessels (mean time for the abdominal/thoracic aorta, 4 s; visceral/renal arteries, 10 s and contralateral iliac arteries, 36 s). All procedures were technically successful. No GW-associated complications occurred, particularly breakage or disruption of thrombus. Handling regarding stiffness, flexibility and guidance were similar to usual standard angiographic GWs.
Conclusion: Initial in vitro und in vivo results of the MR-compatible GW showed the possibility for further clinical application of endovascular interventions in humans.

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Intra-arterial infusion of carbon dioxide-saturated solution as a sensitizer for anti-cancer effect of Cisplatin in a rabbit VX2 liver tumor model

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Purpose: Intra-arterial infusion of carbon dioxide (CO_2)-saturated solution has been reported to inhibit tumor growth in a rabbit VX2 thigh tumor model from our group. This study was design to evaluate the efficacy of intra-arterial infusion of CO_2-saturated solution and its combination therapy with a fine-powder formulation of cisplatin (DDP-H) infusion in a rabbit VX2 liver tumor model.
Material and Methods: Twenty-eight Japanese white rabbits with VX2 liver tumors (implanted 3 weeks before intra-arterial infusion) were randomly and equally divided into four groups: control group (saline solution), CO_2 group (CO_2-saturated saline solution with a pH of 4.0), DDP-H group (1.75mg/kg DDP-H), and combined group (CO_2-saturated solution and DDP-H). The tumor volume was measured by contrast-enhanced CT at the procedure day and at three and seven days after procedure. CT images and tumor growth rate were compared.
Results: The mean±SD tumor growth ratio at 3 and 7 days after procedures were 191.7±34.1% and 394.3±124.4% in the control group, 179.6±35.9% and 359.0±25.8% in the CO_2 group, 154.1±16.2% and 253.5±39.1% in the DDP-H group, and 110.2±20.1% and 200.5±53.0% in the combined group, respectively. There was no significant difference in the mean tumor growth rate between the control and CO_2 groups. The mean tumor growth rate of the combine group was decreased significantly compared with that of the DDP-H group at 3 days after the procedure ($p < 0.05$).
Conclusion: Intra-arterial infusion of CO_2-saturated solution appears to be a beneficial therapeutic modality, as a sensitizer for anti-cancer effect of DDP-H, in a rabbit VX2 liver tumor model.

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Feasibility of percutaneous isolated pancreatic perfusion chemotherapy: evaluated by CT during isolated celiac arteriography

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Purpose: To determine the optimal infusion rate and evaluate the feasibility of anterior mesenteric artery (AMA) occlusion for percutaneous isolated pancreatic perfusion (PIPP) using CT arteriography.
Material and Methods: All experiments were approved by the Institutional Animal Experiment Ethics Committee. Twelve pigs were divided into four groups and PIPP was performed. Angiography during PIPP was performed without and with balloon occlusion of AMA to observe hemodynamic changes in the pancreas (group 1). Contrast media in an extracorporeal circuit was circulated through the pancreas at three different infusion rates (12, 24, and 36 mL/min) for 20 min to evaluate surrounding organ enhancement, especially that of the pancreas without and with AMA occlusion (groups 2, 3, and 4, respectively). CT was performed before and during PIPP without AMA occlusion and immediately during PIPP with AMA occlusion. Enhancement of each organ was observed and compared in each condition.
Results: Angiography showed no apparent differences in opacification without and with AMA occlusion. Without AMA occlusion, CT arteriography demonstrated whole pancreas enhancement without duodenum enhancement at the 36-mL/min infusion rate; however, part of the head and/or body of the pancreas was unenhanced at the infusion rates of 12 (100%) and 24 (67%) mL/min. Whole pancreas enhancement was observed at all three infusion rates with AMA occlusion. However, duodenum enhancement was observed only at the 36-mL/min infusion rate (100%).
Conclusion: PIPP appears to be feasible for the perfusion of the pancreas. This method enables the delivery of drugs to a part or whole of the pancreas, as required.

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Transarterial delivery of magnetic nanoparticles to achieve selective hyperthermia in the liver

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Purpose: To develop a reliable method for delivering magnetic nanoparticles (MNp) to liver tumours, in order to generate selective critical hyperthermia (HT).
Material and Methods: CC-531 colorectal cancer cells were inoculated in the left liver lobe (LLL) of Wag/RijCrl rats guided by ultrasound (US). Thirty-five days later, the existence of tumours was confirmed using US. Rats were divided into three groups (not infused, saline and MNp), and all of them were exposed to HT. MNp or saline were infused using a microcannula introduced through the splenic artery to the hepatic artery. HT was induced with an electromagnetic applicator, capable to generate a magnetic field (frequency: 606 MHz, intensity: 16 minutes at 16 kA/m, plus 5 minutes at 10 kA/m). Temperature was monitored with probes placed in the tumour, LLL and rectum.

Results: Fourteen animals developed liver tumours of 0.47±0.32 ml. Control animals presented a thermal increase ranging 3-6°C, which did not induce tissue damage. Thermal increase in animals infused with saline was 6.2°C in the liver and 5.8°C in the tumour; the percentage of damage observed in tumour tissue showed no differences (p=0.657) from the expected necrosis due to tumour volume (2.5±1.7% vs. 3.8±1.3%). Rats infused with MNp showed a thermal increase of 9.4°C in the liver and 8.8°C in the tumour; three of the animals showed extensive tumour destruction (>85%).
Conclusion: Hepatic artery cannulation is a reliable method to deliver MNp into hepatic metastases.
HT induced by an electromagnetic applicator and MNp transarterially administered may be a potential treatment for liver metastases.

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Radiofrequency ablation for recurrent fibromatosis: a stubborn condition is finally subdued!

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Purpose: To evaluate the safety and efficacy of RFA in managing recurrent fibromatosis.
Material and Methods: A retrospective analysis of 27 fibromatosis patients treated with 71 sessions of RFA from January 2008 to December 2014 was done. Inclusion criteria were recurrent fibromatosis refractory to primary treatment, i.e. surgery, RT, CT or immunotherapy. RFA was done under CT guidance. Patients were followed up every 3 months to assess clinical benefits and radiological response. Response evaluation was done clinically by improvement in the range of movements (ROM) and radiologically by calculating change in volume of the lesion at follow-up and percentage decrease.
Results: A total of 71 sessions of RFA was done in 27 patients with fibromatosis (mean number of sessions, 2.6). Mean follow-up was 34 months (range, 1-90 months). Eight patients had upper limb involvement, 10 lower limb, 4 chest wall, 2 mediastinum and 3 retroperitoneum. Quantification of reduction of size was 0-25% in 15 patients, 26-50% in 4 patients, 51-75% in 5 patients and 76-99% in 3 patients. Pain score (visual analogue score) reduced in patients having pain from 6.52 to 2.06. Complications: Post-procedure pain was the chief complaint, which subsided with analgesics. Two patients had neurological deficit (foot drop). Extensive necrosis in one case needed aspiration for symptom relief.
Conclusion: Radiofrequency ablation of recurrent fibromatosis is a safe and effective treatment option. Procedure is well tolerated, with significant improvement in quality of life with good long-term locoregional disease and symptom control.

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Comparison of pharmacokinetics and drug delivery properties of doxorubicin/Lipiodol® formulations in a hepatocellular carcinoma (HCC) rabbit VX2 model

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Purpose: To compare pharmacokinetics and drug delivery properties of doxorubicin/Lipiodol® formulations in a hepatocellular carcinoma (HCC) rabbit VX2 model.
Material and Methods: Twenty-seven New Zealand rabbits, implanted with VX2 tumor in liver, received selective hepatic artery infusion of 0.3-mL doxorubicin/Lipiodol® formulations, without supplementary embolization. Group A (n=14) received mixed 1.5-mg doxorubicin (in 150-µL saline)/150-µL Lipiodol® (ratio: 1:1), and group B (n=13) received mixed 1.5-mg doxorubicin (in 75-µL densifying agent)/225-µL Lipiodol® (ratio: 1:3) supplemented with 3-mg tensioactive substance. Doxorubicin alone was also selectively administrated intra-arterially at 1.5 mg per animal in group C (n=6). Physicochemical characterization was evaluated by microscopic methods. Doxorubicin concentrations were measured (HPLC fluorescence) in plasma (from 5 to 45 minutes after injection) and both in tumor and normal liver at 1 day (n=6) after injection.
Results: In group A, an oil-in-water formulation (droplet size=50 µm) was stable for less than 12 hours, whereas in group B, a water-in-oil formulation (droplet size=5 µm) was stable for more than 24 hours. Plasmatic doxorubicin peak at 5 minutes was significantly lower in group B (19.0±5.8 µg/L) than in group A (275.3±78.5 µg/L, p<0.001), which itself was significantly lower than in group C (563±282 µg/L, p<0.05). At day 1, tumor doxorubicin concentration was significantly higher in group B (20957±9022 mg/kg) than in group A (8093±4466 mg/kg, p<0.05). Doxorubicin in normal liver and metabolites (plasma and liver) were below the limit of quantification (<100 mg/kg).
Conclusion: Stabilized water-in-oil doxorubicin/Lipiodol® formulation reduces systemic drug exposure and increases early tumor liver drug accumulation.

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Research on R2*map of tracking adipose tissue-derived mesenchymal stem cells labeled by super para-magnetic iron oxide in rat liver

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WITHDRAWN

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Percutaneous radiofrequency ablation for chondroblastoma: single-centre experience in a tertiary cancer centre in India

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Purpose: To evaluate clinical outcomes in chondroblastoma patients treated with radiofrequency ablation (RFA).
Material and Methods: Retrospective analysis of prospectively maintained data of 11 biopsy-proven chondroblastoma lesions treated at our institute from January 2010 to December 2014 using RFA was performed. RFA was performed with multi-tined electrodes under computed tomography guidance (CT). Lesion characteristics were determined from imaging studies (MRI/PET-CT). Symptoms were assessed before and 24 hours and 6 weeks after the procedure. All patients were followed up to assess the recurrence of pain or any complications. Follow-up MRI and PET-CT were performed to evaluate post-RFA changes, growth plate and the articular cartilage.
Results: Eleven male patients were treated (mean age, 18 years). Lesions were located in the proximal humerus (n=2), proximal tibia (n=3), proximal femur (n=4), distal femur (n=1) and lunate (n=1). Mean volume of lesion was 6.8 mL. All patients reported relief of symptoms on post-procedure day 1 and on follow-up at 6 months. Mean follow-up period was 28 months. Complete return of limb movements was found in all the patients except in the one with lunate lesion. Complete metabolic regression in the target lesion was obtained

on PET-CT on follow-up. Follow-up MRI did not reveal growth plate abnormality. No major complications were noted in our patients.
Conclusion: Percutaneous RFA appears to be a safe, effective and minimally invasive alternative to open surgical method for chondroblastomas. Further research and long-term follow-up is required for substantiating the long-term benefits of RFA in this subset of patients.

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Ultrasound-guided punctures: improved hygiene using a novel disinfectant ultrasound couplant spray

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Purpose: The number of endovenous procedures performed by radiologists under ultrasound monitoring is rapidly increasing. A new disinfectant ultrasound couplant spray (DUCS) containing octenidine and phenoxyethanol was evaluated.
Material and Methods: Both legs of 20 patients (32–73 years) with symmetric venous disease were randomized to (A): standard, consisting of mapping using conventional ultrasound gel, 2x disinfectant according to surgical requirements, intervention using sterile ultrasound gel or (B): mapping using DUCS (>3 min contact time), interventional preparations using DUCS (>2 min contact time). Contact plate samples were taken prior to puncture and after intervention (>3 min contact time). Colony-forming units (CFU) were determined in addition to procedural time.
Results: The evaluation of 20 cases (40 legs; 168 samples) showed bacterial growth after completed hygienic preparation for group A (standard) with a mean of 11.6 CFU (0–74) versus group B (DUCS) with 2.6 CFU (0–19). After treatment, group A showed increased growth at 17.5 CFU (2–180), while group B showed just 2.1 CFU (0–8). Comparing corresponding locations, DUCS-treated areas were superior or equal to those treated with standard in 93.8% of the samples. Mean procedural time was 18:20 min for standard and 14:10 min for DUCS-using procedures. Gel consumption was 32–71 ml (mean, 51) for standard and 4–8 ml (5.4 ml) for DUCS.
Conclusion: The use of the novel DUCS seems to provide similar or even better hygienic conditions than those achieved by conventional alcoholic disinfection, and it may help to simplify ultrasound-monitored procedures.

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Closing postoperative gastric tube pleural fistula with an Amplatzer ASD closure device

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A 67-year-old male with carcinoma esophagus (T3N1M0) underwent transthoracic esophagectomy. He presented with persistent pleural drainage secondary to gastric tube pleural fistula at the upper anastomotic site. An atrial septal closure device augmented with n-butyl cyanoacrylate was used to successfully close the defect.

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Combined role of endovenous laser ablation (EVLA), alcohol and lipiodol embolisation and foam sclerotherapy in endovascular treatment of venous malformations and congenital varicosity

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A 16-year-old male presented with grossly dilated tortuous congenital varicosity, cord-like tender varices and blackish discoloration on the thigh and congenital venous malformations of the left lower limb, with subcutaneous venous hypertrophy, and complained of haematuria, chronic leg pain and knee-joint deformity.

GI tract intervention

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Percutaneous gastrostomy – indications, outcome and complications: 5-year experience at a tertiary care cancer hospital

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Purpose: To review our institutional indications for percutaneous radiological gastrostomy (PRG), procedure success and complications and to see how we compare to international studies.
Material and Methods: Five-year data from January 2010 to December 2014 was retrospectively reviewed. It showed a total of 79 PRGs. All patient's electronic medical records were reviewed for indication, endoscopic attempt/limitations, procedure report and clinical notes. Patients were followed up till the last follow-up for any gastrostomy-related complaints/complications. Data were analysed using SPSS 20; procedure success, indications and complications were calculated as a frequency and percentage.
Results: Amongst 79 patients, age range was 12-83 years, with a mean of 46.7 years. Most frequent age group was 51-60 years (26.58%). Majority 50 (63.29%) were males, and the most common primary disease site was post-cricoid CA (24.05%), with only 9.11% patients having primary site of disease outside the head and neck. One patient had GBM, and others had mid- and distal esophageal lesions. Commonest histopathology was SCC, with moderate-grade SCC being most common (46.84%).
Endoscopy failed in 18.99% patients and was limited in 78.48%, primarily due to limited mouth opening in head and neck malignancy. Procedure success rate was 97.5%, with a mortality of 3/79 (3.7%). Major complication rate was 6.3%, with 1 case of aspiration; 2 patients needed surgery for peritonitis, and 1 patient had peritonitis but was a poor surgical candidate.
Conclusion: PRG is a safe, minimally invasive procedure, which is a good alternative in patients with limitations to endoscopic PEG placement. Our data is comparable to international studies.

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Trans-jejunostomy stent placement in patients with malignant small bowel obstructions

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Purpose: This study aims to evaluate the clinical effectiveness of trans-jejunostomy stent placement in patients with malignant small bowel obstructions (MSBO).

Material and Methods: Between March 2009 and November 2014, 14 patients (age range, 20–81 years; mean, 59 years) with MSBO from advanced abdominal malignancies were enrolled in this study. Percutaneous direct jejunostomy tube was placed at 30–50 cm upstream to MSBO based on CT. Self-expandable stents were placed to cover MSBO through the jejunostomy entry in the same session (n=7) or at 1–10 days after jejunostomy (n=7). Post-stent balloon dilation was performed as needed. A retrospective analysis was conducted for technical success, bowel decompression, diet improvement, and procedure-related complication.
Results: Stent placement was technically successful in 13 patients (92.8%). One to three stents were placed to recanalize one (n=9), two (n=4), or three (n=1) MSBOs. In one patient, stent delivery could not reach the target obstruction due to tortuous small bowel. Adequate bowel decompression was achieved in all patients (100%). All patients tolerated liquid (n=3), soft (n=7), and normal diet (n=4). Jejunostomy tube was removed (n=13) at 5–83 days after stent placement. Major complications (21.4%) included wound infections (n=2) and localized peritonitis (n=1), which were successfully treated with antibiotics (n=2) and percutaneous drainage (n=1).
Conclusion: Trans-jejunostomy stent placement is an effective treatment in patients with MSBO from advanced abdominal malignancies. It can provide good symptomatic palliation even in patients with multifocal obstructions. Major complications are not uncommon but can be managed conservatively.

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Insertion of balloon-retained gastrostomy tube: a single-centre review of 319 patients

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Purpose: To evaluate outcomes and complications following primary placement of balloon-retained gastrostomy tube.
Material and Methods: All patients who underwent radiologically inserted gastrostomy (RIG) over a 7-year period were retrospectively identified from the Radiology Information system. Procedural and clinical parameters were collected by review of the patient archive and communication system, electronic patient records system and a local, prospective database maintained by the nutrition team. All RIGs sited using a standardised technique with 2 gastropexy sutures. Complications classified by the Society of Interventional Radiology (SIR) classification system for complications by outcome. Statistical analysis was performed with the χ^2 test.
Results: In all, 319 patients underwent RIG during the study period; 65% (n=206) male and 35% (n=113) female, with a mean age of 65 (range 18-95). Further, 45% (n=144) were sited for head and neck malignancy, 37% (n=119) for neurogenic dysphagia and 4% (n=14) for oesophageal malignancy. Technical success was 97%. Overall, complications occurred in 19% (n=60) of patients; 74% (n=51) of complications were classified as minor and 26% (n=18) major. The most frequently encountered complications were pain and tube displacement. Thirty-day procedure-related mortality rate was 0.6% (n=2), with two patients dying following intraperitoneal administration of feed after tube displacement. Average gastrostomy dwell time was 410 days (1-2524). There was no association between sex, age, indication for placement, tube Fr size and complications.
Conclusion: RIG is a safe and effective method of maintaining the nutritional status of patients unable to maintain sufficient oral intake.

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Mid-term results of emborrhoid: results of a prospective multicenter study

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Purpose: To assess the safety and efficacy of the emborrhoid technique (embolization of the superior hemorrhoidal arteries) in patients unfit for surgery.
Material and Methods: Between 1-2014 and 1-2015, we embolized 25 consecutive patients (mean age 62 years) suffering from disabling chronic rectal bleeding related to hemorrhoidal disease and contraindication (n=11) or failure of previous surgical or instrumental treatment (n=14). All patients were discussed in multidisciplinary consensus including a dedicated proctologist/surgeon and an interventional radiologist. We performed super-selective micro-coil embolization (pushable fibered 2–3-mm/0.018" coils) of the distal branches of the superior rectal arteries with a micro-catheter through a right femoral 5-F approach under local anesthesia. Clinical results were assessed based on bleeding and overall patient satisfaction.
Results: Immediate technical success was 100%, with no complications. The average number of embolized arteries per patient was 3, for an average of 9 coils per patient. Median follow-up was 5 months. Significant bleeding reduction was observed in 64% of patients (16/25) and in 5 additional patients after re-embolization, accounting for a total success rate of 84% (21/25). In 4 (16%) patients, we did not observe any significant bleeding improvement. Overall patient satisfaction was observed in 80% of patients.
Conclusion: Distal coil embolization of the superior rectal arteries for treating chronic rectal bleeding is safe and effective in patients beyond proctologic resources.

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Non-healing postsurgical fistulas: image-guided treatment with the injection of cyanoacrylic glue

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Purpose: To assess the feasibility, safety and effectiveness of percutaneous image-guided injection of cyanoacrylic glue in the treatment of postsurgical enteric fistulas that did not not heal after standard treatment.
Material and Methods: Sixteen patients (10 males and 4 females) with postsurgical enteric fistula were treated with percutaneous injection of cyanoacrylic glue (Glubran2®, GEM s.r.l., Viareggio, Italy). In all patients, standard percutaneous drainage and/or percutaneous transhepatic biliary drainage had failed in achieving the resolution of the fistula. Under CT and/or fluoroscopic guidance, the catheter was advanced to the site of the fistula via a percutaneous or transhepatic approach, and a mixture of 1:1 to 1:5 cyanoacrylic glue and iodized oil was injected at the level of the fistula.
Results: In all cases, it was possible to reach the site of the fistula with the catheter and perform the injection as planned. No complications

occurred. Resolution of the fistula was achieved in 15/16 (93.7%) cases with a median of 1 (range, 1–3) injection. No patients required further surgery. None of the patients showed recurrence of the fistula.
Conclusion: Percutaneous injection of cyanoacrylic glue is feasible, safe, and effective in treating postsurgical fistulas not responsive to standard treatment. This technique may represent a new option to avoid surgical reoperation.

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Endovascular embolisation of non-variceal gastrointestinal haemorrhage: 15-year single-centre experience

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Purpose: Gastrointestinal haemorrhage remains a major cause of patient mortality and morbidity. The aim of our study was to identify any associations between baseline variables and outcomes in patients treated with endovascular embolisation for acute non-variceal gastrointestinal haemorrhage.
Material and Methods: Retrospective data of patients treated at our institution between January 2000 and February 2015 was collected. Baseline variables, including demographic and clinical data, were retrieved from the patients' medical records. Procedural details and clinical outcomes were collected and statistical analysis was performed using SPSS v20™.
Results: Forty-two patients (mean age, 69.2; range, 29–95; M:F=20:22) were included. Twenty-two patients had UGI haemorrhage, and 20 had LGI haemorrhage. Embolic agents included coils (27 cases), gelfoam (4 cases), particles (1 case), glue (4 cases) and combinations of coils and gelfoam (4 cases) and coils and glue (2 cases). Chi-square test and Pearson correlations were performed. Thirty-day mortality correlated with the number of procedures (p=0.030). Treatment success highly correlated with intra-procedural visualisation of a bleeding point (p=0.001). There was a linear relationship between recorded procedural complications and the number of embolisation attempts (p=0.050).
Conclusion: Though a small sample size limited our analysis, important correlations were identified, which may improve outcome prediction in patients presenting with acute gastrointestinal haemorrhage.

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Visceral artery pseudoaneurysm: what the interventional radiologist needs to know about all endovascular techniques

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Learning Objectives: To describe the indications and the possible endovascular therapies for visceral artery pseudoaneurysm exclusion.
Background: Visceral artery pseudoaneurysm is now being diagnosed with increasing frequency because of the routine use of computed tomography, magnetic resonance, and ultrasound. Diagnostic radiology plays a major role in the detection and characterization of splenic artery aneurysms. Advantages in endovascular therapies have allowed interventional radiologists to contribute to the management of visceral artery pseudoaneurysms. Endovascular procedures are performed with the goal of preventing pseudoaneurysm expansion and rupture. This goal is accomplished by excluding the pseudoaneurysm from the arterial circulation and pressure.
Clinical Findings/Procedure: The purpose of this poster is to illustrate 1) imaging evaluation of visceral artery pseudoaneurysm, 2) the possible endovascular therapies [embolization (isolation technique, glue, and coils) and covered stent placement], and 3) advantages and limitations of these endovascular techniques.
Conclusion: Clinical history and imaging characteristics of the visceral artery pseudoaneurysm dictates its treatment. Thus, each patient is a candidate for the most rapid and efficient endovascular procedure for his/her anatomy.

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Anterograde–retrograde rendezvous procedure using a TIPSS needle for the treatment of radiation-induced upper oesophageal occlusion

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Learning Objectives: To describe a novel procedure utilising endoscopic evaluation of TIPSS needle deployment to recanalise complete oesophageal occlusion in head and neck cancer patients presenting after radiotherapy.
Background: Strictures of the oesophagus are reported in up to 30% of head and neck cancer patients treated with chemoradiation. They can be extremely morbid, causing dysphagia, dyspnoea and life-threatening aspiration. Patients presenting with complete oesophageal occlusion pose a particular challenge.
Clinical Findings/Procedure: Two such patients presented with aphagia following upper oesophageal strictures progressing to complete occlusions. Previous balloon dilatations were unsuccessful. Under general anesthesia, a BMC catheter was placed into the oesophageal stump from an anterograde approach. A paediatric endoscope was manipulated to the lower extent of the occlusion via a pre-existing PEG. A Rosch-Uchida (TIPSS) needle was positioned through the catheter; under endoscopic vision/fluoroscopic guidance, the oesophageal occlusion was punctured. An Amplatz superstiff wire was passed through the TIPSS needle and grasped with a biopsy forceps through the endoscope from below. The new tract was dilated with 4- and 6-mm balloons. The strictures were at the level of cricopharyngeus, and thus too proximal to the stent; therefore, a nasogastric tube was placed over the wire to maintain tract patency. Over 3 weeks, the tract was dilated to 20 mm. The first patient has had the nasogastric tube removed and is eating a soft-food diet, with monthly balloon dilatations. The second patient is undergoing weekly tract dilatation.
Conclusion: In complete oesophageal obstruction, needle recanalisation followed by serial balloon dilatation is feasible, restoring enteral nutrition and improving patient's quality of life.

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Nutriflower: a new balloon-free long-term button gastrostomy

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Learning Objectives: To assess a prototype button gastrostomy with an intragastric retainer shaped from the tube stem, thus avoiding trauma to the stoma and permitting much longer dwell times than balloon-retained tubes.
Background: Eighteen patients referred for long-term gastrostomy tube replacement were offered a CE-marked 14-Fr Nutriflower (Vygon, Ecouen, France). Tubes were replaced without local anaesthesia, unless required for removal of the pre-existing gastrostomy.

Primary placement was attempted in 2 additional patients.
Initially, Nutriflowers were changed routinely after 6 months; now, they are left until a problem develops. 24/7 home support was offered for the first week, and follow-up was performed until tube removal. Patients gave formal consent, IRB approval was granted.
Clinical Findings/Procedure: All replacement tubes were inserted and subsequently replaced without difficulty. Local anaesthesia was not required, even in patients with previously traumatic exchanges. Two patients still have a Nutriflower in situ after a median of 2041 days; 8 were removed due to end of treatment and 8 were changed back to balloon tubes. No tube blockages or accidental displacements occurred. Sixteen of 18 patients (89%) preferred Nutriflower to balloon gastrostomies due to pain-free exchange, reliability and lack of balloon maintenance. Primary placement, however, was challenging due to the lack of wire guidance. One was successful; one was partially deployed in the track.
Conclusion: Nutriflower was widely preferred by the recruited patients. The device is pain-free to exchange, very durable with dwell times up to 5 years and has extremely reliable intragastric fixation, making this an ideal device for children. However, modification is required for primary insertion.

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Gastrointestinal bleeding and peripheral embolotherapy with ethylene vinyl alcohol copolymer (Onyx): a single-center experience

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Learning Objectives: To determine the efficacy, the risk of nontarget vessel embolization, and ischemic complications of ethylene vinyl alcohol copolymer (Onyx; ev3, Plymouth, MN) in the management of gastrointestinal (GI) bleeding and peripheral embolotherapy.
Background: Superselective arterial embolization is a common therapeutic procedure for visceral hemorrhage.
Clinical Findings/Procedure: Between December 2013 and May 2014, 23 patients underwent embolotherapy with the liquid embolic agent Onyx 34 and 18. In all cases, we used a microcatheter (ranging from 1.7 Fr to 2.8 Fr) to administer the embolic material. All angiograms were retrospectively studied to evaluate immediate complications such as migration into nontarget vessels, and all patient records were reviewed to identify the patients who presented with ischemic complications that required surgical intervention or prolonged hospital stay. Follow-up was performed until discharge from hospital. Embolotherapy with ethylene vinyl alcohol copolymer (Onyx) was performed for treatment of acute arterial hemorrhage (18 patients) and preoperative tumor embolization (5 patients). Migration of Onyx into nontarget vessels occurred in 1 patient; it was observed with Onyx 18. No ischemic complications emerged in any patient. No re-bleeding was observed after embolization in any GI bleeding group.
Conclusion: Embolization using the liquid embolic agent Onyx is safe and effective, but specific skills and cost are still limiting factors in the use of this good embolic device.

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Embolization of hemorrhoidal arteries: the emborrhoid technique

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Learning Objectives: In this presentation, we will present the technical steps to achieve successful embolization of hemorrhoidal arteries (the superior rectal artery) for the treatment of patients suffering from disabling chronic rectal bleeding related to hemorrhoidal disease.
Background: The favorable results of elective trans-anal Doppler-guided hemorrhoidal artery ligation have demonstrated that hemorrhoidal bleeding is a disease related to excessive arterial inflow.
The emborrhoid technique consists of coil embolization of the distal branches of superior rectal arteries.
We already reported our favorable technical and clinical experience after a first feasibility report by Vidal et al. in 2014.
Clinical Findings/Procedure: Embolization is performed using a right femoral approach through a 5-Fr introducer sheath in an outpatient setting. The inferior mesenteric artery is selectively catheterized, which is, most of the time, easy, except in very atheromatous patients. The superior rectal arteries are then catheterized with a micro-catheter, followed by selective angiography in order to identify the number/location of the target arteries. We use pushable 0.018-inch fibered coils of 2 and 3 mm in diameter and 3 cm long (average 9 coils/patients) and aim at occluding all arteries in a single session. Clinical follow-up is performed in collaboration with a dedicated proctologist.
Conclusion: The emborrhoid technique is a new field of peripheral embolization, offering very attractive clinical results. The technique is relatively easy and could be offered in many vascular interventional radiology centers in Europe and worldwide.

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Image-guided interventional procedures in hepatic adenomatosis

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Learning Objectives: To describe some treatments involving interventional radiology modalities for patients with hepatic adenomatosis.
Background: Hepatic adenomatosis is by definition the presence of more than 10 adenomas involving both liver lobes. Characteristically, it should not have correlation with glycogen storage disease and show less association with exogenous steroids and oral contraceptives. Incidence is estimated in 3 per 1,000,000 patients per year, usually in the 3rd-4th decades. Patients commonly are asymptomatic, and rupture and malignant transformations are the most important complications.
Clinical Findings/Procedure: Four cases will be described. Two of them presented with abdominal pain and liver bleeding and were treated with transarterial embolization. It will be demonstrated that patients presenting multiple and large lesions (>3.0 cm) can be effectively treated by elective embolization and/or radioablation. In another patient with multiple small and closely packed nodules, an MRI-US fusion guided biopsy was performed, promoting the target-lesion sample collection.

Conclusion: Interventional radiology procedures are well established in malignant liver nodules. Similarly, it showed to be effective in symptomatic lesions, with the advantage of greater liver parenchyma preservation.

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Trans-hepatic assisted duodenal stent insertion (THADS)

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Learning Objectives: Describe the technique in duodenal stent placement via trans-hepatic assisted route after endoscopy failed or was anatomically not feasible (previous surgery).
Background: Patients with tumours involving the duodenum and head of pancreas may present with duodenal/gastric-outlet obstruction together with jaundice. Where treatments of both duodenal and biliary obstruction are indicated, the management options include endoscopic or radiologically guided enteral stenting and PTC. Failure of enteric stenting will lead to chronic gastric venting or surgical bypass.
Clinical Findings/Procedure: We describe 4 cases with jaundice in which endoscopic duodenal stenting failed and PTC was indicated. The level of obstruction varied from D1 to D3.
All patients received procedural sedation/analgesia. Standard percutaneous trans-hepatic cholangiogram was performed under ultrasound guidance. Cholangiogram demonstrated the level of biliary obstruction, and the lesion was crossed with a hydrophilic wire and duodenogram performed, demonstrating the enteric lesion.
Under fluoroscopic guidance, a duodenal stent was deployed (Niti-D) through the trans-hepatic route and optimum placement was confirmed. The biliary stent (closed cell, uncovered) was deployed subsequently, and satisfactory drainage was confirmed. In one patient with proximal duodenal lesion, the hydrophilic wire was manipulated through the trans-hepatic route into the stomach, which was snared through the oropharyngeal route under fluoroscopic guidance followed by standard fluoroscopic-guided duodenal stent deployment. The trans-hepatic access tract was closed with Avitene flour. Patients demonstrated no immediate procedure-related complication and could commence semi-solid diet.
Conclusion: In jaundiced patients with symptomatic duodenal strictures in whom endoscopic management has failed, our technique provides a minimally invasive alternative for palliative treatment.

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Intraarterial platelet infusion for patients with intractable gastrointestinal hemorrhage and severe thrombocytopenia

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Learning Objectives: To assess the safety and efficacy of direct intraarterial (IA) infusion of platelets into the mesenteric vasculature in pediatric and adult patients with intractable hemorrhage and thrombocytopenia.
Background: Endovascular approaches used for the treatment of acute nonvariceal gastrointestinal (GI) hemorrhage have traditionally included vasopressin infusion and embolization. However, for patients with diffuse or multifocal hemorrhage and severe refractory thrombocytopenia, or unidentified angiographic abnormality, these approaches may not be suitable because platelet counts and coagulation parameters may not be adequate to allow for the formation of a stable clot. Pediatric patients with steroid- and transfusion-refractory GI graft-versus-host disease (GVHD) causing intractable lower GI hemorrhage may also not be candidates.
Clinical Findings/Procedure: Four patients treated with direct IA infusion of platelets into the mesenteric vascular territory supplying the hemorrhage are described. Two were pediatric patients with steroid- and transfusion-refractory GI GVHD causing intractable lower GI hemorrhage and refractory thrombocytopenia, referred for salvage therapy; one adult patient with bowel vasculitis; and another adult patient with occult bleeding source. Platelet infusion was performed selectively from the superior and inferior mesenteric arteries and celiac trunk. In all patients, after IA platelet infusion, blood product requirements were immediately reduced, bleeding from the GI tract resolved by clinical and laboratory criteria, and no bowel ischemia was seen. In pediatric patients, immediate angiographic response was noted.
Conclusion: This procedure may provide an effective alternative for the management of intractable GI hemorrhage in the setting of severe refractory thrombocytopenia, and may be performed in seriously ill patients.

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Percutaneous imaging-guided management of calculous pancreatitis, complicated by pancreatic pseudocyst formation and PV thrombosis

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A patient with obstructive calculous pancreatitis complicated by pseudocyst formation and main PV thrombosis underwent successful percutaneous management by pseudocyst drainage and PV percutaneous trashepatic stenting, allowing resolution of pancreatitis and restoration of PV flow.

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Successful percutaneous angioembolization of bleeding jejunal varix by acrylate glue and coils

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We present a case of chronic liver disease with portal hypertension, multiple varices at portosystemic anastomoses, and an ectopic jejunal varix on CT. The treatment was percutaneous embolization of the bleeding varix using glue and embolization coils by portal venous approach.

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Use of Penumbra™ aspiration system for endovascular recanalization of right hepatic artery thrombosis after liver transplantation

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CT angiography showed right hepatic artery thrombosis in a 56-year-old patient 27 days after liver transplantation. Penumbra™ 4MAX reperfusion catheter was inserted into the thrombus with the aspiration pump connected. It was advanced over the occlusion and then carefully withdrawn until successful clot removal.

Gynaecological intervention (including UFE)

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Pre-delivery uterine artery embolisation prevents peri-/post-partum haemorrhage (PPH) in placental implantation anomalies

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Purpose: The increasing rate of cesarean delivery has led to many patients having placental implant anomalies (previa, accreta and percreta) in following pregnancies and so high risk of peri-/post-partum hemorrhages (PPH).
The aim of this study was to assess the feasibility of a predelivery intervention consisting in uterine artery embolization (UAE) immediately before cesarean section in order to decrease patient morbidity due to bleeding and so the blood units transfused.
Material and Methods: From November 2012 to June 2014 we enrolled 30 patients with placental anomalies. All had previous cesarean delivery and at the moment of the intervention were at the 35-36 week of pregnancy.
In the gynecological operating room, we used a mobile angiograph to superselectively embolize uterine arteries with reabsorbable pladgets injected through 2.7-Fr microcatether. We applied 5 dosimeters on the back of the patient to measure the radiation dose to the uterus, considered as to the fetus.
Results: The procedure was always technically completed. In all, 63.3% of the patients did not require transfusions at all, and the overall rate of blood units transfused was 0.8 ± 1.8; no patient was admitted to the intensive care unit. Mean procedural time was 6'24'', and mean dose to the uterus was 23.34 mGy. Mean time between embolization and delivery was 6'30''.
Conclusion: Predelivery UAE seems to be a valuable preventive technique able to significantly reduce bleeding during cesarean sections in patients with placental anomalies at high risk for PPH. In experienced hands, the radiation dose to the foetus is negligible considering 100 mGy as the threshold value.

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Transvaginal tubal infertility treatment: preliminary study

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Purpose: Abnormalities of the fallopian tubes represent a significant percentage of the causes of female infertility. In a study, 3,424 hysterosalpingograms (HSG) were assessed: in 15.2% cases, unilateral obstruction, and in 12.2% cases, bilateral obstruction was detected. Occlusion by mucous plugs is one of the most common causes of obstruction.
Material and Methods: In 2013, 54 patients with potentially bilateral obstruction (confirmed in a classic HSG) were sent to the Interventional Radiology Department. Forty-five patients with bilateral tubal obstruction ware qualified (78 fallopian tubes). All procedures were performed under fluoroscopy. Into the uterine cavity, a 12-F mother catheter was introduced. Uterine fallopian entrances ware catheterized with a coaxial catheter system. An attempt to overcome the obstructed fallopian segment was made with appropriately selected atraumatic microdevices.
Results: Technical success, patency recovery, and flow of contrast media into the peritoneal cavity were obtained in 88% of cases. Six months after the questionnaire was conducted, 12 patients got pregnant, which corresponded to clinical success of 26%.
Conclusion: Transvaginal tubal recanalization in cases of bilateral tubal occlusion in the proximal part is a minimally invasive, safe, and effective method of treatment, which implies a high percentage of clinical success. Due to the increasingly widespread availability of interventional radiology cath labs, this method seems to be an important alternative.

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Uterine artery embolization for a symptomatic leiomyoma and follow-up results

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Purpose: To evaluate fibroid size using ultrasonography (US) and magnetic resonance imaging (MRI) after uterine arterial embolization (UAE) of leiomyoma.
Material and Methods: Six hundred and two women with symptomatic leiomyoma underwent bilateral transcatheter UAE.
Mean age, 35.5 years (range, 20–52). All patients underwent US and MRI before and after UAE. Volumes of fibroids were evaluated at 1 month (M), 3 M, 6 M, and 12 M.
Results: A moderate reduction in fibroid size was observed at 1 M after UAE. Decrease in fibroid size determined by US was 18.4% and by MRI was 17.3% at 1 M. The following reduction in fibroid size was observed: at 3 M, by US, 41% and by MRI, 42.7%; at 6 M, by US, 58.4% and by MRI, 59.3%; and at 12 M by US, 70.8% and by MRI, 72.7%.
Doppler US control showed blood flow decrease during the first M after UAE; at 3 M, blood flow in uterine arteries was restored. No significant changes in the blood flow data had been observed at 12 M.
We also noticed the disappearance or significant reduction of clinical symptoms: pain, menorrhagia, and pressure symptoms.
Conclusion: UAE is an effective, minimally invasive type of leiomyoma treatment. MRI and US are the modalities that can accurately estimate fibroid changes and blood flow in uterine arteries. The tendency of fibroid shrinkage after UAE is well defined in the period from 1 M to 24 M.

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Bleeding uterine arteriovenous malformations (UAVM) – imaging findings and arterial embolization: our experience

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Purpose: To describe ultrasonographic and angiographic findings and endovascular technique of embolization in women with symptomatic UAVM, likely acquired after pregnancy, abortion, and iatrogenic procedures on the uterus.
Material and Methods: Between May 2013 and December 2014, 8 women with a diagnosis of UAVM (age 30-41 years) were admitted to our angiosuite for diagnostic angiography, followed by uterine artery embolization (UAE). The clinical characteristics, Doppler US and angiographic features, technical success rate of embolization, procedure-related complications, and clinical follow-up data were assessed. Clinical success was defined as immediate symptomatic resolution with disappearance of vascular abnormality on subsequent imaging studies.
Results: All (8/8) patients had a history of important recent bleeding. Color Doppler US showed the presence of multiple tubular anechoic lesions focally or asymmetrically distributed in the thickened myometrium or endometrium with turbulent, low-impedance, high-velocity color flow. Preliminary diagnostic angiography confirmed the presence of hypervascular lesions with generally a single feeding artery and a large nidus. Early venous filling was detected in 5/8 patients. Further, 7/8 patients underwent UAE (3 bilateral, 4

unilateral) with PVA particles and coils. All the treated patients had a complete relief of symptoms during follow-up. Procedure-related complications were not observed in any patient. No pregnancies were reported after procedures, but this was patients' choice. Uterine vascularity and echostructure were investigated by color Doppler and US few months (2-14 months) later, and no structural abnormality was observed.
Conclusion: UAVM embolization is a safe and effective first-line therapeutic option for the management of patients with symptomatic UAVM. In selected cases, bilateral embolization may be necessary.

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Outpatient uterine fibroid embolization: reducing the pain and shortening the length of stay

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Purpose: Limitations of outpatient uterine fibroid embolization (UFE) are related to recovery time and pain management and include staff and space requirements, costs, possible end-of-day hospital transfer, and physician's reluctance to refer. In 2014, we addressed these issues by altering pain management and vascular access hemostasis. This report evaluates the modifications.
Material and Methods: The Arstasis hemostasis system replaced manual vascular control in 2014. Vascular access by 5Fr femoral approach and 500–700-micron PVA particulate embolization was unchanged. Microcatheters were used occasionally. Pain management (2013) utilized prochlorperazine for nausea and vomiting (N&V) and midazolam, ketorolac, and morphine sulfate (MS) for a score greater than 5 on visual pain scale, supplemented with sublimase, as needed. In 2014, percutaneous trans-abdominal superior hypogastric plexus block (SHPB) replaced MS. We compared patient demographics, fibroid size, medication utilization, morbidity, efficacy, discharge time, and status.
Results: Thirty-four patients did not undergo SHPB. They received an average of 10.85-mg MS, 57.4-mcg sublimase, 0.35-mg midazolam, and 74.55-mg ketorolac. Thirty percent of patients were drowsy or lethargic, or complained of pruritus, 18%; N&V, 29%; or residual pain, 39%, requiring oral analgesic upon discharge at 5 hours.
Thirty-one of 34 SHPB (91%) were successful. Patients required an average of 170-mg sublimase, 2.3-mg midazolam, and 50.77-mg ketorolac. One patient required MS and developed N&V. All were alert, without drowsiness, lightheadedness, or lethargy. None had pruritus or significant pain upon discharge at 3 hours.
There were no complications of SHPB or vascular access hemostasis.
Conclusion: SHPB is more effective and better tolerated than MS for pain management after UFE, making ambulatory treatment more expeditious and practical.

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Does temporary bilateral balloon occlusion of the common iliac arteries reduce the need for intra-operative blood transfusion in cases of placenta accretism?

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Purpose: Bilateral balloon occlusion has been employed as a prophylactic measure in cases of placenta accretism prior to caesarean section, with the aim of reducing blood loss and its associated morbidity/mortality. There is, however, no clear consensus on its efficacy in the current literature.
The objective of this study was to assess the efficacy of bilateral balloon occlusion of the common iliac arteries (CIA) in reducing intraoperative morbidity in cases of placenta accretism.
Material and Methods: The databases of the pathology department and interventional radiology suite were reviewed over a 9-year period. Fifty-two cases of confirmed placental accretism who underwent caesarean section with or without hysterectomy were identified and divided into two groups: 25 cases had temporary occlusion of the common iliac arteries (CIA) during delivery and these were considered the study group, and the remaining 27 did not have temporary occlusion of the CIA and were considered the control group.
The two groups were compared based on gravidity, age group, postoperative haemoglobin, drop in haemoglobin, estimated blood loss (EBL), transfusion requirement and the histopathological subtypes of placenta accretism.
Results: There was no statistically significant difference between the study and the control groups regarding EBL, post-operative haemoglobin drop, transfusion requirement or placenta accretism histopathological subtype.
Two cases in the study group had acute thromboembolic complications. Both groups had one patient requiring a massive intraoperative transfusion.
Conclusion: Our findings did not demonstrate that balloon occlusion of the CIAs helped to significantly decrease intraoperative morbidity during caesarean section surgery for placenta accretism.

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Evaluation of changes in sexual function related to uterine fibroid embolization (UFE): preliminary results of the French SFICV EFUZEN study

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Purpose:
- To evaluate sexual function and quality of life before and 1 year after UFE
- To determine impact of imaging findings (MRI data) before and 3-6 months after UFE on changes in sexual function and quality of life

Material and Methods: This prospective, multicenter (25 centers) French observational study included 264 consecutives symptomatic women referred in the centers for UFE using Embozene (Celonova) particles. Sexual function score and quality of life score were calculated using the previously validated Female Sexual Function Index (FSFI) by Rosen and UFS-QOL by Spies, respectively, before and 1 year after UFE. MRI was performed before and 3-6 months after UFE. Data recorded were uterine and main fibroid volume and percentage of fibroid enhancement after injection of gadolinium. Impact of imaging data on FSFI and QOL scores after UFE was assessed.
Results: Post-UFE disappearance of menorrhagia and pelvic pressure symptoms was present in 185/217 (85.3%) and 190/217(87.6%) women, respectively. Improvement of both FSFI and QOL score at 1 year after UFE was found in 134/170 (78.8%) and 163/192 (84.9%), respectively. The impact of percentage of uterine volume or main fibroid reduction and decrease of fibroid enhancement on change in post-embolization global UFS-QOL and FSFI scores was not established.
Conclusion: At 1 year post-embolization, UFE significantly improves quality of life and sexual function.

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Balloon-assisted occlusion of the uterine arteries as a prophylaxis in cesarean section for patients at risk of accretism

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Purpose: Placental accretism is the main cause of obstetric hemorrhage and peripartum hysterectomy. The purpose of the study was to evaluate the outcomes of balloon-assisted occlusion of the uterine arteries (UA) in cesarean section (CS) for patients at risk of accretism.
Material and Methods: Between May 2011 and December 2014, 22 women diagnosed with placenta previa at risk of accretism were scheduled for CS. Seventeen patients underwent prophylactic UA catheterization before surgery. Effectiveness of vascular occlusion was fluoroscopically confirmed. Fetal cardiotocography was ensured throughout the procedure. Then, patients were taken to the operation room; after fetus removal, balloons were inflated. Under obstetrician's request, UA were embolized with Gelfoam. Sheaths were maintained for 24 hours, then removed.
Results: Balloon-assisted (B-A) patients had a mean age of 35 years and a mean gestational age of 34 weeks. Thirteen patients (76.5%) had previous uterine surgery; 11 patients (64.7%) had bleeding episodes during pregnancy. Embolization was performed on 12/17 patients (70.6%). Hysterectomy rate was 5/17 (29.4%) in B-A patients and 2/5 (40%) in non-assisted patients. Mean blood loss for B-A patients was 1,708 ml compared to 2,040 ml for the surgical ones. Mean hospitalization time was 10 days for B-A patients compared to 31 days for CS ones. Two B-A patients had post-partum hemorrhage, one of which required hysterectomy and the other was embolized.
Conclusion: Balloon-assisted occlusion of the uterine arteries appears to reduce blood loss, hysterectomy rate, and hospitalization time. Moreover, if post-partum hemorrhage occurs, embolization can be performed effectively and further reduce the risk of hysterectomy.

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Prophylactic internal iliac artery occlusion balloon placement in patients with invasive placenta

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Purpose: To compare outcomes when prophylactic internal iliac artery (IIA) occlusion balloons are placed to reduce operative blood loss for patients with placenta percreta, increta, or accreta.
Material and Methods: A retrospective review of our institutional records from October 2009 to December 2014 identified patients with invasive placenta treated with or without prophylactic IIA balloon placement. The electronic medical record was reviewed to compare operative outcomes and complications between these groups.
Results: A total of 40 patients were identified: 73% (29/40) had IIA occlusion balloons placed, 45% (18/40) had placenta percreta, 25% (10/40) had placenta increta, 23% (9/40) had placenta accreta; and 7% (3/40) had no evidence of invasive placenta on reviewing the pathological specimens. The mean surgical blood loss was lower (1765 mL vs. 2831 mL, $p < 0.01$) for the patients who had occlusion balloons placed. There was no statistical difference in mean blood loss between patients with placenta percreta (1933 ml) compared with increta or accreta (2161 ml, $p = 0.3$), irrespective of the occlusion balloon placement. Two patients had complications related to occlusion balloon placement: one was noted on postoperative CT to have a small nonobstructing arterial dissection at the aortic bifurcation, extending into the right common iliac artery which did not require intervention, and the other required blood transfusion for a postprocedural groin hematoma.
Conclusion: Preoperative prophylactic placement of IIA occlusion balloons is an effective procedure to reduce operative blood loss in patients with invasive placenta.

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Effectiveness of MRgFUS in uterine adenomyosis treatment: 2-year MRI follow-up and clinical outcomes

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Purpose: To analyze the efficacy of uterine adenomyosis treatment using magnetic resonance-guided focused ultrasound (MRgFUS) evaluating the imaging and clinical result after 24 months.
Material and Methods: From October 2011 to October 2012, we treated, using MRgFUS, 7 patients with adenomyosis (2 diffuse form and 5 focal forms) diagnosed by MRI. Patients were submitted to only one treatment. We subjected the patients to contrast-enhanced MRI respectively before treatment and at 3, 6, 12, and 24 months after treatment in order to evaluate the thickness of the junctional zone, the uterine morphology, and the possible recurrence of the pathology. Symptomatology was assessed using the symptom severity score questionnaire comparing the pre-treatment score to the one obtained after 2 years.
Results: After 24 months from the treatment, 5 patients with focal form of adenomyosis did not present with recurrence of pathology with a thickness of the junctional zone < 12 mm and good morphology of the uterine wall. Only 2 out of 7 patients showed a recurrence of adenomyosis focus with a junctional zone > 12 mm, and they were subjected to a second treatment. Symptoms just after 12 months presented a reduction of about 80% when compared to the pre-treatment symptoms.
Conclusion: MRgFUS allows us to control a pathology that tends to redevelop. Treatment with MRgFUS permits a good resolution of the symptoms, maintaining the uterus integrity, without recurrence of pathology in focal adenomyosis. The diffuse forms of adenomyosis are more difficult to treat, but it is possible to repeat the treatment.

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Role of gonadotropin-releasing hormone (GnRH) agonist therapy in patients undergoing uterine artery embolization (UAE) for uterine fibroids: rate of necrotic area reabsorbtion and clinical results

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Purpose: To evaluate the role of gonadotropin-releasing hormone (GnRH) agonist therapy after uterine artery embolization (UAE) for uterine fibroids in women aged between 40 and 50.
Material and Methods: We treated 29 symptomatic patients affected by uterine fibroids measured between 4 and 10 cm. Twelve out of 29 patients received GnRH agonists after 1 month from UAE (group A), and 17 did not receive any therapy after UAE (group B). Patients were subjected to contrast-enhanced MRI after 1 month from treatment in order to evaluate the extension of necrotic area

and then after 12 months from treatment in order to analyse the different reabsorption rate of necrotic area in both groups. We evaluated the clinical results after 12 months using the SSS questionnaire.
Results: All patients showed a mean value of necrotic area extension of 91.5%. Eight of 12 (66.6%) patients belonging to group A showed a mean necrotic area reabsorption of 85% after 12 months, and 4 patients of group A showed a mean necrotic area reabsorption of 65%. Fourteen of 17 patients belonging to group B showed mean necrotic area reabsorption of 60% after 12 months, and only 3 patients belonging to group B (17.6%) showed a mean necrotic area reabsorption of 85%. Patients of both groups presented a similar improvement of the symptoms after 12 months without any serious complications.
Conclusion: The association of GnRH agonists with UAE treatment seems to be an effective therapy, with a faster reabsorption of necrotic area in patients treated using UAE.

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Intrathecal anaesthesia and post-procedural pain control in patients who underwent UFE

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Purpose: Transcatheter arterial embolisation in the treatment of symptomatic myomas has proven effective in reducing or eliminating bleeding, which entails painful ischaemic symptoms.
Our work aims to report on the assessment of post-procedural pain control in relation to the number of myomas.
Material and Methods: Thirty patients aged 24–40 years were examined. All of them underwent subarachnoid anaesthesia with 0.5% levobupivacaine (2.5 ml; 12.5 mg) and morphine 100 gamma (0.1 mg). We used the VAS linear scale, as filled in by the patients for 5 days at different times of the day, taking into account the presence of single or multiple myomas. The pain relief therapy consisted of the following: Oxycontin 20 mg 8–20, sublingual administration of Perfalgan 1 g 8–16–24 and Plasil 1 tablet 8–20.
Results: No statistically significant difference was observed in the distribution of procedure-related side effects between the patients with single myoma and those with multiple myomas (the average VAS score at 4 hours after the procedure was 3.90±2.41; 5 days after the procedure, 1.62±0.90). The presence of multiple myomas is certainly a factor that significantly affects the average level of pain felt by the patient.
Conclusion: The treatment provided was equally (and significantly) effective in reducing the average pain score both in patients with single myoma and in patients with multiple myomas. The reduction in pain is increasingly evident, and particularly with regard to the first day of treatment, it appears to be significantly reduced starting on the 4th day of treatment.

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Intra-arterial oxytocin infusion for balloon-assisted cesarean section in patients at risk of accretism: is it effective? Preliminary results

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Purpose: Placental accretism is a risk factor for massive uterine bleeding during cesarean section (CS), which may require hysterectomy. The purpose of the study was to evaluate the preliminary results of the infusion of oxytocin (Syntocinon) inside uterine arteries during balloon-assisted (B-A) cesarean section for patients at risk of accretism.
Material and Methods: Between May 2011 and November 2014, 17 women diagnosed with placenta previa at risk of accretism were scheduled for CS, and they underwent prophylactic UA catheterization before surgery. After the fetus removal, in addition to balloon-assisted arterial occlusion, 6/17 patients received oxytocin through the lumen of the Fogarty balloons to enable uterine contractility and prevent bleeding or hysterectomy. After CS, sheaths were maintained for 24 hours and then removed.
Results: Intra-arterial oxytocin (I-O) infusion was performed on 6/17 (35%) patients. Embolization was performed for 11/17 patients (70.6%) who did not receive intra-arterial oxytocin; only one I-O patient was embolized with gelfoam. Hysterectomy rate was 16.7% for I-O patients when compared with 36.4% for non-I-O patients. Mean blood loss/blood units transfusion were 1,192 ml/0.17 and 1,991 ml/1.81 for I-O and non I-O patients, respectively. No postpartum complication occurred in patients who received intra-arterial oxytocin. Two non-I-O patients had postpartum hemorrhage: one required hysterectomy, and the other was embolized.
Conclusion: Our preliminary results, although of a limited number of cases, suggest that intra-arterial oxytocin infusion during balloon-assisted cesarean section may be effective in reducing blood loss, tranfusions, and hysterectomy rate.

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Uterine artery embolization for adenomyosis: percentage of necrosis predicts mid-term clinical recurrence

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Purpose: To evaluate the effect of the degree of necrosis after uterine artery embolization (UAE) on symptom recurrence at mid-term clinical follow-up in patients with adenomyosis.
Material and Methods: Study protocol was approved by the institutional review board, and informed consent was obtained. Fifty women (mean age, 39.9 years; range, 28-51 years) who underwent UAE for symptomatic adenomyosis were retrospectively analyzed. All patients underwent contrast-enhanced magnetic resonance imaging (MRI) at baseline and 3 months after UAE, and were followed clinically for at least 18 months. The percentage of necrosis was measured three-dimensionally on MRI at 3-month follow-up. The percentage of necrosis cut-off point for predicting symptom recurrence was estimated. Patients were divided into two groups according to the cut-off point. The rate of clinical recurrence was compared between groups, and risk factors for clinical recurrence were identified.

Results: During the follow-up period (range, 18-48 months), recurrence occurred in 12 of 50 patients. The 34.3% cut-off point of necrosis was calculated to predict symptom recurrence (AUC = 0.721; 95% CI: 0.577-0.839; p=0.0043). Patients with less than 34.3% necrosis (group A) were at significantly higher risk of recurrence than patients with more than 34.3% necrosis (group B) (hazard ratio, 7.0; 95% CI: 2.2, 22.4; p=0.001). Initial uterine volume and type of adenomyosis were not associated with recurrence.
Conclusion: The percentage of necrosis in patients with adenomyosis after UAE may predict symptom recurrence at mid-term follow-up. The cut-off percentage of necrosis required to predict symptom recurrence was 34.3% in this study.

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A new angiographic imaging platform reduces radiation exposure for uterine fibroid embolization

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Purpose: Because most of the women undergoing uterine artery embolization (UAE) are pre-menopausal, the exposition of women's reproductive organs to radiation during UAE should be as low as reasonable achievable. The purpose of this study was to quantify the radiation exposure reduction of a new C-arm imaging platform for women with symptomatic uterine fibroids being treated using UAE.
Material and Methods: Fifty-three consecutive women (mean age 45.7 years, range 32-59 years) were treated using UAE either on the new or on a standard C-arm imaging platform (n=34 vs 19). The new system includes optimized acquisition parameters and real-time image processing. Air kerma (AK), dose area product (DAP), and acquisition time for digital fluoroscopy (DF) and digital subtraction angiography (DSA) were recorded. The Wilcoxon rank-sum test was used to assess statistical differences between the platforms.
Results: There was no significant difference in DF or DSA time for new and standard platforms (median DF 26.1 vs. 28.3 minutes, p=0.91 and median DSA 64.6 vs. 62.6 seconds, p=0.59), indicating that the procedure's course was similar between the two cohorts. Compared to the standard platform, the new platform significantly reduced the cumulative AK and DAP by 68% and 74%, respectively (median 0.53 Gy and 138.4 Gy·cm^2 vs. 1.62 Gy and 528.7 Gy·cm^2, respectively, p<0.01 for both). Specifically, DAP for DF and DSA decreased by 59% (median 75.3 vs. 184.8 Gy·cm^2, p<0.01) and 82% (median 57.7 vs. 314.4 Gy·cm^2, p<0.01), respectively.
Conclusion: The new imaging platform significantly reduced radiation exposure for women with symptomatic uterine fibroids being treated using UAE.

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The role of interventional radiology in managing invasive placenta

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Learning Objectives:
1. Define invasive placenta.
2. Describe imaging findings of invasive placenta on ultrasound and MRI.
3. Review the prophylactic role of internal iliac balloon occlusion in managing invasive placenta.
4. Review the prophylactic and emergency role of uterine artery embolization (UAE) in managing invasive placenta.

Background: Invasive placenta has increased in incidence over the last few decades due to higher rates of Cesarean section. The most invasive form, placenta percreta, is associated with a 7% maternal mortality rate. It is traditionally managed with Cesarean hysterectomy, where nearly half of women require massive transfusions greater than 10 units of packed red blood cells. Vascular interventions, including prophylactic balloon occlusion and emergency UAE, can be performed to help decrease maternal morbidity and mortality.
Clinical Findings/Procedure: Sonographic findings of placenta percreta include increased placental vascularity beyond the uterine contour, abnormal myometrium–bladder interface, loss of retroplacental clear space, and abnormal lacunae. Corresponding T2 heterogeneity may be seen on MRI. After diagnosing placenta percreta, prophylactic vascular balloon occlusion can be considered. It is a short procedure, with minimal complications, and may reduce the need for massive intrapartum transfusion. UAE can be performed prophylactically, to decrease blood loss and the need for Cesarean hysterectomy, or definitively, to manage postpartum hemorrhage due to invasive placenta.
Conclusion:
1. Invasive placenta is a potentially life-threatening condition for the mother.
2. Early diagnosis is important in order to consider prophylactic balloon occlusion.
3. UAE may be used as a temporary or definitive management option for postpartum hemorrhage secondary to invasive placenta.

P-197

Use of an occluder device for closure of vaginal fistulas

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Learning Objectives:
1. To illustrate the method and application of an occluder device in vaginal fistula repair.
2. To show how occluder device technology may be further adapted to allow better utilization in a variety of patients with vaginal fistulas.

Background: Traditionally, vaginal fistula closures are performed surgically. However, there are some patients who are not appropriate surgical candidates, and few treatment options exist for them. Since the introduction of Amplatzer vascular plugs (AVPs) for use in the various clinical applications and organ systems, their applicability has been confirmed successfully in esophagobronchial, gastrocolonic, and ureterovesical fistulas. We have extended their applicability to the treatment of vaginal fistulas.
Clinical Findings/Procedure: Two patients who were not surgical candidates for vaginal fistula repair underwent MRI for consideration of fistula closure via the use of an AVP. In one patient, both transabdominal and transvaginal access were obtained into a mucinous-producing tumor that had fistulized to the vagina. An AVP was

deployed within the fistula, with successful technical and clinical results. In the second patient, an AVP was used to close a colovaginal fistula, in addition to closing a fistula from a rectovaginal communication. Short-term clinical follow-up and post-treatment MRI have documented the stability of this device in these patients.
Conclusion: Use of the AVP in select patients with vaginal fistulas may prove to be beneficial. Long-term viability study of this device is necessary to confirm stability.

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Superior hypogastric nerve block for acute pain control in uterine fibroid embolisation

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Learning Objectives: Understand the technique of superior hypogastric nerve block (SHNB) in uterine fibroid embolisation (UFE), its advantages and potential complications. Compare SHNB with other pain relief methods.
Background: UFE is often associated with severe pelvic pain that may require hospitalization for pain control, often with IV opioid analgesia. The pain typically begins during or soon after UFE, lasting for 6-12 hours, after which the pain reduces significantly. The superior hypogastric plexus supplies uterine sensory innervation. It runs in the pre-vertebral space along S1 to L4 before crossing behind the aortic bifurcation.
Clinical Findings/Procedure: SHNB is performed via an anterior abdominal approach under fluoroscopic guidance. A catheter over the aortic bifurcation is used as a landmark after embolising the left uterine artery. A small gauge needle is advanced percutaneously to the anterior surface of the vertebral body just below the aortic bifurcation. Contrast injection confirms needle tip in retroperitoneum. Regional block is performed by injecting long acting local anaesthetic. Intravascular anaesthetic injection may lead to cardiac dysrhythmia and convulsions, test injection of contrast under fluoroscopy can help avoid this. Bacteremia from needle transgression of bowel has not been reported. Small injection of contrast into the vertebral disk has no clinical significance.
Conclusion: SHNB can eliminate the need for IV and epidural methods of pain control in UFE. It is safe and well tolerated. It slightly prolongs overall UFE procedure time. Significant complications are very rare. SHNB makes the recovery period more comfortable for patients and allows for same day discharge making UFE more cost-effective and accessible.

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Internal pudendal artery rupture during sexual intercourse

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We report the first case of internal pudendal artery embolization to treat refractory post-coital vulvar hematoma in a hemodynamically unstable patient after surgical management failed. This is the second reported case of internal pudendal artery injury following sexual intercourse.

P-200

Giant uterine hemangioma: percutaneous sclerotherapy as an effective treatment

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Sclerotherapy for hemangiomas is well established; however, no report was found for the treatment of uterine lesions. We report a case of a giant uterine hemangioma treating using an ultrasound-/fluoroscopy-guided sclerotherapy by transvaginal access.

P-201

Percutaneous irreversible electroporation of a large centrally located hepatocellular adenoma in a woman desiring pregnancy

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We describe a 28-year-old female with a large, unresectable, non-thermal ablative, centrally located hepatocellular adenoma who wished to get pregnant. Percutaneous CT-guided irreversible electroporation led to rapid tumor shrinkage. Subsequent pregnancy and delivery went uncomplicated.

Imaging

P-202

CT thorax in treatment naïve hepatocellular carcinoma prior to loco-regional therapy: when is there a need?

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Purpose: Pulmonary metastases (PM) is the commonest site of distant metastasis in hepatocellular carcinoma (HCC). Their presence is considered a contraindication to loco-regional therapies. The role of staging CT thorax before loco-regional treatment is currently not defined. This study aims to assess the utility of pre-treatment CT thorax and predictive value of imaging features for PM.
Material and Methods: Retrospective review of cases of treatment naïve HCC referred for locoregional therapy from 2004 to 2013 was performed. Patients with pre-treatment CT thorax were evaluated by two radiologists for presence of PM. HCC features (size, numbers, vascular invasion, nodal status, bone metastases) were recorded, and both univarate and multivariate analysis performed.
Results: A total of 780 patients were reviewed, of which 135 patients had staging CT thorax. Pulmonary metastases (n=17, 12.6%), benign lung lesions (n=41, 30.4%) and indeterminate lesions (n=6, 4.4%) were detected. Among the indeterminate lesions, there were loss to follow-up (n=2), deaths within the study period (n=2) and continued surveillance (n=2). All the patients with PM, were declined loco-regional therapy due to detection of PM. Statistical significant association between pulmonary metastases with number of intra-hepatic lesions ($p<0.01$), primary tumour size ($p=0.018$) and presence of vascular invasion ($p<0.01$) was shown on univariate analysis. On multivariate analysis, the number of intra-hepatic lesions (OR: 9.7; 95% CI: 1.6-57.2, $p=0.012$) and the presence of both hepatic and portal venous invasion (OR: 11.8; 95% CI: 1.1-128.8, $p=0.043$) are the

two independent positive predictors of PM (z=0.01).
Conclusion: Multiple intrahepatic lesions and presence of vascular invasion are independent predictors for PM.

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Preliminary results using a newly developed projection method to visualize vascular anatomy prior to DIEP flap breast reconstruction

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Purpose: In a deep inferior epigastric perforator (DIEP) flap breast reconstruction, CTA is currently considered as the gold standard in preoperative imaging for this procedure. Unidirectional Doppler US is frequently used; however, this method does not distinguish main axial vessels from perforator arteries at the height of the fascia, has a limited penetration depth and cannot assess the deep inferior arteries branching patterns. A new method and system was developed and consisted of a video projector, preoperatively displaying the location and intramuscular course of the perforator arteries and subcutaneous branching on the patient's abdomen.
Material and Methods: All patients (n=9) underwent standard protocol: preoperative CTA and localizing the deep inferior epigastric perforators with a unidirectional Doppler probe. In addition, a 3D reconstruction of the perforator locations based on CTA was projected on the abdomen of the patients. All projected perforator locations were assessed with unidirectional Doppler probe. Intraoperative results were collected for comparison.
Results: A total of 88 locations were marked through unidirectional Doppler, and a total of 100 perforators were projected (p=0.38). In 98 out of 100 projected perforator locations, a Doppler signal was audible. Intraoperative results show 19 out of 34 transplanted perforators were correctly identified with unidirectional Doppler (56.9%±31.4%), where the projection method properly revealed 29 locations (84.3%±25.8%; p=0.030).
Conclusion: The projection method is not only capable of providing more information and identifying more perforators used for transplantation than unidirectional Doppler probing, but is also more accurate in pointing out the corresponding perforator found intraoperatively.

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Change in imaging findings on angiography-assisted CT during balloon-occluded transarterial chemoembolization for hepatocellular carcinoma

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Purpose: We evaluated changes in imaging findings by CT during hepatic arteriography (CTHA) and CT during arterial portography (CTAP) by balloon occlusion of the treated artery and their relationship with the degree of iodized oil accumulation in the tumor during balloon-occluded transarterial chemoembolization (B-TACE).
Material and Methods: Both B-TACE and angiography-assisted CT were performed for 27 hepatocellular carcinomas. The degrees of tumor enhancement on selective CTHA with/without balloon occlusion and accumulation of iodized oil after B-TACE were evaluated. Size of the tumorous portal perfusion defect on CTAP was compared with/without balloon occlusion.
Results: Among 27 tumors, tumor enhancement on selective CTHA changed after balloon occlusion in 14 (decreased, 11; increased, 3). Discrepancy between the degree of tumor enhancement on selective CTHA with balloon occlusion and the degree of accumulation of iodized oil was seen in 18. The degree of accumulation of iodized oil was higher in all 18. The tumorous portal perfusion defect on CTAP significantly decreased after balloon occlusion in 18 of 20 tumors (mean decrease from 21.9 to 19.1 mm in diameter; p=0.0001). Tumor location at the central area, poor tumor enhancement on selective CTHA with balloon occlusion, and no decrease in the tumorous portal perfusion defect area on CTAP after balloon occlusion significantly influenced the poor accumulation of iodized oil in the tumor.
Conclusion: The degree of tumor enhancement on selective CTHA frequently changes after balloon occlusion. Moreover, tumor enhancement on selective CTHA with balloon occlusion did not correspond to the accumulation of iodized oil in most cases.

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4D-CTA for the evaluation of arteriovenous malformations: a pilot study

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Purpose: Digital subtraction angiography (DSA) is considered as the gold standard for evaluating arteriovenous malformations (AVMs). Four-dimensional CT-angiography (4D-CTA) is a new modality to image vascular anatomy and flow characteristics. The objective of the study was to evaluate the applicability of 4D-CTA in patients with AVMs for treatment planning, considering dose and image quality compared with DSA.
Material and Methods: In this cohort study, 23 4D-CTA scans were obtained in 18 patients from June 2011 to March 2014. All 4D-CTAs were acquired using a 320-detector row CT-scanner (Toshiba Aquilion ONE). DSA was performed on a Philips Allura system. Effective dose was calculated using dose-length product and standard dose conversion factors. Effective dose was calculated using the dose-area product. The images were alternately assessed for diagnostic information by two interventional radiologists. A subjective scale was used to compare DSA and 4D-CTA images. Additionally, 8 of the 23 4D-CTA scans were recalculated to 10 frames per second (fps) and compared with the standard 2-fps 4D-CTAs.
Results: 4D-CTA was superior to DSA in 11 of the 18 patients (61%), equal in 4 patients (22%), and inferior in 3 patients (17%). Ten frames per second provided better evaluation of AVM compared with 2-fps CTA. Average effective dose of 4D-CTAs was 10.17 mSv (1.00–57.2; median, 5.53) versus 18.3 mSv (0.089–40; median, 10.5) for DSA.
Conclusion: 4D-CTA seems to be a promising new imaging modality to evaluate AVM. Ten frames per second gave more insight into the angio-architecture than 2-fps 4D-CTA. Dose comparison revealed a lower average and median effective dose for 4D-CTA.

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MR and CT imaging characteristics and ablation zone geometry of locally advanced pancreatic carcinoma treated with irreversible electroporation

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Purpose: To assess specific ablation zone attenuation characteristics on contrast enhanced (ce) CT and ceMRI in the first three months following IRE of locally advanced pancreatic carcinoma. Secondary aim was to quantitatively measure the tumor and ablation zone volumes post-IRE. Evaluation of tumor response after ablation therapy is important in determining treatment success and in guiding future therapy. Familiarity with post-interventional MRI and CT findings is crucial for accurate interpretation of the ablated area.
Material and Methods: Percutaneous IRE was performed in fifteen patients with LAPC. Attenuation characteristics were assessed based on ceCT and ceMRI before IRE and one day, two and six weeks, and three months after IRE. Ablation zone volumes on ceCT and ceMRI were calculated using the Caliper method.
Results: On DWIb800s/mm^2, signal intensities of the ablation zones decreased significantly in all cases ($p<0.05$) postprocedurally, and ADC maps confirmed the drop in diffusion restriction. Both ceMRI and ceCT revealed absent or decreased contrast enhancement with a remarkable hyperenhancing rim in 12/15 patients on ceMRI in the first six weeks post IRE. On average, a notable volume increase of the ablation zone was noted on both ceCT and ceMRI in the first six weeks, which was followed by a considerable decrease in the weeks thereafter.
Conclusion: The present study reveals that the most remarkable signal alteration after pancreatic IRE were shown by DWIb800s/mm^2 and post-contrast MRI. Imaging characteristics might be useful to predict successful ablation and early local recurrence. Future studies should further elaborate on the imaging characteristics after IRE.

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MRI scans of healthy volunteers for tumour treatment planning using FUS for the organs affected by breathing motion in the abdominal area

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Purpose: Respiratory organ motion is a complicating factor in MR-guided focused ultrasound (MRgFUS) therapy. The first step towards a better understanding of respiratory motion was to capture the behaviour of the liver during free breathing in time-resolved volumetric MR images [four-dimensional (4D) sequences]. A protocol is developed to capture liver images with visible vessels and ribs and good soft-tissue contrast, with no artefacts to test this sequence on healthy volunteers.
Material and Methods: To collect data from 40 healthy volunteers, permission from the Ethical Committee was obtained (TASC). Image acquisition sequence planned for the following in this study: a) breath-hold at-end-inhalation; b) breath-hold at-end-exhalation; c) 4D-MRI sequence during natural free-breathing (5 blocks), with each block capturing the field-of-view (FOV) 20 times and d) a break of about half of the block acquisition time between the blocks to cool down. A 1.5T scanner (Signa, HDx, GE Medical Systems, WI, USA) with cardiac coil was used for image acquisition. A 4D pulsed sequence diagram (4D-PSD) was installed in the scanner, and a gradient echo FIESTA sequence with TE: 1.8 ms; flip angle: 45°; bandwidth: 125 kHz and acquisition matrix: 160x96 was applied for 4D imaging. To visualise the vasculature of the liver, a 3D time-of-flight (3D-TOF) sequence was used under the following protocol: TE: 11 ms; flip angle: 30° and acquisition matrix: 360x224.
Results: Preliminary results showed good image quality to observe vessels.
Conclusion: 4D-PSD protocol enabled desired images. Reliability tests need to be completed from volunteer data to apply this technique in clinical treatment scenarios.

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The use of minimally invasive radiologically guided techniques in the management of benign obstructive major salivary gland disease

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Learning Objectives: The aim is to discuss minimally invasive techniques used for the treatment of benign salivary gland obstruction within a major salivary gland (parotid or submandibular). Specifically, we look at radiologically guided sialolith retrieval using wire baskets and balloon dilatation of ductal strictures. We describe these interventions and discuss their risks, benefits and limitations.
Background: The discipline of interventional radiology and its supporting technology and instrumentarium has evolved in recent years to enable us to increasingly offer more minimally invasive management of patient's benign salivary gland obstruction, thereby reducing the need for significantly more invasive surgical removal of the gland.
Clinical Findings/Procedure: We draw on our 10 years' experience in the management of benign salivary gland obstruction. We describe the use of sialography in the localization of obstruction and its characteristics. We describe radiologically guided basket retrieval and balloon dilatation procedures. We discuss their benefits, indications and contra-indications. We discuss the causes of failure and list potential complications.
Conclusion: Radiologically guided approaches to benign obstruction of major salivary gland ducts are relatively simple procedures and can significantly improve and potentially completely remove patient symptoms. Sialography, balloon dilatation or stone retrieval should be offered as viable alternatives to glandular surgical excision, provided these cases are carefully selected and the prognosis is assessed and explained.

P-209

Clinical and imaging features of vascular compression syndromes: from head to toe

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Learning Objectives: To review the disease spectrum related to extrinsic compression between the vessels and adjacent anatomical structures.
Background:
1. Categories of various vascular compression syndromes, which is the entrapment of vessels in the narrow spaces between the adjacent anatomic structures or the extrinsic compression of normal structures between the adjacent vascular structures.
2. Review of the anatomy, pathogenesis, clinical presentation, radiological findings, and treatments of the above-mentioned vascular compression syndromes.

Clinical Findings/Procedure:
1. Vascular compression syndromes, entrapment of the vessels between the adjacent anatomic structures: cranial nerve neurovascular compression syndrome, vascular rings, nutcracker syndrome, SMA syndrome, Fraley's syndrome, May-Thurner syndrome, ovarian vein syndrome.
2. Vascular compression syndromes, vascular compression of the adjacent structures: Paget-Schroetter syndrome, quadrilateral space syndrome, anomalous origin of the coronary artery, thoracic outlet syndrome, hypothenar hammer syndrome, median arcuate ligament syndrome, popliteal artery entrapment syndrome.

Conclusion: Vascular compression syndrome is a wide disease spectrum, which can show various symptoms, signs, and clinical significance all over the human body. Radiological diagnosis of vascular compression syndromes based on vascular anatomy and clinical manifestation can be helpful for their management.

P-210

Novel uses for C-arm cone-beam computed tomography

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Learning Objectives:
1. To provide an overview of the principles of C-arm cone-beam computed tomography (CBCT).
2. To illustrate with examples novel clinical applications in modern interventional radiology (IR) practice.

Background: C-arm CBCT as a means of facilitating the acquisition of volumetric data has been in existence for more than 25 years. However, the introduction of flat panel detectors and faster image acquisition in the last decade has improved spatial, contrast and temporal resolution. This permits data acquisition over large anatomic areas in a single rotation quickly and easily during IR procedures, generating volumes of CT data that can be interrogated and reconstructed to aid the interventional radiologist in real time. This can allow treatment planning and monitoring without the need to leave the IR suite.
The major application of this technology in IR has been 3D angiography and treatment planning for embolization procedures. The technique can however be applied to many non-arterial and non-vascular applications in the IR suite.
Clinical Findings/Procedure: This poster details novel applications for CBCT outside of conventional 3D angiography. We will illustrate with examples how the technique can be applied in other complex situations such as transjugular intrahepatic portosystemic shunting and portal venous interventions, variceal embolization, percutaneous biliary interventions, vertebroplasty and biopsy procedures.
Conclusion: C-arm CBCT technology has evolved to the point where its speed, image quality and ease complements the array of imaging techniques used in the IR suite. Its possible uses have expanded beyond the traditional role in 3D angiography.

P-211

Dual-bolus single-pass CT scan protocol in multi-trauma patients: pros and cons of IR management at a major trauma centre

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Learning Objectives:
1. To provide an overview of CT scan protocols in major-trauma patients.
2. To evaluate the role of the dual-bolus single-pass scan in interventional treatment.
3. To review the decision making CT findings pertinent to embolization.
4. To review pros and cons of CT protocols suitable for IR management.

Background: Multi-trauma patients comprise a significant part of the daily practice in a major trauma centre. A multidisciplinary team approach within specific time limits is crucial for patient management. Accordingly, there is the need for a whole-body CT protocol to be fast without compromising the diagnostic accuracy. A modified dual-bolus single-pass scan appears superior to conventional protocols, but is there a role in IR referral?
Clinical Findings/Procedure: Major-trauma CT protocol was reviewed, and we identified the need to adjust our existing dual-bolus single-pass scan protocol depending on the mechanism of injury, haemodynamic instability of the patient and presence of penetrating traumas and code red alerts in order to facilitate fast and accurate assessment of bleeding patients and prompt referral to IR for management.
Conclusion: Dual-bolus single-pass CT scan protocol has proven to be fast and diagnostic, reduce radiation exposure and facilitate a patient's pathway in a busy major trauma centre. Nevertheless, when bleeding is suspected, modification of the standard protocol is mandatory to accurately guide towards IR management.

P-212

Applicability of cone-beam computed tomography in transarterial chemoembolization of liver lesions

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Learning Objectives: To describe the applicability of cone-beam computed tomography (CBCT) during drug-eluting beads transarterial chemoembolization (DEB-TACE) for hepatocellular carcinomas.
Background: More than 200 sessions of DEB-TACE were performed in 3 years. In about 20%, a CBCT was indicated for one of the following reasons: hypovascular tumor localization (group A); searching of collateral vessels (group B); and evaluation of residual tumoral vascularization (group C). No additional radiation dose was observed compared to patients who did not undergo CBCT.
Clinical Findings/Procedure: CBCT was effective to find the majority of the hypervascular tumors, mainly when the contrast media was injected superselectively in segmental arteries of liver. Hepatocellular carcinomas located in peripheral locations commonly present collateral vessels from nearby organs. CBCT can be helpful to find these vessels and exclude inadvertent embolization. In other cases, CBCT can be also used for predicting short-term tumor response. We are going to demonstrate some cases from all the above-mentioned indications.
Conclusion: CBCT is a great tool in transarterial liver embolization. With restrictive use, the radiation time and complication rates can be reduced, besides increasing technique effectiveness.

P-213

CT angiography for preoperative planning of perforator flaps

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Learning Objectives: To review and illustrate the anatomy of the perforator vessels by using multidetector CT angiography (MD-CTA). To describe the acquisition protocols and methods to obtain the coordinates of the perforator vessels for preoperative planning of each flap performed in our institution.
Background: Perforator flaps represent an evolution in reconstructive surgery, improving flap versatility and adaptability to the defect to be reconstructed and donor site morbidity (as they respect adjacent structures like muscles and nerves) and shortening the length of the surgical procedure.

Correct identification of perforating vessels allows a faster and safer surgical procedure. MD-CTA has become an essential tool since its high precision allows correct identification of perforating arteries and exploration of adjacent structures.
Clinical Findings/Procedure: The images are acquired in the arterial phase, following our technical protocol. Identifying a proper anatomical reference is important to extrapolate our coordinates to the patient so that the surgeon can easily find the perforator arteries. We choose the anatomical reference according to the perforating artery to be studied. Diameter, ramification and route are assessed for selecting the best perforator artery. At our institution, the perforating flaps more frequently performed are thoracodorsal, deep and superficial inferior epigastric, lateral circumflex femoral and gluteal arteries.
Conclusion: MD-CTA plays a central role in the preoperative study of perforator flaps. Location of the dominant perforator allows faster and safer surgery. Radiologist must have precise knowledge of the topographic anatomy for identifying the perforator arteries. Use of anatomical references is essential to communicate the exact location of these arteries.

P-214

Bremsstrahlung SPECT/CT, PET/CT, and intraarterial CTA in patients treated with Yttrium-90 radioembolization

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Learning Objectives: To show activity distributions and the absorbed dose to tumor compared to healthy liver using Bremsstrahlung SPECT/CT, PET/CT, and intraarterial CTA in patients treated with Yttrium-90 (Y-90) radioembolization.
Background: Currently, the amount of Y-90 activity that is administered is determined by a simplified approach, which is not highly patient-specific and does not consider the radiation absorbed dose to the tumor. One of the reasons that a dosimetry-based treatment planning approach is not adopted is the difficulty in imaging Y-90 activity distribution by SPECT and PET using current technology.
Clinical Findings/Procedure: Post-radioembolization imaging was Bremsstrahlung SPECT/CT and Y-90 PET/CT. Tumor and healthy liver outlines defined on CTA were applied to SPECT/CT and PET/CT following CT-CT registration. Quantitative PET/CT images were input to the DPM Monte Carlo dosimetry code to determine 3-D absorbed dose distributions.
There was good agreement between Y-90 activity distributions determined by Bremsstrahlung SPECT/CT and PET/CT. The ratio of absorbed dose to tumor to that to the treated healthy liver ranged from 1.2 to 5 for six tumors evaluated in two patients. The mean absorbed dose to tumor ranged from 128.7 Gy to 640.8 Gy, while the dose to the treated healthy liver ranged from 109.9 to 129 Gy. The absorbed dose was higher in more vascular lesions, as predicted by pre-procedure mapping CTA.
Conclusion: These preliminary results show that mean absorbed dose can be determined by Bremsstrahlung SPECT/CT and PET CT with good correlation to vascularity identified on CTA.

P-215

Cirrhosis with porto-pulmonary collateral

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WITHDRAWN

P-216

Dissection in a rare anomaly of non-bifurcating cervical carotid artery

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Many anomalies of carotid artery circulation have been described. One of these is an extremely rare anomaly of non-bifurcating cervical carotid artery. Vascular pathologic findings of the rare non-bifurcating cervical carotid artery have not been discussed much in the literature.

P-217

A case of Loeys Dietez syndrome mimicking vascular type of Ehlers-Danlos syndrome

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We found a case of 37-year-old female of Loeys Dietez syndrome with acute aortic dissection. CT angiography before surgery revealed marked dilated vein of Galen due to multiple dural arteriovenous fistulae, and embolization was performed.

P-218

A case of giant pharyngeal venous malformation successfully treated by transoral sclerotherapy

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We report a case of a giant pharyngeal VM successfully treated by sclerotherapy. C-arm CT makes it possible to assess the precise placement of the sclerosant and perform safer sclerotherapy in the pharynx.

Neuro and carotid intervention

P-219

Treatment of symptomatic stenosis of the basilar artery with balloon-expandable Apollo™ stents

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Purpose: To observe the safety and effectiveness of balloon-expandable Apollo™ stents (MicroPort Medical, Shanghai, China) for the treatment of symptomatic stenosis of the basilar artery.
Material and Methods: Fifty-two patients with symptomatic stenosis (>70%) of the basilar artery were treated with Apollo stents. The mean duration of clinical follow-up was 19 months. Clinical evaluation was based on the modified Rankin Scale (mRS).
Results: Stent placement was technically successful in all the 52 patients. Symptoms were improved in 42 patients after stenting (mRS≤2), whereas in 10 patients, the mRS was >2.
Conclusion: Placement of balloon-expandable Apollo™ stents is a safe and efficacious alternative for the treatment of symptomatic stenosis of the basilar artery.

P-220

Transvenous embolization for the treatment of refractory carotid-cavernous sinus fistulae

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Purpose: To investigate the effects of transvenous embolization for the treatment of refractory carotid–cavernous sinus fistulae (CCF).
Material and Methods: Twenty-five patients with refractory CCF underwent transvenous embolization. A femoral vein–inferior petrosal sinus approach was used in 16 patients, and a femoral vein–facial vein–superior ophthalmic vein approach was used in the remaining 12 patients. Embolization materials included controllable coils (Guglielmi detachable coil, electrolytically detachable coil), free coils and silk. At 3–24 months after treatment, angiography was conducted in 10 patients and telephone follow-up was conducted in the other 18.
Results: DSA immediately after procedure showed that complete obliteration of CCF was achieved in 20 patients. Residual shunting was observed in five patients (two with drainage of the pterygoid plexus and three with drainage of the inferior petrosal sinus). Headache and vomiting were common after embolization. Follow-up angiography showed residual shunting in four patients, residual drainage of the inferior petrosal sinus in one patient, and residual drainage of the pterygoid plexus in one patient. Recurrence was not observed in six patients with complete obliteration. Patients undergoing follow-up by telephone interview did not report symptoms.
Conclusion: Transvenous embolization could be the next line of therapy if transarterial embolization of CCF is not successful.

P-221

Initial experience with innovative pericardium-covered neurovascular stent

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Purpose: The covered stent is a new option in endovascular therapy; it is specifically designed for immediate endovascular reconstruction of a segmentally diseased artery. Experience with covered stents for neurological indications is still limited. We describe our first five cases with cerebral aneurysms treated with a pericardium-covered stent (AneugraftNx; ITGI Medical Ltd., Or Akiva, Israel) for vessel reconstruction.
Material and Methods: Five patients, 3 females and 2 males, underwent treatment for giant and blister aneurysms of the internal carotid artery (ICA). Their ages were between 22 and 55 years (mean: 38.2). Only one patient had subarachnoid haemorrhage; and this patient also had a blister aneurysm of the ICA ophthalmic segment. While two patients had aneurysms of the ICA cavernous segment, one had an aneurysm of the ICA petrous segment. The fifth had a giant aneurysm of the posterior communicating artery. One of the left ICA cavernous segment aneurysms was a recanalized one treated previously with stent-assisted coiling.
Results: Full blood vessel reconstruction was achieved and the aneurysms were immediately and completely excluded from the blood flow. In three patients, two AneugraftNx stents were used. All patients were discharged without any neurological deficit. Two patients underwent follow-up angiograms (at the 3rd and 8th months), which showed no aneurysm filling and no in-stent stenosis. They were also symptom-free.
Conclusion: Covered neurological stents may provide an effective tool for the safe and immediate exclusion of aneurysms in the cerebral vasculature, particularly in the treatment of wide-necked aneurysms. More clinical data is still needed on the subject.

P-222

Endovascular revascularization for nonacute intracranial vertebrobasilar artery occlusion

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Purpose: To evaluate the technical feasibility, safety, and midterm effect of endovascular revascularization of nonacute intracranial vertebrobasilar artery occlusion.
Material and Methods: Consecutive data of patients who suffered nonacute intracranial vertebrobasilar artery occlusion beyond 24 hours and underwent endovascular revascularization were retrospectively collected and analyzed. Complications and recurrent events during the follow-up period were recorded. Pre- and postoperative modified Rankin scale (mRS) scores were used and compared.
Results: All 27 patients but one (96.3%) obtained successful recanalization. The decline in median mRS score, which was 4 [interquartile range (IR); 2–5] preoperatively and 3 (IR, 1–5) on discharge, showed statistically significant difference (P=0.002, Z=3.116). Five patients suffered procedural complications, namely two dissections, one in-stent thrombosis during operation, one thrombus disruption and translocation during operation, and one acute reocclusion after operation. During 21 months after operation, three deaths, one stroke, and two transient ischemic attacks occurred. The latest median mRS scores were 1 (IR, 0–3). The ratio of patients with mRS≤2 increased from 25.9% before operation to 63.0% at present. Seventeen patients received imaging follow-up during 9 months, 6 had restenosis, and 3 of them were symptomatic. Subgroup analyses revealed better functional recovery (lower mRS) in patients with vertebral artery occlusion (P=0.035, Z=2.111) and those with basilar artery occlusion (P=0.020, Z=2.333).
Conclusion: Endovascular revascularization for nonacute intracranial vertebrobasilar artery occlusion beyond 24 hours is technically feasible, and improves disability recovery. However, the rates of procedural complication and restenosis are high.

P-223

Endovascular therapy for acute stroke: a 4-year evolution of the method resulted in improved clinical outcome

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Purpose: The purpose of our study was to test the improved clinical outcome after endovascular stroke treatment on analysing 4-year results from the University Medical Centre. The impact of time period (evolution of endovascular therapy) was also studied.
Material and Methods: A total of 134 patients with National Institutes of Health Stroke Scale (NIHSS) ≥10 who presented with normal computed tomography (CT) findings were treated with endovascular therapy at a single centre from 2009 to 2012. A large vessel occlusion was confirmed with CT perfusion and CT angiography examination in all the enrolled patients, and intravenous thrombolysis was used in eligible patients. Clinical outcome presented as modified Rankin Scale (mRS) score was analysed throughout the studied period. Procedure duration time and procedure-related adverse event rate were also analysed.

Results: A patient had a 2.21-times greater probability for mRS of ≥2 at discharge in 2009/2010 compared with that in 2011/2012 (95% CI, 1.0–5.0). The procedure duration time was reduced from 124 (2009) to 43 minutes (2012) (p≤0.01). Procedure-related adverse event rate decreased from 21% (2009) to 2% (2012) (p≤0.01).
Conclusion: Improved clinical outcome was achieved using endovascular therapy in our selected cohort of acute stroke patients over 4 years. Reduced procedure duration time and low procedure-related adverse event rate represent important contribution to improved clinical outcome. According to our experience, endovascular therapy is an effective and a safe treatment for intracranial large vessel occlusion.

P-224

Treatment of vertebral artery ostial stenosis by bioresorbable vascular scaffold

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Purpose: At present, there is no solution for in-stent restenosis (ISR) for vertebral artery aspect. The main reason of the ISR is intimal hyperplasia. Bioresorbable vascular scaffold system was used in the vertebral artery stenting to prevent ISR.
We would like to assess the occurrence of ISR after bioresorbable vascular scaffold system stenting and long-term results.
Material and Methods: Ten bioresorbable vascular scaffold Abbot Vascular Absorb have been used in vertebral artery stenosis since August 2014 in the research center of neurology. Average age was 65±8 years. Patients comprised 6 men and 4 women. All patients had a vertebrobasilar insufficiency. The stenosis of vertebral artery ostium was determined by ultrasound scanning. Three patients had had stroke in the vertebral basilar system within 6 months before investigation. All patients had the lumen of vertebral artery restored to normal. Patients were examined by ultrasound scanning, CT-angiography and brainstem auditory evoked potential 6 months after stenting.
Results: There were no lethal outcomes or stroke during the observation time. No ISR in vertebral artery, as confirmed by ultrasound scanning.
Conclusion: Ongoing study, final results will be available in August 2015.

P-225

Intracranial thrombectomy and aneurysms: prevalence and impact on treatment

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Purpose: Intracranial aneurysms and strokes have two major characteristics in common: the location pattern, which is clearly in favor of the anterior cerebral circulation, and risk factors such as age, arterial hypertension, and smoking. Due to these coincidences, it seems reasonable that there is a higher probability of an incidental aneurysm when intracranial thrombectomy is performed. Aim of this study was to investigate the prevalence of intracranial aneurysms in the target vessels of intracranial thrombectomies and the possible aneurysm-related complications.
Material and Methods: In 300 consecutive patients who underwent intracranial thrombectomy between 01/2012 and 08/2014, all DSAs were retrospectively analyzed regarding the affected vascular territory, aneurysm number, localization, and aneurysm-related complications. Patient-related data were age, gender, arterial hypertension, and smoking.
Results: In total, 11 patients were diagnosed with aneurysms in the target vessel. The prevalence of at least one aneurysm in the target vessel was 3.9% in the anterior and 2.4% in the posterior cerebral circulation. In one affected patient, a periprocedural rupture of the MCA-bifurcation aneurysm occurred with consecutive subarachnoid hemorrhage.
Conclusion: Concerning the overall prevalence of saccular intracranial aneurysms of approximately 3.2% in all territories, the prevalence of 3.9% in recanalized patients only in the affected territory shows an approximately doubled overall prevalence in patients with large vessel occlusion compared with the overall prevalence in normal population. Although overall aneurysm-related complication rate during thrombectomy is very low (0.3%), interventionalists should be aware of an overall higher aneurysm prevalence in their treated patients.

P-226

Endovascular treatment of recurrent basilar artery occlusion with mechanical thrombectomy

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A rare case of a 62-year-old man with proximal basilar artery occlusion successfully treated with mechanical thrombectomy developed, 4 days after revascularisation, recurrent occlusion in the distal part of the basilar artery; it was successfully treated with mechanical thrombectomy.

P-227

Catastrophic case of a ruptured blister aneurysm

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Blister aneurysms are challenging because of diagnostic and therapeutic dilemmas. We present a case of a ruptured blister aneurysm with a negative CTA, which was performed a few hours after SAH and showed a rapidly growing neck few days after coil embolization.

P-228

Endovascular treatment of acute myocardial infarction complicated by the development of cerebral embolism

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Demonstration of a clinical case of intravascular treatment of acute myocardial infarction complicated by stroke as a result of cerebral embolism due to coronary thrombus, and its subsequent successful removal from the internal carotid artery.

Oncologic intervention

P-229

Conventional transarterial chemoembolization versus drug-eluting bead transarterial chemoembolization in the treatment of hepatocellular carcinoma

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Purpose: To compare the overall survival of patients with hepatocellular carcinoma (HCC) treated with lipiodol-based conventional transarterial chemoembolization (cTACE) versus drug-eluting bead transarterial chemoembolization (DEB-TACE).
Material and Methods: An electronic search of our radiology information system revealed 674 patients who received TACE between 11/2002 and 07/2013. Five hundred and twenty patients received cTACE, and 154 received DEB-TACE. In total, 424 patients were excluded because they had a tumor type other than HCC (n=91), liver transplantation after TACE (n=119), lack of histological grading (n=58), incomplete laboratory values (n=15), other reasons (e.g., previous systemic chemotherapy) (n=114), and lost to follow-up (n=27). Therefore, 250 patients were finally included for comparative analysis (n=174, cTACE; n=76, DEB-TACE).
Results: The two groups did not differ significantly with regard to sex, overall status (Barcelona Clinic Liver Cancer classification), liver function (Child-Pugh), portal invasion, tumor load, and tumor grading (all, p>0.05). The mean number of treatment sessions was 4±3.1 in the cTACE group versus 2.9±1.8 in the DEB-TACE group. Median survival was 409 days (95% CI: 321–488 days) in the cTACE group compared with 369 days (95% CI: 310–589 days) in the DEB-TACE group (p=0.76). In the subgroup of Child A patients, the survival was 602 days (484–792 days) in the cTACE group versus 627 days (364–788 days) in the DEB-TACE group (p=0.39). In Child B/C patients, the survival was considerably lower: 223 days (165–315 days) for cTACE versus 226 days (114–335 days) for DEB-TACE (p=0.53).
Conclusion: The present study revealed no significant difference in survival between cTACE and DEB-TACE.

P-230

Adverse events of balloon-occluded transarterial chemoembolization (B-TACE) for hepatocellular carcinoma: initial experience

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Purpose: The purpose of this study was to evaluate the adverse events of balloon-occluded transarterial chemoembolization (B-TACE) for hepatocellular carcinoma (HCC) in our initial experience compared with conventional TACE (C-TACE).
Material and Methods: B-TACE in our initial experience of 50 cases compared with C-TACE using a conventional microcatheter in 50 cases as a historical control. Adverse events were assessed using Common Terminology Criteria for Adverse Events (CTCAE) version 4.0.
Results: The adverse events in B-TACE were fever (grade 3: n=3; 6%), abdominal pain (grade2: n=7; 14%), nausea (grade 2: n=14; 28%), vasovagal reflex (n=6; 12%), elevation of alanine aminotransferase (ALT) (grade 3: n= 9; 18%), and elevation of bilirubin (grade 3: n=2; 4%). Only elevation of ALT (grade3) was dominant in B-TACE with a statistically significant difference compared with C-TACE (Fisher's exact test: $P < 0.05$). Moreover, 3 cases (6%) of liver abscess and one (2%) of liver infarction occurred in B-TACE. On the other hand, no severe adverse events (liver abscess and infarction) occurred in C-TACE. The frequency of liver abscess and infarction was higher compared with C-TACE, but there was no significant difference (Fisher's exact test). The risk factor of liver abscess and infarction in B-TACE is biliary dilatation by multivariate logistic regression analysis ($P < 0.05$).
Conclusion: Elevation of ALT (grade3) was dominant in B-TACE with a statistically significant difference. However B-TACE had severe adverse events (liver abscess and infarction) for patients who have biliary dilatation aptitude without a statistically significant difference.

P-231

Single-centre experience of 105 solid thoracic tumours treated with percutaneous high-energy microwave ablation (MWA)

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Purpose: High-energy microwave ablation (MWA) is increasingly used as a minimally invasive alternative to surgery for the treatment of solid thoracic tumours; however, relatively little data has been published on treatment outcomes. We report complications, technical success and technique effectiveness of MWA procedures performed at a single tertiary referral centre.
Material and Methods: A local ethics committee approved the review. Data on patient and tumour characteristics, procedure technical success and computed tomography follow-up imaging were prospectively collected. Technique effectiveness was deemed to be the lack of unexpected late local recurrence at the treatment site after a technically successful treatment.
Results: Between June 2012 and June 2014, 105 solid thoracic tumours were treated with MWA in 55 patients (mean age, 63 years; range, 12–89; 24 men). Primary tumours were colorectal (n=20), sarcoma (n=24), lung (n=7) and other (n=3). The mean (SD) tumour size was 14 mm (6.7 mm). Technical success was 96%, mean follow-up interval was 13.8 months (range, 1–28.5). Local tumour progression was observed in 2 of 102 cases (2%). Pneumothorax requiring chest tube insertion occurred in 13 of 77 sessions (17%). Of these 13 sessions, pneumothorax was intentionally induced in 3 patients during treatment. There were no other major complications. Overall survival rates at 1 and 2 years were 97.5% and 77.5%, respectively.
Conclusion: MWA of solid tumour deposits is safe and effective. This cohort compared very favourably to other modalities including radio frequency ablation.

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Long-term follow-up of post-chemoembolization cholangiopathy

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Purpose: The idea of transarterial chemoembolization (TACE) is selective liver tumor treatment by chemotherapy/ischemia combination due to the dominant arterial supply of the neoplastic tissue, while the rest of the hepatic parenchyma has 80% portal and 20% arterial perfusion. The only hepatic structures with the intrinsic dominant arterial supply are the bile ducts. Post-TACE bile duct injury and its consequences are to be assessed.
Material and Methods: Since 1994, 371 patients have undergone 873 TACE procedures (mean 2.5 procedures per patient, range 1-13) in N.N.

Blokhin Cancer Research Center for hepatic malignancies. Patients were followed up by clinical examination, laboratory tests, and imaging procedures, with a special emphasis on biliary complications.
Results: Symptomatic post-embolization cholangiopathy developed in 7 patients with primary (4) and metastatic (3) liver tumors (5 males, 2 females; age range 32-65 years) from 1 week to 5 months after TACE. Biliary complication rate was 1.8% per patient and 0.8% per procedure. MRI demonstrated bile duct irregular dilatations and strictures (5), multiple post-necrotic bile duct cysts (4), liver abscess (3), regenerative nodules (1), ascites (1). Five patients died due to sepsis (1 patient at 1 month after TACE), liver failure (3 patients at 6-8 months), and disease progression (1 patient at 31 months). One patient is alive for 5 months after TACE, showing obstructive jaundice requiring percutaneous transhepatic biliary drainages. One patient was lost to follow-up.
Conclusion: Interventional radiologists need to be aware of late, potentially fatal, post-TACE biliary complications for planning TACE material, inter-TACE intervals, and post-procedural therapy.

P-233

Combination therapy of transarterial chemoembolization (TACE) and radiofrequency ablation (RFA) for small hepatocellular carcinomas (≤3cm): comparison of its safety with TACE or RFA monotherapy

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WITHDRAWN

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Is microwave ablation superior to radiofrequency ablation for hepatic lesions? Meta-analysis

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Purpose: To evaluate the efficacy and safety of microwave ablation (MWA) compared with radiofrequency ablation (RFA) for hepatic lesions using meta-analytical techniques.
Material and Methods: A search of Medline, Embase, PubMed, Cochrane, and Google Scholar databases was performed. Meta-analysis of overall survival (OS), local recurrence rate (LRR), disease-free survival (DFS), and adverse events (AEs) were performed.
Results: Overall, 16 studies involving 2062 patients were included. MWA was found to have a significantly better 6-year overall survival compared with that for RFA (OR, 1.47; 95% CI, 1.09–1.99). The two ablative techniques had similar 1- to 5-year overall survival, DFS, LRR, and adverse events. MWA was reported to be significantly cheaper than RFA ($1200 vs. $2000) and to have a lower number of treatment sessions (1.7 vs. 2.6) and to be associated with a shorter overall treatment duration (average, 78 vs. 102.9 minutes).
Conclusion: Compared with RFA, MWA may yield greater benefit in terms of long-term survival and short-term costs; however, randomized controlled trials are warranted to confirm these findings.

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High-frequency jet ventilation versus conventional ventilation for CT-guided lung tumor ablation under general anesthesia

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Purpose: Thermal ablation therapies for lung tumors require a precise insertion of needle into the tumor guided by computed tomography (CT). These techniques are hampered by respiratory movements, which increase complications and morbidity. High-frequency jet ventilation (HFJV) is a technique delivering high-flow gas pulses with minimal respiratory movement enabling to immobilize the tumor. The aim of our study was to determine whether HFJV facilitated CT-guided lung tumor ablation compared to conventional ventilation (CV).
Material and Methods: A monocentric control trial was performed at Gustave Roussy Hospital (Villejuif, France). The ventilation technique was randomly selected: HFJV or CV. The type of treatment (radiofrequency, cryotherapy, and microwave) was chosen by the radiologist depending on the size and localization. Data of patients and techniques were recorded. Parametric and non-parametric quantitative data were compared by Student independent-samples t test and Mann-Whitney-Wilcoxon test, respectively. Fisher's exact test was performed for qualitative data.
Results: Nineteen patients with 27 lung tumors versus 26 patients with 41 lung tumors were included in the CV and HFJV groups, respectively. Time duration (median [range], 460.2 s [120-1800] vs 300 s [120-900]; p=0.04) and radiation dose (181.28 mGy·cm [37.08-589.16] vs 123.6 mGy·cm [61.8-354.32]; p=0.01) required for needle placement in the tumor was significantly lower in the HFJV group. There was no difference in tumor size (p=0.34), rate of pneumothorax (p=1), and drained pneumothorax (p=0.39).
Conclusion: CT-guided needle placement into lung tumor seems to be faster and less irradiant under HFJV compared to CV. This ventilation technique could help radiologist to insert the needle especially for hard-to-treat localizations.

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Percutaneous radiofrequency ablation of sporadic Bosniak III or IV lesions: treatment techniques and short-term outcomes

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WITHDRAWN

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A single-centre cost analysis in treatment of advanced hepatocellular carcinoma: TARE versus sorafenib

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Purpose: TARE is a promising treatment in advanced HCC. We compare our centre costs for sorafenib and TARE treatments.
Material and Methods: We matched 166 consecutive patients with advanced HCC treated with Sorafenib since June 2009 (Group SOR) and 19 treated with TARE between June 2011 and June 2014. Patients were grouped for treatment time (Group SOR1: <2 months of treatment; Group SOR2: >2 months of treatment). Group SOR1 drug

expenses were not further considered according with the agreed 'pay-for-result policy'. In Group SOR2, 24 patients (Group SOR3) presented with monolobar disease and no metastasis (BCLC B 54%) so as to be potentially treated with TARE. Sorafenib cost was calculated according with the total effective caps intake for each patients (€ 28.7/caps). TARE costs included Yttrium-90 and hospitalisation expense (€ 17.761/patient).
Results: Patients in Group TARE were treated with a single treatment session. Median time of treatment in Group SOR3 was 272 days (154-994), with a median intake of 2.8 tablets/day. Median follow-up time was 476 days in Group SOR3 and 266 days in Group TARE. Survival at 12, 18, 24 and 36 months was respectively 66.7%, 37.5%, 24.3% and 19.4% in Group SOR3 and 64.1%, 64.1%, 64.1% and 32% in Group TARE. The GLOBAL treatment costs for Group SOR3 and Group TARE were € 671,809.6 and € 337,459.00, respectively (median € 27992/patient in Group SOR3 vs € 17761/patient in Group TARE; p =0.028).
Conclusion: TARE treatment in advanced HCC may reduce costs; survivals could be better than that with sorafenib treatment.

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Adverse effects of the irreversible electroporation ablation of liver malignancies under CT fluoroscopic guidance: single-center experience

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Purpose: The purpose of this study was to describe the frequency of adverse events and risk factors after the CT fluoroscopy-guided irreversible electroporation (IRE) of malignant hepatic tumors.
Material and Methods: Eighty-five IRE procedures were performed for 114 malignant liver tumors: 52 primary and 62 secondary hepatic tumors in 56 patients (42 men and 14 women; mena age, 70 years) were retrospectively analyzed with regard to mortality and treatment-related complications. Complications were evaluated according to major and minor complications. Complications were evaluated according to the standardized grading system of the Society of Interventional Radiology. Factors influencing the occurrence of major and minor complications were determined by logistic regression models.
Results: No IRE-related death occurred. In 92.9% (79 of 85) of IRE procedures, no major complications occurred, and in 81.2% (69 of 85) of IRE procedures, no minor complications occurred. The most frequent major complication was post-ablative abscess [4.7% (4 of 85)] that significantly more often (p=0.010) affected patients with bilioenteric anastomosis [43% (3 of 7 ablation procedures)] than patients without this condition [1.3% (1 of 78 ablation procedures)]. Bilioenteric anastomosis was additionally identified as the risk factor for major complications, in general, (p=0.002). Minor complications mainly consisted of hemorrhaging and thrombotic alterations of the portal venous system.
Conclusion: CT fluoroscopy-guided IRE ablation of malignant liver tumors is a relatively low-risk procedure. However, patients with bilioenteric anastomosis seem to have an increased risk of post-ablative abscess formation.

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Percutaneous CT-guided cryoablation for renal tumors with high-surgical complexity: clinical and outcome evaluations in a multicenter study

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Purpose: To evaluate the clinical and oncological outcomes of percutaneous renal cryoablation (PCA) in high-surgical complexity renal tumors defined by a PADUA score of ≥10.
Material and Methods: A retrospective multicenter study was conducted. We compared the clinical and oncological outcomes after a PCA in patients with renal tumor, having a PADUA score of ≥10 (Group 1) and PADUA score of <10 (Group 2) treated from November 2011 to January 2014. Both technical failures (TF) and local tumor relapse (LTR) were considered as local treatment failures (LTF). Recurrence-free survival probabilities were estimated by the Kaplan–Meier method. A log-rank test was performed to compare recurrence-free survival.
Results: A total of 163 masses in 142 patients were treated. The mean follow-up period for all patients was 12.3 months. Considering all treated tumors, there were 6.1% LTF (2.8% TF and 3.3% LTR). Twenty-one patients had a PADUA score of ≥10. In this population, 3 (14.3%) LTR were seen. A difference in the survival analysis was found between the two groups (log-rank, 0.05). The local recurrence-free survival at 1 year was 87.8% for Group 1 and 96.1% for Group 2. Overall, seven patients with LTF underwent a second treatment, with no recurrences seen after a mean period of 5.8 months.
Conclusion: PCA appears to provide a safe treatment option with low complication rates. A slightly higher risk of local treatment failure can be expected in patients with a PADUA score of ≥10 due to the high-procedural complexity of these lesions.

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Delayed-arterial phase cone-beam CT improves the visibility of colorectal and sarcoma liver metastasis compared to DSA during intra-arterial therapy

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Purpose: Improved visibility of colorectal and sarcoma liver metastasis (CRCLM and SLM) during intra-arterial therapy (IAT) could improve tumor targeting. The purpose of this study was to assess the visibility of CRCLM and SLM on dual-phase cone-beam CT (DP-CBCT) and digital subtraction angiography (DSA), with reference to pre-interventional contrast-enhanced magnetic resonance imaging (CE-MRI) of the liver.
Material and Methods: Of 141 CRCLM and 34 SLM patients who received IAT from January 2010 to October 2014 at our institution, 10 and 3 patients, respectively, had intra-procedural DP-CBCT and were included in this retrospective study. DP-CBCT was acquired after a single injection of contrast agent in the tumor-feeding arteries. The

visibility of each lesion was graded on a three rank scale (complete, partial and none) on DP-CBCT and DSA images and compared to CE-MRI. McNemar's test was used.
Results: Forty-six CRCLM and 16 SLM were included. On DSA, 41.3% of CRCLM and 37.5% of SLM were completely or partially depicted. Early and delayed arterial phase (EAP and DAP)-CBCT achieved significantly higher sensitivities at 84.8% and 95.7% for CRCLM and 87.5% and 100% for SLM, respectively (p<0.02). With regard to complete lesion depiction, EAP-CBCT was significantly better than DSA for CRCLM (43.5% vs. 15.2%; p=0.007), but not for SLM (25.0% vs 18.8%; p=1.0). DAP-CBCT, however, was significantly better than EAP-CBCT and DSA for complete depiction of both CRCLM and SLM (91.3% and 100%, respectively; p<0.001).
Conclusion: DAP-CBCT significantly improves the visibility of CRCLM and SLM during IAT and should be used as standard intra-procedural imaging technique.

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Triple-drug TACE versus single-drug TACE with doxorubicin-loaded LC beads: survival outcome analysis of 313 consecutive HCC patients

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WITHDRAWN

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Cone-beam computed tomography in transarterial chemoembolization (TACE) of the liver: preliminary experience

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Purpose: To compare the results of TACE assisted by cone-beam computed tomography (CBCT-protocol TACE group) with those of TACE performed without CBCT (standard-protocol TACE group).
Material and Methods: From January 2011 to December 2014, 40 patients with HCC underwent multiple TACEs for a total of 78 procedures using embolization particles preloaded with chemotherapy drug. Of these 78 procedures, 54 were performed using the standard protocol, while 24 were performed with the CBCT protocol, using the "XperCT-" protocol of our angio-equipment (Philips Healthcare, Netherlands). Technical success and imaging response to treatment assessed by mRECIST criteria were evaluated for both protocols.
Results: In the standard-protocol TACE group, we registered 9 (17%) complete (CR) and 14 (26%) partial responses (PR) and 21 (39%) stable disease (SD) and 10 (18%) progression of disease (PD) cases using the mRECIST score. In the CBCT-TACE group, we obtained 13 (54%) cases of CR, 4 (17%) cases of PR, and 5 (21%) cases of SD, while in 2 (8%) TACEs, PD was registered; however, they were not related to evolution of the lesions that were previously treated but to the appearance of more HCC nodules, which were not present in previous examinations.
Conclusion: At present, the available data in literature, regarding the use of CBCT built-in angiographic equipment for the endovascular treatment of HCC is still poor. Our preliminary results show a significant increase in the number of complete responses using the CBCT-protocol due to greater selectivity in the embolization procedure. Furthermore, after the learning curve phase, we believe that CBCT can reduce the procedural time and dose to patients.

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Transcatheter arterial chemoembolization using HepaSphere Microspheres™: preliminary results of a monocentric study

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Purpose: To present our experience using HepaSphere Microspheres™ (Biosphere Medical) loaded with doxorubicin in patients with unresectable hepatocellular carcinoma.
Material and Methods: From December 2005 to December 2014, 235 patients (188 males and 47 females; mean age, 72 years; medium follow-up, 6-month) were treated by selective TACE using HepaSphere Microspheres™ loaded with doxorubicin. The diameter of the lesions ranged from 25 to 176 mm, with a mean diameter of 64.2 mm. Before treatments, 75.7% of patients had Child-Pugh A; 24.3%, had Child-Pugh B; in accordance with BCLC staging, 33.3% of patients had stage A; 64.7%, stage B; 2.1%, stage C. The etiology of cirrhosis referred to HCV in 132 patients, HBV in 22, alcohol-related liver disease in 48, and nonalcoholic steatohepatitis (NASH) in 33.
Results: Technical success rate was 100%, with complete devascularization of the lesions at the end of all procedures. The overall survival at 6 months was 84.2 %; 12 months, 66.3%; 24 months, 54.2%; and 36 months, 44.3%. On subdividing the sample according to the BCLC staging, 6-month survival of 91% for stage A; 86%, stage B; and 50%, stage C; 12-month survival of 75% for stage A and 74% for stage B; 24-month survival of 61% for stage A and 64% for stage B; 36-month survival of 60% for stage A and 50% for stage B were obtained.
Conclusion: Our experience demonstrates that TACE using HepaSphere™ is feasible, with a low complication rate and promising efficacy. Larger series and randomized studies are mandatory to confirm these preliminary results.

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Indications and technique of percutaneous imaging-guided Wirsung duct interventions on pancreatic head cancer patients

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Purpose: Percutaneous image-guided pancreatic duct (PD) drainage and subsequent second-line procedures (duct recanalization and endoluminal biopsy) are presented.
Material and Methods: Thirteen patients underwent PD drainage because of PD obstruction-related clinical symptoms (pancreatic irritation, recently diagnosed diabetes). PD was accessed using either ultrasound (n=7) or CT (n=6) guidance by 22G to 18G needles. Drainage catheter was placed under the real-time fluoroscopy guidance. Second-line procedures [metal stent placement (n=2), endoluminal RFA & metal stent placement (n=4), and endoluminal biopsy (n=1)] were performed via PD drainage fistula. Endoluminal RFA was performed using a novel 5-Fr diameter RF device, metal stent placement by the conventional technique, and endoluminal biopsy by a forceps device (NJP1). After procedure, drainage catheter was repositioned.
Results: Drainage was successful in all 13 cases, including the case of non-dilated PD in post-biopsy pancreatic fistula. Clinical improvement was documented, and pancreatic juice discharge varied between 300 and 900 ml/day. Three patients with recent onset of diabetes showed a dramatic improvement in glycemic control.

Second-line procedures were fulfilled in 6 (85.7%) of 7 cases; in 1 (14.3%) case, the procedure completion was impossible due to guidewire conduction failure. All patients tolerated the procedure well. There was no 30-day or hospital mortality; no technique-specific complications were observed.
Conclusion: Percutaneous image-guided PD drainage and second-line procedures (stenting, endoluminal RFA & stenting, and endoluminal biopsy) are safe and effective in the management of pancreatic head cancer patients.

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Effectiveness and safety of percutaneous markings under CT guidance using a mixture of diagnogreen, fat emulsion, and lipiodol for the localization of small pulmonary lesions before video-assisted thoracoscopic surgery

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Purpose: To retrospectively estimate the effectiveness and safety of percutaneous markings under CT guidance using a mixture of diagnogreen, fat emulsion, and lipiodol for the localization of small pulmonary lesions before video-assisted thoracoscopic surgery (VATS).
Material and Methods: From January 2011 and October 2014, percutaneous markings under CT guidance using a mixture of diagnogreen, fat emulsion, and lipiodol for the localization of 100 small pulmonary lesions were performed in 100 consecutive patients (55 men and 45 women; mean age, 68 years) on the same day of VATS. The mean size of nodules on CT was 1.1 cm (range, 0.4–2.2 cm). Technical success rate, the rates of successful localization of small lesions during VATS and the successful localization in resected specimens, and complication rate were evaluated.
Results: Technical success rate was 95% (95 of 100 lesions). In four patients with technical failure, small lesions could be localized by the detection of hematoma in the visceral pleura during VATS. The rate of successful localization of small lesions during VATS was 96% (96 of 100 lesions). The rate of successful detection of small lesions in resected specimen was 100% (100 of 100 nodules). Pneumothorax was noted in 44 patients (44%). In all patients with pneumothorax, no additional treatment was needed.
Conclusion: Percutaneous markings under CT guidance using the mixture of diagnogreen, fat emulsion, and lipiodol were effective and safe for localizing small pulmonary lesions before VATS.

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Feasibility of radiofrequency ablation protocol using low power to delay the steam popping

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Purpose: Steam popping frequently occurs in conventional RFA with high power, increasing the risk of tumor spread. We hypothesized that RFA with low power will decrease the intensity of popping at delayed timing, so that we may prevent spreading viable tumor cells. We performed experiments to prove our hypothesis using ex vivo bovine liver.
Material and Methods: RFA protocols with high power up to 200W (group 1) and low power up to 70W (group 1) were established. In the first phase, RFA was conducted for 12 minutes. We compared the ablation volume, intensity and timing of maximal popping sound, and total energy generated for RFA between groups 1 and 2. In the second phase, RFA was conducted until maximal popping occurred. The ablation zones on histologic specimen were compared between the two groups.
Results: Compared to group 1, the maximal popping occurred at a significantly delayed timing in the group 2 (50±11 sec vs. 397±117 sec after starting RFA, $p<0.001$), but without difference in intensity (0.70±0.18 vs. 0.83±0.26, $p=0.138$). The ablation volume after RFA for 12 minutes did not differ between groups 1 and 2 (18.46±1.35 cm^3 vs. 15.78±0.64 cm^3, $p=0.086$). However, on the histologic specimen obtained when maximal popping occurred, the area of complete coagulation necrosis was significantly larger in group 2 ($p<0.05$).
Conclusion: RFA with low power delays the steam popping while providing comparable therapeutic effect to RFA with high power. Delaying the maximal popping can prevent spreading tumor cells, because it occurs after achieving adequate ablation zone.

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First-in-man transcatheter endovascular celiac artery denervation for pancreatic cancer pain

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Purpose: To assess the efficacy and safety of transcatheter endovascular radiofrequency denervation of the celiac artery as an alternative to traditional neurolytic celiac plexus block for palliation of pancreatic cancer pain.
Material and Methods: Five patients with pharmacologically uncontrolled pain from pancreatic adenocarcinoma (4 patients) or pancreatic neuroendocrine cancer (1 patient) underwent endovascular radiofrequency celiac denervation. A radiofrequency multielectrode (EnligHTN; St Jude, Saint Paul, MN) was placed percutaneously in the celiac artery via the femoral artery under local anesthesia using a special introducer (Destino Twist TD; Oscor, Tampa, FL). Radiofrequency was applied to the endothelium (7±1 points) according to an automatic algorithm. The pain caused by nerve ablation was controlled with opioids. The analgesic effect was scored according to a visual analog scale (VAS) of 1 to 10 at 24h, 48h, 1 week (5 patients), and 1 month (3 patients), and painkiller consumption was recorded.
Results: There were no procedure-related complications, and the patients were discharged the following day. Endovascular radiofrequency denervation of the celiac artery produced effective pain relief within 1 week in all patients (VAS reduced from 7.8±0.27 to 3.9±1.43). Pain relief persisted throughout the observation period. Opioid consumption decreased by an average of 30%, and patients reported a considerable improvement in the quality of life.
Conclusion: Transcatheter endovascular radiofrequency denervation of the celiac artery is a simple and safe procedure that appears to be effective in palliation of intractable pancreatic cancer pain.

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Portal lipiodolisation as a therapeutic endpoint in transarterial chemoembolization (TACE) of unresectable hepatocellular carcinoma, assessed in a retrospective cohort study

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Purpose: Transarterial chemoembolisation (TACE) is a palliative treatment for hepatocellular carcinoma (HCC) with proven survival benefit. However, a dose protocol or endpoint has yet to be established. Due to the dual vascular supply of hepatic tumours, it has been long proposed that injection until visualisation of lipodol in the portal circulation could result in a more complete compact lipiodolisation (CL), a proven predictor of prolonged survival. We aimed to evaluate if portal lipodolisation (PL) was associated with CL.
Material and Methods: In a retrospective cohort analysis, we studied 152 patients with unresectable HCC in their first TACE procedure using lipiodol/cisplatin emulsion. CL was defined as the absence of an arterial enhancing lesion, as assessed by computed tomography one month post-treatment. PL was defined as any lipiodol visualised in the portal circulation during the TACE procedure. Analysis was completed using chi-squared analysis and logistic regression.
Results: Twenty-nine patients were excluded due to lack of follow-up CT; 68 patients (55%) demonstrated PL, and 55 (45%) demonstrated CL. CL was not significantly increased in the PL group vs the non-PL group (70.5 vs 60.0%, OR 1.6, 95%CI 0.75-3.38; p=0.30). Smaller size was strongly associated with CL (mean 26.9 vs 35.3mm, OR 0.95, 95%CI 0.92-0.99; p=0.02); however, dose was not found to be significantly associated with CL (mean 18.5 vs 21.74mL, OR 0.97, 95%CI 0.94-1.01; p=0.16). Survival data is pending and will be presented at the conference.
Conclusion: No statistically significant association was found between CL and PL. A proven dosing protocol is yet to be established for TACE.

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Hepatocellular carcinoma: comparison of chemoembolization with 70–150-µm versus 100–300-µm doxorubicin-eluting beads

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Purpose: To compare safety and imaging response with 70–150-µm versus 100–300-µm doxorubicin drug-eluting beads (DEBs) to determine the optimal particle size for chemoembolization of hepatocellular carcinoma (HCC).
Material and Methods: Thirty-eight patients who underwent DEB chemoembolization and follow-up for HCC between August 2010 and May 2013 were analysed. Adverse events (AE) were recorded according to The National Cancer Institute Common Terminology Criteria for Adverse Events version 4.03. Tumour responses were evaluated according to the modified Response Evaluation Criteria In Solid Tumors (mRECIST) guidelines in HCC. Responses and AEs were compared between the 70–150 µm and 100–300 µm groups using Fisher exact test.
Results: Patients in the 100–300 µm group had higher rates of postprocedure abdominal pain (40.0% vs 8.3%; P = .011), nausea and vomiting (40.0% vs 8.3%; P = .011) and fatigue (70.0% vs 36.1%; P = .025) compared with patients in the 70–150 µm group. There were tendencies toward higher rates of CR by mRECIST in the 70–150 µm group (53.3% vs 34/8%).
Conclusion: This retrospective study shows similar objective response rates in both 70–150 µm and 100–300 µm groups. However, CR rate in patients who underwent TACE with 70–150-µm DEBs was higher than in those who underwent TACE with 100–300-µm DEBs.

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The benefit of transradial approach in patients undergoing chemoembolization for unresectable pancreatic cancer

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Purpose: We aimed to assess whether radial approach (RA) was superior to femoral approach (FA) in patients undergoing chemoembolization for unresectable pancreatic cancer.
Material and Methods: Twenty-two patients were enrolled into our study from October 2013 to February 2015. RA was used in 10 patients and FA in 12 patients. Clinical characteristics of the patients were comparable between the two groups. All procedures were performed through the left radial artery in the RA group and through the right femoral artery in the FA group. After selective catheterization of the gastroduodenal artery, arteriography was performed to recognize the pancreatic blood supply. Microcatheter was used to perform coil embolization distal to the origin of the branches that supply pancreatic tumor. Lipiodol and gemcitabine were used for chemoembolization.
Results: Chemoembolization procedures were successfully performed in all patients. The duration of the procedure (51.2 vs. 56.4 minutes, p>0.05), time needed for target artery catheterization (13.4 vs. 14.2 minutes, p>0.05) and radiation exposure (0.44 vs. 0.49 mZv) were comparable between the two groups. Major vascular complications were not seen in both groups. RA was associated with a statistically significant reduction in all parameters of procedural discomfort.
Conclusion: Clinical success, duration of the procedure, radiation exposure, and rate of major vascular complications are comparable between the patients undergoing chemoembolization for unresectable pancreatic cancer using the transradial and transfemoral approach. RA is associated with a significant reduction in all parameters of procedural discomfort.

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Pharmacokinetics and safety of transarterial sorafenib chemoembolization in VX2 tumor model of rabbit liver

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Purpose: To assess the safety and feasibility of the intraarterial delivery of tyrosine kinase inhibitor sorafenib to the hepatic tumor using transarterial chemoembolization method in VX2 tumor model of rabbit liver as a novel approach to hepatocellular carcinoma therapy.
Material and Methods: Twenty New Zealand white rabbits were used in the study. A VX2 tumor chip (0.125mL in volume) was implanted in left hepatic lobe of each rabbit two weeks before treatment. After placement of a catheter in the left hepatic artery, ten rabbits (treated group) were treated with emulsion of sorafenib and ethiodized oil (9mg and 0.5mL, respectively), and ten rabbits (control group) were treated with 0.5mL of ethiodized oil only. Liquid chromatography tandem mass spectrometry was used to measure the concentration of sorafenib in the peripheral blood 0.5, 1, 2, 4, 24, and 72 hours after treatment and in the liver tissue 72 hours after treatment. Serum hepatic enzymes and total bilirubin concentrations were measured before and 24 and 72 hours after treatment in all rabbits.
Results: Mean serum sorafenib concentration showed a peak at 2 hours after treatment (0.5 hour, 62.7; 1 hour, 96.3; 2 hours, 121.0; 4 hours, 110.3; 24 hours, 80.2; and 72 hours, 30.8 ng/mL). Mean tissue concentration was 9902.3 ng/g, and the average tissue-to-serum

ratio was 321.9. Serum hepatic enzymes and total bilirubin concentrations were higher in the treated group; the elevation was transient.
Conclusion: Transarterial chemoembolization with sorafenib in ethiodized oil can be an effective method for localized delivery of this drug to the hepatic tumor.

P-252

Breast tumors treated with percutaneous image-guided cryoablation: a prospective single-center experience in 23 consecutive nonsurgical patients

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Purpose: To present our preliminary experience on breast tumors treated with US/CT-guided percutaneous cryoablation without subsequent surgery.
Material and Methods: Nonsurgical patients were enrolled following the indications of a multidisciplinary board.
We collected the following data:
- Tumors: location, histology, maximal diameter, distance from skin
- Procedure: anesthesia, hospitalization length, complications
- Follow-up: clinical and radiological (MRI at 3,12, and 18 months for the evaluation of local recurrence, skin retraction, inflammation, or burn)

Results: Twenty-three tumors (21 ductal carcinomas and 2 lobular carcinomas; 7 grade 1, 10 grade 2, 4 grade 3, and in 2 cases grade was not available;18 with positive hormone receptors; median maximal diameter of 14 mm) were treated in 23 female patients (median age, 85.0 years). Median distance from the skin was 17 mm (range, 5–60 mm). Nineteen patients were treated under local anesthesia, and four under local anesthesia + conscious sedation. Hospitalization lasted for 1 day in 47.8% of cases and 2 days in the remaining 52.2%. Two (8.7%) cases of skin necrosis and four (17.4%) cases of hematoma were noted immediately. In one case (4.3%), skin retraction was still evident at 12-month follow-up. MRI follow-up at 3 months showed an incomplete treatment in 8.7%, no recurrence was noted at 1 year. At 18 months, nine patients underwent follow-up, two of them presented with a recurrence at distance (new breast tumor and lymph node).
Conclusion: Cryoablation of breast tumors is safe with good local control in elderly patients. Most of the treatments can be performed under local anesthesia on an outpatient basis.

P-253

Measurement of radiation dose to patients' skin while performing cone-beam CT-guided percutaneous radiofrequency ablation of the lung

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Purpose: To measure radiation dose on patients' skin during cone-beam CT-guided radiofrequency ablation (RFA) of the lung.
Material and Methods: Images were acquired with roller mode and automatic exposure control.
We applied 3 skin "PSD" (Unfors) sensors connected to a display unit. Sensors were placed considering angular response.
We collected the following data:
- Patients: BMI (weight [kg]/height^2 [cm])
- Lesions: size and location within pulmonary lobes
- Cumulative dose registered by all the applied sensors (mGy).

Results: Nineteen patients (10 males, 9 females; mean age 65.5 ± 11.0 years, mean BMI 23.7 ± 5.6, range 16.2–32.9) were enrolled. Twenty-four lung tumors (6 primary lung cancer, 18 metastases, mean size 12.3 ± 8.3 mm) were treated in 18 sessions. Thirteen tumors (mean size 13.6 ± 10.4 mm) were located in upper lobes and 11 (mean size 10.9 ± 4.9 mm) in lower/median lobes. Lesions size did not differ between upper and lower lobes ($p = 0.44$). Overall mean dose to patients' skin was 7.0 ± 4.2 mGy (range 3.16–14.8); mean dose in upper lobe tumors was 8.2 ± 4.7 mGy vs 5.1 ± 2.8 mGy in lower lobe tumors ($p = 0.11$); distance between patient and beam source being not constant as well as patient positioning (decubitus prone/supine/lateral). Patients with a BMI < 25 received less mean dose than those with a BMI ≥ 25 (5.6 mGy vs 10.6 mGy, $p = 0.01$).
Conclusion: During CBCT-guided lung ablation, radiation dose to patients' skin is acceptable. Higher doses are expected for patients with BMI ≥ 25.

P-255

Transcathether arterial chemoembolization plus radiotherapy is superior to chemoembolization alone for hepatocellular carcinoma: a comprehensive systematic review and meta-analysis

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Purpose: To evaluate the efficacy and safety of transcatheter arterial chemoembolization plus radiotherapy (TACE+RT) compared to TACE alone for unresectable hepatocellular carcinoma (UHCC) using meta-analytical techniques.
Material and Methods: A search of Medline, EMBASE, PubMed, Cochrane and Google Scholar databases was done. Meta-analysis of overall survival (OS), complete response (CR) and adverse events (AEs) were performed. Subgroup analysis on study design, anticancer drug, radiotherapy type, embolization type, presence of portal venous thrombosis (PVT) and duration between TACE and RT was done.
Results: There were 25 trials (11 RCTs) involving 2,577 patients. TACE+RT showed significantly better 1-year overall survival (OR:1.36, 95% CI 1.19-1.54) and CR (OR:2.73, 95% CI 1.95-3.81) than TACE alone. The survival benefit progressively increased for 2-, 3-, 4- and 5-year overall survival (respectively: OR:1.55, 95% CI 1.31-1.85; OR:1.91, 95% CI 1.55-2.35; OR:3.01 95% CI 1.38-6.55; OR:3.98 95% CI 1.86-8.5). There was an increased incidence of gastroduodenal ulcers, alanine transaminase elevation and total bilirubin elevation in TACE+RT compared to TACE alone. Subgroup analyses showed non-significant trends where overall survival was greater for TACE+RT in patients with PVT compared to those without PVT.
Conclusion: TACE+RT was more therapeutically beneficial than TACE alone for UHCC.

P-256

Cone-beam CT-guided non-vascular oncological interventions: is it possible to live without CT?

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Purpose: A retrospective review of our experience in non-vascular CBCT-guided interventions over a period of 8 weeks when CT was temporarily not available.
Material and Methods: From June to August 2013, the unit of our oncology institute was re-built; thus, no CT was available. We retrospectively reviewed the non-vascular CBCT-guided interventions performed by two senior interventional radiologists during this

period. We evaluated technical complexity considering patient's corpulence, target size, mobility and depth, adjacent vulnerable structures, anaesthesia (local/general). Com-plications were recorded. When available, technical success was assessed based on objective criteria (positive biopsies and rate of complete lung ablation after 1 year).
Results: We performed 32 biopsies (15 thoracic, 11 bone, 6 retroperitoneal or pelvic), 15 thermoablation (14 lung, 1 bone), 34 cementoplasties (22 spinal, 12 extravertebral) and 3 splanchnic neurolysis. No biopsy, referred to our department was transferred to another institution. No significant complication occurred except moderate pneumothoraces that resolved after a maximum of 2 days, chest tube and one minor self-resolving hemoptysis. The rate of positive biopsies was 90.6% (29/32). Among the three negative bone biopsies, two of them became positive after a second biopsy. All lung, retroperitoneal and pelvic biopsies were positive. Complete focal lung ablation after 1 year was achieved in all cases.
Conclusion: CBCT can replace CT guidance for various interventions. However, deeply situated mobile targets close to vulnerable structures may be still difficult to reach and often need several 3D acquisitions. Corpulent or low-compliant patients remain poor candidates for CBCT-guided intervention if 3D navigation is required.

P-257

Percutaneous radiofrequency ablation of hepatic tumor under epidural anesthesia: prospective evaluation of feasibility and factors related to intraprocedural pain

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Purpose: To prospectively evaluate the feasibility of ultrasonographically guided percutaneous radiofrequency ablation (PRFA) for hepatic tumors under epidural anesthesia and factors related to intraprocedural pain.
Material and Methods: Twenty-four patients with 25 sessions were enrolled. They underwent PRFA under epidural anesthesia from January 2012 to March 2014. For epidural anesthesia, 10 mL of 1% lidocaine was injected into the epidural space, and an epidural catheter was placed. Continuous injection of ropivacaine was started through the catheter, depending on the degree of their pain. Pain levels at some predetermined points during the procedures were assessed using visual analogue scale (VAS). Characteristics of patients and tumors, PRFA procedure, anesthetic procedure, and complications were reviewed. We divided the sessions into two groups: group A with mild pain (VAS score < 4.50) and group B with severe pain (VAS score ≥ 4.50). Statistical analysis was performed to compare these factors between two groups.
Results: The mean VAS score was 2.12 ± 3.06 (range, 0–9). Patients presented with mild hypotension in 16 sessions (64%). All sessions were completed without pain exacerbations; however, six sessions (19%) were classified into group B. The factors significantly related to group B were shorter distance from ablated areas to the hepatic capsule and the diaphragm based on univariate analysis (p value = 0.013 and 0.005, respectively).
Conclusion: Epidural anesthesia is an effective method during PRFA for hepatic tumors. The factors related to intraprocedural pain were shorter distance from ablated areas to the hepatic capsule and the diaphragm.

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DC-beads M1 irinotecan drug-eluting beads (DEBIRI) as a closure treatment for patients with controlled liver colorectal cancer metastases as a chemotherapy holiday option

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Purpose: Chemotherapy holidays for stable patients under treatment is a major quality of life issues. Our hypothesis was that two DEBIRI could help to reach sustainable lesion stability. The goal of our study was to assess the liver response rate at 3 months and the progression-free survival (PFS).
Material and Methods: This monocentric study was performed from 03-2012 to 12-2014. All consecutive patients asking for "chemo-holiday" with controlled CRCLM were referred to DEBIRI. Two DEBERI were scheduled at 30-day interval. Whole liver DEBIRI treatment was administrated in a regional manner.
Results: Eighteen patients (62.8 ± 11.1 years [47–80]) were referred to DEBIRI. Chemotherapy lines (2.7 ± 1.20 [2–6]) per patient was previously given. All patients were SD. Twenty-nine DEBIRI sessions were performed (1.6 sessions per patient). Eleven (61%) patients received two DEBIRI sessions. The tumor diameter at baseline was 38 ± 26 mm (15–170). Liver invasion by tumors was <25%: 26%–50% in 10 (62%) and 30% in 6 patients. At the 3-month follow-up, all patients were alive. The average tumor diameter was 29 ± 22 mm (12–169). PR and SD were observed in 4 (15%) and 12 (75%) patients, respectively. The progression-free survival was 253 ± 35.4 days (171–321).
Conclusion: DEBIRI as closure therapy for patients requiring a chemo-holiday based on a "two stop-shop" approach provides a sustainable local disease control with a low rate of complications.

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Safety and efficiency of the Delcath 2nd generation filter in percutaneous hepatic perfusion with melphalan for unresectabel hepatic metastases of colorectal cancer and uveal melanoma

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Purpose: Open isolated hepatic perfusion (IHP) with melphalan is an effective therapy for unresectable liver metastases, but it is a one-time-treatment associated with high morbidity and mortality rates. Percutaneous hepatic perfusion (PHP) is a minimally invasive alternative that allows the isolated perfusion of the liver using catheters and an extracorporeal filter system. We aimed to analyse the toxicity and pharmacokinetics of PHP using the Delcath 2nd generation filter system.
Material and Methods: IRB approval and informed consent were obtained. This study was a part of two ongoing phase-II trials, investigating PHP in patients with unresectable liver metastases of colorectal carcinoma or uveal melanoma. Melphalan dosage was 3 mg/kg. Pharmacokinetic blood samples were taken at baseline and at set time intervals during and after the procedure from the following locations: the median cubital vein and from the extracorporeal

system both before and after the filter. Complications were assessed according to CTCAE v 4.0. After the occurrence of febrile neutropenia in the second study patient, administration of granulocyte colony-stimulating factor at <48 hours after PHP was added to the protocol.
Results: Between January and September 2014, 15 PHP procedures were performed in 10 patients. Blood samples were taken in 11 procedures. No procedure-related death occurred. Seven patients developed grade 3 complications, mostly asymptomatic leukocytopenia and thrombocytopenia. One patient had febrile neutropenia with bacterial pharyngitis. Analysis of the first blood samples showed a filter efficiency of 93%.
Conclusion: The efficiency of the Delcath 2nd generation filter is very high, and PHP with the filter was associated with no mortality and acceptable morbidity.

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Early experience of irreversible electroporation (IRE) for liver malignancies in UK

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Purpose: Irreversible electroporation (IRE) is a new ablative technique used to destroy cancerous cells by subjecting cells to short pulses of high-voltage direct current. It selectively damages cancerous cells while sparing adjacent supporting connective tissue, such as blood vessels, bile ducts and nerves, allowing more targeted treatment compared with other types of treatment.
We share our early experience with IRE as one of the first UK tertiary care institutes. We assessed efficacy, safety and response to this cancer treatment with particular emphasis on liver malignancies.
Material and Methods: This is an ongoing project; all patients treated with IRE from March 2013 to August 2014 are included. Follow-up is performed prospectively by dual-phase CT/MRI in 4-6 weeks following treatment along with clinical review in the IR clinic.
Response to treatment was categorised as per modified RECIST criteria into CR (complete response), PR (partial response), SD (stable disease) or PD (progressive disease). Specific indications for IRE preference over other ablation techniques recorded. Early survival analysis was performed using Kaplan-Meier survival curve.
Results: Nine patients were included (2 females, 7 males). Mean age was 64. Diagnoses were colorectal metastasis (n=6), multifocal HCC (n=2) and neuroendocrine liver metastasis (n=1). Twelve lesions were treated. Mean tumour size treated 2.0cm (range 1.0-4cm); 58% of lesions had PR (n=7) and 42% (n=5) CR. Post-procedure, 10% (n =1) had haemorrhage requiring embolisation and 10% (n=1) had fast atrial fibrillations treated medically.
Conclusion: IRE is a safe and effective ablative modality.
It increases the options for tumour ablation in lesions located close to vital structures and inaccessible locations.

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Radiofrequency ablation in the treatment of intrahepatic cholangiocarcinoma: systematic review and meta-analysis

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Purpose: To perform a meta-analysis and systematic review on the clinical efficacy and safety of radiofrequency ablation (RFA) in the treatment of intrahepatic cholangiocaricnoma (ICC).
Material and Methods: A comprehensive literature search of the Ovid MEDLINE, and EMBASE identified studies, describing the use of RFA for the treatment of ICC. Data describing overall survival, local tumor progression, and complications were collected.
Results: Seven observational studies were reviewed. A total of 84 patients were included in this systematic review. The pooled 1-year, 3-year, and 5-year survival rates were 82% (95% CI, 72–90%), 47% (95% CI, 28–65%), and 24% (95% CI, 11–40%), respectively. One or two major complications occurred in the four studies, and only one patient died of liver abscess and subsequent sepsis despite percutaneous drainage and antibiotics treatment.
Conclusion: Conclusion: RFA may serve as one of the locoregional treatment options in patients who have ICC when surgery is not an option.

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Balloon-occluded arterial stump pressure before balloon-occluded transarterial chemoembolization

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Purpose: To evaluate balloon-occluded arterial stump pressure (BOASP), which is responsible for effective balloon-occluded transarterial chemoembolization (B-TACE), at each hepatic arterial level before B-TACE using a 1.8-French tip microballoon catheter for unresectable hepatocellular carcinoma (HCC).
Material and Methods: The BOASP at various embolized portions was retrospectively investigated. "Selective" and "Non-targeted" BOASP was defined as BOASP at the subsegmental or segmental artery and at the lobar artery, respectively.
Results: The measurement of the BOASP was carried out in 87 arteries in 47 patients. The BOASP above 64 mmHg was revealed in caudate lobe (A1), left medial segmental (A4), right anterior superior segmental (A8), anterior segmental, and right and left hepatic arteries. Significant difference was noted in the incidence of BOASP above 64 mmHg between "Non-targeted" and "Selective" BOASP ($p = 0.01$). "Non-targeted" BOASP was significantly higher than "Selective" BOASP ($p = 0.0147$). In addition, significant difference was noted in the incidence of the BOASP above 64 mmHg between the BOASP at A1, 4, 8, and anterior segmental arteries and the BOASP at other subsegmental and segmental arteries ($p < 0.0001$). The BOASP in A1, 4, 8, and anterior segmental arteries were significantly higher than other subsegmental and segmental arteries ($p = 0.0003$).
Conclusion: "Non-targeted" B-TACE should be avoided to perform effective B-TACE, and "Selective" B-TACE at A1, 4, 8, and anterior segmental arteries may become less effective than that at the other segmental or subsegmental arteries.

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Dual-phase cone-beam computed tomography-based navigation imaging in transarterial chemoembolization for hepatocellular carcinoma: preliminary results of a prospective randomized trial

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Purpose: To quantitatively assess procedural impact of dual-phase cone-beam computed tomography (DP-CBCT)-based navigation imaging in transarterial chemoembolization (TACE) for hepatocellular carcinoma (HCC).
Material and Methods: In this ongoing prospective trial, 38 HCC patients (36 men; 55±10 years; 13 first-time TACE) were randomly selected to undergo TACE using navigation imaging, which automatically detected tumors and feeding arteries by registering DP-CBCT

from early arterial and delayed venous phases. Fifty-four other HCC patients (47 men; 56±11 years; 17 first-time TACE) were treated conventionally using digital subtracted angiography (DSA). Tumor detectability in CBCT, DSA, and pre-operative CT or magnetic resonance (MR) imaging was analyzed. Intraprocedural tumor-feeder visibility in CBCT and DSA was rated (good, fair, and poor) by the operators. Success in superselective embolization, number of DSA acquisitions, fluoroscopy time, air kerma (AK) and dose-area product (DAP) were compared.
Results: In procedures using CBCT (mean, 4.5 scans), tumor detectability was superior in CBCT than in DSA (n=80 vs. n=65; p<0.001) and CT/MR (n=76; p=0.172). Tumor-feeder visibility was rated good in 60% and fair in 21% of CBCT images vs. 32% and 42% in DSA. Between the two groups, DP-CBCT navigation imaging resulted in more superselective embolization (55% vs. 39% of total procedures, respectively), significantly less DSA acquisitions (n=2.7±1.0 vs. n=3.5±0.9; p<0.001) and fluoroscopy time (4.0±4.3 vs. 7.0±3.8 min; p<0.001), and comparable AK (median [interquartile range], 0.32 [0.24–0.44] vs. 0.31 [0.24–0.48] Gy) and DAP (127 [89–166] vs. 102 [71–146] Gy·cm^2).
Conclusion: DP CBCT-based TACE navigation imaging improves tumor and feeding artery detectability and superselective embolization success.

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Superselective ophthalmic artery chemoinfusion (SOAC) in retinoblastoma: should it be the first-line treatment option in naive eyes for globe salvage?

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Purpose: To assess the safety and efficacy of SOAC in intraocular retinoblastoma.
Material and Methods: Retrospective analysis of 19 patients scheduled for 3 cycles of ophthalmic artery chemoinfusion with melphalan/melphalan+carboplatin [melphalan, 0.3–0.4 mg/kg (max. 7.5 mg); carboplatin, 15–30 mg]. Cycle was repeated after 3 weeks as per tumor response. Investigations done pre- and postprocedure were CBC, coagulation profile, RFT, B-Scan, MRI, EUA, and ERG.
Results: We treated 21 eyes in 19 patients with 63 sessions of SOAC. Technical success rate was 92% (catheterization was successful in 58/63 sessions). Mean number of sessions of SOAC per eye was 2.76 (range, 1–6 sessions per eye), with a mean follow-up period of 10.2 months (range, 1–27 months). Out of these, 9 showed complete response, 8 eyes showed good response and are on treatment, 3 eyes were enucleated, and 1 eye received EBRT. No relapse was observed during follow-up period. The overall globe salvage rate was 81% (17/21 eyes saved). The globe salvage rate in naive eye was 92.3% (12/13) as compared with previously treated eye (62.5%). No major complications of the procedure were noted. No major adverse effects were seen during follow-up.
Conclusion: SOAC for intraocular retinoblastoma is a safe, effective, and novel technique for achieving good tumor response, and it offers a means for globe salvage, while preserving useful vision in patients with intraocular retinoblastoma. When used as first-line treatment, we achieved a globe salvage rate of 92.3% in our series, with lower incidence of systemic toxicity.

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Usefulness of transcatheter arterial embolization using a mixture of absolute ethanol and iodized oil prior to percutaneous cryoablation for intraparenchymal renal cell carcinomas

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Purpose: To evaluate the feasibility and usefulness of transcatheter arterial embolization (TAE) using a mixture of absolute ethanol and iodized oil (Lipiodol) prior to CT-guided percutaneous cryoablation (PCA) for intraparenchymal renal cell carcinomas (RCCs).
Material and Methods: Fourteen patients (10 men and 4 women, mean age 65.1±9.4 years) who underwent TAE prior to PCA from April 2013 to February 2015 for RCCs that were less than 4cm, were 50% or more intraparenchymal, and could not be visualized on non-contrast-enhanced CT or 0.3T MRI, were selected. A mixture of ethanol and lipiodol was selectively injected into the feeding arteries of RCCs using a microcatheter. Feasibility of TAE, visualization of RCCs during PCA procedure, and clinical and renal functions were investigated.
Results: The mean tumor diameter was 23.4±7.2 (range, 12-35) mm. In 13 of 14 cases, TAE was successfully performed without complications. In these cases, puncture of RCCs was performed without difficulty by targeting lipiodol accumulation. The safe margin between the RCC and iceball was also clearly visualized during PCA. In all 13 cases, there was no incomplete ablation or local recurrence during the mean follow-up period of 7.7 months. In one case with failed TAE, the feeding artery of the RCC was not detected. There were no significant changes in renal function between before TAE and after PCA.
Conclusion: TAE using a mixture of absolute ethanol and lipiodol prior to PCA improves visualization of intraparenchymal RCCs and facilitates a safe and accurate procedure.

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Correlation between RENAL nephrectomy score and clinical outcome following percutaneous cryoablation for 99 renal cell carcinomas

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Purpose: To investigate correlation between RENAL nephrectomy score and clinical outcomes, including renal function, in patients who underwent percutaneous cryoablation (PCA) for renal cell carcinomas (RCCs).
Material and Methods: The data of patients who underwent image-guided PCA for RCCs between September 2011 and February 2015 were retrospectively reviewed. The RENAL nephrectomy scores were calculated and were categorized into low (4-6), moderate (7-9), and high (10-12). Procedural and oncological outcomes and renal function were compared between each group.
Results: Among 99 treated RCCs, 41 (42.4%) were scored low, 41 (42.4%) moderate, and 17 (17.2%) high. There were no significant differences between each group in mean age (69.0±11.0, 69.5±11.9, and 67.7±10.0 years, respectively) (p>0.05) and preoperative renal function [mean serum creatinine level, (1.05, 0.92, and 1.15 mg/dl respectively) (p>0.05)].
There were no significant differences in the rate of complete ablation among each group (87.8%, 85.3%, and 82.3%, respectively) (p>0.05). However, a significantly large number of cryoneedles was

required in high and moderate groups than in the low group (mean 4.29, 3.56, and 2.68, respectively) (p<0.05). There was no significant difference in the local recurrence rate between each group (2.4%, 4.9%, and 0% respectively) (p>0.05) during a mean follow-up period of 11.3 months. There was no significant difference in the rate of increase of serum creatinine level among each group (mean 7.4%, 13.1%, and 16.4%, respectively) (p>0.05).
Conclusion: Although a large number of cryoneedles was required, PCA is a feasible nephron-sparing treatment even for RCCs with high RENAL nephrectomy score.

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A systematic review and meta-analysis of minimally invasive imaging-guided treatment of breast tumors

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Purpose: The aim of this study is to systematically review the efficacy of imaging-guided treatment of breast tumors.
Material and Methods: In February 2015, a literature search was performed on MEDLINE, EMBASE, and the Cochrane Database of Systematic Reviews using the keywords: "radiofrequency", "microwave", "laser", "percutaneous", "high-intensity focused ultrasound", "cryoablation", "breast", "cancer", and "ablation". We analyzed only original English language literature. For each article, we collected information about number of patients, dimension of treated lesions, technical success and effectiveness, complication rate. Heterogeneity (I^2) was evaluated using the Cochrane Q statistics: P-value <0.100 was considered significant.
Results: A total of 688 articles were initially retrieved; 616 were excluded based on abstract or full text. Seventy-two articles were finally analyzed, with a total of 1631 patients. The used technique was RFA in 35 articles (736 patients), laser ablation in 12 (240 patients), microwave in 3 (78 patients), HIFU in 11 (240 patients), and cryoablation in 11 (239 patients). Range of tumor size was 2-60 mm. Major complication rate (burns grade 2 or 3, necrosis, pneumothorax) was 6%; minor complication rate (local discomfort, burns grade 1) was 12%. Overall technical success and effectiveness were 96% and 76%, respectively; at subgroup analysis 96% and 82% for RFA; 96% and 68% for HIFU; 96% and 73% for cryoablation; 98% and 61% for laser ablation; and 94% and 90% for microwaves. Heterogeneity was high (I^2 75%). In subgroup analysis, effectiveness was significantly different among techniques (P<0.001).
Conclusion: In conclusion, percutaneous thermal ablation of breast tumors is technically feasible; RFA and microwaves showed higher effectiveness.

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Effectiveness of radiofrequency ablation in the treatment of benign thyroid nodules

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Purpose: The usual treatment for symptomatic and autonomously functioning benign thyroid nodules was surgery until the advent of new techniques such as radiofrequency ablation (RFA). This study aimed at estimating RFA efficacy and comparing it with the surgical treatment of benign thyroid nodules.
Material and Methods: The retrospective analysis included the results of treatment of 225 patients with benign tumors of the thyroid gland, received in the Samara Oncology Center. Seventy-five patients underwent RFA. One hundred and fifty patients underwent surgical treatment. Among the patients who underwent RFA, 15 (19.3%) patients had autonomously functioning thyroid nodules and 60 (80.7%) had symptomatic ones, and in the surgery group, the number of patients were 37 (24.6%) and 113 (75.4%), respectively.
Results: RFA reduced nodular volume by 70% after 6 months, and it was an effective method for treating nodule-related clinical problems and hot nodules. Cosmetic results were excellent in 100% of patients in the RFA group. In the surgery group, patients rated cosmetic results as "excellent" in 113 (75%) cases, "good" in 17 (11%), and "acceptable" in 20 (14%) cases depending on their scar. No serious complications such as thyroiditis, voice change, and hematomas were observed in RFA patients. In the surgical treatment, complications were more significant. We observed 9 cases of hypocalcemia, and 2 cases of wound complications. There were 2 cases of bleeding, requiring surgical wound revision. Twenty-eight percent of patients developed hypothyroidism.
Conclusion: RFA was effective and safe for treating benign thyroid nodules. RFA had less complications than surgery, and it might be recommended for treating benign thyroid nodules as the first-line treatment.

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Transarterial chemoembolization of hepatocellular carcinoma with doxorubicin-eluting beads with sizes below 100µm

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Purpose: The purpose of this study was to investigate short-term safety and efficacy of the new generation of doxorubicin-loaded drug-eluting beads with sizes below 100µm.
Material and Methods: From March 2013 to April 2014, 20 consecutive patients with HCC underwent TACE with super-selective access using 40- or 75-µm drug-eluting beads (Embozene TANDEM Microspheres; CeloNova BioSciences Inc, San Antonio, TX) loaded with doxorubicin. Patients were followed up with MRI examinations before the treatment and then monthly for three months. Local response was evaluated with modified response evaluation criteria in solid tumors (mRECIST).
Results: Overall complete response (OCR), partial response, stable disease, progressive disease (PD), and overall objective response were 50%, 15%, 10%, 25%, and 65% and 50%, 11%, 17%, 22%, and 61% at the first and third months, respectively. The presence of nontarget lesions cause increased levels of OCR and decreased levels of PD. OCR for target lesions ≤ 5cm was 100% during the follow-up period. AST and ALT levels were increased within 24 hours after TACE, declining to normal values within 1-2 months in most patients.
Conclusion: In conclusion, according to mRECIST, there was no difference in the short-term response between 40-/75-µm microspheres and larger-sized doxorubicin-eluting beads when compared with literature data. However, OCR rate was higher for target lesions ≤ 5cm than for larger lesions.

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Interventional treatment of thoracostomach-airway fistula after esophagogastrectomy with covered stents

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Purpose: To evaluate the clinical value of treating thoracostomach-airway fistula after esophagogastrectomy with covered stents.

Material and Methods: Through SCT and digital radiography with a water-soluble medium, we diagnosed 22 patients with thoracostomach-airway fistula (6 thoracostomach-tracheal fistula, 2 thoracostomach-carina, 13 thoracostomach-left principal bronchial, and 1 thoracostomach-right principal bronchial). Covered stents were selected on the base of the site, size, and number of thoracostomach-airway fistulas. Under fluoroscopic guidance, 24 stents were implanted in 22 patients with thoracostomach-airway fistulas.
Results: Stent placement was technically successful in all patients. The stent completely sealed off the fistula in 18 of 22 patients, choking after drinking and eating vanished as soon as the fistula was closed, and a normal diet could be swallowed after stent placement. Four of 22 patients had persistent aspiration symptoms due to incomplete closure (initial clinical failure). During follow-up, the fistula reopened in 11 of 22 patients with initial clinical success. Eight reopened fistulas were sealed off with stent placement, and in 3, a feeding nasoenteric tube and a nasogastric decompression tube were inserted. All patients died during follow-up, and mean survival was 14±4.56 weeks (range, 1-42 weeks) after stent placement.
Conclusion: The airway covered stent placement is an effective and safe treatment for thoracostomach-airway fistula.

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The treatment of airway complex stenoses involving the tracheal carina with an inverted Y-shaped self-expandable metal stent

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Purpose: To investigate the feasibility of an inverted Y-shaped self-expandable metal stent for managing airway complex stenoses involving the tracheal carina.
Material and Methods: Under fluoroscopic guidance, 38 patients with airway complex stenoses involving the tracheal carina were treated with an inverted Y-shaped self-expandable metal stent.
Results: Stent placement in the tracheo-bronchial tree was technically successful in 38 patients with an obliteration of dyspnea immediately after stent placement and with no occurrence of obviously dyspnea and bleeding. During the follow-up period of 8.85 ± 6.12 months (ranging from 1 to 18 months), 11 patients died of the following causes unrelated to stent insertion; the airway stenoses symptom of 27 patients was improved, and their general physical and living qualities were also improved.
Conclusion: Use of the inverted Y-shaped self-expandable metal stent in the management of airway complex stenoses involving the tracheal carina was a simple and safe procedure with a good short-term clinical efficacy.

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Pharmacokinetics and histopathological findings of chemoembolization using cisplatin powder mixed with degradable starch microspheres in a rabbit liver tumor model

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Purpose: Our phase II clinical study recently showed that novel TACE using cisplatin powder mixed with degradable starch microspheres (DSM; mean diameter, 40 µm; half-life, 30 min) achieved a high-tumor response rate of 61% for colorectal metastases after the failure of FOLFOX. To date, there is no pharmacological data for this treatment. The purpose of this study was to evaluate the pharmacokinetics and histopathological findings of cisplatin powder mixed with DSM (Cis/DSM-TACE) compared with those of cisplatin arterial infusion (Cis-AI).
Material and Methods: Eighteen rabbits with VX2 liver tumors were divided into two groups: Cis/DSM-TACE group (n=9) and Cis-AI group (n=9). In the Cis/DSM-TACE group, a mixture of cisplatin powder and DSM (25 mg/mL) was injected. The endpoint of the injection was near to the stasis of hepatic arteries. In the Cis-AI group, cisplatin solution (1 mg/kg) was infused.
Results: The mean cisplatin concentrations in VX2 tumor at 1 hour, 24 hours, and 72 hours were 8.59, 7.50, and 6.39 µg/g, respectively, in the Cis/DSM-TACE group, whereas they were 2.43, 0.71, and 0.45 µg/g, respectively, in the Cis-AI group (P=0.232, 0.016, and 0.019, respectively). There was no significant difference in the cisplatin concentrations in plasma. Histopathological examination revealed 40-µm microspheres present inside the tumors at 1 hour but completely disappeared at 24 hours. The mean tumor necrosis rates at 24 hours were 83.3% in Cis/DSM-TACE group and 56.7% in Cis-AI group.
Conclusion: Even after the degradation of microspheres, Cis/DSM-TACE can maintain high-cisplatin concentrations in the tumor for 72 hours, achieving high-tumor necrosis rate.

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New staging markers: the role of 3D baseline evaluation in patients with hepatocellular carcinoma

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Purpose: This study evaluated and compared the capability of 1D and 3D radiological measurements on baseline MRI to predict overall survival (OS) in patients with unresectable hepatocellular carcinoma (HCC).
Material and Methods: In all, 122 patients with unresectable HCC treated with TACE were retrospectively included. Quantitative 3D segmentation analysis was performed on 296 lesions to assess patients' enhancing tumor burden (ETB), calculated from enhancing tumor volume in relation to the liver volume. Furthermore, diameters were measured. All analysis were performed on the arterial phase of the baseline contrast-enhanced MRI. Numeric cut-offs were used (3cm for diameter, <3 lesions; 4% for ETB) in order to stratify patients into two groups. Survival was assessed using Kaplan-Meier analysis (KM) and compared using Cox proportional hazard ratios (HR) as well as k-values; k-values were calculated for the largest and all lesions to support the choice of number of lesions analyzed with 3D measurements.
Results: KM showed a significant stratification for both methods ($p<0.05$). However, multivariate analysis showed superiority for ETB that outruns 1D methods (HR 4.6 [95%CI, 2.6-8.1, $p<0.001$] for ETB vs. HR 2.7 [95%CI, 1.3-5.8, $p=0.008$] for diameter-based evaluation). k-values for ETB were 0.782 (0.745 for evaluation of the largest lesion) and for diameter-based measurements 0.698.
Conclusion: The concept of ETB is a highly significant predictor of OS in TACE patients that outruns 1D measurements by far. Furthermore, 3D enhancement analysis of the largest tumor lesion represents patients' entire tumor affection in a good manner with significant prediction of OS in patients with multifocal HCC.

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Lessons and early results from the largest single-centre experience in Europe of the treatment of occular melanoma liver metastases with chemosaturation via percutananous hepatic perfusion

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Purpose: We present the lessons learnt from the largest single-centre experience of chemosaturation percutaneous hepatic perfusion (PHP) for the treatment of metastatic ocular melanoma in Europe.
Material and Methods: We retrospectively collected mortality, morbidity, intra-procedural, imaging and complication data on 22 consecutive patients who were planned for PHP treatment over a 30-month period. We present initial survival data, complications and experience gained performing the procedure.
Results: Twenty patients received 34 treatments. Two patients could not be treated, one due to tumour-related anatomical distortion making liver isolation impossible, one due to development of IVC thrombus between assessment and attempted treatment. These were excluded from treatment efficacy data. We have recorded 6 complications requiring treatment. No procedure-related deaths have been seen. Nine deaths from disease progression occurred after a median of 264 days from the first procedure. Eleven patients remain alive after a median of 280 days with one complete response ongoing at >1 year. Two patients (10%) have had complete imaging responses in the liver, and 13 (65%) had a partial liver response. Two patients (10%) had stable disease for >3 months.
From the diagnosis of liver metastases 11 patients (55%) survived to one year and 3 (15%) for >2 years. Review of the operation notes has revealed several technical changes over the 30-month period.
Conclusion: PHP is an effective palliative treatment in a bleak disease with an acceptable side effect profile. Administration of PHP has been a steep learning curve with good multidisciplinary cooperation essential.

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High-intensity focused ultrasound ablation (HIFU) of patients with prostate cancer: status quo 2015

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Purpose: To define the current role of HIFU treatment for prostate cancer, according to the results of two leading European centers.
Material and Methods: HIFU is a local treatment for prostate cancer, with 17 years of clinical experience during which approximately 32,000 HIFU treatments have been performed worldwide. Of these treatments, 2,700 have been performed at institutions in München-Harlaching and 1,000 at the Samara Oncology Center. We present the current status of HIFU to be used as noninvasive local therapy in the curative or palliative approach for men with different stages of prostate cancer.
Results: Median PSA level 12 months after rHIFU treatment was 0.04 ng/ml (0–2.24) for low-risk group, 0.5 ng/ml (0–48.4) for high-risk group, and 0.5 ng/ml (0–3.2) with failure after EBRT; at 120 months after rHIFU treatment, it was 0.5 ng/ml (0.02–3.6) for low-risk group, 3.2 ng/ml (0–21.38) for high-risk group, and 1.7 ng/ml (0–9.8) with failure after EBRT. Patients with low risk had 4.5% of progression, with high risk had 25%, with failure after EBRT had 19.6%. Kaplan-Meir analyses of the total group indicated that the risk of progression after 1-year follow-up was 10%, and after 15-year follow-up, it was 25%.
Conclusion: The current role of the HIFU ablation is effective in the treatment of all stages of the PC, castrate-resistant prostate cancer. HIFU also may be used as a salvage therapy after other treatment failures.

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Proposal of a simple scoring system for intermediate-stage HCC patient candidates for TACE

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Purpose: To identify predictors of overall survival (OS) in naive intermediate-stage HCC patients undergoing transarterial chemoembolization (TACE) and to suggest an objective point score for patient stratification.
Material and Methods: We retrospectively reviewed clinical and demographic data of 149 patients (125 males; mean age, 65 years) with naive intermediate-stage HCC treated with TACE between 2006 and 2011. One-month tumor response was defined according to mRECIST. Stepwise Cox regression model was used to identify predictors of OS and develop an objective point score.
Results: Median OS was 22.7 months. At multivariate analysis, negative independent predictors for OS were age of >65 years (HR, 1.80; P=.0048), ascites (HR, 2.36; P=.0041), and progressive disease after TACE (HR, 4.68; P<.0001), while positive independent predictors were tumor size of ≤60 mm (HR, 0.49; P=.0015), according to RECIST 1.1 and complete response after TACE (HR, 0.64; P=.048). A 5-point scale pre-procedural and an 8-point scale pre- and post-procedural scores were created, and for each, three groups of patients were identified. Regarding pre-TACE score, patients with <0 points had a significantly longer OS (40.2 months, group A) compared with patients with scores of 0 (27 months, group B) and >0 (15.3 months, group C). When considering pre- and post-procedural variables, the group post-A had median OS of 40.2 months, significantly longer than that of post-B (scores, 0–1; median OS, 21.1 months) and post-C (score, ≥2, median OS, 8.3 months) groups.
Conclusion: Combining pre- and post-TACE parameters, our scoring system enables a simple stratification of intermediate-stage HCC patients, deemed candidates for TACE.

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Irreversible electroporation (IRE) of malignant liver tumors close to the major portal or hepatic veins: is it safe and effective?

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Purpose: IRE has been proposed as a nonthermal ablation that offers specific advantages over thermal methods, notably absence of heat-sink effect and avoidance of thermal damage to vessels or bile ducts. Our aim was to verify the theoretical advantages of IRE and investigate local efficacy and complications of CT-guided percutaneous IRE for hepatic malignancies located immediately adjacent to the major portal and hepatic veins and bile ducts.
Material and Methods: Twenty-four metastases in 19 patients (mean age, 62±12 years) who were suffering from liver tumors, with a mean size of 17 mm (range, 7–44 mm) underwent percutaneous hepatic IRE. All lesions were located immediately adjacent to the

major hepatic veins, portal vein branches, or both and therefore not suitable for RFA. Three–five IRE probes (active tip length, 1.5–2.5 cm) were placed strictly parallel under CT-guidance. All patients underwent systematic follow-up CT and MRI.
Results: Complete ablation of the target was achieved in 22/24 (92%) cases, with a safety margin of 5–10 mm confirmed by CT and MRI. No major procedure-related complications were observed. All adjacent major portal or hepatic veins remained perfused at long-term follow-up. In 4/22 cases (18%), local recurrence adjacent to the ablation zone was observed between 1 and 12 months after treatment. In one patient, a clinically asymptomatic arterio-portal fistula developed not requiring treatment. One patient with a metastasis located on the portal bifurcation developed mild left-sided cholestasis.
Conclusion: IRE for primary and secondary hepatic malignancies located adjacent to the large portal or hepatic veins proved to be both safe and efficient with regard to local control.

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Endovascular intervention for management of life-threatening hemorrhage after liver radiofrequency ablation: outcome in 14 patients at a single tertiary referral center

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Purpose: To evaluate the safety and clinical efficacy of endovascular Intervention for the management of hepatic radiofrequency ablation (RFA)-related bleeding.
Material and Methods: A retrospective review was performed for all patients who underwent endovascular treatment for hepatic RFA-related bleeding from January 2001 to December 2013. We identified a total of 14 patients (age ranged from 50 to 76 years and with a median age of 62.7). Clinical data, abnormalities seen on CT, and details regarding the endovascular procedures were assessed, as were the outcome of each procedure and procedure-related complications.
Results: The incidence of hepatic RFA-related bleeding was 1.2% (62 in 5196 patients). Of 62 patients with direct or indirect sign of hemorrhage seen on CT, a total of 14 patients underwent endovascular intervention. The remaining 48 patients spontaneously recovered following conservative treatment. The right hepatic artery (35.7%, 5/14; A8 (n=4) and A6 (n=1)) was the most commonly treated artery, and among extrahepatic arteries, the right lower posterior intercostal artery (28.5%, 4/14) was found to be the most common. Extravasation of contrast media with or without pseudoaneurysm was the most commonly detected abnormality on digital subtraction angiography (57.1%, 8/14). Transcatheter arterial embolization was performed in the majority patients (92.9%, 13/14), while only one patient with active portal venous bleeding was treated with percutaneous transhepatic portal vein embolization. Successful hemostasis without rebleeding was achieved in 14 patients (100%). There was no major complication after endovascular treatment.
Conclusion: Endovascular intervention is safe and effective for controlling life-threatening hemorrhage after liver RFA without the need for laparotomy.

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Systematic evaluation of hepatic MR imaging findings after irreversible electroporation (IRE)

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Purpose: The aim was to describe the normal course of local signal intensity changes that can be expected after IRE; this knowledge is important in order to allow the sensitive detection of SI changes that are not within normal limits, i.e., likely represent local recurrence.
Material and Methods: Eighteen patients (9 males, mean age 62 years) with 21 malignant liver tumors (20 secondary, 1 HCC) underwent percutaneous IRE. Patients underwent pre- and post-interventional hepatic MRI according to a standardized protocol before treatment; within 2 and 24 hours after IRE; and at 1, 2, 4, 6, 8, and 12 weeks after IRE, and every 3 months thereafter. MR images were systematically evaluated.
Results: Even after successful IRE, in 15/21 cases, target lesions were still visible, with unchanged SI and internal architecture as before IRE, for 3-9 months after IRE in 7/15 cases and >12 months in 2/15. The target lesion shrank over time and was surrounded by an ablation zone, which appeared as an intermediate hyperintense area until 1 week after IRE. Thereafter, the ablation zone changed its SI and appeared as an intermediate hypointense in the center, with a hyperintense rim, the latter exhibiting strong contrast enhancement. This appearance persisted for 1-4 months in 13/21 cases, only 2 weeks in 6/21, and >3-6 months in 2/21. Ablation zones shrank over time and disappeared completely in 8/21 cases.
Conclusion: IRE induces complex signal intensity changes that vary over time. In most cases, the treated target lesions were visible within the ablation zone over a longer period of time, making the diagnosis of local recurrence difficult.

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MRI-guided transurethral ultrasound ablation in patients with localized prostate cancer: 12-month outcomes of a prospective multi-national phase I clinical trial

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WITHDRAWN

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Irreversible electroporation (IRE) to treat locoregional pelvic tumor recurrences

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Purpose: To describe the initial clinical experience with irreversible electroporation (IRE) to treat locoregional pelvic tumor recurrences.
Material and Methods: A retrospective analysis was performed of five patients who were treated with IRE for local pelvic tumor recurrences unsuitable for additional resection, re-irradiation, or other focal therapies due to the vicinity of the lumbosacral, sciatic, or femoral nerves. Adverse events were assessed using the CTCAE 4.0 criteria. The clinical

outcome was determined using general symptom assessment, including Seddon's peripheral nerve injury (PNI) scores at baseline and 24h and 3 months post-IRE. Radiological outcome was evaluated comparing baseline with follow-up MRI and 18F-FDG PET-CT every 3 months.
Results: Between December 2012 and November 2014, five patients underwent percutaneous CT-guided IRE with palliative intent to treat recurrences of primary rectal (n=4) and cervical carcinoma (n=1). Median largest tumor diameter was 4.5cm (range 4.1-5). IRE-induced PNI was present at 24h in 4/5 patients (all CTCAE-grade II): 3 patients showed lower limb motor loss (PNI grade 2), and 1 developed a hypotonic bladder (PNI grade 2). At 3 months, neural function partly recovered in one patient and persisted in the other three. Partial and indeterminate residual F18-FDG PET-CT uptake was found in all cases. After a median follow-up of 9 months (range 2-26), unequivocal progression was observed in 3 patients (at 7, 8, and 8 months).
Conclusion: IRE may represent a suitable technique to treat locoregional pelvic tumor recurrences, although, as opposed to preclinical animal studies, permanent neural function loss can occur when IRE is performed near or around nerves.

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Serial transarterial embolization in giant cell tumors of the sacrum: an effective pain-palliative treatment option

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Purpose: To evaluate the clinical efficacy and response of serial transarterial embolization in giant cell tumors of the sacrum.
Material and Methods: Twenty-one patients with biopsy-proven sacral GCTs received an initial primary treatment with serial arterial embolization between July 2007 and January 2015. Patients underwent serial embolization using particulate embolic material at 6–8-week intervals. Patients were assessed by clinical evaluation and imaging (CT/MRI) for response evaluation. Visual analogue pain scale and quality of life questionnaires (EORTC-QLQ, version 3) were used for assessing clinical benefits.
Results: The mean follow-up duration in this series was 33 months (range, 3–89 months). All 21 patients demonstrated a substantial pain relief and an improvement in the quality of life after arterial embolization. Preprocedural visual analogue pain score was 5–9 with a mean of 7.3, whereas mean pain score after embolization was 1.4. Three patients underwent surgical intervention after arterial embolization. Disease stabilization was noted in 16 of the remaining 18 cases. Peripheral calcification developed in 12/21(57.1%) of the cases. Two patients showed tumor progression on follow-up and required an alternate treatment. Two patients developed urinary retention after the procedure, which improved over a 2–3-week period with no long-term sequelae.
Conclusion: Serial arterial embolization is a useful primary treatment modality for large SGCTs, given the favorable long-term results with no potential morbidities of alternative treatments. It offers an effective pain palliation in SGCT patients. Serial embolization can also be used as an interval procedure to downsize the tumor to make it suitable for surgery.

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Reduced efficacy and increased complications in obese hepatocellular carcinoma patients after transarterial chemoembolization

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Purpose: Obesity is associated with increased risk of hepatocellular carcinoma (HCC), with higher rates of complications and disease recurrence after liver transplantation and ablation. We studied the impact of obesity on outcomes after transarterial chemoembolization (TACE).
Material and Methods: We retrospectively identified 114 TACE (58 HCC patients; 85% due to hepatitis B or C; mean age, 62 years; mean MELD score, 10; mean AFP, 805). Medical charts were assessed for body mass index (BMI), clinical, and procedural data. The 1–2-month follow-up CT or MRI was assessed using mRECIST criteria for residual/recurrent disease or new lesions. For analysis, patients were grouped by low (<25) and high (≥25) BMI.
Results: Residual/recurrent disease on 1–2-month imaging was more common after TACE in patients with high BMI than in those with low BMI (63% vs. 31%; X^2: 8.3; p=0.004), as were new lesions (42% vs. 19%; X^2: 4.9; p=0.02). Mean BMI differed between cases with complete response (mean, 25±1), stable disease/partial response (mean, 29; SE, 1), or progressive disease (mean, 29±1) by one-way ANOVA (p=0.003). Of 58 patients, 9 had complications. Patients with complications had higher BMI than those without complications (30 vs. 27; p=0.05 by Mann-Whitney U test). Two deaths within 1 month occurred in obese patients (BMI, 33 and 34).
Conclusion: High BMI is associated with more residual/recurrent disease, new lesions, and progressive disease after TACE for HCC and possibly with increased complications. Obesity may lead to a more rapidly progressive and difficult to treat HCC.

P-284

MDCT-guided percutaneous needle biopsy of mediastinal lesions: anatomic considerations and different approaches and techniques

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Learning Objectives: To describe and illustrate the anatomy and type of approaches and techniques for MDCT-guided percutaneous biopsy of mediastinal lesions.
Background: MDCT-guided percutaneous needle biopsy allows access to lesions in virtually all mediastinal locations. The direct mediastinal approach, which enables extrapleural needle placement, is the preferred method to avoid the risk of pneumothorax. Techniques that allow extrapleural access include the parasternal, paravertebral, and transsternal.
Two alternatives to these direct mediastinal approaches are a) rotation of the patient to create a new anterior mediastinal approach and b) iatrogenic parapleural effusion to create a new posterior mediastinal approach. The latter approach is the transpulmonary, which involves penetration of the lung and visceral pleura by the needle and is generally associated with a high risk of pneumothorax.
Clinical Findings/Procedure: MDCT-guided percutaneous needle biopsy of mediastinal masses is a safe and effective technique for

obtaining tissue diagnosis. The aim of this poster is to illustrate and discuss 1) the anatomic consideration of the mediastinum, 2) the various approaches used for imaging-guided mediastinal biopsy, 3) technical aspects, advantages, limitations, and complications of each technique, and 4) patient preparation and positional maneuvers.
Conclusion: A better knowledge of mediastinal anatomy using MDCT facilitates planning of a safe and effective percutaneous access for needle biopsy, especially in deep lesions. Various techniques, such as injection of physiologic saline solution and use of positional maneuvers, help in avoiding puncture of the visceral pleura and main arterial vessels, thus decreasing the risk of complications.

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MDCT-guided percutaneous neurolysis of celiac plexus via the anterior approach: why, when, and how

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Learning Objectives: To illustrate the technique of MDCT-guided percutaneous neurolysis of celiac plexus in patients with pancreatic tumors in whom systemic analgesics were ineffective.
Background: Intractable pain is the most invalidating symptom in patients with pancreatic tumors. In these cases, celiac plexus blockade, with the interruption of the major afferent sensitive nerves, can be used for the control of pain. This therapeutic option (neurolysis) is a relatively safe and efficacious technique under MDCT guidance. The neurolysis is created by the injection of neurolytic agents to destroy the sensitive celiac plexus.
Clinical Findings/Procedure: The use of neurolysis in celiac plexus has decreased in recent years due to advances in spinal analgesia. However, it is still an attractive option for pain control in many patients with tumor, such as pancreatic tumor. The aim of this poster is to illustrate 1) the anatomic consideration of the celiac plexus, 2) the indications of percutaneous neurolysis, and 3) all tips and tricks of MDCT-guided percutaneous neurolysis of celiac plexus via the anterior approach technique.
Conclusion: Pancreatic cancer pain is amendable to various types of analgesic interventions. In the most severe cases, interventional radiology involving MDCT-guided percutaneous neurolysis of celiac plexus can be used as a sole agent for pancreatic tumor pain control or as a useful adjunct in decreasing opioid dose requirements and side effects.

P-286

Percutaneous cryoablation of the celiac plexus in cancer patients

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Learning Objectives:
1. To show how to take advantage of the anesthetic properties of cryoablation to relieve pain in patients with upper abdomen malignancies
2. To present our technique of celiac block using cryoablation
3. To remind the risks and anatomical constraints of the procedure

Background: The policy for treating patients with pain from upper abdomen malignancies is a combination of pharmacological treatments (mainly opioids) and neuroablative procedures (mainly alcohol). In patients with locally advanced cancer, alcohol diffusion is unpredictable, making celiac block difficult and/or ineffective. Cryoablation combines antitumor, antiangiogenic, and neurolytic properties and represents a valuable alternative in these patients.
Clinical Findings/Procedure: The celiac axis is localized on contrast-enhanced CT. A Chiba needle is used for local anesthesia. Due to the diameter of the cryoneedles (17-gauge Ice Sphere), the posterior approach is the method of choice. A bilateral posterior paravertebral approach allows placing one cryoneedle on each side into the antecrural space between the celiac trunk and superior mesenteric artery under CT guidance. The cryoablation protocol can be a single 10-minute freezing cycle (pure neurolysis) or two 10-minute freezing cycles, each followed by a 10-minute passive thawing cycle (both neurolysis and antitumor effect). The pain usually decreases by 4 to 5 points on the visual analog scale (VAS, 0-10). Complications are rare, provided attention is paid to adrenals and vessels.
Conclusion: Percutaneous cryoablation of the celiac plexus is an effective and safe method to diminish pain and reduce opioid requirements in patients with upper abdomen malignancies. Interventional radiologists who dispose of the cryoablation technique can easily perform it.

P-287

Bronchial and bronchopleural fistulas after percutaneous radiofrequency ablation of the lung: risk factors, prevention and management

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Learning Objectives: The aim of this educational exhibit is to analyse the risk factors, prevention and management of bronchial (BF) or bronchopleural (BPF) fistulas occurring after percutaneous radiofrequency ablation (PRFA) of the lung.
Background: BF and BPF are potential rare complications after PRFA, which consist of a communication either between a bronchus and the ablation zone (BF) or between a bronchus and the pleural cavity through the ablation zone (BPF). Risk factors, management and prevention of these complications will be presented.
Clinical Findings/Procedure: Without any specific treatment, a favorable spontaneous evolution of BF is often observed. Most of the cavitations may spontaneously disappear. However, a careful monitoring of these cavities is recommended because of the increased risks of delayed complications such as pyogenic abscess or aspergilloma.
BPF occurs most often when coagulation necrosis, which is represented by ground-glass opacity, abuts the visceral pleura. Risk factors are pneumothorax, radiotherapy, primary pulmonary neoplasm and emphysema. Chest tubes, surgery, bronchoscopy (occlusion of the BPF with some materials) or eventually percutaneous embolization of the BPF could be performed to seal the fistula.
Conclusion: Before the procedure, patients presenting with emphysema or chronic bronchitis need to be informed of the possible risk of fistula. Prevention measures exist, in particular subpleural tumours need to be treated with caution. In the case of intractable fistula, percutaneous embolization may be required.

P-288

Combination of RFA with TACE for treatment of HCC: a systematic review of unresolved clinical issues

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Learning Objectives: We aim to systematically review the current evidence for various issues of combined transarterial chemoembolization (TACE) with radiofrequency ablation (RFA) for the treatment of hepatocellular carcinoma (HCC).
Background: Recently, the use of combined TACE-RFA for the treatment of HCC has been increasing. However, there are still unanswered clinical questions requiring further evidence.

Clinical Findings/Procedure: Until December 2014, there were 18 published reports that compared the effectiveness of and complications associated with combined TACE-RFA to RFA monotherapy. Although the treatment protocols and the study results vary to some degree, there is consistent evidence indicating that combined TACE-RFA can improve the overall survival and recurrence-free survival rates compared with RFA monotherapy. However, several issues remain. Regarding the technical issues, we need to get consensus to establish a standardized protocol such as choice of agents for TACE and interval between TACE and RFA. In addition, we need further evidence to compare combined TACE-RFA with other treatment strategies in various clinical settings to establish clinical indications of combined TACE-RFA. Currently, we lack enough evidence for the complications associated with combined TACE-RFA. These issues can be resolved through literature review, generation of high-quality primary study results, and international/local consensus meeting. In this systematic review, we collected and categorized the current literature evidence according to these issues so that readers can seize the concepts in a balanced manner.
Conclusion: Although there is consistent evidence favoring combined TACE-RFA over RFA monotherapy, there are still some clinical issues remaining to be answered.

P-289

How to properly "dock" a port: a pictorial review of implantable chest port complications

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Learning Objectives:
1. Be familiar with the proper techniques for successful chest port placement.
2. Become familiar with the many potential complications associated with chest ports and their insertion.
3. Be able to identify the imaging features associated with chest port complications that may be found on chest radiographs and CT scans.

Background: Ultrasound- and fluoroscopic-guided placements of chest ports have become common procedures in interventional radiology. It is important to understand the possible complications in order to prevent or minimize issues so that patients can begin chemotherapy as soon as possible.
Clinical Findings/Procedure:
1. Discuss the ideal location of chest port placement.
2. Discuss immediate complications such as vascular injury, pneumothorax, port pocket hematoma, and catheter malpositioning.
3. Discuss delayed complications such as catheter migration, reservoir displacement, fibrin sheath formation, pericatheter thrombus formation, vascular stenosis, pinch-off syndrome, and infection.
4. Discuss treatment options of the described port complications.

Conclusion: After completing this educational exhibit, the viewer will be aware of potential port complications, many of which may be incidentally identified on imaging studies obtained for other purposes.

P-290

Percutaneous ablation of renal tumours: current state

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Learning Objectives:
1. To present an overview of the percutaneous minimally invasive treatment options for renal tumours.
2. To illustrate them with step-by-step explanations.
3. To present some tips and tricks to avoid complications.
4. Special reference will be made to the image guidance modalities (CT, MRI, ultrasound fusion imaging).

Background: Percutaneous tumour ablation has gained an important place in the treatment of kidney cancers. It has been shown that radiofrequency, cryo- and MW ablation have good tumour-specific response with preservation of renal function.
Clinical Findings/Procedure: Stage 1A disease (<4 cm, organ confined) presents the best scenario for percutaneous ablation. Patient general status (age, life expectancy, renal function, risk of metachronous lesions in hereditary neoplasms) and comorbid conditions play an important role in decision making.
- High-quality image guidance is required (CT, MRI). MR guidance offers a real-time feedback, but has limitations (i.e. need for MR-compatible instrumentation). Ultrasound can be used to guide instrument positioning but cannot safely monitor the ablation zone.
- Visualisation of the ice-ball, minor peri-/post-operative pain and minor toxicity on the urothelium are primary benefits of cryoablation.
- Protective measures (hydro/CO_2 dissection, retrograde pyeloperfusion, needle tracking) and strategies (preoperative embolisation) are required to add safety and optimise procedure outcomes.
- Complex cases (large and/or central tumours) can be addressed percutaneously, but they are associated with higher complication rates and incomplete treatment.

Conclusion: Percutaneous ablation is a safe and effective option for the treatment of early stage renal tumours.

P-291

Y90-radioembolization of hypovascular liver lesions: role of cone-beam CT

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Learning Objectives: To describe the role of cone-beam CT (CBCT) in the diagnostic work-up of Y90-radioembolization (Y90-RE) in patients with hypovascular liver tumors.
Background: Y90-RE represents a promising locoregional treatment approach in different types of primary and metastatic liver lesions. Meticulous planning with angiography (DSA) and technetium-99m–labeled macroaggregated albumin (99mTc MAA) scintigraphy is needed to avoid non-target embolization and to ensure adequate delivery of microspheres to all tumors. This diagnostic work-up may be particularly challenging when dealing with relatively hypovascular primary (e.g., cholangiocarcinoma) or metastatic liver lesions.
Clinical Findings/Procedure: The role of CBCT in the diagnostic work-up of Y90-RE will be presented. CBCT allows the precise definition of extrahepatic enhancement and hepatic tissue perfusion, facilitating the identification of tumor arterial feeders, parasitic arteries, and extrahepatic arterial branches requiring embolization. Moreover, in the setting of hypovascular liver lesions, the degree of tumor arterial perfusion detected by CBCT may be able to predict the bead distribution after treatment and could be used as a predictor of treatment success.
Conclusion: During the diagnostic work-up of Y90-RE, CBCT provides additional information and can help modify treatment planning. Its routine use should be promoted, particularly when dealing with relatively hypovascular lesions that cannot be clearly displayed with conventional DSA.

P-292

"Get up – get off" technique for port-a-cath-related superior vena cava occlusion angioplasty: report of three cases

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Superior vena cava occlusion with port-a-cath entrapment and dysfunction needs catheter removal and stent angioplasty, followed by new central catheter insertion.
One-step endovascular technique successfully used in three patients with preservation of the same port-a-cath is described.

P-293

Intranodal lymphangiography for the treatment of refractory pelvic lymphatic leakage

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We present our technique in detail and discuss the clinical applications of intranodal therapeutic lymphangiography for the management of refractory pelvic lymphatic leakage.

P-294

Preoperative embolization in the treatment of mediastinal paraganglioma: a case report

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A 68-year-old patient with asthenia, chest pain, and a hypervascularized mass in the middle mediastinum identified as paraganglioma, a rare tumor characterized by important vascularization that makes surgical procedures complex and dangerous.
Selective embolization was arranged to minimize the risk of intraoperative bleeding.

P-295

Feasibility of bronchial artery embolization (BAE) for locally aggressive endobronchial metastasis

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We present a unique case of a middle-aged female presenting with clinically significant hemoptysis secondary to metachronous endobronchial papillary thyroid carcinoma (PTC) metastasis. This was effectively treated with bland trans-catheter BAE embolization, resulting in complete cessation of active bleeding.

P-296

Rapid tumor necrosis after DEB-TACE of a neuroendocrine metastasis of the liver, resulting in a perforation with biliary leakage and peritonitis with the need for laparotomy

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Transarterial Chemoebolization with Drug-eluting Beads (DEB-TACE) is a standard procedure in interventional oncology with a low complication rate. This case report shows pre-, intra- and post-treatment imaging findings and intraoperative pictures of a perforated necrosis after DEB-TACE of a neuroendocrine liver metastasis. This complication finally led to biliary leakage with peritonitis which could only be treated by laparotomy.

Others

P-297

Clinical predictors in determining outcomes of computed tomography-guided transthoracic needle biopsy

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Purpose: Patients who received computed tomography (CT)-guided percutaneous transthoracic needle biopsy (TTNB) procedures may experience adverse outcomes. We investigated the clinical predictors of diagnostic performance and adverse outcomes.
Material and Methods: This was a retrospective analysis of CT-guided lung biopsies from eight hospitals, which included 384 biopsies performed between June 1, 2012 and May 31, 2013. Univariate and multivariate linear regression analyses were performed to estimate the significance of specific risk factors associated with diagnostic accuracy and complication rates.
Results: Poor diagnostic accuracy was associated with lesions that were located within the bottom third of the lung; smaller in size; and within patients who were unable to remain motionless during the procedure. Lesions with a greater pleural to lesion distance were associated with a higher risk of complication.
Conclusion: Multiple factors affected the diagnostic performance of CT-guided lung biopsies. These included lesion location and size and intra-procedural patient motion. Increased pleural-to-lesion distance is a significant predictor of TTNB complications.

P-298

Evaluation of the efficacy of an interactive interventional radiology case-based electronic tablet application on the academic development of radiology residents

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Purpose: To evaluate the efficacy of an interactive case-based electronic tablet application on the academic development of radiology residents.
Material and Methods: The electronic tablet-based application was comprised of case modules covering common and unique cases that were organized to parallel the educational objectives of current IR residency training. Each case was developed into an interactive multimedia module. Each case module contained a brief history, relevant case imaging, interactive test questions, brief case summary, and supplementary multimedia. The application was distributed to medical students and radiology residents rotating through IR. A control cohort of rotating trainees did not receive the application. All trainees were given a pre-test at the beginning and post-test at the end of their clinical rotation. Both tests also contained a random selection of questions related to the case topics presented in the application.
Results: Thirteen trainees received the application compared to a control cohort of 14 trainees. Trainees who received the application demonstrated a 15.6% average improvement in scores compared to 2.9% in the control cohort (p=0.04). 85% of trainees who received the application demonstrated an improvement in scores (range:

-11%–42%) compared to 42% of trainees in the control cohort (range: -11%–32%). Trainees using the application demonstrated significantly greater improvement in scores on questions obtained from the application (p=0.02).
Conclusion: This application is a novel tool to teach trainees and provides a more interactive way to learn radiology. This study supports the use of electronic tablet-based applications as an effective tool to teach IR.

P-299

Balloon pulmonary angioplasty (BPA): fluoroscopy-based registration of a pre-acquired C-arm CT (CACT) for procedure guidance

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Purpose: To investigate the use of a fluoroscopy-based registration of a pre-acquired CACT for procedure guidance in patients suffering from chronic thromboembolic pulmonary hypertension (CTEPH) undergoing BPA.
Material and Methods: 42 BPAs performed in 27 CTEPH patients (9m, 70±14y) were included. Twenty-two BPA procedures were guided by selective CACT acquired directly before BPA (G1). In another twenty BPAs (G2), two orthogonal fluoroscopy images of the chest where acquired and semi-automatically matched with a superimposed volume rendering (VRT) of a pre-acquired CACT using dedicated software (syngo-Fusion®, Siemens). In both cases, volume rendering-based graphic representation (VRT guidance) was generated indicating the origin and course of the segmental pulmonary arteries (SPA). Based on VRT guidance, the IR planned an apt working projection (WP-P). If necessary, the used WP (WP-U) was adapted. Agreement of WP-P and WP-U, duration of the procedure and radiation exposure data was documented and compared between the two groups (Wilcoxon-test).
Results: 143 SPA were intended to undergo BPA. Agreement of WP-P and WP-U was obtained in G1 82% and G2 86%. BPA was successfully performed in G1 91% and G2 94%. Intervention time was 126min G1 and 117min G2. No severe side-effects occurred. Overall dose-area product (DAP) was significantly higher for G1 (9289±4221 vs. 5448±2629µGym^2, p=0.002). Mean DAP related to fluoroscopy (G1 5260±3472 vs. G2 4045±1884µGym^2, p=0.38) and DSA (G1 1888±957 vs. G2 1402±1071µGym^2, p=0.05) was comparable between the two groups.
Conclusion: The use of fluoroscopy-based 2D3D registration of CACT images for BPA-guidance is feasible and bares the potential to save radiation exposure.

P-300

Use of a triple-lumen balloon catheter for unilateral pulmonary artery occlusion test in the preoperative evaluation of pneumonectomy

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Purpose: Unilateral pulmonary artery occlusion (UPAO) test is effective for predicting the size of the residual pulmonary vascular bed after pneumonectomy. A triple-lumen balloon catheter can take three roles in the UPAO test: measurement of the pulmonary artery pressure (PAP) with side hole, occlusion of the unilateral pulmonary artery with balloon, and flushing of saline with tip hole to prevent thrombus formation at the distal site. The aim of this study was to evaluate the usefulness of this catheter for the UPAO test.
Material and Methods: The UPAO test was performed in 84 patients, 68 males and 16 females, with a median age of 64 years (range, 23–76) between June 2003 and January 2015. When the mean PAP (mPAP) was less than 30 mmHg, pneumonectomy was considered tolerable. Technical success and clinical success rates and complications were evaluated. Technical success was defined as the completion of the UPAO test, and clinical success was defined as an absence of postoperative right heart failure in patients who underwent the lung surgery.
Results: In 81 of 84 patients, the UPAO test was performed successfully (technical success rate, 96%). Median mPAP was 19 mmHg (range, 12–42). In 5 patients, mPAP was 30 mmHg or more, and pneumonectomy was avoided. There was no patient who developed postoperative right heart failure (clinical success rate, 100%). Temporal cardiac arrest occurred in 1 patient due to the migration of the balloon catheter to the main pulmonary artery (complication rate, 1.2%).
Conclusion: The UPAO test using the triple-lumen balloon catheter appears to be useful.

P-301

Transbronchial cryobiopsy assisted by interventional radiology techniques in the diagnosis of interstitial lung disease: yield and complications of a multidisciplinary procedure

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Purpose: In some cases in which clinical and radiological features are not sufficient to establish the diagnosis of interstitial lung disease (ILD), histopathologic diagnosis is being required. Transbronchial cryobiopsy (TBCB) is a technique used to obtain samples of the pulmonary tissue. During the procedure, a cryoprobe is inserted through the working channel of a bronchoscope and implanted into the distal segmental bronchus to obtain frozen lung tissue. We present the yield and safety of TBCB assisted by interventional radiology techniques in the diagnosis of ILD.
Material and Methods: In 85 patients with nondiagnostic clinical and radiological findings of ILD, TBCB was performed. The procedures were performed in an interventional radiology room under general anesthesia and fluoroscopic control, involving a multidisciplinary medical team of anesthesiologist, pulmonologist, and interventional radiologist. Four tissue samples from lung segments previously selected by HRCT were taken for each patient. A 2.4-mm distal diameter cryoprobe was used, connected to a nitrous oxide source to freeze the lung parenchyma. A 6-mm wide angioplasty balloon driven over a 0.035" hydrophilic angled guidewire was implanted under fluoroscopy within the segmental bronchus where the biopsy was performed to prevent bleeding.
Results: Ninety-seven percent of the samples were adequate for diagnosis. Usual interstitial pneumonia (39%) was the most common histopathologic pattern. Complications appeared in 14% of TBCB: moderate bleeding (10), hypoxemia (2), exacerbation of ILD (1), pneumothorax (1), and pneumonia (1).
Conclusion: TBCB is a procedure with high diagnostic yield in ILD, and it appears feasible and safe for patients when performed in a proper manner.

P-302

CBD, ureter, and pancreatic duct blocking stones: percutaneous management by balloon-assisted percutaneous descending litholapaxy (BAPDL)

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Purpose: The technique of percutaneous stone evacuation from CBD, ureter, and pancreatic duct is presented.
Material and Methods: Forty-eight BAPDL procedures have been performed for 43 patients (CBD stones, 36; ureteral stones, 2; and pancreatic duct stones, 5) with blocked duct who underwent balloon-assisted percutaneous descending litholapaxy (BAPDL), which followed the preliminarily performed PTC, wirsungostomy, or nephrostomy. BAPDL procedures were performed under fluoroscopy guidance using the guidewire technique. BAPDL steps were as follows: guidewire conduction into the duodenum or bladder, distal duct and sphincter dilation, and balloon deflation and positioning above the blocking stone, followed by the descending evacuation of stone in the duodenum or bladder by the pushing-down efforts of a half-inflated balloon via an introducer sheath, according to the heavy-duty guidewire.
Results: BAPDL enabled the stones to descend down successfully in the first procedure in 38 cases, in 2 cases of multiple CBD stones, and in 1 case of big size (2.4 cm) CBD stone; in 2 cases of multiple wirsungolithiasis, more than one BAPDL procedure was attempted. In 1 PD case, the guidewire conduction failed on the second attempt. Finally, the duct patency was restored in 42 (97.6%) cases. Two minor complications (conservatively managed mild bleeding) were documented in 2 (4.7%) patients (1 ureter stone and 1 CBD stone), and in 1 (2.4%) case of CBD, BAPDL patient generated acute pancreatitis, requiring open surgery.
Conclusion: BAPDL is safe and effective, and it should be routinely suggested as a treatment option in cases in which percutaneous drainage is performed.

P-303

An evaluation of the service provision by interventional radiology in the management of postpartum haemorrhage in the United Kingdom

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Purpose: Guidelines advise that interventional radiology (IR) is an important management option for both prophylactic planning for anticipated postpartum haemorrhage (PPH) and emergency treatment of PPH. The utilisation of IR is, however, variable. This study aimed to evaluate the provision of IR services for PPH management in the UK.
Material and Methods: Online questionnaires were emailed to 498 consultant interventional radiologists identified from the electronic mailing list of the British Society of Interventional Radiologists.
Results: Of the 100 completed questionnaires received, 89 worked in units providing some cover for PPH control (70 stating this service was available 24/7), and 11 in units with no provision for this service. Most utilised prophylactic pre-procedure balloons and embolisation post-delivery. However, only 35% considered themselves to have a good level of competency with these procedures. In emergency cases, the median time lag from referral to the IR procedure was 30-60 minutes. All respondents viewed the provision of IR for PPH as important.
Conclusion: The 20% response rate is partly explained by the fact that not all consultants who received the survey were eligible to complete it (e.g., some not working within IR anymore or having moved abroad). This study found that guidelines advocating more widespread use of IR are not met to an acceptable standard. Limitations reported include obstetricians not utilising the service often enough or radiology and maternity being on different sites. Greater awareness of the role of IR and better communication between the disciplines managing PPH may help to ensure that best practice is achieved.

P-304

Comparative efficacy of radiofrequency and laser ablation for the treatment of benign thyroid nodules: systematic review including traditional pooling and Bayesian network meta-analysis

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Purpose: To compare the efficacy of radiofrequency ablation (RFA) and laser ablation (LA) for treatment of benign solid thyroid nodules, using a systematic review including traditional pooling and Bayesian network meta-analysis.
Material and Methods: A comprehensive literature search in PubMed-MEDLINE, EMBASE, and the Cochrane Library databases identified prospective studies evaluating the % mean change [absolute mean change (ml)] in nodule volume after RFA or LA. Studies from 1 January 2000 to 1 November 2013 were included. Review of 128 potential papers, including full-text review of 33, identified 10 eligible papers covering a total of 184 patients for meta-analysis. The %mean change [absolute mean change] in nodule volume over a six-month follow-up was compared between RFA and LA.
Results: Based on the traditional frequentist approach, the pooled % mean change (95% CI) of RFA and LA was 76.1% (70.1-82.1) and 49.9% (41.4-58.5), respectively, and the pooled absolute mean change (95% CI) of RFA and LA was 8.9 ml (6.6-11.2) and 5.2 ml (4.3-6.1), respectively. Based on the Bayesian network meta-analysis, RFA achieved a larger pooled % mean change (95% CrI) and absolute mean change (95% CrI) compared to LA [77.8% (67.7-88.0) vs. 49.5% (26.7-72.4), and 9.2 ml (5.8-11.9) vs. 5.3 ml (2.1-8.5), respectively]. The RFA group has the highest probability of being the most efficacious treatment (98.7%). There were no major complications after either RFA or LA.
Conclusion: Our analyses show superior efficacy of RFA compared with LA for treatment of benign solid thyroid nodules without major side-effects.

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Cardiac and renal safety after the administration of iodixanol and iopromide in patients with chronic kidney disease and congestive heart failure

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Purpose: Intra-arterial contrast media (CM) may increase the cardiac preload in the process of percutaneous coronary intervention (PCI), especially for patients with chronic kidney disease (CKD) and congestive heart failure (CHF). This study was to investigate the impact

of CM with different osmolality on cardiac preload in patients with CKD and CHF.
Material and Methods: Ninety non-ST elevation acute coronary syndrome (NSTE-ACS) patients with CKD (estimated glomerular filtration rate of ≤60 ml/min) and CHF were equally randomized to receive either iodixanol 320 (Visipaque) or iopromide 370 (Ultravist) in PCI processes. We applied transpulmonary thermodilution technique to observe the change of hemodynamic indices in the perioperative period.
Results: Baseline characteristics were well matched between the two groups. There was no significant difference in CIN between the iodixanol and iopromide groups (17.8% and 28.9%; P=0.213). Extravascular lung water (EVLWI) and global end-diastolic indices (GEDI) and central venous pressure (CVP) were all significantly increased in the iopromide group (8.4±3.2 ml/kg vs. 13.1±3.8 ml/kg in EVLWI; 962±362 ml/m^2 vs. 1381±472 ml/m^2 in GEDI; 11±5 mmHg vs. 14±5 mmHg in CVP; all P<0.001), and the changes in these preload indices in the iopromide group were all significantly greater than those in the iodixanol group (P<0.05). The incidence of acute heart failure (AHF) in the iopromide group was significantly higher than that in the iodixanol group (P=0.048).
Conclusion: Iopromide could significantly increase cardiac preload in patients with CKD and CHF compared with iodixanol, and this is associated with a higher likelihood of occurrence of AHF events.

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Percutaneous CT fluoroscopy-guided radiofrequency ablation of unilateral aldosterone-producing adrenal adenomas with bipolar ablation system: single-center pilot study

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Purpose: To evaluate the technical and clinical success rates and complications of percutaneous CT fluoroscopy (CTF)-guided radiofrequency ablation (RFA) with a newly developed bipolar ablation system for the treatment of unilateral adrenal aldosterone-producing adenomas (APAs).
Material and Methods: Eight APAs (mean diameter, 15.1 mm; range, 10.0-19.0 mm) in 8 patients (3 men and 5 women; mean age, 54.8 years; range, 36-68 years) were included in this pilot study. All APAs were treated with percutaneous CTF-guided RFA. Contrast-enhanced low-dose CT scans were obtained immediately after RFA to assess the ablated areas and to evaluate complications. Seven days after RFA, repeat contrast-enhanced CT scans were performed to assess if the procedures were successful. When the entire adenoma was not contrast-enhancing, the procedure was judged technically successful. The procedure was judged clinically successful if plasma aldosterone concentration and urinary aldosterone excretion at 7 days after RFA were normalized without additional medication. Additionally, changes in blood pressure and in the number of antihypertensive agents were evaluated.
Results: The technical and clinical success rates were 100%. Moreover, the number of antihypertensive agents decreased after the procedure in all patients. No severe complications associated with RFA, such as hypertensive crises, were observed. Although all patients reported local pain during RFA, the pain could be relieved by analgesics administration. There were minor complications (atelectasis: five patients (62.5%) and retroperitoneal hemorrhage: one patient (12.5%)), but none of them required special treatment.
Conclusion: This pilot study suggested that percutaneous CTF-guided RFA with a bipolar ablation system is effective and safe for the treatment of APAs.

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Occupational dose optimization using active personal dosimeters: preliminary results

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Purpose: Occupational radioprotection optimization by means of active personal dosimeters (APD).
Material and Methods: A Raysafe i2 APD system was used, which gave real-time dose rate and cumulative dose values. After proper characterization, the APDs were positioned on the operators' torso. Data for 40 interventional procedures were collected, and the correlation between patient dose and occupational dose was investigated, considering both the operators' position and, if possible, the usage of the X-ray shielding available in the angiographic room.
Results: Good correlation was obtained between the kerma per area product (KAP) and APD readings for the first operator, when the operator was standing close to the image detector with the X-ray shielding whether properly positioned (0.508 mSv/Gy·cm^2; Spearman-r = 0.955; P = 0.0008) or not properly positioned (1.381 mSv/Gy·cm^2; Spearman-r = 0.951; P < 0.0001). The correlation between the reference air kerma (Kar) and APD readings in the same conditions was also good, when the X-ray shielding was both properly positioned (0.131 mSv/mGy; Spearman-r = 0.921; P = 0.009) and not properly positioned (0.294 mSv/mGy; Spearman-r = 0.920; P < 0.001).
Conclusion: The employment of APDs has pointed out to the operators a significant dose reduction both by using the X-ray shielding properly, if possible, and by adopting dose optimization criteria for performing the procedure when shielding could not be used. Thus, the APD system can be considered an affordable and effective training tool in order to improve the operators' habits.

P-308

Economic evaluation of glass yttrium-90 microspheres versus sorafenib for the treatment of advanced hepatocellular carcinoma: cost effectiveness analysis in the United Kingdom

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Purpose: Treatment options for patients with advanced hepatocellular carcinoma (aHCC) are limited; sorafenib, a multi-targeted tyrosine kinase inhibitor, is the first-line standard of care for patients with well-preserved liver function and advanced tumours (classification, BCLC-C stage). Yttrium-90 (Y-90) is an emerging alternative to sorafenib, and it is being evaluated in randomised phase III studies. We evaluated the cost effectiveness of Y-90 versus sorafenib to investigate the incremental cost utility (ICER).
Material and Methods: A Markov model with three health states (stable disease, progression and death) was developed to estimate 10-year (lifetime) outcomes for median survival (mOS), time-to-progression (TTP), adverse events, quality of life and costs. Evidence was taken from the published studies identified through a literature review.
Results: Y-90 increased TTP (6.2 vs. 4.9 m) and mOS (13.8 vs. 9.7 m); quality-adjusted life years (QALY) favoured Y-90 (1.12 vs. 0.85). Total mean cost of Y-90 vs. sorafenib, including management of adverse events and post-progression chemotherapy, was £21,441 vs. £34,050. Y-90 treatment was associated with a QALY gain of 0.27 at a lower cost and therefore dominated. Moreover, Y-90 dominates if TTP and mOS are assumed to be equivalent. Deterministic and

probabilistic sensitivity analyses showed that results were sensitive to the parameters of cost, mOS and TTP.
Conclusion: This health economic analysis suggests that Y-90 glass microspheres may improve outcomes and reduce NHS costs compared with sorafenib in patients with aHCC.

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Conservative management of latent splenic pseudoaneurysms after blunt injury

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Purpose: Generally, latent splenic pseudoaneurysms (SPAs) after blunt injury are treated by transarterial embolization (TAE) because of the risk of delayed hemorrhage. However, some SPAs had been reported to occlude spontaneously, and their management is still controversial. We report our experiences in SPA management.
Material and Methods: One hundred and two patients were treated nonoperatively for blunt splenic injury from 2008 to 2014. Of these, 16 patients (mean ISS, 25.9±11.6; OIS 1 patient with Grade 2, 8 with Grade 3, and 7 with Grade 4) developed latent SPAs on follow-up CT at a mean number of 5.6±2.9 days after blunt injury. SPAs were treated based on physician preferences by TAE or conservative therapy. Pseudoaneurysm characteristics, treatment, and follow-up results were reviewed.
Results: Mean number of latent SPAs in 16 patients was 2.1±1.0 with a mean diameter of 11.8±6.5 mm. Among the 16 patients, 9 underwent conservative treatment, 5 underwent TAE, and 2 were transferred to other hospitals.
Mean diameter of latent SPAs in the conservative treatment group was 11.9±3.6 mm (range, 7–20 mm). All SPAs were thrombosed spontaneously at 10±3.2 days after the injury (range, 7–15 days) and at 5.2±1.2 days after the diagnosis (range, 3–7 days). Median period of strict bed rest and median total period of bed rest were 7 days (range, 2–31 days) and 13 days (range, 2–62 days), respectively. Median length of hospital stay was 15 days (range, 9–62 days). No delayed hemorrhage occurred during the follow-up period.
Conclusion: Conservative treatment is feasible and safe for small, latent SPAs (<20 mm). Long period of bed rest is required.

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Outcomes of tracheobronchial temporary partial covered stent placement for benign disease

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Purpose: To retrospectively determine mid-term outcomes in patients who have undergone temporary partial covered tracheobronchial stent placement for benign diseases.
Material and Methods: This is a retrospective analysis of 51 consecutive patients who received the stent placement between January 2009 and March 2014. Causes of airway stenosis included tracheal tube injury (n=15), tracheobronchomalacia (n=8), tracheal amyloid (n=6), and endobronchial tuberculosis (n=22). Thirty-one patients were treated with temporary partial covered stent and 20 with temporary partial covered branched stent. All stents were removed after approximately 85-95 days of placement. Respiratory function test was prospectively performed before and 1 day after stent placement. Respiratory function was assessed in terms of visual analog scale (VAS) and Karnofsky Performance Status (KPS). All cases were scheduled for clinical and imaging follow-up using CT before stent placement and at 1 and 6 months after removal of the stent to measure the diameter of the stenosis on CT.
Results: The procedure was completed in all patients without complications. VAS and KPS significantly improved ($p<0.05$). Statistically significant difference between diameter of the stenosis before stent placement and that at 1 month after stent removal was identified ($p<0.05$). Statistically significant difference between diameter of the stenosis before stent placement and that at 6 months after stent removal was identified ($p<0.05$). However, no significant deference was noted between 1 month and 6 months after stent removal.
Conclusion: Temporary partial covered stent is feasible and effective to manage with benign tracheobronchial stenosis.

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Geniculate artery embolisation for haemarthrosis post-knee surgery: a review

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Learning Objectives: To review the potential causes of bleeding post-knee surgery, including iatrogenic vascular injury as well as delayed pathology such as synovial hypervascularity causing recurrent haemarthrosis.
To describe the role of interventional techniques in the treatment of such patients, including coil embolisation, particulate embolisation, the use of liquid embolic agents and stent-graft insertion.
Background: Vascular complications are rare following knee surgery and can be difficult to diagnose and treat, requiring specialist techniques and comprehensive understanding of the arterial anatomy. We describe common causes and endovascular treatments for post-knee surgery haemorrhage and review the relevant anatomy, concentrating on the geniculate arteries.
Clinical Findings/Procedure: We review the imaging and treatment of 7 cases (6 patients) treated at our institution for bleeding complications post-knee surgery, 6/7 cases following knee replacement.
Angiography demonstrated small vessel injury in 4 patients, 3 of which were due to pseudoaneurysms arising from the geniculate arteries and underwent successful coil embolisation. Another with evidence of small vessel injury was embolised using Onyx liquid embolic agent. In 1 patient, there was a traumatic large vessel injury to the popliteal artery that was treated with stent-graft insertion.
Two cases presented later with recurrent haemarthrosis, and synovial hypervascularity was demonstrated on catheter angiography. These were treated successfully with superselective microcatheter PVA particle embolisation via the geniculate arteries.
Conclusion: There are a variety of pathologies that can cause both acute and delayed presentation of bleeding post-knee surgery. Catheter angiography is often required to diagnose the underlying vascular abnormality and advanced embolic techniques for treatment.

P-312

Lymphatic intervention for various kinds of lymphorrhea

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Learning Objectives: To learn about lymphatic interventions for various kinds of lymphorrhea.
Background: Lymphorrhea, defined as the leakage of lymphatic fluid, can develop as an iatrogenic complication of thoracic, cardiac, abdominal, and neck surgery. Massive lymphorrhea, including chylothorax, is uncommon, which sometimes becomes a serious condition associated with adverse sequelae. Early intervention has become increasingly popular as a treatment strategy for such conditions.
Clinical Findings/Procedure: Six sessions of lymphatic intervention for lymphorrhea (chylothorax: 4, abdominal lymphorrhea: 2) are

being presented. Referring to the information obtained by intranodal lymphography (IL), the optimal intervention was chosen.
In 5 cases, IL visualized the lymphatic fluid leakage. Of the 4 cases with chylothorax, fine-needle puncture of the cisterna chyli visualized by IL under fluoroscopy was possible in 3, followed by embolization of the thoracic duct with NBCA after successful insertion of a microcatheter in 2. In the case in which microguidewire insertion resulted in failure, IL was still helpful for appropriate drain insertion and sclerotherapy of the fistula using OK-432. In the other case of chylothorax, thoracic duct was punctured with a fine needle under CT fluoroscopy, followed by NBCA injection, which resolved the leakage. Of the 2 cases with abdominal lymphorrhea, in 1 case, IL successfully visualized the lymphatic fistula from paraaortic lymphatics, which spontaneously resolved without additional treatment, and in the other case, the fistula at the hepatic hilum was visualized only by percutaneous transhepatic lymphangiography and resolved after appropriate drain insertion and sclerotherapy with OK-432.
Conclusion: Lymphatic intervention for lymphorrhea is safe and feasible.

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Hereditary hemorrhagic telangiectasia (HHT): screening for significant complications

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Learning Objectives: To promote a working knowledge of effective screening for the life-threatening complications of HHT, which can be utilized by practitioners, as well as patients and family members.
Background: HHT (autosomal dominant inheritance) affects approximately 1 in 5000 people, so awareness of the disease is limited. The abnormal vascularity affecting HHT patients stems from genetic mutations of proteins that influence signaling of vascular endothelial cells and lead to either telangiectasias or arteriovenous malformations (AVMs) in a variety of organ systems.
Clinical Findings/Procedure: Screening of symptomatic or asymptomatic AVMs in HHT patients is important to reduce morbidity and mortality from complications in the pulmonary, cerebral, and hepatic circulations. Other significant complications of HHT include iron deficient anemia from epistaxis or chronic GI blood loss. Diagnosis of HHT can be made by clinical methods using the Curaçao criteria or genetic testing. Patients frequently have visible telangiectasias of the lips or finger tips. Epistaxis is the most frequent symptom and can be graded using the epistaxis severity score. Patients are screened via laboratory evaluation for iron deficient anemia, echo-bubble cardiology for pulmonary shunts, and brain MRI to evaluate for cerebral AVMs. With a positive echo-bubble study, patients are referred for a chest CT; and if pulmonary AVMs are found of treatable size, they are embolized. Cerebral AVMs are treated by various methods, including catheter-based techniques. Referral to an experienced ENT is helpful for refractory epistaxis.
Conclusion: Knowledge of appropriate HHT screening is important to reduce life-threatening complications in such patients.

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Radiation protection in interventional radiology: a review beyond aprons, goggles and shields

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Learning Objectives: This educational review will encompass both technical and behavioural aspects of radiation protection in interventional radiology (IR).
Background: IR is now at the forefront of modern hospital medicine with increasing demand for IR services both in and out of hours. Not only are procedure numbers increasing but also is the complexity of cases. This increase in the number and complexity of IR procedures has led to an increase in ionising radiation exposure. This highlights the importance of understanding and applying good principles of radiation protection. Cataract development and head and neck tumours are increasingly reported among practitioners. It is vital to minimise ionising radiation to the staff and patient, while maintaining an acceptable image quality without compromising the quality of clinical care. This goal is only achievable with appropriate education and training in radiation protection.
Clinical Findings/Procedure: We will review operational and behavioural factors, such as reloading and magnification of previous studies, road map creation and last image hold, as well as equipment advances such as dose rate alarms, DoseAware systems, pulsed fluoroscopy, fluoroscopy dose rate, flat panel detectors, intelligent filtration, virtual collimation and image processing software, including frame averaging, recursive filtering and edge enhancement.
Conclusion: Radiation protection in IR includes a wide array of variables, from operational and behavioural factors to equipment and technical advancements.
Setting local standards and training, with regular audit, are vital to improve the awareness and maintain the quality of care by reducing the ionising radiation exposure.

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Embolization of visceral artery aneurysms: individualizing therapeutic options

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Learning Objectives: The purpose of this study is to review the current concepts and treatment strategies of visceral artery aneurysms (VAAs), based on the clinical presentation, comorbidities, location, size, and nature of the aneurysm (true vs false).
Background: The prevalence of visceral artery aneurysms (VAAs) ranges between 0.1% and 2%. There has been an increase in number of reported VAAs, which may be attributed to increased awareness, improved imaging modalities, and increase in number of percutaneous procedures. CT angiography remains the diagnostic modality of choice. The most common location of VAAs is the splenic artery, followed by the hepatic artery. VAAs carry a significant risk of rupture, as high as 44% for hepatic aneurysms. Presently, endovascular repair is considered as the first-line treatment of VAAs. Management principles and treatment options have evolved; the choice of technique should be based on the type and local anatomy of VAAs. Technical success relies on the exclusion of VAAs from the circulation, combined with preservation of distal flow.
Clinical Findings/Procedure: Therapeutic options for VAAs, including the sac-packing technique, sandwich technique, use of covered stent, and stent-assisted coil embolization, are illustrated with cases from our teaching files. We will emphasize the reasons behind each particular choice of procedure, according to the vessel pathology

and tortuosity, suitability of a particular treatment strategy, and our technical experience.
Conclusion: Treatment of VAAs requires familiarization with different kinds of embolization techniques and knowledge of their indications in order to apply the most suitable option, taking into account the individual patient.

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Percutaneous neurolysis with pulsed radiofrequency: from A to Z

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Learning Objectives:
1. To review the basis of pulsed RF neurolysis
2. To illustrate with case-based examples most common applications of pulsed RF neurolysis in the management of chronic pain
3. To provide tips and tricks for safe and efficient pulsed RF neurolysis

Background: Ablation of nervous system elements can be performed by means of extreme cold (cryoablation), of alcohol or phenol application (chemical neurolysis) and of high temperature radiofrequency. RFA can be safe, efficacious, precise and reproducible. Fluoroscopy or computed tomography is used for precise electrode placement. Motor and sensory stimulation tests are used prior to ablation increasing safety and precision.
Clinical Findings/Procedure: Pulsed RF uses brief 'pulses' of high-voltage RF energy, aiming at localised voltage fluctuations without excessive heating that might cause coagulation necrosis. During pulsed RF, the generated heat is dissipated between pulses, resulting in a transient inhibition of evoked synaptic activity. Pulsed RF results in more reversible and less neuro-destructive effect than continuous RF. Proposed protocol includes 20-ms pulsing with voltage less than 60 kHz aiming for a target temperature of less than 42°C. Clinical applications of pulsed RF neurolysis include cervical or lumbar facet joint nerve ablation, sacroiliac joint nerve ablation, intervertebral disc RFA, dorsal root ganglion and sympathetic ganglia RFA.
Sympathetic ganglia RFA include application of the technique in celiac plexus, lumbar sympathetic plexus, thoracic sympathetic chain and ganglion impar.
Conclusion: Pulsed RF neurolysis represents an attractive alternative in the therapeutic armamentarium of chronic pain management. Imaging guidance along with motor and sensory stimulation tests provide precise placement of the electrode, thus enhancing safety and efficacy.

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Rapid haemorrhage control (RHC)

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Learning Objectives:
1. Review of current practices of haemorrhage control in interventional radiology
2. Indications
3. Commonly used devices
4. Tips and tricks
5. Avoiding pitfalls

Background: Interventional radiology is increasingly taking a leading role in acute haemorrhage control. Common causes include gastrointestinal and postpartum haemorrhage, trauma, coagulopathy and iatrogenic vessel rupture. It is critical for interventionalists to understand the aetiology and immediate management strategies to stabilise patients and maintain patient safety. Increasingly, interventional radiologists are expected to form an integral part of the trauma team and provide their experience in haemorrhage control secondary to trauma and vessel injury. Advances in vascular access, embolisation, balloon occlusion therapy and percutaneously inserted stent grafts have facilitated rapid control of haemorrhage using minimally invasive techniques. This poster aims to provide a guidance in the current management of acute haemorrhage.
Clinical Findings/Procedure: The following points will be discussed:
1. Aetiology
2. Indications
- Signs
- Markers
- History / mechanism of injury
3. Imaging of choice
4. Patient safety in the angiography room
5. Technique and equipment:
- Immediate control in a major vessel (>6 mm, aorta, iliac arteries)
- Immediate control in an intermediate vessel (4-6 mm)
- Immediate control in a small vessel (<4 mm)
- Immediate control in a solid organ
- Immediate control in postpartum haemorrhage

Conclusion: Knowledge and awareness of haemorrhage control is an essential repertoire for all levels of interventional radiologists. Given the current demands for prompt minimally invasive haemorrhage control in large centres, we hope the above information serves as a quick summary and refresher.

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Resuscitation in the angiography room

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Learning Objectives: Safe resuscitation in interventional radiology is a vital skill that all interventionalists should have and update routinely. This poster aims to highlight the steps in resuscitating a patient following an emergency during an interventional procedure in the angiography room. The common aetiologies and their appropriate management will be considered and summarised.
Background: Given the ever-increasing complexity of cases being performed in the interventional radiology department, resuscitation in the angiography room is a crucial skill to learn and maintain. It is also the responsibility of the lead interventionalist to train and monitor the competencies of the team and to make sure everyone is up to date with the current resuscitation protocols. Knowledge of the available emergency drugs and collaboration with hospital crash teams is an essential factor in delivering emergency care to the patient in a timely manner.
Clinical Findings/Procedure: This poster aims to cover the following points related to this topic:
1. Aetiology of common emergencies in the angiography room
2. Immediate management
– **A-A**irway
– **B-B**reathing
– **C-C**irculation and **C**all for help
– **D-D**o not remove catheters or wires or sheaths, **D**rugs
– **E-E**valuate the situation
3. Drugs
4. Crash teams
5. Following resuscitation
– Patient safety
– Can you continue / complete the procedure?
6. Team brief and follow-up

Conclusion: Management of emergencies in interventional radiology is a crucial skill for any trainee and practicing physician to acquire and maintain. Regular updates and team simulation exercises/role plays will play a crucial role in the team's readiness to deal with emergencies.

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Optimizing care for the obese patient in interventional radiology

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Learning Objectives:
1. Understand the challenges obese patients pose for interventional radiologists
2. Elucidate strategies to optimize care for obese patients undergoing invasive procedures
3. Describe pathophysiology of increased risk of malignancy in obese patients

Background: More than a third of US adults are obese. Increased weight is associated with elevated risk of coronary artery disease, diabetes, hypertension, hepatobiliary disease, and many cancers, including endometrial, breast, and colon. These diseases increase the likelihood that these patients will require an IR procedure. Given their comorbidities, obese patients may be poor surgical candidates, often referred to IR.

Clinical Findings/Procedure: Obesity poses challenges peri- and post-procedurally. Obesity may threaten the airway, increasing required sedation doses and sedation risk. Obese patients are difficult to position and may require higher kVp, exposing themselves and staff to excess radiation. Ultrasound guidance may be inadequate. Obese patients have more frequent non-diagnostic renal biopsies. Overweight patients have increased risk of groin complications after arteriotomies from inadequate compression. Optimizing care for obese patients entails careful planning, e.g., ensuring availability of appropriate-length devices, intra-procedure considerations such as collimating to reduce radiation, and peri-procedure counseling on deleterious effects of obesity. Obesity heightens cancer risk, particularly hepatocellular carcinoma, possibly from chronic hepatic inflammation. Understanding these mechanisms may elucidate novel antineoplastic therapies.

Conclusion: Due to high prevalence and associated comorbidities, obesity is common among IR patients. Recognizing special considerations for this population may reduce risks and improve outcomes after IR procedures. Understanding the mechanisms predisposing the obese to increased cancer risk, particularly HCC, may also help direct future cancer therapies.

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Clotting for the radiologist

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Learning Objectives: This poster is a joint venture between radiology and haematology. We will cover essential information which a radiologist should know before embarking on any invasive procedure be it biopsy, drainage or even an endovascular procedure.

Background: When undertaking radiologically guided procedures, the practitioner needs to consider the risks to the patient. Although such procures are often minimally invasive, the outcomes can be fatal in a patient with a clotting abnormality. This may be due to an inherent abnormality which the patient already has, an acquired abnormality secondary to illness or an iatrogenic abnormality.

Clinical Findings/Procedure: In this poster, we will briefly cover the clotting cascade before discussing where the abnormalities occur and how these can be detected and addressed. We will cover blood test results and discuss at what levels one is safe to proceed. We will also cover some of the newer anticoagulants which the radiologist may have no clinical experience of; we will cover how they work and how they can be reversed in either an elective or emergency situation.

Conclusion: Knowing if a patient has a clotting abnormality and understanding how it occurs is vital for a clinician trying to decide if the risks of a procedure outweigh the benefits. Knowing if and how it can be treated may change the decision to proceed or at least the steps taken pre-procedure.

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A case of misplacement of a central line into the brachiocephalic artery traversing the internal jugular vein (IJV): successful treatment with Angioseal whilst maintaining patency of the IJV

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We present a case of a 47-year-old lady who presented with a misplaced central line into the brachiocephalic artery, traversing both walls of the right internal jugular vein. The line was safely removed and successfully treated with an Angioseal closure device.

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Percutaneous retrieval of dislodged portacath from the pulmonary trunk in an infant

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An infant was admitted for chemotherapy, but blood could not be aspirated from the portacath. CXR demonstrated the dislodged catheter tubing straddling the pulmonary arteries. It was successfully and uneventfully retrieved percutaneously using a goose-neck snare.

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Endovascular treatment of an inadvertent left internal mammary artery to great cardiac vein fistula

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Herein we present a case of an iatrogenic LIMA to coronary sinus anastomosis treated by detachable coil embolization. Use of detachable coil offers more precise deployment in the treatment of the aortocoronary fistula.

P-323

Unconventional employment of a vascular plug

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A 61-year-old woman with misplacement of the central venous catheter (CVC) on the origin of the right common carotid artery.
An endovascular treatment was performed to remove CVC and close the access site by placing a vascular plug along the arterial wall.

P-324

Trans-lymphatic therapy for the management of postsurgical lymphocele refractory to sclerotherapy

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We report a case of a female with a postsurgical cyst in the pelvic cavity that was refractory to percutaneous drainage and sclerotherapy, but it was successfully treated by intranodal lymphangiography with embolization of the lymphatic inflow using N-butyl cyanoacrylate.

P-325

Therapy of a symptomatic aortoesophageal and esophagotracheal fistula

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Massive aortoesophageal bleeding from the aortoesophageal fistula following stent implantation to treat an esophagotracheal fistula in stenosing esophageal carcinoma.
Endovascular sealing of the penetrated aortic ulcer using TEVAR was performed, with additional simultaneous overlapping esophageal stent-graft implantation to seal the persistent esophagotracheal fistula.

P-326

Cisterna chyli embolization for massive chylous ascites due to esophagectomy

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A patient with abdominal lymphatic leakage underwent a cisterna chyli embolization in three different sessions. The procedures were made by percutaneous transabdominal access of cisterna chyli after lymphangiography with direct puncture, under ultrasound guidance, of an inguinal lymph node.

P-327

Emergency endovascular treatment of subclavian arteriogastric fistula after esophagectomy with gastric tube reconstruction via poststernal route

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A 68-year-old man with a history of esophagectomy and gastric pull-up was brought to emergency department due to life-threatening gastrointestinal bleeding. Computed tomography revealed right subclavian arteriogastric fistula, and subclavian artery stent-graft placement was performed to treat the hemorrhage.

Peripheral vascular disease intervention

P-328

Histopathologic differences of experimental aneurysms treated with bare, fibered, and PGLA microcoils

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Purpose: To evaluate histopathologic features in experimental aneurysms embolized with bare, fibered, and PGLA coils.
Material and Methods: All animal work was performed in compliance with relevant guidelines and received approval from the institutional animal care committee. Eight experimental aneurysms were reconstructed to the carotid artery in 2 swine. We divided them into 3 groups: bare coil alone (B group), combination of fibered and PGLA coil (F/P group), and PGLA coil alone (P group). We embolized with bare coil in 2 aneurysms, combination of fibered and PGLA coil in 4, and PGLA coil in 2. We assessed the extent of coverage of neointima macroscopically at 5 weeks. Histopathologic data of all aneurysms at 5 weeks were also analyzed in terms of neointimal formation, fibrosis, foreign body cell infiltration, and organization.
Results: No significant differences were found among each group regarding aneurysm size and VER (volume embolization ratio). Neointima was present in all aneurysms macroscopically, excluding a limited area associated with protrusion of the coil loop in 2 aneurysms. Neointimal thickness was significantly greater in the FP and P groups than in the B group (P=0.01). No significant differences were found regarding the extension of fibrosis and organization in each group. Inflammation with foreign body cell infiltration tended to be greater in the F/P group (P=0.06) but was not significantly different.
Conclusion: Neointimal formation was prominent in the F/P and P groups. Foreign body cell infiltration tended to be greater in the F/P group.

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Three-year outcome of the heparin-bonded Viabahn for superficial femoral artery occlusive disease

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Purpose: Self-expanding covered stents for superficial femoral artery (SFA) occlusive disease have undergone an evolution during the years. Early results of latest generation, the heparin-bonded Viabahn with a contoured proximal edge, were promising, with reported 1-year primary patency rates of 73–78% in long lesions. The aim of the present study was to present the 3-year outcome of the heparin-bonded Viabahn for SFA occlusive disease.
Material and Methods: All patients treated with a heparin-bonded Viabahn at three centers between April 2009 and December 2011 were included in the study and retrospectively analyzed. Clinical state in Rutherford category, ankle-brachial indices (ABI), and duplex ultrasound scans were the features of follow-up at 6 weeks and 6, 12, 24, and 36 months. Primary endpoints of the study were 3-year primary, primary assisted, and secondary patency rates.
Results: A total of 73 SFAs in 70 patients were treated with a heparin-bonded Viabahn and included in the study. Fifty-four patients were males (78%), and the mean age was 70.0 ± 9.1 years. The mean lesion length was 17.4 ± 7.0 cm, and 84% of patients were classified as TASC-2 C and D. Median follow-up was 25 months (range,

2–55 months). The 3-year primary, primary assisted, and secondary patency rates were 59%, 71%, and 82%, respectively, with a 3-year freedom from amputation of 100%.
Conclusion: The use of heparin-bonded Viabahn for SFA occlusive disease is related to patency rates within the limits of surgical reconstruction. The procedure is related to a low morbidity and amputation rate.

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Minimally invasive treatment of Trans-Atlantic Inter-Society II Type C and D iliac occlusive disease

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Purpose: The purpose of our study was to evaluate immediate- and long-term results of hybrid and open surgery operations in the patients with chronic ischemia for TASC II C and D iliac lesions.
Material and Methods: In this prospective, nonrandomized study conducted from 2010 to 2013, 65 patients with the diagnosis of aortoiliac atherosclerotic disease were included. Sixty-five iliac endovascular procedures (99 stents) were performed. All patients had critical ischemia and objective evidence of TASC II type C and D iliac occlusive disease.
Results: Early (<30 days) stent thrombosis was detected in two cases (3%). In 2 (3%) patients, there was evidence of post procedural distal thromboembolism. The mean follow-up was 26.5 months (range, 6–48). The cumulative primary stent patency at 1, 2, 3 and 4 years was 96±2.8%; 92.4±4.4%; 79.5±7.8% and 68.2±9.8% respectively. Limb salvage rate at 1 and 2 years was 94.5±3.2% and 87.5±5.5% respectively. The stent length of approximately 100-mm cut point produced a sensitivity of 85.7% and a specificity of 93.1%. The primary patency rates at 24 months were 91.7% ± 7.9% for the stents ≤100 mm and 78.3% ± 10.3% for the stents >100 mm, respectively (P = 0.033).
Conclusion: Iliac artery stenting is an effective minimally invasive, endovascular treatment for extensive occlusive disease of iliac segment (TASC C and D).
Our study has revealed an increased risk of stent thrombosis or in-stent restenosis in patient with stents >100 mm.

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Magnetic resonance angiography of a new hybrid nitinol ring stent for accurate anatomical and functional assessment of in-stent restenosis

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Purpose: Metallic vascular stents cause significant susceptibility artefacts on MR imaging, prohibiting accurate assessment of restenosis by MR angiography (MRA). The authors report the application of MRA for anatomical and functional follow-up imaging of a novel hybrid heparin-bonded nitinol ring vascular stent (TIGRIS; Gore Medical) in the popliteal artery that allows artefact-free in-stent lumen visualisation.
Material and Methods: A single-centre prospective study of 8 individuals with TIGRIS femoropopliteal artery stent placement was conducted. MRA included first a turbo-spin-echo non-contrast acquisition and second a time-resolved 3-station contrast-enhanced 3D bolus chase. Phase-contrast velocity-encoded acquisitions were acquired above and within the TIGRIS stents for functional assessment. Quantitative vessel analysis of multiplanar reformatted MRA images were performed to calculate in-stent restenosis (diameter stenosis; %). Peak systolic velocity ratio (PSVR) was derived from the velocity encoded data to ascertain percentage stenosis. Systolic pressure gradients across the TIGRIS stents were assessed with the use of the modified Bernoulli equation.
Results: From December 2013 to November 2014, 10 TIGRIS stents were assessed with non-contrast, contrast-enhanced and phase contrast-MRA at 6-month follow-up. All imaged stents demonstrated artefact-free visualisation of the stent lumen and allowed for phase contrast flow measurements in the stented segment. Percent in-stent restenosis was 23.3±23.4% and corresponding estimated PSVR was 1.2±0.4. Bernoulli-derived pressure gradient was 3.8±5.0mmHg. One case of >50% restenosis was identified (65% diameter stenosis with PSVR 1.8 and 11mg gradient).
Conclusion: The TIGRIS hybrid nitinol ring stent allows for non-invasive quantitative anatomical and functional MRA imaging of lumen restenosis for longitudinal follow-up purposes.

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Use of drug-coated balloon PTA as a first-line treatment for all SFA lesions

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Purpose: To investigate the efficacy of drug-coated balloon angioplasty for all SFA lesions.
Material and Methods: The patient cohort was a subgroup of the prospective controlled trial IN.PACT Global conducted at our institution. Between October 2012 and September 2014, 92 patients (116 limbs treated) were enrolled. The efficacy endpoint of the trial was freedom from clinically driven TLR and primary patency within 12 months. Safety endpoint included freedom from MAE through 30 days, freedom from target limb amputation and freedom from TLR within 12 months.
Results: Of the 92 patients enrolled, 88% had intermittent claudication and 12% presented with critical limb ischemia. For lesion treatment, only 30% received a bail-out stenting for residual stenosis or flow-limiting dissections. The overall mean lesion length was 149.6 mm. Early results show a freedom from TLR at 12 months of 92% and a primary patency at 12 months of 88%.
Conclusion: Treatment of all real-world SFA disease with DEB seems safe and feasible, shows promising primary patency rates and appears to have lower bail-out stenting rates than POBA in other SFA trials. As these 12-month data show promising results, full 12-month and preliminary 24-month data will be presented at the congress.

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OffRoad™ re-entry catheter system for subintimal recanalization of chronic total occlusions in femoropopliteal arteries: primary safety and efficacy results of the Re-ROUTE trial

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Purpose: To demonstrate efficacy and safety of the reentry device.
Material and Methods: A total of 92 patients (mean lesion length 175.1 ± 85.4 mm) were enrolled in this prospective, single-arm, multicenter, post-market study conducted at 12 centers in Europe. To be eligible for the study, patients were required to have claudication or critical limb ischemia and a de novo or re-occluded CTO lesion in a native femoropopliteal artery. Target lesion length ≥ 1 cm and ≤ 30 cm and a minimum reference vessel diameter of 4 mm by visual assessment were required.
Results: Eighty-seven patients were evaluable for the primary 30-day safety endpoint. The composite rate of device-related major

adverse events was 3.4% (3/87). All 3 events were clinically significant peripheral embolisms, and the event rate was lower than the prespecified acceptable threshold. Effectiveness was based on device technical success, defined as placement of a guidewire in the true lumen distal to a CTO as confirmed by an angiography core lab. The core lab-confirmed success rate was 92.1% (70/76); however, the core lab was unable to evaluate all cases due to lack of proper post-operative images. Site-reported technical success was 84.8% (78/92). Technical success rates exceeded the prespecified performance goal.
Conclusion: The Re-ROUTE trial results demonstrate acceptable performance of the OffRoad system in terms of safety and technical success.

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Tack-optimized angioplasty for femoropopliteal arteries using the Tack-It endovascular systemTM: single-center experiences

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Purpose: Dissection or tissue flaps often occurs after the angioplasty of femoropopliteal arteries, resulting in a need for stent placement to prevent restenosis or reocclusions, if left untreated. The aim of this study was to evaluate the safety and effectiveness of the Tack-It endovascular system™ (Intact Vascular, Wayne, PA), which is indicated for tissue apposition to optimize balloon angioplasty instead of normally used stents.
Material and Methods: Sixteen subjects (mean age, 72.6±8.4 years) were enrolled and treated with the Tack-It endovascular system™ after the angioplasty of femoropopliteal arteries. The tack, which is made of nitinol, has a length of 6 mm and low outward force and indicated for arterial vessel diameters from 2.5 to 5.5 mm. The mean lesion length was 51.9±26.4 cm. The median stenosis was 91.6±10.6%. A median of 1.7±1.0 dissections after angioplasty was observed, and 3.4±1.59 tacks were implanted per subject.
Results: The technical success rate was 100%. The ankle-brachial index (ABI) improved from 0.60±0.19 at baseline to 0.99±0.18 after 1 month and 0.93±0.15 after 12 months ($p<0.05$). Pain-free walking distance improved from 81.3±78.1 m to 200.0±141.4 m. There were no major adverse events. There were no cases of death or amputation during follow-up. We observed one restenosis during follow-up.
Conclusion: The results of the study demonstrate that the Tack-It endovascular system™ is a very safe and effective treatment option to optimize the results of angioplasty. Long-term clinical evidence is needed to confirm the clinical benefits of this novel technology.

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Efficacy of percutaneous sclerotherapy for venous malformations causing airway tract stenosis

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Purpose: Airway tract venous malformations can cause significant clinical problems, such as fatal airway obstruction, and they are challenging to treat. The purpose of this study was to evaluate the efficacy of percutaneous sclerotherapy for venous malformations causing airway tract stenosis.
Material and Methods: From August 2009 to November 2014, 16 percutaneous sclerotherapy procedures were performed in 8 patients (4 males and 4 females; mean age, 37.8 years; range, 3–53 years) with airway tract venous malformations. The patients presented with the following symptoms: sleep apnea (n=8), hemorrhage (n=1), and dysphagia and dyspnea (n=1). MR imaging revealed airway tract stenosis in all patients, the major sites of which were as follows: oral cavity (n=4), pharynx (n=6), and larynx (n=2). Diffuse or multiple venous malformations were observed in 5 patients, while the other 3 patients had localized lesions. All procedures were performed under general anesthesia using fluoroscopy, including five procedures under endoscopic guidance. Four patients had tracheotomy before the sclerotherapy. We used absolute ethanol, air-mixed polidocanol foam, air-mixed monoethanolamineoleate foam, or n-butyl-2-cyanoacrylate (NBCA) mixed with lipiodol.
Results: Technical success was assessed by MR imaging and symptoms. Venous malformation volume was reduced in all patients, with significant clinical improvement of their symptoms. All complications, such as pain, ulcer in oral cavity, ventilator-associated pneumonia, temporary worsening of dysphagia, and mediastinal emphysema with subcutaneous emphysema, healed with conservative management.
Conclusion: Percutaneous sclerotherapy was effective in the treatment of venous malformations causing airway tract stenosis.

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Foot perfusion CT: an experimental validation and an initial clinical experience

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Purpose: To validate dynamic volume perfusion CT using an upslope method to measure foot blood flow (BF) in an animal experiment and demonstrate the feasibility and usefulness of this method in a clinical study.
Material and Methods: A perfusion CT experiment was first performed using rabbits. A color-coded perfusion map was reconstructed, and the measured BF in the map was compared with the reference standard microsphere method. A total of 17 perfusion CT sessions were then performed: (a) once in 5 human patients and (b) twice (before and after endovascular revascularization) in 6 patients. The perfusion maps were reconstructed and analyzed.
Results: The animal experiment revealed a strong correlation (R^2=.965) in BF between the perfusion CT and microsphere method. Perfusion maps were successfully obtained in 16 human clinical sessions (94%), with the use of 37 ml of contrast media and an effective radiation dose of 0.36 mSv (the K factor for knee: 0.00023). The plantar dermis showed the highest BF among all anatomical structures of the foot. After a successful revascularization procedure, the BF of the plantar dermis increased by 153%. The interpretations of the color-coded perfusion map correlated well with both clinical and angiographic findings.
Conclusion: Perfusion CT could measure the foot BF in both animals and humans. It can be a useful modality for the diagnosis of peripheral arterial disease by providing quantitative and spatial information on foot perfusion status.

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Application of a novel percutaneous vascular closure device based on a matrix patch (FISH) after 6F transfemoral access

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Purpose: The objective of this study was to evaluate the effectiveness and safety of a percutaneous closure system based on a matrix patch for achieving hemostasis.
Material and Methods: In this study, from 2014 to 2015, a percutaneous vascular closure system (FISH) was used in 45 patients (mean age, 69.6 ± 11.1 years) in the antegrade and retrograde technique within the context of angiographic intervention. The system was used in conjunction with transfemoral approaches with a sheath size of 6F. Postinterventionally (on the following day and after 6 weeks), follow-up was conducted clinically using color-coded ultrasound.
Results: Immediate hemostasis was achieved in 42/45 patients (93.3%). In three cases, a correct positioning of the patch was not possible because of device malfunction or massive vascular wall calcifications. In these cases, manual compression was successful. There was one retroperitoneal bleeding, requiring transfusion. Minor complications were not observed.
Conclusion: Safe and effective hemostasis is possible with the percutaneous FISH closure system at puncture sizes of 6F.

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New catheter for converting an antegrade puncture into a retrograde access and vice versa using a single arterial puncture

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Purpose: We describe the use of a new catheter for converting arterial access from an antegrade puncture into a retrograde access and vice versa. The catheter has been successfully used in seven patients without complications.
Material and Methods: Seven patients with bilateral lower limbs atherosclerotic arterial disease were treated using a new specifically shaped 4-F, 40-cm long catheter with a 6-mm angled tip at 90°. Upon completion of the treatment of the first identified lesion, the new catheter was introduced through the sheath; and once the tip emerged into the common femoral artery, it was rotated so that the distal tip faces the opposite direction. The catheter was also used to gain access into the superficial femoral artery when the arterial puncture was too proximal to the femoral bifurcation.
Results: We have treated multiple arterial lesions in both legs located up- and downstream by using a single access through the CFA. All patients were treated as day-case procedures, and there were no complications when using the new catheter. This new catheter can also be used in treating dialysis venous access when there are efferent as well as afferent lesions.
Conclusion: The new catheter will facilitate the treatment of multiple lesions in different limbs through one access puncture site. Ultimately, the risk of bleeding is reduced and more patients will have their treatment as day-case procedures. The catheter also helps in gaining easy access into the SFA when the arterial puncture happens to be close to the femoral bifurcation.

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Transarterial embolization using imipenem/cilastatin sodium for refractory skin ulcer

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Purpose: The presence of arteriovenous communications, micro-shunts, in patients with chronic skin ulcers has been confirmed in several studies. Imipenem/cilastatin sodium might be useful to embolize such micro-shunts. The purpose of this study was to evaluate the therapeutic effects and feasibility of transcatheter arterial embolization using imipenem/cilastatin sodium as an embolic agent to treat refractory skin ulcer.
Material and Methods: Four patients with refractory skin ulcers were enrolled in this clinical study. All patients had already received treatment, but the lesions had proven refractory. Computed tomography angiography was performed to confirm the presence of micro-shunts before treatment. In all patients, lesions were in the lower extremities and were associated with unremitting pain. Micro-shunts were confirmed on arteriography, and a 2-Fr micro-catheter was inserted and advanced as close as possible to the target lesion. Transcatheter arterial embolization using imipenem/cilastatin sodium was then performed. Technical success, healing of skin lesions, pain, and adverse effects were assessed.
Results: The technical success rate was 100%. All patients were discharged from our hospital within 1 week without any major adverse events. In all patients, pain fully resolved within about 1 month after the first procedure. The procedure was repeated three times for one patient, and the lesion was fully healed. Other patients have undergone this treatment once and are being followed-up. Lesions in these cases have been shrinking.
Conclusion: Transarterial embolization using imipenem/cilastatin sodium was effective and feasible as an embolic agent for refractory skin ulcer in this cohort. Further studies in larger cohorts are needed to validate the procedure.

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Peripheral blood concentration of everolimus following drug-eluting stenting of long infrapopliteal lesions

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Purpose: Although the use of drug-eluting stent (DES) is rapidly increasing in everyday clinical practice, there are no studies reporting the levels of drug released into the systemic circulation following infrapopliteal procedures. We investigated the concentration of everolimus in peripheral blood following DES implantation in long (≥60 mm) infrapopliteal lesions.
Material and Methods: Venous blood samples in 15 patients were drawn at baseline just before the implantation of the first stent (Promus Element™ Plus BTK; Boston Scientific) and at 30 minutes and at 1, 2, 4, and 14 hours after last stent and at 1-month follow-up. Mean stented length was 130.1±98.8 mm (range, 62–412). For the primary endpoint of everolimus quantitative determination in whole blood, both the homogeneous particle-enhanced turbidimetric immunoassay QMS everolimus using Indiko analyzer (ThermoFisher Scientific) and the most sensitive method of high-performance

liquid chromatography mass spectrometry were performed. Secondary endpoints included adverse events at 1-year follow-up.
Results: The mean total dose of everolimus received by the patients was 0.528±0.218 mg (range, 0.290–1.064). Whole blood concentrations post-implantation were 2.44±1.925 ng/ml (range, 1.1–6.0) at 30 minutes, 1.92±1.87 ng/ml (range, 0.7–6.1) at 1 hour, 1.74±1.50 ng/ml (range, 0.7–5.1) at 2 hours, 1.25±0.97 ng/ml (range, 0.0–3.3) at 4 hours, 0.73±0.62 ng/ml (range, 0.0–1.7) at 14 hours, and 0 at 1 month. No adverse events were noted.
Conclusion: Our findings suggest a limited exposure to the systemic circulation of everolimus following DES implantation of long infrapopliteal lesions. No drug-related adverse events were noted at 1-year follow-up.

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Balloon pulmonary angioplasty for chronic thromboembolic pulmonary hypertension (CTEPH)

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Purpose: To evaluate the effectiveness and safety of balloon pulmonary angioplasty (BPA) in the treatment of chronic thromboembolic pulmonary hypertension (CTEPH) in patients with an inoperable disease.
Material and Methods: Twenty patients (10 females; aged 55.18 ±15.57 years) were treated for CTEPH, and 37 procedures of BPA were performed since October 2013. Overall, 105 vessels have undergone angioplasty. All but three patients were disqualified from pulmonary endarterectomy (PEA) due to distal localization of thrombi. The rest had persistent pulmonary hypertension after PEA. For each patient's functional capacity (NYHA class), right heart catheterization (RHC) was performed before and after the BPA procedure. During RHC, hemodynamic measurements were recorded, including pulmonary vascular resistance (PVR) and mean pulmonary artery pressure (mPAP). Selective pulmonary arteriography confirmed the distal localization of thrombi. BPA was performed using a femoral venous access. Balloon diameter of 2–5 mm was used (pressure up to 4 atm), resulting in an improvement during control angiography.
Results: Assessment of hemodynamic parameters before and after BPA showed a significant decrease in PVR (11.7±4.3 vs. 6.6±2.2 Wood units) and mPAP (58±6 vs. 41±9 mmHg). The percentage of patients in the III and IV NYHA class decreased from 95% before BPA to 35% after BPA. One patient died, and reperfusion pulmonary injury was observed in six. Moreover, several minor complications occurred, including hemoptysis (n=7), dyspnea (n=1), desaturation (n=3), atrial arrhythmia (n=1), and subcutaneous hematoma (n=1).
Conclusion: BPA seems to be a promising strategy for inoperable CTEPH. Hemodynamic and clinical assessment showed significant improvement.

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A monocenter randomized clinical trial of PAClitaxel drUg-eluting Balloon versus standard percutaneous transluminal Angioplasty to reduce restenosis in patients with in-stent stenoses in the superficial femoral and proximal popliteal artery (PACUBA I Trial)

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Purpose: The hypothesis tested was that paclitaxel-eluting percutaneous transluminal angioplasty (PePTA) significantly reduces restenosis rates in superficial femoral artery (SFA) and femoropopliteal artery (FA) in-stent restenosis (ISR) compared to standard percutaneous transluminal angioplasty (sPTA).
Material and Methods: This prospective dual-center single-blind randomized clinical trial was performed on 74 consecutive patients with symptomatic SFA- or FP-ISR. Clinical outcome and patency rates were assessed at 6 and 12 months.
Results: The primary patency rates for PePTA and sPTA were intention-to-treat 58 (95% CI 0.44-0.77) versus 31% (95% CI 0.18-0.52; log-rank p=0.016) at 6 months and 40 (95% CI 0.26-0.64) versus 13% (95% CI 0.05-0.36; log-rank p=0.016) at 12 months. Freedom from target lesion revascularization (TLR) was 88 (95% CI 0.78-0.99) versus 83% (95% CI 0.71-0.98) for PePTA versus sPTA (log-rank p = 0.11) at 6 months and 49 (95% CI 0.32-0.75) versus 22% (95% CI 0.1-0.48; log-rank p = 0.11) at 12 months. TASC A+B lesion primary patency rates were 73 (95% CI 0.54-0.99) versus 28% (95% CI 0.12-0.65; log-rank p = 0.008) for PePTA versus sPTA at 6 months and 55 (95% CI 0.33-0.91) versus 10% (95% CI 0.02-0.58; log-rank p = 0.008) at 12 months. Six- and 12-month cumulative relative improvement in Rutherford category was slightly higher in the PePTA group; there was no significant difference in ankle-brachial index between groups.
Conclusion: Paclitaxel-eluting balloon angioplasty yields improved primary patency in the treatment of SFA/FP - ISR compared to sPTA, especially in short lesions.

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Popliteal artery aneurysm repair in the endovascular era: 14-year single-center experience

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Purpose: To compare outcomes of endovascular popliteal aneurysm repair versus great saphenous vein bypass and prosthetic bypass.
Material and Methods: From 2000 to 2013, patients with popliteal aneurysms were retrospectively divided into endovascular treatment (group A); GSV bypass (group B); and prosthetic graft bypass (group C). Survival, primary and secondary patency, and freedom from reintervention rate were estimated. Differences in ankle-brachial index (ABI), in-hospital length of stay, and limb loss were reported along a mean follow-up of 49 months.
Results: Sixty-seven patients were included: 25 in group A, 28 in group B, and 14 in group C. PAA was symptomatic in 23. Technical success rate was 100%. No perioperative deaths occurred. Five-year estimated survival was 78%. Estimated 5-year primary patency for groups A, B, and C was 71%, 81%, and 69%, respectively. Estimated 5-year secondary patency for groups A, B, and C was 88%, 85%, and 84%, respectively. Estimated 5-year freedom from reintervention for groups A, B, and C was 62%, 84%, and 70%, respectively. A significant difference between preoperative ABI versus postoperative ABI was observed (P=.001). InH-LoS was significantly shorter in group A (P<.001). Overall limb salvage was achieved in all but one patient.

Conclusion: PAA endovascular repair has good early- and long-term outcomes with different treatment options. Endovascular treatment was not inferior to surgical repair with a reduced InH-LoS. It can be successfully employed even in non-elective setting.

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A novel hydrodynamic approach of polyethelene oxide to arteriogenesis in a rat model of lower limb ischemia

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Purpose: In a rat model of chronic ischemic lower limbs, the drag reduction agent PEO can increase blood flow to the abdominal aorta, increase local blood flow perfusion, and reduce hind leg circulation resistance.
Material and Methods: Lower limb chronic ischemia model was established for the validation of periodic PEO in an animal model on and after treatment. Chronic aortic blood flow to the hind limb ischemic rat's abdomen and leg's loop resistance, the influence of certain For further drag reduction efficiency associated with drag reduction agent, the chronic dosing study model laid the foundation. The method of ultrasound imaging of microcirculation to observe the PEO for chronic ischemia of the skeletal muscle was used. The effect of microcirculation combined with pathology was evaluated by immunohistochemical analysis and microCT technology from different angles. Evaluation of drag reduction agent in a rat model of angiogenesis with chronic lower limb ischemia.
Results: Drag reduction agent PEO can increase blood flow to the abdominal aorta in a rat model of chronic ischemic lower limbs, increase local blood flow, and reduce loop resistance in the rat hind legs at the same time. The drag reduction agent can increase the microcirculation blood flow in the rat model of chronic ischemic hind limbs. Promote ischemic rats hind limbs artery to form, the form is mainly generated by promoting the small artery.
Conclusion: We hypothesized that DRPs can also promote arteriogenesis by FSS increment. The present experiments would be therefore undertaken to test the hypothesis and to investigate the underlying mechanism in an ischemic hind limb models of chronic femoral occlusion.

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Efficacy of treatment of edge stenosis of endografts inserted for superficial femoral artery stenotic disease

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Purpose: The role of endografts in the treatment of extensive superficial femoral artery (SFA) occlusive disease is enlarging. Results are limited by the occurrence of edge stenosis. The aim of the study was to retrospectively evaluate the efficacy of the treatment of edge stenosis of endografts inserted for SFA occlusive disease.
Material and Methods: All patients treated between November 2001 and December 2011 with a self-expandable polytetrafluoroethylene endograft were gathered in a prospective database in three hospitals. The incidence of primary edge stenosis and the incidence of re-edge stenosis after treatment were retrospectively noted, and a comparison was made between the results of percutaneous transluminal angioplasty (PTA) and extension of the endograft.
Results: A total of 88 patients presented with 115 edge stenoses, of which the majority presented within 1 year after the insertion of the endograft (mean time to edge stenosis 10.7 ± 8.2 months). Seventy-three stenoses (63%) manifested at the proximal edge and 42 at the distal edge (37%). One-year incidence of restenosis and/or occlusion was 45% after PTA and 43% after endograft extension, with 1-year patency rates of 81% and 92%, respectively. The incidence of restenosis/occlusion after treatment with PTA was 12% higher at 2 years compared with that after endograft extention (55% vs. 43%).
Conclusion: Edge stenosis may be well treated with either PTA or extension of the endograft. The incidence of restenosis and/or occlusion after both PTA and extension is high, but patency rates are acceptable. Aggressive surveillance is needed during the first year after insertion.

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Contemporary management of critical lower limb ischaemia in TASC D lesions, with subintimal angioplasty in femoro-popliteal lesions, tibial angioplasty, and sequential compression biomechanical device for infra-inguinal arterial occlusion: experience and quality-of-life outcome learned over 25 years

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Purpose: We aim to evaluate a comprehensive lower limb salvage program for management of critical limb ischaemia (CLI).
Material and Methods: From 2002 to 2012, 5876 patients were referred with peripheral vascular disease. Of them, 987 had CLI and 798 had intervention. Of 441 patients studied, 190 patients (206 procedures) had subinimal angioplasty (SIA) for TASC D femoro-popliteal occlusions, 80 patients (89 procedures) had tibial balloon and cool eximer laser angioplasty (TBA) for tibial occlusions and 171 patients with severe CLI, not suitable for revascularization, joined the sequential compression biomechanical device (SCBD) program. Mean age was 74±8 years.
Results: Peri-operative mortality was 1.6% for SIA vs 0% for TBA. Length of hospital stay was TBA 3.8±2 days vs SIA 14±16 days, $p<0.0001$. Five-year freedom from major adverse events was 68% for SIA, 59% for TBA and 62.5% for SCBD, $p=0.1935$. Five-year freedom from target lesion revascularization was 85.9% for SIA and 79% for TBA. One-year sustained clinical improvement was 82.8% for SIA, 68% for TBA and 68% for SCBD. Further, 83% SCBD patients had no rest pain within 1 week. Gangrene remained dry and non-progressive. Ulceration healed in 93%. No device-related complications occurred. Five-year limb salvage was 94%. Quality Time spent Without Symptoms of disease or Toxicity of treatment (Q-TWiST) was 24.7 months for SIA, 8.5 months for TBA and 38.13 for SCBD. Cost per quality-adjusted life years was €5,662.79 for SIA, €12,935.18 for TBA and €2,943.56 for SCBD.
Conclusion: All treatment pathways were cost-effective, minimally invasive and allowed rapid patient turnover without compromising limb salvage.

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Drug-coated balloon (DCB) angioplasty versus conventional angioplasty for the treatment of the superficial femoral artery (SFA) and PI segment in PAD patients: interim results of the FREERIDE study

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Purpose: The use of paclitaxel drug-coated balloon (DCB) in PAD patients during the percutaneous transluminal angioplasty (PTA) treatment of femoropopliteal lesions might result in a significantly

reduced restenosis rate. Thus, the FREERIDE study investigates the inhibition of restenosis by Freeway DCB versus standard balloon (POBA) for the treatment of de novo occluded stenotic lesions or reoccluded and restenotic lesions in the superficial femoral artery (SFA) and popliteal arteries (PI segment).
Material and Methods: Two hundred and eighty patients will be randomized either to Freeway DCB or to POBA in 23 centers worldwide. The primary endpoint is the clinically driven target lesion revascularization rate (TLR) at 6 months. Further, several secondary endpoints such as late lumen loss and patency rate at 6 months, TLR at 12- and 24-month follow-up (FU), improvement in Rutherford classification and ankle-brachial index (ABI), and MAE at FU will be investigated.
Results: Until today, 140 patients have been enrolled, and 100 of them completed the 6-month FU. At 6 months, FU-positive trends, regarding TLR rate and the number of MAE for the drug-coated balloon Freeway were observed. Furthermore, there were positive trends in the patency rate and in the improvement of Rutherford classification after Freeway PTA versus POBA.
Conclusion: The updated interim results indicate that the Freeway DCB might provide an advantage for angioplasty in SFA and PI segment lesions. DCB might overcome the existing limitations in the treatment of peripheral disease.

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The AURORAA registry: 3-year results using interwoven nitinol stents for extensive distal femoropopliteal occlusive disease

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Purpose: In the endovascular treatment of extensive disease in the distal superficial femoral and popliteal level, you can encounter flow-limiting problems, where stent placement is needed after balloon angioplasty. Most of the standard bare nitinol stents will have difficulties in these areas. With the introduction of the Supera vascular mimetic implant (Abbott Vascular, Santa Clara, Cal, US), we may have an answer in treating those problematic lesions.
Material and Methods: Because of Supera's design, 6 interwoven nitinol wires, it has extraordinary characteristics: very flexible; kink, fracture, and crush resistant, together with great radial force. This enables it to mimic the forces and movement of the native vessel. We have treated 130 patients with extensive distal femoropopliteal disease (TASC II C and D) who did not respond to balloon angioplasty and who needed stent placement with placement of Supera.
Results: Results of the single-center prospective AURORAA registry: Follow-up by ultrasound. Seven patients died of non-interventional causes. Nine patients had an occlusion due to progressive distal peripheral arterial disease. Six-month primary patency was more than 90%, 12-month was 80.3%, 24-month was more than 70%, and 3-year was 70.8%. No stent fractures or flow-limiting kinking were observed. Average lesion length: 14 cm; average stent length: 18 cm. Technical success rate: 96%.
Conclusion: The Supera vascular mimetic implant is a solution when "classic" nitinol stents are not indicated, due to its special characteristics that truly mimic the native vessel movements and in-working forces.

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The randomized Freeway Stent Study finished enrollment and favors the use of drug-coated balloons over plain balloons for the postdilatation of nitinol stents in the SFA and PI segment to lower restenosis rate

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Purpose: Stents are needed in up to 50% of all peripheral interventions where PTA with plain or drug-coated balloons alone will not reopen the vessel sufficiently. Nevertheless, the restenosis rate of stents is still a major limitation of peripheral arterial interventions. Drug-coated balloons potentially overcome the problem of in-stent restenosis when used for postdilatation after primary nitinol stenting in the SFA and PI segment.
Material and Methods: The Freeway Stent Study is a prospective, randomized, international trial started in 15 centers in Germany and Austria; 200 patients were enrolled and randomized equally to primary nitinol stenting followed by either DCB (Freeway™) or plain balloon postdilatation. Primary endpoint is clinically driven target lesion revascularization (TLR) at 6 months; secondary endpoints include further clinical and safety evaluations like shift in Rutherford classification and ABI, LLL, patency rate, and MAE.
Results: Enrollment was finished in 2015. Over 170 patients have finished the 6-month and almost 140 the 12-month follow-up. The results highly favor the use of Freeway™ DCB over plain balloon based on clinically driven TLR at 6 and 12 months. This is supported by significantly better clinical outcomes for PAD patients treated with DCB as postdilatation device.
Conclusion: The use of DCB as postdilatation device is investigated in a new approach to decrease the restenosis rate after nitinol stenting in the SFA and PI segment. The latest interim results of the Freeway Stent Study show that DCB might significantly lower the in-stent restenosis rate in the treatment of PAD patients.

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Popliteal aneurysms treated with Viabahn endoprosthesis: experience and long-term results in 25 patients

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Purpose: To retrospectively evaluate the efficacy and long-term patency rates of popliteal aneurysm stenting using the Viabahn-covered endoprosthesis.
Material and Methods: Twenty-five patients were treated from 2011 to 2014 (mean age, 72 years) with PAA (average size, 3 cm) in 25 limbs, of which 38% were symptomatic. All patients were treated with endovascular stent coated with Viabahn (Gore). After intervention, all patients were maintained in antiplatelet therapy with clopidogrel or aspirin or both. The mean follow-up was 363 months (range, 2–34 months), and it was carried out with an echo color doppler. One patient was lost to follow-up.
Results: The popliteal endoprosthesis resulted to be patent at 6, 12, and 24 months in 25/25, 24/24, and 18/22 patients, respectively. No limb underwent amputation. Two patients underwent a second intervention during the follow-up period.
Conclusion: The repair of popliteal aneurysms using the Viabahn endoprosthesis is safe and efficient. The popliteal artery was proven to be patent at 24 months in 81% of the patients. No limb underwent amputation.

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Carbon dioxide imaging during peripheral angioplasty procedures significantly reduces the risk of contrast-induced nephropathy

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Purpose: Contrast-induced nephropathy (CIN) is the leading cause of iatrogenic acute kidney failure. So far, CIN prophylaxis is limited to intravenous hydration albeit with inconclusive effectiveness. CIN risk is compounded by other comorbidities, especially diabetes mellitus, and has an estimated incidence of up to 20% in case of pre-existing renal impairment. Our purpose is to demonstrate the efficacy of carbon dioxide (CO_2) imaging in preventing CIN during peripheral interventions.
Material and Methods: We formally initiated use of CO_2 as an alternative contrast agent in patients with impaired renal function (eGFR<60ml/min/1.73m^2) undergoing peripheral angioplasty and/or stenting. From March 2014 to December 2014, 50 consecutive critical leg ischemia patients (68% diabetes, baseline eGFR=38.6±13.2ml/min/1.73m^2) were enrolled in a prospective clinical audit. Cases were matched 1:2 with a historical cohort treated with iodinated contrast (June 2012 to December 2013; 65% diabetes, baseline eGFR=43.3±12.2ml/min/1.73m^2). Patient files were analysed for collection of baseline demographics, use of concomitant hydration and nephrotoxic medications.
Results: Volume of iodinated contrast was reduced by nearly 90% (17.8±16.1ml in case of CO_2 vs. 115.9±57.8ml; p<0.001). The incidence of CIN (defined as 25% increase in serum creatinine or 0.5 mg/dl (44µmol/l) increase within 48-72 hours of contrast administration) was 14% (7/50) in CO_2 cases vs. 29% (29/100) in the matched cohort (p=0.045). Receiver-operating characteristic analysis showed that injection of >25ml iodine contrast was 94.4% sensitive in predicting CIN (adjusted OR: 6.9; 95%CI: 1.6-30.6).
Conclusion: CO_2 imaging during peripheral angioplasty procedures allows for significant reduction of CIN incidence. No more than 25ml of iodinated contrast should be allowed in high-risk patients.

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Carbon dioxide angiography: how to overcome radiological and mechanical constraints

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WITHDRAWN

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A novel thromboaspiration system to treat acute ischemia of vessels in the peripheral and visceral arterial circulation: preliminary results of the PRISM study

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Purpose: Existing endovascular options in the treatment of peripheral/visceral arterial thromboembolism face many risks. A Penumbra/Indigo system provides a novel approach featuring a highly trackable and effective aspiration system validated for ischemic stroke treatment. Herein, we present preliminary results from the PRISM trial, the first multicenter study designed to obtain initial safety/efficacy data in patients with confirmed peripheral or visceral artery occlusions.
Material and Methods: To date, 38 patients have been enrolled in this retrospective, multicenter trial. Thromboembolectomy using the Penumbra/Indigo system was performed in cases of failed thrombolysis or acute ischemia or in patients with distal embolism, resulting from other interventions. Primary sites of occlusion included the popliteal (44.7%), peroneal (7.9%), superficial femoral (13.2%), posterior tibial (10.5%), profunda femoris (5.3%), superior mesenteric (5.3%), anterior tibial (7.9%), renal (2.6%), and brachial (2.6%) arteries.
Results: Mean patient age was 71.6±14.8 years. Baseline angiographic TIMI 0/1 scores were reported for all patients. Prior to intervention with the Penumbra/Indigo system, 44.7% of patients received only thrombolytic therapy, 2.6% received only mechanical intervention, 7.9% received both therapies, and 44.7% were treated frontline with the Penumbra/Indigo system. Median time from symptom onset to procedure was 5.0 days (IQR, 2.0–26.0). Post-procedure, 97.3% of patients were successfully revascularized to TIMI 2 (35.1%) or TIMI 3 (62.2%). Five SAEs were observed in two patients: myocardial infarction, anemia, renal insufficiency, metabolic acidosis/shock, and mesenteric ischemia. None were classified as related to the study device.
Conclusion: Primary experience with the Penumbra/Indigo system shows encouraging results with safe, efficient thrombo-aspiration in the periphery and viscera, and its use is validated across a broad scope of applications beyond the neurovasculature.

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Foot embolization occurred during limb salvage procedures in patients with critical limb ischemia, successfully managed with a mechanical thrombo-aspiration device

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Purpose: Periprocedural acute distal embolism is a potential complication, which may occur during percutaneous revascularization of the femoropopliteal and below-the-knee district. To date, no gold standard of treatment has been established. The purpose of this study was to assess the safety and efficacy of Penumbra thromboaspiration device in overcoming BTK distal embolization.
Material and Methods: Twelve cases using mechanical thromboaspiration post-foot embolization complications in limb salvage treatment are reported. Each case was treated using a mechanical thrombectomy device, the Penumbra System (Penumbra Inc, Alameda, USA), traditionally used during acute ischemic stroke therapy, also exploiting a plantar-to-pedal loop technique.
Results: Technical success was 100% in all patiens, defined as a full reopening of treated occluded vessels. We observed no complications.
Conclusion: Our initial experience using the Penumbra System in the peripheral vasculature demonstrates a safe, rapid, and effective approach to address intra-procedural foot embolization, avoiding possible grave clinical sequelae. Follow-up in a larger cohort is warranted.

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Optimizing subintimal angioplasty using the Pioneer Volcano Re-Entry device: single monocentric experience

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Purpose: To evaluate the efficacy and safety of the Pioneer Catheter in patients with chronic total occlusion (CTO) of superficial femoral artery, evaluating its impact on re-entry technical success and the

post-angioplasty diagnostic value to detect residual stenosis, hidden to fluoroscopy.
Material and Methods: From October 2014 to March 2015, 40 patients affected by TASC II-D superficial femoral artery CTO were treated with subintimal recanalization. In 20 patients (group A) the manual reentry technique was used and in 20 patients (group B) the Pioneer IVUS-guided reentry catheter was used. Precision in targeting the expected reentry site has been compared. Moreover IVUS was used to assess potential post-angioplasty residual stenosis, then treated with spot stents.
Results: Technical success was achieved in all cases (100%). In group A, the planned in-target re-entry was achieved in 9/20 cases (45%). In group B, the in-target re-entry was achieved in 18/20 cases (90%) and in 2 cases (10%) a lower reentry site was achieved because of long dense calcification with large cone of shadow and with a wall hardly penetrable by needle. In 4 cases (20%) the post-angioplasty IVUS exam documented residual stenosis, then treated with spot stents.
Conclusion: In our experience, this device is an ideal adjunct in the treatment of Superficial Femoral Artery occlusions when an accurate re-entry cannot be achieved with the conventional subintimal technique. A valid technical success aided by an high re-entry precision could accelerate the learning curve allowing more procedures of limb salvage. Moreover the IVUS 360° evaluation improved the diagnostic power to detect post-angioplasty subintimal residual stenosis, even hidden to fluoroscopy and treatable with spot stents, potentially increasing patency in short and long term period.

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Hydrodynamic re-entry: a novel technique in subintimal angioplasty of below-the-ankle vessels

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Purpose: To report our preliminary results with hydrodynamic re-entry technique (HRT) in subintimal angioplasty of ankle and below-the-ankle (BTA) vessels.
Material and Methods: Four hundred fifty-eight patients with critical limb ischemia underwent endovascular recanalization at our center in 2014. In 19 patients (11 males and 8 females aged 71 ± 12 years) with chronic total occlusion of the tibial arteries, in which subintimal approach using standard re-entry strategies failed, HRT was attempted. With this technique, the operator performed a gentle manual injection of diluted contrast dye with a 4F catheter into the distal subintimal space close to the patent true distal lumen. Under continuous fluoroscopic surveillance, manual pressure is progressively increased in order to achieve a tear in the intimal flap and a connection with the true lumen.
Results: In 2/19 (10.5%) patients, an extravascular leaking of the contrast dye was noted, and the HRT was interrupted; procedures were successfully completed by the retrograde approach. In 17/19 (89.5%) patients, HRT was effective in creating a tear connecting the subintimal space and true distal lumen. In all these cases, it was possible to advance a wire into the true lumen and conclude the procedure as planned. No major complications occurred.
Conclusion: In our preliminary experience, HRT seems to be a feasible, safe, and effective strategy for achieving re-entry after subintimal dissection in ankle and BTA vessels, and it holds the potential of offering successful endovascular recanalization to an additional patient population.

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Misago RX nitinol stent when used in the treatment of atherosclerotic lesions in the popliteal artery: results from e-MISAGO registry

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Purpose: Despite the fact that the number of endovascular procedures with stenting popliteal arteries has significantly increased over the last decades, there is still no consensus about primary stenting of these lesions. This is the first report of a large multi-centre registry, which assessed the safety and efficacy up to 1 year of Misago RX nitinol stents when used in the popliteal artery.
Material and Methods: Three hundred twenty-nine patients with atherosclerotic lesions in the popliteal artery (P1, P2 and P3 segments) from 45 sites in 12 countries participated in prospective, non-randomised, multi-centre registry, and they were followed up to 12 months after the index procedure. The primary efficacy endpoint was target vessel patency at 1 year. The study had an independent clinical event committee, which adjudicated all adverse events.
Results: The patients with a mean age of 72.9 years were mostly males (61.7%), and 76.7% had hypertension, 41.1% had a history of smoking and 40.8% were diabetic. Mean lesion length and RVD were 52.2 mm and 5.5 mm, respectively, and mean diameter stenosis was 93.1%. At 1 year, the symptoms of ischemia improved in 79.3% of patients, ABI increased from 0.6 to 0.9 and 90.7% of patients had an improvement in the Rutherford index. A total of 4.6% of patients died, most of them due to cardiac cause, while 4.9% had an amputation. Primary patency at 1 year was 91.5%.
Conclusion: This study confirms the value of the Misago RX nitinol stent for treating lesions in all segments of the popliteal artery.

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Clinical results of PADI trial: percutaneous transluminal angioplasty versus drug-eluting stents for infrapopliteal lesions in critical limb ischaemia

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Purpose: Endovascular infrapopliteal treatment of patients with critical limb ischaemia (CLI) with percutaneous transluminal angioplasty (PTA) and bail-out bare metal stenting (BMS) is hampered by restenosis. In interventional cardiology, drug-eluting stents (DES) have shown better patency rates and are standard practice nowadays. An investigator-initiated, multi-center and randomised trial was conducted to assess if DES also improved the outcome of infrapopliteal lesions in CLI.
Material and Methods: Adults with CLI (Rutherford score≥4) due to infrapopliteal lesions were randomised to receive PTA with bail-out BMS or DES with paclitaxel. Primary endpoint was 6-month primary binary patency of treated lesions defined as ≤50% stenosis on computed tomography angiography. Clinical endpoints were major and minor amputation, treatment in interim, death, Rutherford score, peri-procedural complications and serious adverse events.

Results: Seventy-four limbs (73 patients) were treated with DES, and 66 limbs (64 patients) received PTA±BMS. The observed major amputation rate remained lower in the DES group until 2 years post-treatment (p=0.066). Less minor amputations occurred after DES until 6 months post-treatment (p=0.03). Survival until 2-year follow-up and an improvement in Rutherford score after 6 and 12 months was comparable in both groups. Neither did the number of peri-procedural complications nor did the serious adverse events differ.
Conclusion: CLI patients with infrapopliteal lesions treated with DES showed a lower major amputation rate persisting until 2 years post-treatment and less minor amputations compared with those treated with PTA and bail-out BMS. In these patients, a treatment strategy with DES should therefore be considered.

P-359

Gunshot vascular trauma of the superficial femoral artery: endovascular stenting

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Learning Objectives: To describe the possible penetrating vascular lesions of the superficial femoral artery (SFA) after lower extremity gunshot, and the indications of endovascular stenting.
Background: Penetrating vascular injuries due to gunshot trauma of the SFA may lead to a variety of arterial diseases. These vascular injuries can be acute or chronic. Little scientific data have been published on endovascular stenting for treating lower extremity traumatic vascular injuries, and just a few case reports exist regarding its use in the SFA.
Clinical Findings/Procedure: The purpose of this poster is to describe the four possible penetrating vascular injuries (pseudoaneurysm, intimal disruption, arteriovenous fistula, and total artery rupture) of the SFA, and indications of endovascular stenting in the first three types of lesions. This endovascular approach has lower morbidity, may reduce blood loss, decreases recovery time, has no iatrogenic nerve injury, and has a lower rate of infection than an open approach.
Conclusion: When possible, endovascular stenting of the SFA after traumatic gunshot injury is a safe and efficient treatment method.

P-360

Pseudoaneurysms: what an interventional radiologist should know about their diagnosis and management

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Learning Objectives:
1. Describe various type of pseudoaneurysms.
2. Describe their aetiological factors and imaging features.
3. Discuss their management strategies.

Background: A pseudoaneurysm (PSA) is a contained rupture with disruption in all 3 layers of the arterial wall. It may occur because of one of the following reasons: 1) traumatic; 2) post-catheterisation; 3) infection and 4) at the site of native artery and synthetic graft anastomosis. This educational exhibit discusses all four types of PSA, their imaging features and subsequent management strategies.
Clinical Findings/Procedure: We did a retrospective analysis of all the patients who presented with various types of PSA from 2008 to 2015 in a large tertiary-care hospital. Clinical presentations, imaging features and management were noted, and clinical outcome was measured.
Conclusion: PSAs are a common finding in day-to-day interventional procedures. Non-invasive imaging methods such as duplex and contrast-enhanced CT scans are preferred and accurate. Thrombin injection and covered stent placement are highly successful methods of treating PSAs with up to 97% success rate and a low complication rate (<1%).

P-361

Development of a PROficiency-based StePwise Endovascular Curricular Training (PROSPECT) program

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Learning Objectives: A PROficiency-based StePwise Endovascular Curricular Training (PROSPECT) program has been developed, consisting of e-learning and endovascular hands-on simulation modules. The program addresses basic endovascular skills, treatment of symptomatic iliac and superficial femoral artery atherosclerotic disease, and complication management.
Background: Focus on patient safety, work-hour limitations, and cost-effective education is putting pressure to include simulation training into endovascular training to acquire minimal invasive techniques; but curricula using this technology are still lacking.
Clinical Findings/Procedure: Forty-nine subjects (29 medical students, 20 endovascular therapists) were recruited. Construct validity of e-learning and simulation cases was investigated. Performances were assessed using multiple-choice questionnaires (MCQ), valid simulation parameters, and post-hoc video-based evaluations using global rating scores (GRS) and examiner checklists. Experts obtained higher scores for MCQs than did medical students (median 24.5-22.0 vs. 15.0-12.0; P<0.001). Students took significantly longer to treat iliac and femoral lesions (3.3-14.8 vs. 5.8-30.1 min.; P=0.001-0.04). In more complex cases, fluoroscopy time was significantly higher for students (8.3 vs. 21.3 min.; P=0.002; 7.3 vs. 13.1; P=0.03). Video-based scorings were higher for experts in all cases using GRS (51.0-42.0 vs. 29.5-18.0; P<0.001) and examiner checklist (81.5-75.0 vs. 54.5-43.0; P<0.001). Proficiency-levels (median expert scores) were determined. Two students achieved all benchmarks, which confirmed feasibility.
Conclusion: A feasible and validated program has been developed to structure and enhance endovascular skill training of the lower limbs in a safe environment. PROSPECT allows training of cognitive, technical, and non-technical endovascular skills. A randomized controlled trial has been initiated to study the impact of PROSPECT on real-life performances, patient outcomes, and cost-effectiveness.

P-362

High-flow arteriovenous malformations: lessons learned from challenging cases

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Learning Objectives: The purpose of this poster is to share some of our experience in the management of high-flow arteriovenous malformations (AVMs) based on problem cases.
Background: High-flow AVMs are rare and complex lesions that may involve any part of the body. They often represent a therapeutic challenge because of their complex anatomy and behavior. The type of embolic agent and access may be determined by the anatomy of the lesion, localization, size, operator's experience, etc.

Clinical Findings/Procedure: We selected the following problem cases:
1. Direct alcohol injection into the nidus of a foot AVM.
2. Use of the Amplatzer plug in a renal AVM.
3. Histoacryl and lipiodol embolization of a uterine AVM.
4. Alcohol and cement injection into an osseous AVM.
Conclusion: Each AVM poses a therapeutic challenge. It is important to be familiar with the different embolic agents, their indications, and routes of administration.

P-363

Carbon dioxide-guided peripheral angioplasty in patients with anaphylaxis to iodinated contrast medium: how I do it

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Learning Objectives: Use of CO_2 angiography to treat intra-arterial disease in patients with an allergy to iodinated contrast medium.
Use of gadolinium-filled angioplasty balloons in order to prevent exposure to iodinated contrast medium in case of balloon rupture.
Use of sizing balloons to define intra-arterial stenosis and prevent the use of contrast medium.
Background: The demand for endovascular therapy to treat peripheral vascular disease is expanding, particularly in the elderly who often have several additional co-morbidities. The replacement of contrast medium with intra-arterial CO_2 is a recognised technique for preventing contrast-induced nephropathy following angiography. We present an additional indication for the use of CO_2angiography in patients with an allergy to iodinated contrast medium.
Clinical Findings/Procedure: We describe our technique of successfully treating intra-arterial disease using CO_2 angiography and gadolinium-filled angioplasty balloons in patients with an allergy to iodinated contrast medium. All angiographic images were obtained following delivery of CO_2 using a conventional kit with CO_2 cylinder and plunger. The angioplasty balloons were filled with gadolinium in order to prevent exposure to iodinated contrast medium in case of balloon rupture. Flow was re-established in the targeted vessel being treated in all cases, both above and below the knee.
Conclusion: CO_2 offers many advantages as an imaging agent. It is 20 times more soluble in blood than oxygen, not nephrotoxic, inexpensive and is not allergenic. We present a small series of patients with known allergy to contrast medium, in whom arterial flow was re-established without the use of any contrast medium.

P-364

To review the current literature and establish the difference in outcome with the use of drug-eluting versus uncoated balloon angioplasty in SFA stenosis

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Learning Objectives: To review the current literature and establish the difference in outcome with the use of drug-eluting versus uncoated balloon angioplasty in SFA stenosis.
Background: Peripheral artery disease carries a significant morbidity and mortality. Drug-eluting balloons have been successfully used in the coronary circulation, and there is much interest in their use in the peripheral circulation. The approach to treating atherosclerotic SFA disease is complex and much debated, owing to challenges in this vessel such as movement and complex lesion morphology.
Clinical Findings/Procedure: A literature search was performed using available search databases, including UpToDate and Cochrane, and a search of the Ovid Medline and PubMed databases was performed. The terms and synonyms of femoral artery, stenosis, balloon angioplasty, drug-eluting or coated or Paclitaxel were searched. A reverse citation analysis was performed to identify further articles. The available abstracts were reviewed for relevance by a single reader. No guidelines or consensus statements were found relevant. A single meta-analysis with a total population of 381 patients was reviewed, and five well-controlled RCTs were assessed. Relevant editorials and opinion pieces were reviewed for further information. The endpoints of target lesion revascularization, late lumen loss, and angiographic restenosis were improved by the use of drug-eluting balloons. All-cause mortality was not significantly different between the groups.
Conclusion: The population size in published RCTs and overall numbers in the meta-analysis are small; however, there is agreement between trials and improved endpoints with the use of drug eluting balloons over non-coated balloons in SFA stenosis. Further trials are awaited.

P-365

Diagnosis and treatment of exercise-induced external iliac artery endofibrosis

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Learning Objectives:
1. To examine the proposed etiology of external iliac artery endofibrosis.
2. To review the presentation and diagnosis of patients with external iliac artery endofibrosis.
3. To discuss the treatment options, including conservative management, endovascular stenting, and surgical therapies.

Background: Endofibrosis is most commonly reported in endurance athletes, often long-distance cyclists. Repetitive hip flexion may lead to an arteriopathy that often involves the external iliac artery and results in exercise-induced claudication.
Clinical Findings/Procedure: Extreme endurance exercise results in repetitive hip flexion, psoas hypertrophy, and excessive vessel length that may result in arterial injury. The aerodynamic cycling position causes arterial fixation and repetitive trauma to the layers of the affected artery. Otherwise healthy young individuals may present with exercise-induced leg pain. Provocative ABIs and Duplex ultrasound are often abnormal. CTA, MRA, or DSA may demonstrate arterial stenosis, thrombosis, or dissection, most commonly in the external iliac artery. Conservative management consists of limiting the inciting endurance activity. A number of surgical options exist, including vessel release, endofibrosectomy with patch angioplasty, interposition graft placement, and vessel shortening operations. Endovascular treatment with angioplasty and stent placement provides a minimally invasive treatment option.
Conclusion: Endofibrosis is a debilitating condition affecting otherwise healthy endurance athletes. Patients may be initially misdiagnosed until claudication is further investigated with physiologic studies or anatomic imaging. Traditional therapy consists of surgical intervention. Angioplasty alone has been largely ineffective. Endovascular stent placement may provide a durable result and avoid the risks of surgical management.

P-366

Use of long detachable coils and stent-graft coverage in the repair of a complex common iliac aneurysm with insufficient landing zone

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A 64-year-old man had a common iliac aneurysm that extended to the ostium of his only patent internal iliac artery (IIA). Balloon-assisted coiling with detachable coils followed by "suboptimal" stent-graft placement excluded the aneurysm and preserved IIA flow.

P-367

Successful percutaneous transfemoral retrieval of a primarily misplaced and dislocated balloon-expandable stent in a transbrachial left subclavian artery stent angioplasty

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We report a case of an intraprocedural migration of a balloon-expandable stent into the descending aorta after misplacement in a proximal left subclavian artery stenosis. The stent could be successfully snared and retrieved transfemorally through a 16-F sheath without additional arteriotomy.

P-368

Successful endovascular repair of a ureteral-iliac artery fistula

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A 79-year-old patient with a history of abdominoperineal surgery, radiation therapy, and chronic ureteral stenting presented with gross hematuria caused by left ureteral-iliac artery fistula. This was successfully treated endovascularly with covered stent.

P-369

Frequent shoulder luxation as a presumable cause of a brachial artery aneurysm

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A 51-year-old woman with frequent luxation of the right shoulder developed an aneurysm at the transition between the deep brachial artery and humeral circumflex artery, which was successfully resolved using a stent graft.

P-370

Percutaneous trans-arterial retrograde embolization for proximally ligated internal iliac artery aneurysms

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Proximal ligation of internal iliac artery aneurysm without distal control may lead to continued aneurysm growth with subsequent risk of rupture from the retrograde flow. We report such two cases successfully treated by percutaneous transarterial retrograde embolization via collateral arteries.

P-371

Endovascular treatment of a limb-threatening paradoxical embolism consequent to acute deep venous thrombosis in a young patient with L-transposition of the great arteries: a case report

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We present a case of ALI caused by paradoxical embolism consequent to extensive iliofemoral DVT in an 18-year-old patient with L-transposition of the great arteries. The patient was successfully treated using Jetstream atherectomy and AngioJet thrombectomy systems.

P-372

Covered stent repair of mammary artery rupture

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A 48-year-old woman received left mammary artery bypass heart surgery. During CVC placement, she experienced an iatrogenic left mammary artery tear with massive hemorrhage. An IABP was applied and a successful covered stenting of the artery was carried out.

P-373

Stent-graft placement in anterior tibial artery pseudo-aneurysm in a patient with neurofibromatosis type 1

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Vascular involvement of neurofibromatosis type 1 (NF-1) is very rare and may present as aneurysm, obstruction, or stenosis. We present the case of a 51-year-old woman with NF-1 in whom stent-graft placement in anterior tibial artery pseudoaneurysm was performed.

P-374

Definitive treatment of a persistent sciatic artery: case report and literature review

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Persistent sciatic artery is a rare congenital condition caused by failure of regression of the sciatic artery *in utero* and normal femoral artery development, leading to vascular insufficiency of the lower limb, aneurysm formation and occlusion. Case report and literature review.

P-375

Treatment of sac expansion of a ligated popliteal artery aneurysm using Onyx with contrast-enhanced ultrasound as follow-up

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We present a case illustrating the diagnostic and technical challenges of embolisation using Onyx for sac expansion in a surgically ligated popliteal aneurysm secondary to retrograde filling from crural branches, highlighting the usefulness of novel contrast-enhanced US imaging following radio-opaque Onyx embolisation.

P-376

Endovascular stent graft of a ruptured popliteal artery due to knee luxation via proximal and distal approach

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For treatment of a covered rupture of the popliteal artery, a second vascular approach via the anterior tibial artery was necessary. Through narrowing both guidewires in the free paravascular space, we could establish a solid connection for stent-graft implementation.

P-377

Repositioning a dislocated stent in the below-the-knee area

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Occlusion of bypass and stent, at distal anastomosis, bounced back in the artery, retrograde puncture: wire in occluded stent. Antegrade wire between stent and graft wall, retrograde then snared, redirected wire reversal: covered stent to secure the displaced stent.

Radiation safety

P-378

Dosimetric study of varicocele embolisation in paediatric patients

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Purpose: Varicocele embolisation is a percutaneous procedure performed with fluoroscopic assistance. The aim of this study is to evaluate gonad radiation dose and estimate hereditary risk and lifetime fatal cancer risk in paediatric population.
Material and Methods: From September 2014 to date, 30 paediatric patients, aged from 12 to 18 years underwent percutaneous embolisation of the spermatic vein, using a "low-dose" protocol. A double transmission chamber was used to measure the entrance surface dose and the dose-area product. Three thermo-luminescent dosimeters were placed adjacent to the scrotum to directly measure gonad dose. A PC-based Monte Carlo program was used to estimate effective dose from the recorded DAP. The hereditary effect was made by combining the gonad doses with risk factor for that population. The total fatal cancer risk was estimated by multiplying each organ dose by cancer risk factor for that organ and summing up the results.
Results: Mean fluoroscopy time was 5 min 10 sec; mean DAP, 2.05 Gy·cm^2 and mean ESD, 7.70 mGy. Mean gonad dose was 0.27 mGy (deterministic threshold of sterility: 150 mGy) and effective dose was 0.86 mSv (1 year of natural background radiation: 2.4 mSv). Hereditary risk was less than one case per 100000 treated (0.00085%). Radiation-induced fatal cancer risk was 2.1 cases per 10000 treated (0.021%).
Conclusion: In paediatric patients, the radiation-induced risk in varicocele embolisation is content. Adequate field-limiting measures, anti-scatter grid removal, never use radiography and limited fluoroscopy are the most significant to optimise exposure. The dosimetric investigation is not limited to an "experimental speculation" but is under the direct responsibility of radiologists.

P-379

Are we close enough to the new annual 20mSv occupational dose limit for the lens of the eye?

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Purpose: To measure eye lens doses in interventionalists and estimate annual doses.
Material and Methods: Small optically luminescence dosimeters (OSL) were attached to the goggle left sidepiece, at both sides of the left protection shield. The inner dosemeter (protected by the lateral shield) was assumed to measure the eye lens dose. Other OSL personal dosimeters were located at physicians' chest left side. Physicians wore dosimeters over one-month periods. Interventional radiologists remained in the control room during imaging acquisition. The ceiling suspended screen was used regularly in the catheterization laboratory.
Results: Twenty-three-monthly dose values were obtained from 8 interventionalists (radiologists and cardiologists) with standard workload (2-5 procedures/day). Depending on the goggle model, the dose reduction factor ranged from 1.4 to 5.2. For the monthly dose at eye lens, the average±sd, 1st, 2nd, and 3rd quartiles resulted in 175±132, 73, 161, and 225, μSv respectively. Outside the goggles, measured doses were (average±sd) 578±336, Q1=291, Q2=561, and Q3=795 μSv. The linear regression between the chest over apron and the outer goggle readings was goggles = 0.67·chest, with Pearson correlation of r^2=0.55.
Conclusion: It is important to choose well-designed goggles with proper lateral protection, the dose reduction factor could be otherwise as low as 1.4. Provided appropriate protection rules are respected, the extrapolation of the monthly lens dose to one working year would lead to 1.9 mSv (well below the 20 mSv limit). The extrapolation outside the goggles would produce 6.4 mSv/y. There was a weak correlation between chest and goggle readings.

P-380

Dose evaluation for Rendu-Osler disease patients undergoing pulmonary embolization

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Purpose: The exposure data and the peak skin dose (PSD) were evaluated in the absence of data in literature for patients with Rendu-Osler disease undergoing pulmonary embolization.
Material and Methods: Eighteen procedures have been performed on 16 patients (7 males and 9 females; average age, 47 years; range, 8–77 years), and for each patient, exposure data such as total air kerma per area product (KAP_{TOT}), cumulative dose (K_{ar}), fluoroscopy time (FT), and number of frames (N_{FR}) were recorded. A biplane flat panel Philips Allura XperFD 20/20 system was used for the procedures. In 13 cases, only the PA projection was used, while in 5 cases, both PA and lateral were used. The calculation of PSD was derived from the K_{ar} value, following Jones' method. The Mann-Whitney test was used for statistical analysis. A p value of <0.05 was considered to represent a statistically significant result.
Results: The KAP_{TOT} ranged from 77.22 to 1776.65 Gycm^2 (median, 349.82), FT ranged from 10 to 72 min (median, 41), and K_{ar} values

ranged from 0.36 to 6.07 Gy (median, 1.54). The PSD ranged from 0.50 to 6.66 Gy (median, 1.96), and it was higher than 3 Gy in four cases. Pearson's test showed moderate correlation between KAP_{TOT} and K_{ar} (r=0.7081, p=0.0010), and it showed no correlation between KAP e FT (r=0.1384, p=0.5839) or between K_{ar} and FT (r=0.4179, p=0.0844).
Conclusion: Pulmonary embolizations have to be considered as high-dose procedures. Follow-up has to be performed for patients with PSD>3 Gy.

P-381

Ionizing radiation associated with percutaneous interventions: how much do biliary procedures generate?

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Purpose: To analyse ionizing radiation produced during different percutaneous biliary procedures.
Material and Methods: Radiation data of 229 consecutive, percutaneous biliary interventions (109 patients; male/female 59/50; age 61.3±19.4) carried out in the OR with a C-arm (Arcadis Varic; Siemens) were analysed. Cumulative fluoroscopy time (min), mAs, kV and distance to X-ray tube were converted to mSv. Procedures were grouped as follows: cholangiogram only (through previous drainage); placement of 1 external drain; 2 external drains; 1 internal/external drain; 1 stent; 2 or more stents; exchange of 1 drain; dilation of hepaticojejunostomy and transluminal forceps biopsy. Comparison was done between cholangiogram vs. diverse procedures, benign vs. malignant strictures and left- vs. right-sided approach. Data was expressed as median (range) due to non-parametric distribution. The Mann-Whitney U-test was used for statistical analysis. A p<0.05 was considered significant.
Results: Most stent placements, dilations and biopsies were done as combined procedures. Radiation data (mSv): for cholangiogram, 55.5 (5.5–377.5); 1 external drain, 189.3 (41.9–2442.6, p<0.01); 2 external drains, 375.5 (147.2–585.1, p<0.01); 1 internal/external drain, 269.3 (41.9–1434.4, p<0.01); 1 drain exchange, 103.0 (6.9–915.2, p=0.07); 1 stent, 190.4 (23.4–1169.6, p<0.01); 2 or more stents, 479.5 (39.5–1418.1, p<0.01); dilation, 162.8 (2.6–1152.0, p<0.05); biopsy, 322.8 (166.8–1584.9, p<0.01); left approach 159.5 (28.1–1424.9) vs. right 220.8 (28.1–1424.9) (p<0.05); benign 154.1 (2.6–2442.6) vs. malignant 212.9 (5.5—1584.9) (p<0.05).
Conclusion: Radiation produced during different percutaneous biliary interventions may vary widely. They are lower in transdrainage cholangiograms, left-sided access and benign strictures. However, due to potentially high-risk doses generated, safety protocols should be encouraged in every IR environment.

P-382

Comparison of transcatheter atrial septal defect closure in a novel approach to overcome the defect versus the standard approach

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Purpose: The aim of this research was to compare an innovative transcatheter closure (NoC) of atrial septal defect (ASD) with the standard closure (StC).
Material and Methods: In this retrospective study, 128 patients underwent either the StC or NoC at our center between September 2013 and August 2014. The occluder was selected according to intraprocedural transthoracic echocardiographic results. The novel step of NoC was that the delivery sheath containing the occluder crossed the defect from the right atrium to left atrium directly without a guidewire. Patients were followed up at 1, 3, 6 and 12 months after the procedure.
Results: A total of 127 patients were analysed (StC = 75 and NoC = 50). One patient was referred for surgery. No differences in baseline characteristics and comorbidities were found between the two groups. A total of 135 defects were confirmed in 127 patients, with a mean diameter of defects of 19 ± 7 mm (5–32 mm). One hundred twenty-six ASD devices with a mean diameter of 27 ± 8 mm (10–40 mm) and one 30/30 PFO device had been deployed successfully. The fluoroscopy time (239 ± 144 sec vs. 311 ± 124 sec, p = 0.003) and procedure time (33 ± 13 min vs. 40 ± 13 min, p = 0.003) were significantly lower in the NoC group. The complications were similar in the two groups.
Conclusion: The NoC, which removes the superselection of the superior left pulmonary vein, may reduce the time of procedure and fluoroscopy. The incidences of complications were similar to those in the StC.

P-383

Image noise reduction techniques for hepatic digital subtraction angiography: comparison between the half-dose and quarter-dose DSA acquisition of image quality

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Purpose: To evaluate the impact of image noise reduction techniques with quarter-dose DSA acquisition in hepatic DSA.
Material and Methods: Thirty consecutive patients (M:F=25:5; mean age, 64 years) with hepatocellular carcinoma underwent hepatic DSA with image noise reduction techniques during transcatheter arterial chemoembolization. Preliminary celiac or hepatic angiograms were obtained with half-dose DSA acquisition. After chemoembolization, follow-up celiac or hepatic angiograms were obtained with quarter-dose DSA acquisition. The dose-area product (DAP) was calculated for each image and compared. Three readers (two radiologists and one resident) evaluated image quality according to the five-score scale.
Results: The mean DAP per image was 0.837 mGy/cm^2±0.247 for the quarter-dose acquisition and 1.461 mGy/cm^2±0.447 for the half-dose acquisition. The mean dose reduction ratio was 42.4%±5.1 (p<0.001). The mean image quality scores were 4.667±0.479 for the quarter-dose acquisition and 4.733±0.450 for the half-dose acquisition. Overall image quality was not significantly different (p=0.601) between the two DSA acquisition techniques.
Conclusion: In the hepatic DSA, image noise reduction techniques with quarter-dose DSA acquisition reduced the patient entrance dose by 42.4% compared with half-dose DSA acquisition, without a significant loss in image quality.

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Interventional radiology in pregnant and lactating patients: fetal and neonatal risks

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Learning Objectives:
1. Discuss the stochastic and deterministic risks and the process of counselling prior to intervention.
2. Clarify the factors affecting the dose received by the fetus and ways of minimising fetal radiation.

3. We give an example of how the fetal radiation is calculated by our physics department and doses from our institution for the most likely procedures.

Background: Intervention on pregnant women is a subject most interventional radiologists regard with hesitation as

- there is no level I data and there will never be.
- wide range of issues and factors involved in calculating the risks from radiation, e.g. maternal dose, fetal dose, stage of gestation at the time of exposure.

Clinical Findings/Procedure: The most common procedures requested are placement of occlusion balloons where post-partum haemorrhage is expected, nephrostomy and inferior vena cava filter placement and renal artery angioplasty. We work with the physics department who are present during procedure to ensure conditions are optimised and to calculate the fetal dose. We have analyzed our procedure record and our institutional fetal doses, which are very helpful in counselling mothers prior to intervention. All our cases had a fetal radiation dose below the deterministic effect and most below the background risk for stochastic effects.

Conclusion: When intervention needs to be carried out on pregnant women, all measures to keep radiation to a minimum should be taken. Working with the physicists has been invaluable for optimising conditions for each case. Knowledge of the expected dose is vital in counselling women prior to intervention, which in our experience has been reassuring.

Renal and visceral artery intervention

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Italian National Multicentre survey on endovascular treatment of renal aneurysms

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Purpose: We report the Italian National Multicentre survey on endovascular embolization of renal aneurysms.

Material and Methods: We collected the clinical results on the endovascular embolization of renal aneurysms of 10 Italian National Centres: San Carlo Borromeo (Milan), San Raffaele (Milan), Molinette (Torin), Policlinico Tor Vergata (Rome), San Paolo (Milan), SS. Annunziata (Chieti), Santa Croce e Carle (Cuneo), Sant'Andrea (Rome), SS. Nicola e Filippo (Avezzano), and Humanitas (Milan). The indications for treating renal aneurysms included the following: symptomatic aneurysms, large (>2 cm) or enlarging aneurysms in patients anticipating pregnancy, and ruptured aneurysms.

Results: The total number of patients from the 10 Italian National Centres were 139 (99/139 males; 71%), with a mean age of 58 years (SD, ±17 years). Hypertension was found in 70 patients, hypercholesterolemia in 28 patients, and diabetes mellitus in 10 patients. The renal aneurysm diameter was <2 cm in 79 patients, 2–5 cm in 58 patients, and >5 cm in 2 patients. Endovascular embolization devices were as follows: coils in 52 patients, stent and coils in 39 patients, covered stent in 34 patients, flow diverter in 8 patients, and embolic liquids in 5 patients. Intra-procedural and subsequent complications were as follows: nontarget embolization (5 patients), aneurysm revascularization (4 patients), partial stent occlusion (2 patients), and renal perforation (that was embolized; 1 patient).

Conclusion: The treatment of renal aneurysm needs a multidisciplinary discussion, an accurate patient selection, tailored devices for patient anatomy, and procedure performed by expert operators with an adequate learning curve.

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Endovascular treatment of visceral artery aneurysms

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Purpose: Visceral artery aneurysms (VAAs) are intra-abdominal aneurysms that occur in the coeliac trunk and in superior and inferior mesenteric arteries or their branches. They are uncommon vascular anomalies but can be life-threatening, with mortality ranging from 10% to 25% and up to 75% in pregnant women. Currently available treatment options include transcatheter embolisation, percutaneous implantation of covered stent, or surgical resection. The aim of our study was to demonstrate the methods of minimally invasive endovascular treatment of the visceral artery aneurysms and to assess their applicability and efficacy.

Material and Methods: Between January 2000 and April 2014, 63 patients with VAAs (aged 23–81 years) underwent endovascular treatment. Different techniques were used: 34 aneurysms were embolised with coils, and covered stents were implanted in 19 patients; in 10 cases, transcatheter direct thrombin injection into the sack of the aneurysm was implemented.

Results: Almost all aneurysms (60/63) were successfully excluded from the circulation. Follow-up examinations with Doppler USG or angio-CT were performed in 53 patients between 3 and 18 months after treatment. No reperfusion of the aneurysmal sac was observed in any of the followed up patients. Satisfactory results were observed in all the 53 examined patients.

Conclusion: Percutaneous treatment of visceral artery aneurysms is both safe and effective. Endovascular treatment of these lesions should be considered as the primary treatment option. Good treatment results depend on proper assessment of the aneurysm's morphology by means of angio-CT or angiography as well as on the selection of an appropriate vascular approach and endovascular technique.

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Single-center experience in endovascular treatment of visceral artery aneurysms and pseudoaneurysms: embolization versus covered stenting versus combined approach

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Purpose: Visceral artery aneurysms (VAAs) and pseudoaneurysms (VAPAs) are rare but potential life-threatening entities. Our purpose was to evaluate all the endovascular treatment options.

Material and Methods: Eighty-one patients with a radiological diagnosis of VAA or VAPA were treated. A diagnostic angiography was performed to evaluate the most appropriate treatment: TAE with coils/polyvinyl alcohol (PVA)/vascular plugs (Amplatzer); self-expandable covered stenting (Viabahn, Gore); or combined approach (TAE and Viabahn). Etiology of the aneurysm, arterial approach, and vessel involved were recorded.

Results: VAA was diagnosed in 34/81 cases, and VAPA in 47/81.
Among the VAAs, a specific cause was identified in only 4/34 cases

(3 due to genetic disorders, 1 mycotic). Causes of VAPAs: 32/47 post-surgical; 9/47 post-percutaneous procedures; 4/47 post-pancreatitis; and 2/47 unknown. Femoral approach was chosen in 77/81 patients, and left transaxillary in the remaining 4. Arteries involved were splenic (23/81); hepatic (19/81); superior mesenteric (15/81); renal (13/81); gastroduodenal (8/81); and left gastric (2/81). TAE was chosen in 67/81 patients. Metallic coils, if necessary with PVA or vascular plugs, were used in 63/81 cases and PVA alone in 4/81. A covered stent was inserted in 10/81 cases, and 4/81 needed a combined approach. Considering all TAE, we observed clinical success in 65/67 patients (in 10 cases, thanks to a further TAE), excluding one death and one surgical resolution. In 15/67 patients, TAE induced ischemic areas in the organ treated (especially spleen and kidney). Except for the above-mentioned complications, covered stent placement was successful in all the patients.
Conclusion: Endovascular treatment of VAAs/VAPAs is a safe, feasible, mini-invasive procedure with low morbidity and mortality rates.

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Endovascular management of transplant renal artery stenosis: preliminary results

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Purpose: Transplant renal artery stenosis (TRAS) is a recognized complication resulting in post-transplant hypertension associated with allograft dysfunction, and has an incidence rate of 1%-23%. The diagnosis is suspected based on Doppler ultrasound images, while renal arteriography continues to be the gold standard for diagnostic confirmation and treatment. There is still controversy regarding the potential benefits of endovascular treatment of these lesions in terms of graft survival, improvement in renal function, and blood pressure normalization. The aim of this study was to assess the safety and efficiency of TRAS endovascular therapy.
Material and Methods: All cases of TRAS admitted for treatment in our unit from January 2011 to January 2015 were reviewed retrospectively. Freedom from reintervention, graft survival, postoperative serum creatinine level, blood pressure evolution, and the number of antihypertensive drugs pre- and postprocedure were analyzed.
Results: Nineteen patients (10 men, 9 women) presenting with TRAS were referred. Presentation was graft function alteration in 89.4%. Stenting was performed in all 19 patients. Freedom from reintervention rate was 94.7%. Serum creatinine levels decreased from 4.9 mg/dL (range, 0.7-10.1 mg/dL) preoperatively to 1.4 mg/dL (range, 0.7-3.0 mg/dL) at discharge. Glomerular filtration rates increased from 24 mL/min (range, 6.0-95 mL/min) to 62.7 mL/min (range, 39-106 mL/min). Systolic and diastolic blood pressure varied from 144 mmHg (range, 90-183 mmHg) and 81 mmHg (range, 108-60 mmHg) to 125 mmHg (range, 100-173 mmHg) and 74 mmHg (range, 60-84 mmHg), respectively. The number of antihypertensive medications remained unchanged.
Conclusion: Endovascular management of TRAS is safe and causes decrease in serum creatinine.

P-389

The efficacy of CO_2 angiography to detect active bleeding in the hemorrhage of colonic diverticula

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Purpose: Active bleeding of the colonic diverticulum is occasionally obscured on conventional angiography, although extravasation was revealed in a prior contrast-enhanced CT (CECT). The purpose of this study was to evaluate the efficacy of carbon-dioxide (CO_2) angiography in patients with active bleeding of the colonic diverticulum proven on CECT but obscured on conventional angiography.
Material and Methods: Between April and December 2014, 13 patients (8 women and 5 men; 65–88 years) underwent angiography for hemorrhage of the colonic diverticulum. Extravasation had been previously detected in dynamic CECT in nine patients. However, active bleeding could be detected in four patients in conventional angiography with iodinated contrast material. CO_2 angiography was applied in four cases among the remaining nine patients.
Results: In three of the four patients, active bleeding was detected with CO_2 angiography. Extravasation from the responsible vasa recta was detected in the prior CECT in these three patients. A microcatheter was successfully inserted into the responsible vasa recta in the three patients. No active bleeding was seen on CECT in the remaining one patient.
Conclusion: CO_2 angiography was useful to detect the bleeding point in colon diverticulum, even though extravasation was obscured on conventional angiography. Superselective microcatheter insertion into the responsible vasa recta was effective to prove the bleeding point with CO_2 angiography.

P-390

Transcatheter management of haemodynamically stable splenic injuries: CT score to guide therapeutic decisions

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Purpose: To identify a multi-detector computed tomography (MDCT)-based score for the therapeutic management of haemodynamically stable patients with blunt splenic injury.
Material and Methods: We retrospectively reviewed clinical and demographic data of all patients with splenic trauma admitted at our Emergency Care Unit between 2012 and 2014. Twenty-five haemodynamically stable patients (19 males; mean age, 44 years) were included. CT scans performed at admission were reviewed to create a score based on the following: amount of haemoperitoneum (scale, 0–3), presence of pseudoaneurysms (scale, 0–2), active bleeding (scale 0–1), and number of involved arterial branches (scale 0–2) and lesion location (scale 0–2). Lesion volume was calculated.
Results: Twelve (48%) patients underwent non-operative management (NOM), while in 13 (52%) patients, splenic arterial embolisation (SAE) was performed followed by splenectomy in 4 (30.7%) patients. The average number of hospitalisation was 12.3±5 days; no peri-procedural deaths occurred. By CT imaging, a 9-point scale score was created; three groups of patients were identified: minor risk (0–3), intermediate risk (4–6) and high risk (7–9). The score was significant ($P<.05$) related to the successful management of patients. Patients with a score of ≤3 were successfully treated with NOM; in patients with a score of 4–6, SAE was successful, while in patients with a score of >7, surgery may be required after SAE. On multivariate analysis, our CT score was the strongest predictor of successful management compared with AIS-90 and splenic injury scale scores.
Conclusion: In haemodynamically stable patients with blunt splenic trauma, the proposed CT score may facilitate therapeutic decisions, which identifies those patients requiring SAE.

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Revascularisation of high-grade bilateral renal artery stenosis: effects on hypertension, renal function and cardiovascular events

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Purpose: To investigate the effects of revascularisation of high-grade bilateral renal artery stenosis on renal function, hypertension and cardiovascular event occurrence.
Material and Methods: A total of 52 revascularisations for high-grade bilateral renal artery stenosis were performed between 2006 and 2011, 33 patients undergoing conservative treatment served as the control group. High-grade renal artery stenosis was assessed by colour-coded duplex ultrasound. The evolution of anti-hypertensive medication, renal function, hypertension, cardiovascular event occurrence and complications were compared between the two groups.
Results: The groups did not differ significantly. Average follow-up time was 34.5 months. At baseline, patients in the revascularisation group took significantly more anti-hypertensive drugs than the patients in the medical group (3.9 versus 3.0; $p<0.05$). Following revascularisation, the number of anti-hypertensive drugs was reduced by 0.76, while it increased by 0.47 in the conservative group ($p<0.0001$). Patients in the conservative group were hospitalised more frequently for heart failure (38.5% versus 13.6%; $p=0.016$). More patients in the conservative group died during follow-up (39.4% versus 10%; $p=0.041$). Serum creatinine tended to fall from 2.2 mg/dl to 1.8 mg/dl after intervention, and it did not change significantly in the conservative group (2 mg/dl at baseline and at the end of follow-up). Blood pressure changed from 154/78 mmHg to 140/73 mmHg after intervention and from 159/74 mmHg to 150/80 mmHg in the conservative group.
Conclusion: Our results suggest a benefit of revascularisation over medical therapy alone in patients with high-grade bilateral renal artery stenosis.

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Some of the peritoneal and retroperitonial bleedings could be SAM!

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Learning Objectives: To understand the clinical and radiologic features of segmental arterial medioysis (SAM) for accurate diagnosis and determination of appropriate treatments.
Background: SAM is a rare nonarteriosclerotic, noninflammatory vascular disease of unknown origin and presents with intra-abdominal bleeding, which may result in a life-threatening situation. Since the long-term natural history is unclear, there is no consensus on a definitive treatment of SAM.
Clinical Findings/Procedure:
- Aneurysmal rupture commonly presents with life-threatening abdominal, retroperitoneal, or intracranial hemorrhage, with a previously estimated mortality rate approaching nearly 50%.
- CTA or angiography is useful for making a radiologic diagnosis of SAM.
- Characteristic imaging findings of SAM include string of beads, fusiform and saccular formation of aneurysms, and arterial wall thickening and dissection.
- The treatment options are mainly laparotomy, TAE, and conservative therapy.
- Recently, several reports revealed that the unruptured aneurysms are rarely exacerbated and could be followed up by contrast-enhanced CT.

Conclusion: Accurate diagnosis based on CTA or DSA findings is crucial for appropriate treatment selection. Especially, the unruptured aneurysms may be closely followed up by contrast-enhanced CT.

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Role of interventional radiologist in splenic trauma

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Learning Objectives:
1. Recognition and classification of traumatic splenic injuries on CT scan.
2. Knowledge of interventional radiological procedures in traumatic splenic injuries.

Background: Trauma centres in the UK were established to care for patients with multiple serious injuries that could result in death or serious disability. Splenic injuries have often necessitated operative management traditionally; the advent of 24-hour imaging and interventional radiology has led to an increase in spleen-preserving therapy. This pictorial review focuses on the radiological appearance of various splenic injuries encountered in our level 1 trauma centre and corresponding interventional radiology management.
Clinical Findings/Procedure: We did a retrospective 6-year analysis of all traumatic splenic injuries and management, including interventional procedures.
Conclusion: The spleen is amongst the most commonly injured abdominal organ in blunt trauma. Radiologists should be aware of the imaging features and appropriate interventional treatment.

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Renal embolizations: simple to challenging case-based review

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Learning Objectives:
1. To provide an overview of renal pathology amenable to embolization.
2. To review the interventional radiology techniques for safe and successful treatment with maximum renal preservation.
3. To review the decision making using CT findings pertinent to embolization.
4. To learn which tools you always need to have on your shelves.

Background: In any major healthcare centre, renal pathology comprises a significant part of the daily practice of an interventional radiologist. There is a need to identify and comprehend the nature of the renal pathology to plan the treatment strategies and to assess the techniques and complications.
Clinical Findings/Procedure: Our department's experience in native and transplant kidney embolizations was reviewed to provide information about the pathology, renal preservation techniques, embolic materials, outcomes and disasters in challenging cases.
Conclusion:
1. Renal pathology amenable to embolization consists of traumatic and non-traumatic vascular lesions, as well as tumors.
2. Embolization treatment is safe and accurate.
3. New techniques focused in renal function preservation.
4. Nevertheless, in challenging cases, sacrifice of kidney branches might be unavoidable.

P-395

The role of interventional management in renal angiomyolipoma

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Learning Objectives:
1. To learn the roles of interventional radiology of renal angiomyolipoma.
2. To choose appropriate embolic agents for various situations.

Background: The roles and the methods of interventional management differ depending on the situation. The purpose of this presentation is to review the roles and methods of interventional radiology of renal angiomyolipoma based on the literature and the results from our institute.

Clinical Findings/Procedure: Interventional radiology has 3 roles against renal angiomyolipoma:

1. Size reduction

Symptoms caused by large tumor size are indications of embolization for size reduction. An appropriate size criterion has not yet been determined. Various methods for tumor reduction have been reported. At our institution, size-reduction rates with ethanol embolization are higher than those with coil embolization, but no evidence has been identified for a relationship between rate of tumor reduction and choice of embolic agent.

2. Embolization of aneurysm

Aneurysm size may be an important factor linked to rupture. Multiple regression analysis has shown that an aneurysm size of 5 mm or larger is predictive of bleeding. The point of an aneurysm embolization procedure in renal angiomyolipoma is to stop blood flow into the aneurysm. At our institution, coil isolation and/or packing are performed.

3. Hemostasis

Rupture of renal angiomyolipoma is life-threatening. The choice of embolic agent for hemostasis varies depending on the situation, such as vital signs, renal function, and distribution of tumor.

Conclusion: In interventional radiologic procedures for renal angiomyolipoma, appropriate embolic agents should be chosen based on the purpose of embolization and the status of the patient.

P-396

Successful thrombectomy of a transplant pancreatic vein thrombosis

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Eighteen days after combined en-bloc kidney-pancreas transplantation, a thrombosis of the graft pancreatic vein occurred. We performed a successful transvenous interventional thrombectomy using a combination of stent retriever, retraction thrombectomy, stent, aspiration and thrombolysis.

P-397

Endovascular management of a dissected 3-cm celiac trunk aneurysm: primary approach and relapse treatment

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In a 56-year-old man with collagen disease, angioCT revealed a 3-cm dissected celiac trunk aneurysm.
Two times we embolized the common hepatic artery with a 12-mm plug, preserving the splenic artery with a 12x80-mm covered stent and filling the aneurysmal sac with Onyx-18 and microcoils.

P-398

Multiple renal pseudoaneurysms from renal capsule stripping

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We present a case of two metachronous, anatomically distinct renal cortical pseudoaneurysms (PDA), arising from the torn distal cortical arteries, secondary to a large subcapsular haematoma stripping the renal capsule. Both were successfully treated by transarterial embolization.

P-399

Hybrid percutaneous endovascular stent placement for management of dissected graft hepatic artery during living donor liver transplantation

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Endovascular interventions are employed in arterial complications after liver transplantation but have not been used in a combined intraoperative approach. We report a case of intraoperative graft artery dissection during LDLT managed by hybrid microsurgical reconstruction and percutaneous endovascular stent placement.

P-400

Endovascular treatment of congenital hepatic arteriovenous fistula: a case report

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A 1-month-old infant with congestive heart failure. Ultrasound, duplex scan and CTA showed congenital an hepatic arteriovenous fistula with a large aneurysm. There has been no report of a fistula between the hepatic artery and hepatic vein. The patient was treated by endovascular coil embolisation.

P-401

Percutaneous thrombin injection for exclusion of non-catheterizable post-pancreatitis pseudoaneurysm of SMA: an effective and minimally invasive treatment option

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Post-pancreatitis pseudoaneurysms are not uncommon. These have high associated mortality due to propensity to rupture spontaneously. Current standards of treatment advocate immediate intravascular interventions. We describe two cases of non-catheterizable SMA pseudoaneurysms that were successfully treated with percutaneous thrombin injection.

P-402

Large renal angiomyolipoma pseudoaneurysm with inferior vena caval thrombus treated with transarterial embolization in a young girl with tuberous sclerosis: a case report

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A 14-year-old girl with known tuberous sclerosis underwent successful treatment with trans-arterial coil embolization of an 11-cm pseudoaneurysm within a right renal angiomyolipoma complicated by renal vein and vena caval tumour thrombus after presenting with haemorrhage and hypovolemic shock.

P-403

Successful embolization of a 4-cm common and proper hepatic artery aneurysm in a patient with Loeys–Dietz syndrome using uniquely fibered coils: sometimes the best way is also the easiest

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A woman with Loeys–Dietz syndrome had a very complex shaped common and proper hepatic artery aneurysm involving the left hepatic artery and the gastroduodenal artery. We considered many embolizing options, but finally the easiest way was also the best.

P-404

Embolization of symptomatic arterioportal shunts of the liver: two cases

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We embolized arterioportal shunts of the liver in two cases with massive ascites using coils and NBCA. Embolization decreased ascites in both cases, and renal function improved due to relief of IVC compression in one case.

P-405

Transcatheter embolization of failed renal allograft secondary to post-transplant lymphoproliferative disorder (PTLD)

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A 52-year-old male 16 months after left iliac fossa kidney transplant was admitted with subacute graft intolerance syndrome and concurrent post-transplant lymphoproliferative disorder (PTLD). He was successfully managed with endovascular embolization, proven as an effective and safe alternative to open transplantectomy.

P-406

Percutaneous endovascular stent-graft implantation in a post-traumatic superior mesenteric artery pseudoaneurysm with high-flow arterio-venous shunt

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This is a case of endovascular repair of a post-traumatic superior mesenteric artery pseudoaneurysm with high-flow arterio-venous shunt, by positioning a covered stent over the pseudoaneurysm neck, leading to complete resolution of intestinal ischaemia and associated symptomatology.

TIPS and portal vein intervention

P-407

Portal vein embolization via an ipsilateral approach is safe and effective

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Purpose: Portal vein embolization (PVE) is a well-established technique to induce hypertrophy of the future liver remnant in patients scheduled to undergo extended hemihepatectomy. Histoacryl is an inexpensive and reliable embolizing agent but difficult to control. Therefore, if histoacryl is used, usually, a contralateral approach is chosen to avoid non-target embolization. However, a puncture route through the contralateral lobe, i.e., the future liver remnant, has its own downsides. We therefore evaluated the safety of histoacryl-based PVE using an ipsilateral approach.
Material and Methods: Between January 2010 and July 2014, a total 107 PVEs (68 males, 39 females; age 22-84 years, mean 60.37) of the right portal system were performed via percutaneous transhepatic right-sided approach. Right portal branches (S V-VIII) were embolized with a histoacryl/Lipiodol mixture. We recorded the success rates and rates of complications following ipsilateral histoacryl-based PVE.
Results: In 106 patients, PVE was technically successful. In one patient, no appropriate access to the right portal system could be established due to massive right-sided tumor load. In 2/106 patients (1.8%), histoacryl/ Lipiodol dislocated into the main portal trunk and caused non-target embolization, requiring anticoagulation with prolonged hospitalization for 72 hours. A total of 103/106 (98.2%) right-sided ipsilateral histoacryl-based PVE procedures were completed successfully without non-target embolization. Three patients (3/106, 2.8%) developed severe sepsis after the procedure. A total of 77 patients (72.6%) finally underwent successful extended hemihepatectomy.

Conclusion: PVE with histoacryl using an ipsilateral approach is a safe and effective technique to prepare for liver surgery. In experienced hands, non-target embolization is rare.

P-408

Management of Budd-Chiari syndrome by transjugular intrahepatic portosystemic shunt

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Purpose: Budd-Chiari Syndrome (BCS) is a rare heterogonous disorder characterized by hepatic veins, infrahepatic or suprahepatic inferior vena cava obstruction, which leads to hepatic congestion. BCS can be treated medically or surgically or by interventional procedures such as intrahepatic portosystemic shunt (TIPS), which is very effective with most reports indicating promising results. The purpose of this study was to evaluate the long-term outcome of BCS patients treated with TIPS at our Institution.
Material and Methods: Twenty patients with BCS were treated with TIPS at our institution from 2002 to 2011. The clinical records of 19 patients are reviewed retrospectively. The Child-Turcotte-Pugh (CTP) score was used as a clinical follow-up standard.
Results: All TIPS procedures were successful with no mortality or major morbidity associated with this procedure. Of the 19 patients (17, 89%) had patent shunts; however, some required endovascular revisions for occlusion. Only two patients underwent orthotropic liver transplant and the remaining 17 patients maintained stable liver function. All 19 patients (100%) showed clinical and rapid biochemical improvement from the time of procedure until the time of this study. The CTP showed significant decrease in the value between pre-shunt and the last post-shunt follow-ups.
Conclusion: TIPS is very effective in the management of BCS. It is safe and feasible as well as improves survival.

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Real-time 3D CT-image guidance for transjugular intrahepatic portosystemic shunt creation using preoperative CT: a feasibility study

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WITHDRAWN

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Percutaneous imaging-guided management of PV patency and integrity problems: catheter-directed local thrombolysis, stenting, endoluminal RFA & angioplasty or endoluminal RFA & stenting

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Purpose: The spectrum percutaneous restoration techniques for managing PV patency and integrity is presented.
Material and Methods: Of 23 patients with PV patency problem, 19 underwent percutaneous recanalization using endovascular bipolar radiofrequency device. RFA was followed by balloon angioplasty (7 cases; 6 - HCC, 1 - retroperitoneal sarcoma) or vascular stent placement (12 cases; 11 - HCC, 1 - liver cirrhosis). In 2 cases (thrombophilia and HCC), catheter-directed local thrombolysis was performed. In 2 cases of pancreatitis-induced PV stricture and 1 case of pancreatitis-induced PV stricture with porto-biliary fistula, PV stenting was performed. PV was accessed under US guidance and 5G guide catheter was manipulated through the block using guidewire technique under DSA guidance. In case of thrombolysis, thrombolytic agent was injected directly below the thrombus; the stenting procedure was completed by self-expanding vascular stent placement; for RFA processing, the endoluminal radiofrequency device was inserted into the thrombus; the procedure was completed by immediate balloon angioplasty or stenting.
Results: The technical success rate was 82.60%; in 4 cases (17.4%), wire conduction through the organized thrombus was impossible. Postprocedure portography documented significantly improved portal vein blood flow in all patients in whom the procedure was completed. Porto-biliary fistula was successfully managed by percutaneous stenting. Patients tolerated the procedure easily; no intraprocedural complications were detected. In 1 case, serious postprocedure bleeding was documented, which led to multiorgan failure and death.
Conclusion: The percutaneous management of PV patency and integrity problems is effective and should be suggested as a treatment option in selected patients. Procedure track ablation or embolization might prevent bleeding.

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Association of TIPS location along the portal vein with post-procedure bleeding risk in the era of covered stents: results from an 80-patient cohort

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Purpose: The transjugular intrahepatic portosystemic shunt (TIPS) is a procedure used to alleviate the consequences of portal hypertension. Historically, the goal of the operator has been to place the TIPS shunt entirely within the parenchyma of the liver to prevent intraperitoneal extravasation. However, the new PTFE-covered stents, employed to improve patency of the shunt, may make this consideration obsolete, since they provide a contained passage for blood flow.
Material and Methods: We retrospectively studied 80 patients receiving TIPS for indications other than variceal bleed using a covered stent stratified by distance of the shunt from the portal bifrucation: <10mm, 10-20mm, or >20 mm as determined by portal venogram. The outcomes of interest were transfusion, bleeding interventions, use of vasopressors, survival to discharge, number of days to discharge, and change in hematocrit post-procedure.
Results: Thirty-eight patients had a shunt <10 mm from the bifurcation, 24 were 10-20 mm, and 18 had a shunt >20 mm. Mean age was 57 years, and the groups were similar in sex, MELD score, and indication. There was no significant difference between the groups in any of the outcomes of interest, although there was a nonsignificant trend toward patients with TIPS less than 10 mm from the bifurcation having poorer results in each outcome variable.
Conclusion: This preliminary study indicated that patients with PTFE-covered TIPS placed close to the portal bifurcation may still be at increased risk for bleeding events compared to those with covered TIPS placed far from the portal bifurcation.

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A prospective, multicenter study of vascular plug-assisted retrograde transvenous obliteration for the treatment of gastric varices and hepatic encephalopathy

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Purpose: To evaluate the technical and clinical outcomes of vascular plug-assisted retrograde transvenous obliteration (PARTO) for the treatment of gastric varices (GV) and hepatic encephalopathy (HE).
Material and Methods: From March 2012 to June 2014, 73 patients (57, GV; 16, HE) who had undergone PARTO were evaluated in a prospective, uncontrolled multicenter study. Follow-up computed tomography (CT), upper intestinal endoscopy, and clinical and laboratory data were collected to evaluate study endpoints, including technical success, procedure-related complications, clinical success, and follow-up clinical results.
Results: Placement of the vascular plug and subsequent gelatin sponge embolization were technically successful in all 73 patients. The mean procedure time from vascular plug placement to vascular plug detachment was 24 minutes (range, 11–124 minutes). There were no procedure-related complications. Follow-up CT obtained within one week after PARTO showed complete thrombosis of both GV and portosystemic shunts in 72 (98.6%) of 73 patients. Sixty patients who underwent follow-up longer than 3 months showed complete obliteration of GV and portosystemic shunts. Improvement in the Child–Pugh score was observed in 24 (40%) patients at the one-month follow-up. Worsening of ascites and esophageal varices was observed in 14 patients (23.3%) and 16 (26.7%) at the three-month follow-up.
Conclusion: Our present results of PARTO indicate it is technically simple and safe and is clinically effective for the treatment of GV and HE in the presence of a portosystemic shunt. Therefore, PARTO should be considered a valuable treatment modality because of very high clinical success rate and short procedure time without possible complications.

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Radiation exposure during transjugular intrahepatic portosystemic shunt creation: single-center experience

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Purpose: Transjugular intrahepatic portosystemic shunt (TIPS) creation is considered to be one of the most radiation-intensive procedures in interventional radiology. The aim of this study was the evaluation of patient radiation exposure during TIPS creation at our center.
Material and Methods: From 1/2007 to 1/2015, 347 consecutive patients underwent TIPS at our hospital. Procedures were divided into three groups based on different generations of angiography systems and radiological technique used: (I) image intensifier-based angiographic system (IIDS) and the use of anatomic landmark to catheterize the portal system (N=88); (II) IIDS and real-time sonographic guidance to catheterize the portal system (N=48); and (III) flat panel detector-based system (FPDS) and real-time sonographic guidance to catheterize the portal system (N=211). Procedures were retrospectively analyzed for radiation exposure. Fluoroscopy time (FT) given in minutes and dose-area product (DAP) given in cGycm^2 were documented.
Results: The group III had a significantly lower DAP (12907±16748 cGycm^2) compared with that of group II (21771±13098 cGycm^2; p=0.002) and group I (36086±29809 cGycm^2; p<0.001). The difference in DAP between group III and group II was also significant (p<0.001). FT was not significantly different between group II (20.45±10.87 min) and group III (19.76±13.34; p=0.73), while it was significantly lower in group II (25.78±13.52; p=0.02) and group III (p<0.001) when compared with group I.
Conclusion: The use of modern angiographic units with FPDS and real-time sonographic guidance to catheterize the portal system led to a significantly lower radiation exposure and reduced FT during TIPS creation.

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Stent dysfunction following transjugular intrahepatic portosystemic shunt: 14-year experience from a single tertiary medical center

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Purpose: To investigate the clinical outcomes following TIPS with use of bare stents and to assess the risk factor for stent dysfunction.
Material and Methods: A total of 102 patients who underwent TIPS (January 1999 to December 2012) were retrospectively assessed. The incidence of stent dysfunction was determined, and the risk factors associated with it were analyzed using univariate log-rank and multiple Cox's regression analyses.
Results: During the mean follow-up period of 1889 days, recurrence of symptoms was observed in 51 (50%) patients and TIPS revision was required in 37 (36%) patients due to stent dysfunction. The causes of stent dysfunction were stenosis (n=32) and thrombosis (n=5). The location of the stenosis in 32 patients was parenchymal tract (n=22), hepatic venous side (n=8), or portal venous side (n=2). Median stent patency and survival times were 470 days (95% CI 310-630 days) and 1783 days (95% CI 1145-2421 days), respectively. Multiple Cox's regression analysis showed that the portal trunk access (p=.006; OR 2.56; 95% CI 1.3-5.04) was the only independent risk factor of stent dysfunction. Median stent patency with segmental branch access (538 days; 95% CI 0-1204 days) was significantly longer than that in portal trunk access (245 days; 95% CI 104-386 days) (p=.007). There were no significant differences in patient survival (p=.648), worsening of encephalopathy (p=.742), and major complications (p=1.000) between segmental and portal trunk accesses.
Conclusion: TIPS created with segmental branch access has superior patency compared to TIPS with portal trunk.

P-415

Safety and efficacy of sodium tetradecyl sulphate and lipiodol foam in balloon-occluded retrograde transvenous obliteration (BRTO) for large lieno-/gastrorenal shunt

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Purpose: To evaluate the safety and efficacy of sodium tetradecyl sulphate and lipiodol foam (STS foam) in BRTO for gastric fundal varices and large (caliber ≥ 15 mm) lieno-/gastrorenal shunt.
Material and Methods: Forty-eight sessions of BRTO were performed in 46 patients using STS foam. All patients had cirrhosis with a history of gastric variceal bleed or recurrent hepatic encephalopathy (HE) and lieno-/gastrorenal shunt. Clinical and laboratory parameters were evaluated before and after the procedure. All patients were followed up for minimum of 12 months.

Inclusion criteria: Only patients with shunt ≥ 15 mm were included. Exclusion criteria: CTP score ≥ 10, refractory ascites/HCC, and serum bilirubin ≥ 2.5 mg/dl.
Results: Twenty-seven patients had shunt with caliber ≥ 15 mm. Majority of patients were male (M:F = 21:6, mean age, 57 years), and 7 of them had Child's class A cirrhosis, 15 had Child's class B and the rest had Child's class C. Technical success was achieved in 27/28 sessions. Complete obliteration of shunt with clinical improvement was seen in all cases. Patients with gastric varices had no residual varices on follow-up endoscopy. Post-procedure complication (ascites, septicemia) was encountered in 4 patients, and 5 showed worsening of esophageal varices at 3-12 months and underwent endoscopic variceal ligation. Thirty-day post-procedure mortality was observed in one patient (succumbed to sepsis at 4 weeks); the rest were clinically better on discharge and up to a follow-up of 30 months.
Conclusion: Our experience suggests that STS foam is an effective agent for patients with a large shunt undergoing BRTO and offers comparable results in regards to other available agents.

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Long-term efficacy and safety of balloon-occluded retrograde transvenous obliteration of portosystemic shunts in patients with hepatic encephalopathy

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Purpose: We evaluated the long-term efficacy and safety of balloon-occluded retrograde transvenous obliteration (BRTO) in the management of hepatic encephalopathy (HE) due to portosystemic shunts.
Material and Methods: Sixteen patients with HE due to portosystemic shunts underwent BRTO in our department from April 2009 to September 2013. Technical success, clinical symptoms, and laboratory examinations were evaluated. To evaluate the complications of BRTO, CT and endoscopy were performed. Serum ammonia levels and Child-Pugh scores were analyzed pre-BRTO and at 1, 3, 6, and 12 months post-BRTO.
Results: The technical success rates were 100% (16 of 16). The average follow-up period was 11.0±7.03 months. One case had a recurrence of HE 10 months later. The average serum ammonia levels at 1, 3, 6, and 12 months post-BRTO were 60.0±25.3 mg/dL (n=16), 73.7±27.0 mg/dL (n=12), 90.8±40.5 mg/dL (n=12), and 83.1±18.1 mg/dL (n=7). The average Child-Pugh scores at 1, 3, 6, and 12 months post-BRTO were 7.50±1.03 (n=16), 7.17±1.03 (n=12), 7.42±1.24 (n=12), and 6.14±1.35 (n=7). The serum ammonia levels and the Child-Pugh scores were significantly better than the pre-BRTO levels (all $p<0.001$). Increased ascites were observed in three cases. Endoscopic examination post-BRTO showed an aggravation of esophageal varices in two cases and an aggravation of gastric varices in one case.
Conclusion: BRTO for HE with portosystemic shunts is an effective and safe procedure, and it improves liver function in the long term.

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Gross visual appearance of ascites fluid predicts post-TIPS mortality: a retrospective study of 133 patients

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Purpose: While the safety of TIPS has improved as the procedure has matured, it is still not risk free, and prognostic tools are an important part of patient selection. In patients receiving TIPS for refractory ascites or hydrothorax, the procedure is almost invariably preceded by a paracentesis or thoracentesis. The purpose of this study was to evaluate the characteristics of the extracted fluid for prognostically significant factors in patients receiving TIPS.
Material and Methods: In all, 133 patients who received a diagnostic paracentesis or thoracentesis within 1 week of TIPS were included in this study. Seventeen different fluid content variables, including fluid color, clarity, white blood cell type and counts, LDH, glucose, and protein, were investigated for correlation with any of three outcome variables: postprocedure infection, hepatic encephalopathy, and one-year mortality.
Results: Bloody or slightly bloody fluid was associated with a significantly higher mortality risk when compared with clear fluid (HR 3.07 and 2.78, respectively). Fluid monocyte count (HR 1.04 per 50 unit increase), neutrophil count (HR 1.04/50 unit increase), mesothelial cell count (HR 1.23/50 unit increase), and white blood cell count (HR 1.01/50 unit increase) were all significantly correlated with higher mortality. No variable was significantly associated with infection or encephalopathy.
Conclusion: This study found that grossly bloody ascites fluid is strongly correlated with a higher post-TIPS mortality risk. Examination of paracentesis or thoracentesis fluid prior to TIPS, in addition to MELD score and other factors, could be a valuable prognostic tool in selecting patients for TIPS.

P-418

Real-time image guidance in TIPS using 4D ultrasound

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Purpose: The intrahepatic puncture has been identified as the most challenging step of the transjugular intrahepatic portosystemic shunt (TIPS) procedure. The aim of the interventional radiologist is to puncture from the hepatic vein to the portal vein through the liver. Current imaging techniques that are used in this procedure do not provide the physician with three-dimensional (3D) and real-time information about anatomy and instruments. This lack of information makes the procedure risky and time consuming. The aim of this research is to improve the image guidance using a combination of four-dimensional (4D) ultrasound (US), preinterventional planning, image registration, and real-time navigation.
Material and Methods: A planning and navigation software has been implemented in MeVisLab using 3D and 4D US data recorded with Philips iU22 US machine. Planning information performed on a static US volume is transferred to an interventional setup. A registration algorithm is implemented to compensate the breathing motion, and it is accelerated using graphics processing unit (GPU) hardware.

Results: The software allows the physician to plan the trajectory of the needle in a 3D US image using criteria such as the length and angulation of the trajectory. The navigation images are defined based on the planned trajectory and enable the physician to have constant feedback about the anatomy and the needle. A registration algorithm ensures that the real-time image is updated according to the planning data.
Conclusion: We present an application user interface, which will help 4D ultrasound-based image guidance in TIPS and other minimally invasive procedures. Preliminary test results are encouraging.

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Effect of body composition on liver hypertrophy after portal vein embolization prior to major liver resection measured by CT volumetry

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Purpose: To evaluate the effect of body composition measured by CT volumetry on liver hypertrophy after portal vein embolization prior to major liver resection.
Material and Methods: Native and contrast-enhanced CT scans of 54 patients with liver malignancies (17 HCC, 6 CCC, and 31 metastases) were evaluated. Muscle volumes at L3 vertebra were measured. Muscle volume less than 39 cm^2/m^2 (female) and 55 cm^2/m^2 (male) was considered as sarcopenia. Patients with BMI of ≥25 kg/m^2 were considered as obese. Estimated future liver remnant (FLR) was measured with CT volumetry.
Results: Among the 17 female patients none had sarcopenia, 18% had normal weight, 82% were obese, and these results for the male patients were 48.6%, 22%, and 29.4%, respectively. FLR volume increase of the obese patients was lower than that of the normal weight patients (48.68 ± 32.58% vs. 90.12 ± 43.78%). Patients with normal BMI and sarcopenia had significantly lower FLR increment after PVE (22.51 ± 27.94% vs. 90.12 ± 43.78%, $p < 0.01$). Patients with obesity and sarcopenia had significantly lower FLR hypertrophy than patients with normal BMI without sarcopenia (28.36 ± 13.76% vs. 90.12 ± 43.78%).
Conclusion: Patients with sarcopenia have impaired liver regeneration. Assessment of body composition before portal vein embolization therefore is important and if necessary, nutritional correction should be performed.

P-420

Endovascular rescue of malfunctioning surgical shunts used in treatment of children with portal hypertension: case report and review of portal vein thrombosis management in children

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Learning Objectives: To understand the radiographic evaluation of surgically placed portosystemic shunts. To outline the current percutaneous endovascular approaches in the repair of shunt stenosis and/or thrombosis. To observe the effectiveness of endovascular management of shunt malfunction and review the management of pediatric portal hypertension.
Background: Portal vein thrombosis (PVT) leads to portal hypertension in children. Surgical shunts can decompress the portal system after conservative options fail. Though effective, complications include stenosis and/or thrombosis, causing malfunction and eventual failure. Current endovascular approaches allow repair of these complications, potentially avoiding surgical revision or new shunt placement.
Clinical Findings/Procedure:
Case 1: A 10-year-old male with history of biliary atresia developed PVT and cavernous transformation after Kasai procedure and liver transplantation. A distal splenorenal shunt was surgically created. He presented with chronic low-grade lower GI bleeding, and CT venogram raised concern for shunt stenosis. Diagnostic venography confirmed stenosis and elevated pressure gradient, which were successfully treated with balloon angioplasty, leading to resolution of GI bleeding.
Case 2: An 8-year-old male with history of prematurity and necrotizing enterocolitis developed PVT with cavernous transformation. A mesocaval shunt was surgically placed at age 5. Two years later, he presented with encephalopathy, marked splenomegaly, and abdominal pain secondary to shunt thrombosis. Percutaneous pharmacomechanical thrombectomy (PMT) and angioplasty successfully restored flow through the shunt and lead to clinical improvement.
Conclusion: Two patients underwent successful shunt recanalization with clinical improvement. No complications were encountered. Malfunctioning mesocaval and splenorenal shunts can be managed using percutaneous endovascular techniques.

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Balloon-occluded retrograde transvenous obliteration for gastric varices with foam sclerosant: how foam sclerosant changed our procedure

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Learning Objectives:
1. To determine the difference between balloon-occluded retrograde transvenous obliteration (BRTO) for gastric varices with foam sclerosant and conventional liquid BRTO.
2. To learn the benefits of balloon-occluded retrograde transvenous venography (BRTV) with carbon dioxide (CO_2) and BRTO using foam sclerosant.

Background: BRTO is an effective therapeutic option for gastric varices. It has been developed, particularly in Asia, for the past two decades, and is now becoming a common IR procedure worldwide. However, difficulties in technical aspects and complexities in the anatomy of collateral drainage veins from gastric varices are obstacles to performing BRTO. In recent years, the procedural details of BRTO have drastically changed by the introduction of BRTV with CO_2 and BRTO with foam sclerosant.
Clinical Findings/Procedure: This presentation shows our cases of CO_2 BRTV and foam BRTO, particularly focusing on the following points to achieve effective obliteration of gastric varices:
1. Differences in kinetics between liquid contrast material and CO_2
2. Benefits of foam sclerosant compared to liquid agents
3. Details of the foam BRTO procedure and device: technical tips and pitfalls
4. How to determine the end point of the sclerosant injection

Conclusion: BRTO is an effective procedure for gastric varices despite several difficulties. These obstacles can be overcome with CO_2 BRTV and foam BRTO, which are promising treatment options to achieve success.

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Endovascular treatment of congenital extrahepatic portosystemic shunt (CEPS): our experience

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Learning Objectives: Describe the classification, anatomy and embryology, clinical features, and endovascular treatment of CEPS.
Background: CEPS is a rare condition in which the portomesenteric blood drains into a systemic vein, bypassing the liver through a complete or partial shunt. It was first described in 1973 by John Abernethy. Two well-defined types are described. Type 1 (complete): without portal perfusion to the liver; this is subclassified into 1a (splenic vein and superior mesenteric vein drain separately) and 1b (both drain together as a trunk). Type 2 (partial): with a remaining degree of portal perfusion.
The etiology remains unknown, but most likely an abnormal embryological development of the PV.
CEPS can cause a wide spectrum of clinical manifestations and frequently can be associated with other congenital abnormalities.
Clinical Findings/Procedure: We present 5 cases with type 2 CEPS diagnosed and treated in 2014 in our institution. Four patients were treated endovascularly, either in 1 or 2 steps, and 1 was treated surgically. A degree of encephalopathy and portal hypertension was seen in all patients. All were treated by the right jugular vein approach, with different embolic devices. The follow-up has been satisfactory, with complete shunt occlusion and clinical improvement.
Conclusion:
1. CEPS is a rare vascular malformation.
2. A multidisciplinary team has an important role in the diagnosis and management of such patients. Treatment involves liver transplantation for symptomatic type 1 CEPS and surgical closure or embolization for type 2 CEPS.
3. The endovascular treatment in 1 or 2 steps is a safe, feasible, and good treatment option.

P-423

Balloon-occluded retrograde transvenous obliteration successfully performed for a large gastric varix in combination with temporary occlusion of the splenic artery in a child

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We encountered a 10-year-old boy with a gastric varix, which was successfully treated with the occlusion of the splenic artery by the inflation of a balloon catheter during balloon-occluded retrograde transvenous obliteration (B-RTO).

P-424

A novel technique for graded reduction of a gastrorenal shunt in a cirrhotic patient with severe, intractable hepatic encephalopathy

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Cirrhotic with large gastrorenal shunt, intractable encephalopathy. Simon nitinol IVC filter placement in the gastrorenal shunt as scaffold. Detachable coils deployed beyond filter, with simultaneous measurement of intrahepatic pressures to target gradient. Hepatic gradient increased, 7-11 mmHg. Improved mentation, resolved asterixis.

P-425

Portal vein stenosis caused by postoperative pseudoaneurysm in hepatic artery that was treated by transcatheter arterial embolization and portal stent placement

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A 65-year-old male underwent hepatectomy and had intra-abdominal bleeding. CT revealed a large pseudoaneurysm in the hepatic artery, adjacent to the flattened portal vein. Arterial embolization and portal stent placement were performed. Patient has survived for over 4 years, without evidence of stent occlusion.

P-426

Successful management for duodenal varices by balloon-occluded retrograde transvenous obliteration via the right gonadal vein

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A 50-year-old man had tarry stool. CT confirmed duodenal varices draining into the right gonadal vein. Balloon-occluded retrograde transvenous obliteration (BRTO) via the right gonadal approach was performed successfully. We conclude that BRTO is an effective treatment for duodenal varices.

P-427

TIPS implantation as a safe treatment of radiation-induced liver disease (REILD)-related refractory ascites

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A 56-year-old female with a history of breast cancer underwent radioembolization twice for hepatic metastases. After the second treatment, she developed refractory ascites in a radioembolization-induced liver disease context, which was successfully treated with transjugular intrahepatic portosystemic shunt.

P-428

An innovative percutaneous approach with covered stent on portal vein stenosis after iatrogenic injuries

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A male patient underwent a percutaneous portal vein repair with a covered balloon-expandable Jostent, using the TIPS technique, for an iatrogenic injury during left hepatic resection for intrahepatic stones. Follow-up showed regular stent patency.

P-429

Ultrasound-accelerated thrombolysis of a blocked TIPS

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A 49-year-old woman underwent elective TIPS insertion. A failure of symptomatic improvement led to a follow-up CT, which demonstrated TIPS and main portal vein occlusion. This was successfully treated with ultrasound-accelerated thrombolysis using the EKOS system.

P-430

Thrombosis of a large extra-hepatic portal vein aneurysm: endovascular treatment

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A 24-year-old woman with severe abdominal pain caused by a giant, completely thrombosed, extrahepatic portal vein aneurysm extending to superior mesenteric and splenic veins. Treatment was performed by transcatheter intravenous thrombolysis and thrombectomy and transjugular intrahepatic portosystemic shunt creation.

P-431

Percutaneous balloon angioplasty of a narrowed accessory hepatic vein (AcHV) in Budd–Chiari syndrome (BCS)

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A female with BCS presented with gastroesophageal varices. One extremely narrowed AcHV was seen, while other main HVs were occluded. Transhepatic angioplasty was performed for the AcHV. The varices improved without complications. Postoperative course was uneventful at 8 months.

P-432

Percutaneous transportal sclerotherapy treated with n-butyl-2-cyanoacrylate after coil embolization of outflow vessel for gastric varices: a case report

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We present the case of a 66-year-old woman with gastric varices unmanageable by BRTO and treated by percutaneous transhepatic sclerotherapy (PTS) with NBCA after coil embolization. The procedure was effective as an alternative treatment for BRTO; no major complication was encountered.

P-433

Percutaneous transhepatic thrombolysis of symptomatic splenic and portal vein thrombosis after liver transplantation with splenectomy

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A 47-year-old post-liver transplantation female presented with symptomatic portal and splenic vein thrombosis. Percutaneous transhepatic access and subsequent thrombolysis of the portal vein for three days, followed by stent implantation was performed, with almost complete reperfusion of the extra- and intrahepatic portal vein.

Urinary tract intervention

P-434

Safety and efficacy of focal laser ablation (FLA) for organ-confined prostate cancer

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Purpose: Prostate FLA is an interventional technique to treat organ-confined, MRI-visible lesions. The purpose of this study is to examine the effect of FLA on men's urinary and sexual function as well as its ability to control prostate cancers.
Material and Methods: We treated 90 patients since 2013. Eligible patients had focal lesions visible by MRI that were biopsy-proven prostate cancer below a Gleason 8 grade. Ineligible patients had lesions over 2 cm, extracapsular tumor, metastases, or contraindications to MRI.
Patients in this study scored their baseline erectile and urinary functions, and this was repeated at follow-up.
FLA involved transrectal MRI-guided application of diode laser energy, which was monitored by real-time MRI thermometry. MR and PSA follow-up occurred at 6 months and then yearly.
Results: All procedures were successful. One major complication was a rectourethral fistula. Minor and limited events included urgency (n=4), groin pain (n=5), and one bacteremia. Two patients developed new erectile dysfunction: both had bilateral ablations. Six patients (6.7%) required a second FLA. Urinary and sexual function did not differ at 6 months (27 patients with erectile scores of 22.1 pre-FLA and 21.0 post-FLA, p=0.23 and urinary scores 8.5 pre-FLA and 7.5 post-FLA, p=0.39), and function remained stable in the 9 patients followed up for 1 year.
Conclusion: FLA for prostate cancer is safe and has a less than 7% retreatment rate. It has no significant impact on sexual or urinary function, although bilateral disease should be treated carefully. In selected cases, focal treatment of prostate cancer is the primary therapy.

P-435

A newly developed paclitaxel-eluting balloon catheter to prevent granulation tissue formation in a rat urethral model

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Purpose: To evaluate the effectiveness of a newly developed paclitaxel-eluting balloon catheter in preventing granulation tissue formation in a rat urethral model.
Material and Methods: All experiments were approved by the Committee of Animal Research. In 16 Sprague–Dawley male rats (weight range, 300–350 g), a self-expanding metallic bare stent was inserted in the urethra under fluoroscopic guidance. One group of eight rats was treated with paclitaxel-eluting balloon catheter immediately and two weeks after stent placement (group A), while the other group of eight rats received control balloon dilation (group B). Retrograde urethrographies (RGUs) were performed at two and four weeks after stent placement, and all rats were sacrificed at four weeks for histological analysis.
Results: Stent placement and balloon dilation were technically successful in all rats. The average luminal diameter of the stented urethra was significantly larger in group A than in group B on performing follow-up RGU four weeks after stent placement ($P = 0.003$). Histological analysis showed that the percentage of granulation tissue area ($P < .001$), thickness of submucosal fibrosis ($P < .001$), and the number of epithelial layers ($P < .001$) were significantly decreased in group A compared with those in group B. The grade of average inflammatory cell infiltration was not different between the two groups.
Conclusion: The paclitaxel-eluting balloon catheter was effective for the prevention of granulation tissue formation after bare metallic stent placement in a rat urethral model.

P-436

Efficacy of minimally invasive IR procedures in the management of ureteral dehiscence and strictures established by long-term follow-up (10-24 years)

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Purpose: To identify types of ureteral injuries or strictures prone to successful management by IR procedures and to analyze the advantageous cost factors vis-a-vis competitive surgical interventions
Material and Methods: A retrospective study was carried out on 232 patients (134 males, 94 females, 4 children) treated by minimally invasive IR procedures such as percutaneous nephrostomy, stenting with double "J" antegrade stents, balloon dilatation, cutting balloon dilatation, antegrade metallic stents, image-guided ureteroneocystotomy, and stents, with 10–24-year follow-up (mean 13.4 years) to assess rate of success, state of renal function (creatinine, GFR), late complications, and cost for various types of ureteral injuries. Techniques of various IR interventions are described.
Results: Rate of success of IR procedures varied greatly for different types of ureteral injuries and also condition of vascular supply to the injured segment and age of the prevailing condition. For recent iatrogenic injuries, rate of success was 92%; for short stricture with good vascular supply, 85%; for low-velocity projectile injuries with good vascular supply, 76%; for ureteroscopic injuries with good vascular supply, 80%, but with poor vascular supply, only 27%; similarly, for high velocity injuries with poor vascular supply, 28.6%; for long strictures with poor vascular supply, 42.8%; for avascular necrosis 33.3%; and for seat belt-induced injuries (deceleration), 54.5%.
Conclusion: Our data suggest that IR interventions in the management of select type of ureteral injuries are highly effective and of lower cost and hence compete well with the established surgical techniques.

P-437

Urological trauma: imaging and intervention

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Learning Objectives: We present a pictorial review of the range of traumatic urological tract injuries seen at a level 1 trauma centre, and discuss the salient imaging findings and interventional management.
Background: The kidneys, bladder, ureters, urethra and genitals are all susceptible to injury in polytrauma patients. Early diagnostic CT has become a fundamental tool in identifying urological injuries and planning management. Interventional radiology plays a vital role in management pathway of these patients.
Clinical Findings/Procedure: In this review, we describe the appropriate trauma CT protocols for imaging of the renal tract.
We discuss the role of endovascular treatment and superselective embolisation, which has, in our unit, replaced open surgery in the treatment of acute post-traumatic renal haemorrhage and some other less common/unusual post-traumatic urological tract bleeds.
The role for renal revascularisation in cases of dissection/thrombosis of the renal artery is also discussed.
Cases of ureteric and bladder injury where interventional radiology plays a role in urinary diversion are also presented.
Conclusion: Interventional radiology plays a vital role in the management of urological tract trauma. Endovascular techniques have changed the management of renal trauma, where previously open exploration would frequently lead to nephrectomy. Currently, prompt imaging and endovascular embolisation have resulted in increased rates of renal salvage.

P-438

Loop nephrostomy: a new technique

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Learning Objectives: We describe the novel technique of loop nephrostomy placement, which has been successful in treating our small but significant cohort of patients requiring long-term nephrostomies. Recurrent nephrostomy dislodgement can be very problematic in these patients, causing recurrent emergency admissions. In our patients, we have had no tube dislodgement using this novel technique over an 18-month follow-up period.
Background: Our institution serves as a urology hub with a small cohort of patients who, due to complex conditions, have no option for urinary drainage other than a long-term nephrostomy. Stenting and internal drainage is technically not possible. Nephrostomy dislodgement has proven to be a problem with all standard techniques, despite extensive precautions taken for securing the tube. Patients can present with frequent tube dislodgement and recurrent episodes of sepsis, requiring emergency admission and treatment with intravenous antibiotics. This was as frequent as once a month for one of our patients prior to loop nephrostomy placement.
Clinical Findings/Procedure: This exhibit demonstrates a modified technique for long-term nephrostomy placement where a Percuflex nephroureteral stent (Boston Scientific) is modified to form a loop nephrostomy. The loop configuration of the nephrostomy provides a very secure arrangement with no dislodgements over an 18-month follow-up period. Routine over-the-wire exchanges every 4-6 months can take place as a day case.
Conclusion: In the cohort of patients requiring long-term nephrostomies, this new technique has significantly improved their

quality of life as it has eliminated the need for recurrent and regular emergency admissions for nephrostomy resiting.

P-439

How to master PAE: a step-by-step radio-anatomical approach

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Learning Objectives: To offer a simplified step-by-step anatomical understanding of the most important technical features of PAE.
Background: Previous anatomical work based on CTA, angiography and cadaveric studies have described in detail the arterial anatomy of the prostate. However, direct translation into the actual work flow is difficult, and there is a need for an easier teaching process to facilitate PAE spread out into the interventional radiologist (IR) community.
Based on our experience as a PAE training center (>50 IRs trained), we have developed a step-by-step approach to ensure time-efficient learning for experienced vascular IRs.
Clinical Findings/Procedure: First step is identification of the obturator, pudendal and gluteal arteries (homolateral 45° oblique projection). Second step is recognition of the vesical artery, which most often carries a single prostatic artery (PA). Third step is analysis of the PA network on selective PA angiography. There are 2 main situations. The easier is a single branch feeding the whole prostate. The more difficult is early bifurcation because the inferoposterior branch can feed the rectum or the corpus cavernosum and present with direct anastomosis to the internal pudendal territory. Fourth step is identification of anastomosis (intra/extra-prostatic). At this step, the IR should be aware that forceful injection into the PA will often open small anastomoses that do not carry a significant risk during slow flow embolisation. Only in some cases will large, direct, extra-prostatic anastomoses require temporary exclusion to avoid non-target embolisation.
Conclusion: This step-by-step approach is likely to facilitate safe and efficient PAE.

P-440

Tandem transplant ureteral stents: why, when, and how

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Learning Objectives:
1. Discuss the rationale and indications for placing tandem ureteral stents in patients with transplant ureteral strictures (TxUS).
2. Demonstrate the techniques used for the placement and management of tandem transplant ureteral stents.

Background: Percutaneous nonsurgical treatment of TxUS has become the preferred treatment in many institutions, including ours. We have been placing tandem stents after balloon dilatation in the majority of our patients with TxUS for the last 8 years, with a reported stent-free effectiveness of up to 83%. The placement techniques and management of tandem stents for TxUS are not fully presented in the literature.
Clinical Findings/Procedure: We will present our initial rationale as well as a description of our techniques used to place tandem stents for TxUS using both retrograde and antegrade approaches, with illustrative images from our case files, which includes 28 patients. We will also discuss the risks and management of tandem stents, including the high risk of UTI when tandem stents are in place.
Conclusion: Rationale, benefits, and techniques of tandem stent placement for TxUS will be presented along with a discussion of risks and management of these stents.

P-441

Bilateral prostatic artery embolization for intractable hematuria of prostatic origin

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Learning Objectives: Evaluation of the safety and efficacy of bilateral superselective prostatic artery embolization (PAE) for intractable hemorrhage of prostatic origin.
Background: Gross hematuria from prostatic origin refractory to bladder irrigation can be life threatening and challenging to manage. PAE has recently emerged as an effective and less invasive technique to manage hematuria. Between December 2013 and December 2014, 9 PAE procedures were performed in 8 patients aged 69-86 years (average 73) with intractable gross hematuria. Mean time to referral was 18 days (1-40 days). Hematuria was caused by prostate cancer in 4 patients, TURP in 3 patients (1 with cancer and 2 with BPH), and invasive bladder cancer in 1 patient. Prior therapy consisted of continuous bladder irrigation in 4 patients, bilateral nephrostomy in 2 patients, and TURP in 3 patients.
Clinical Findings/Procedure: All cases had bilateral superselective PAE, detected using cone-beam CT and 3D reconstruction. The procedure was successful, with prompt resolution of hematuria. The procedural technique, blood requirements, laboratory values, and PSA levels before and after the procedures were reviewed. On a mean follow-up of 32 weeks (8-56 weeks), no complications were noted. One re-intervention was necessary in 1 patient with invasive prostate cancer due a traumatic NU catheter exchange.
Conclusion: PAE is a safe and less invasive technique for intractable hematuria originating from malignant or benign pathologies of prostatic origin.

P-442

Antegrade ureteral occlusion using the Cera™ Vascular Plug System to treat lower urinary tract fistulas

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This case report describes that the transrenal bilateral ureteral occlusion using the Cera™ Vascular Plug System is a practical, simple, and quick method in a patient with enterovesicovaginal fistulas.

P-443

Arteriovenous malformation of the urinary bladder treated by trans-catheter arterial and venous embolization

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Arteriovenous malformations of the urinary bladder are extremely rare; few cases have been documented. We report a case of a localized arteriovenous malformation of the bladder with painless mild hematuria that was treated successfully by trans-catheter arterial and venous embolization.

P-444

Postoperative ureteral fistula treated using a silicone-covered ureteral occlusion stent

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We report a 49-year-old woman who underwent placement of a silicone-covered ureteral occlusion stent to manage ureteral leakage due to pelvic surgery. A follow-up ureterogram 18 months later confirmed that there had been neither stent migration nor additional urine leakage.

Venous intervention and IVC filters

P-445

Optimal cutoff value for the selective arterial calcium injection test for insulinomas

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Purpose: To evaluate the optimal cutoff value for localizing insulinomas with the selective arterial calcium injection (SACI) test.
Material and Methods: This study included 11 patients (3 men, 8 women; mean age, 59 years; range, 32–70 years) with insulinoma who underwent the SACI test between May 2009 and September 2014. We calculated the optimal cutoff value for the SACI test using receiver operating characteristic (ROC) analysis for the magnified and maximum insulin level. Blood samples were obtained from the right hepatic vein. Calcium gluconate was injected into the gastroduodenal, proximal and distal splenic, proper hepatic, and superior mesenteric arteries. The tumors were localized to the pancreatic head in 2 patients, the pancreatic body in 2 patients, and the pancreatic tail in 6 patients; one patient manifested diffuse lesions.
Results: At the traditional cutoff value (increases exceeded 2 times the magnified insulin concentration), the sensitivity, specificity, and accuracy of the SACI test were 86.4%, 75.7%, and 79.7%, respectively. The area under the ROC curve was 0.792 with magnification; it was 0.877 at the maximum level. The optimal cutoff value derived from ROC curves was greater than 2.4 times and 57 μU/ml. At the optimal cutoff value, sensitivity, specificity, and accuracy were 72.7%, 100%, and 89.8%, respectively.
Conclusion: The optimal cutoff value for the SACI test was a 2.4 times increase in the magnified insulin concentration, and it was 57 μU/ml at the maximum insulin concentration.

P-446

The incidence and management of central vein rupture during PTA for hemodialysis access patients

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Purpose: To evaluate the incidence and management of central vein rupture during PTA for central vein stenosis/occlusion in hemodialysis patients.
Material and Methods: Between 1998 and 2013, 3103 PTAs were performed for central vein stenosis (2437)/occlusion (666) in hemodialysis patients (M:F=1445:1658; brachiocephalic:subclavian=1735:1368) using various techniques. PTA or stenting were performed regardless of vein rupture when a guidewire passed through stenosis/occlusion. The incidence of central vein rupture according to location, sex, right vs. left, thrombosis, stenosis, and occlusion were analyzed using chi-square test. Percutaneous managements of central vein rupture were also evaluated.
Results: Central vein rupture was documented by fistulography in 12 cases (0.39%). All ruptures occurred in occluded lesions (brachiocephalic:subclavian=9:3), and none in stenotic lesions (p=0.00). There were no statistically significant differences in location (p=0.409), sex (p=0.811), right vs. left (p=0.081), and thrombosis (p=0.331). Causes of central vein rupture were as follows: guidewire-induced in nine cases, sharp recanalization with the Colapinto needle in two, and balloon dilation in one. Central vein rupture was managed by low-pressure balloon tamponade at the rupture site (n=2), and observation was followed by percutaneous technique (n=10). In 5 patients, recanalization of central vein failed.
Conclusion: Central vein rupture occurs very rarely during PTA, and majority can be easily managed by percutaneous techniques. When a guidewire passes through the occlusive lesion, PTA can be performed even if central vein rupture occurs.

P-447

Technical contribution of CT during adrenal venous sampling to improve the success rate

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Purpose: As it is now known that primary aldosteronism (PA) is more prevalent than was previously recognized and a potentially curable cause of hypertension and related cardiovascular diseases, the search for a safe and effective means of its diagnosis has reemerged as a topic of interest. Adrenal vein sampling is the gold standard for the diagnosis of PA, but this technique is challenging, and the small right adrenal vein can be particularly difficult to cannulate. The purpose of this study was to evaluate the usefulness of computed tomography (CT) during angiography (angio-CT) in increasing the success of adrenal vein sampling and to identify factors associated with cannulation failure retrospectively.
Material and Methods: A total of 140 consecutive patients with suspected primary aldosteronism, except Cushing's syndrome, treated at a single hospital from June 2008 to May 2013 were included. Catheter misplacement ratios before and after angio-CT were calculated. Univariate analysis of factors related to failed cannulation included gender, age, height, weight, body mass index, adrenal nodules, aldosterone concentration, plasma renin activity, and potassium level. Successful sampling was ultimately defined according to cortisol concentrations in venous blood samples.
Results: Angio-CT detected misplaced catheters in 13 patients (9.3%). The calculated success rate of adrenal vein sampling increased from 86.4% before angio-CT to 95.7% after angio-CT ($P < 0.001$; paired t-test). Univariate analysis showed a tendency for a higher rate of failure of right adrenal vein cannulation in taller patients ($P = 0.066$).
Conclusion: Angio-CT improved the success of adrenal vein cannulation.

P-448

Restoration of hepatic venous outflow in patients with chronic Budd–Chiari syndrome with varied clinical presentation: technical aspects and mid-term clinical outcomes

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Purpose: Treatment of chronic Budd–Chiari syndrome (BCS) aims at the restoration of hepatic venous outflow. In this study, we analysed the technical aspects and clinical outcomes of patients with BCS who underwent recanalisation of obstructed hepatic vein (HV) and/or inferior vena cava (IVC).
Material and Methods: Forty-four patients with chronic BCS presented to Hepatology OPD/Emergency from July 2010 to June 2013. Presenting complaints of 35 patients were ascites, pedal oedema, abdominal-wall collaterals or upper gastrointestinal bleed; and 9 presented with acute-on-chronic liver failure (ACLF). Patients with ACLF were considered for liver transplantation but due to non-availability of organ, 6 of 9 patients were taken up for TIPS or venous recanalisation. For remaining patients, depending on status of native HV, decision for recanalisation or creation of porto-systemic shunt was taken. Recanalisation using jugular or combined percutaneous and jugular approach was performed in patients having at least one normal-looking HV with short-segment occlusion (≤2 cm). INR was maintained above 2.5 after recanalisation.
Results: Three patients with ACLF and 23 of other patients underwent opening of obstructed HV/IVC. Post-procedure patients with ACLF showed gradual improvement in liver-function tests, and liver transplant was avoided; the 23 other patients showed swift clinical improvement. One patient presented with partial occlusion of HV stent 30 months post-procedure and received stent within a stent. Remaining patients remained symptom-free with patent stent up to 36-month follow-up.
Conclusion: Recanalisation of obstructed HV/IVC is the most physiological way of treating patients with chronic BCS. In carefully selected patients, these procedures may provide excellent mid-term outcomes and rarely may even avert liver transplantation.

P-449

Pulmonary vein isolation causing pulmonary venous stenosis: diagnosis and therapy

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Purpose: Pulmonary vein isolation (PVI) is increasingly used in the treatment of supraventricular arrhythmias. The ablation of cardiac muscle around the pulmonary veins leads to a change in venous caliber, which can be appreciated on CT. The ultimate degree of stenosis can be significant, but diagnosis is often delayed until a patient becomes symptomatic; and this condition is associated with significant morbidity. We present our institution's experience with this clinical condition.
Material and Methods: From 2012 to 2014, five patients presented with clinical and imaging features of pulmonary venous stenosis (PVS).
Results: Four patients presented with dyspnoea and one with hemoptysis. All underwent computed tomography angiography (CTA), and three underwent angioplasty with follow-up CTA. CT findings were often not recognised on the first presentation. CT findings in-cluded isolated lobar congestion and edema with asymmetric opacification of the ipsilateral pulmonary vein. Venography confirmed the stenosis and showed significant intra-lung collateral formation. Three patients underwent four endovascular procedures. The procedure involved femoral vein access and crossing the atrial septum with a 4-mm balloon angioplasty device. All had a good immediate result, but restenosis occurred in 50%.
Conclusion: Symptomatic PVS is a late, rare and under-recognised complication of PVI, with considerable morbidity. CTA can be diagnostic with an index of suspicion and characteristic findings. PVS is amenable to percutaneous endovascular balloon therapy, but long-term results are not encouraging. Patients may collateralise over time, and a surgical venous patch is also a consideration. Pulmonary venous stenting remains unproven. We anticipate this will become a more frequent issue presenting to radiologists.

P-450

Non-contrast balanced steady-state MR venography allows accurate depiction of venous outflow in patients presenting with post-thrombotic syndrome

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Purpose: Balanced steady-state free precession MR venography (bSSFP-MRV) is an advanced venous imaging technique, allowing exquisite depiction of venous anatomy without exposure to ionizing radiation or intravenous contrast administration. The purpose of this study was to validate its use to detect venous outflow obstruction in patients presenting with post-thrombotic syndrome.
Material and Methods: Consecutive patients referred for bSSFP-MRV (protocol acquisition involved axial stacked coverage from diaphragm to knees on a 1.5-T Siemens scanner) and intravenous digital subtraction venography (IVDSA) were included in the study. The MRV and IVDSA studies were independently assessed by two board-certified radiologists blinded to clinical details. Abnormal venous segments were classified by each reviewer according to severity of disease as follows: normal, stenosis <70%, stenosis >70% or post-thrombotic webs, chronic occlusion, and absent vessel. Correlations between bSSFP-MRV and IVDSA findings were assessed.
Results: Forty-seven patients (261 vessel segments) had bSSFP-MRV and IVDSA between 2013-5 at the authors' institution. Following exclusion of clinically insignificant discrepancies, correlation between bSSFP-MRV and conventional venography was 99% (true correlation 87%) for lesions above the inguinal ligament and 81% (true correlation 64%) below the inguinal ligament. Sensitivity was 100% and 81% and specificity 95% and 94%, respectively. No adverse MR events were recorded. Mean scan time for bSSFP-MRV was 12 minutes (10-17 minutes).
Conclusion: bSSFP-MRV allows for accurate, non-invasive assessment of venous outflow (suprainguinal veins) in patients presenting with PTS.

P-451

Mechanical thrombectomy with Solitaire AB stents in combination with thrombolysis in the treatment of intracranial venous sinus thrombosis

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Purpose: To retrospectively determine the safety and effectiveness of mechanical thrombectomy for intracranial dural sinus thrombosis with Solitaire AB stents.
Material and Methods: This is a retrospective analysis of 12 consecutive patients with intracranial dural sinus thrombosis who were treated with mechanical thrombectomy using Solitaire AB stents between January 2013 and October 2014. The patients were followed up for 3–12 months after the procedure.
Results: Fourteen Solitaire AB stents were used. The procedure was completed in all patients without complications. At the same time, catheter-directed thrombolysis with urokinase of 300,000–700,000 U was performed in two patients. The postoperative symptoms in all the 12 patients were improved significantly. Glasgow coma scale scores at admission were as follows: 1 case was 3, 1 case was 12, and 10 cases were 15. Glasgow coma scale scores at discharge were as follows: 11 cases were 5 and 1 case was 4. Statistically significant difference between Glasgow coma scale scores at admission and discharge was identified (P<0.05). The patients were followed up for 3–12 months; one patient was followed up by telephone, one was followed up at the outpatient department, six were followed up with MRV, and four were followed up with DSA; none had recurrence.
Conclusion: On using Solitaire AB stents for intracranial venous sinus, mechanical thrombectomy may significantly improve the clinical symptoms of patients. Single-center experience has shown that no obvious complications occurred.

P-452

New gluing modalities for insufficient veins

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Purpose: Gluing of veins is discussed as being superior to thermo-occlusive methods or sclerotherapy. However, the first approved gluing method uses the continuous placement of larger amounts of aggressive, resin-like, and hardly resorbable cyanoacrylate. It is limited to saphenous veins below 12-mm Ø and to the effect of external manual compression. These drawbacks could be overcome by a new modality, which combines pointwise gluing and catheter sclerotherapy.
Material and Methods: In 21 patients undergoing phlebectomy, 38 non-branched vein segments of 10–20 cm in length and 6–12-mm Ø (mean: 8.5 mm) were defined to receive gluing. After applying proximal and distal ligatures, a novel coaxial catheter system (ScleroGlue®) was introduced and foam sclerotherapy (Aethoxysklerol 1%; 1+4 with air) was performed. Foam was then evacuated and pointwise gluing at 5-cm intervals was performed using modified acrylates under negative pressure. The treated vein segment was removed and preserved for histological evaluation.
Results: In 35/38 vein segments, histology showed total denaturation of the endothelium, while in 3/32 vein segments, denaturation was 93–99%. Eighty-two of 91 glued spots (90.1%) were strongly cohesive when exposed to forces of up to 10 N. The amount of glue used was 3–6 mg (mean: 4.6 mg) per cm vein.
Conclusion: The ScleroGlue® project seems to provide reliable denaturation and effective gluing, which was achieved without any external compression and by using very low glue quantities. Clinical studies will start as soon as glue biodegradability is proven.

P-453

Endovenous techniques are improved by ultrasound-guided hyaluronan injection instead of tumescence

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Purpose: Catheter-based methods are replacing surgery in the treatment of saphenous vein insufficiency. However, standard saline-based tumescent anesthesia is not suitable for optimal results as it compresses the vein just for a few hours. We examined a new interventional modality to establish an initial and lasting vein lumen reduction.
Material and Methods: Forty patients (28 females and 12 males; 42–71 years) with an insufficiency of the GSV, diameter of 7.4–23.1 mm, and distance to skin of >10 mm who were receiving endovenous laser treatment (1470 nm) or catheter microfoam were randomized for lumen reduction: one group (A) received hyaluronan solution (NASHA; n=20) with a crosslink ratio of <1.0%, while another group (B) received tumescent fluid (modified Klein's solution). Application of hyaluronan was performed using a coaxial safety system (IntraShape) under ultrasound monitoring. Clinical and sonographic follow-up was performed after 2, 8, 16, and 26 weeks.
Results: Hyaluronan injection was successful in 37/40 cases (93.7%). Initial diameter reduction obtained with hyaluronan was 54–81%; mean, 68.4%. Clinical follow-up showed a complete absence of symptomatic phlebitic reactions as well as of discolorations in hyaluronan-treated segments, while segments with tumescent anesthesia had inflammations in 13/20 cases (65.0%) or mini thrombaspirations (5/20; 25.0%). Visible hematoma were present in 2/20 (10%) after hyaluronan versus 17/20 (85.0%) after tumescence. No adverse events of hyaluronan were observed.
Conclusion: Initial and permanent vein lumen reduction can be obtained using hyaluronan solution instead of tumescence fluid. The procedure is safe and effective. No other procedure including vein gluing is known to offer similar advantages.

P-454

Pelvic congestion syndrome: imaging, classification, and indications for ovarian vein embolization

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Learning Objectives: To evaluate all imaging modalities and the classification of ovarian vein inversion of flow in female patients with suspected pelvic congestion syndrome.
Background: Diagnosis of and treatment for pelvic congestion syndrome have evolved over the years. Its clinical spectrum varies from mild symptoms to debilitating pelvic pain. Many 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 appropriate imaging analysis and classification to define the candidates for intervention.
Clinical Findings/Procedure: We evaluated 89 female patients (mean age, 38 ± 6 years) with possible diagnosis of pelvic congestion syndrome. All patients were evaluated by imaging: duplex US, multidetector computed tomography, or magnetic resonance imaging. All 89 patients had ovarian vein inversion of flow: 5 patients (6%) had grade I, 45 patients (50%) had grade II, and 39 patients (44%) had grade III. Nine patients (10%) with imaging grade III and debilitating pelvic pain underwent phlebography, which confirmed previous

imaging diagnosis, with consequent ovarian vein transcatheter embolization.
Conclusion: Imaging diagnosis has high sensitivity and specificity for the detection of ovarian vein inversion of flow, and it is well-suited as a screening method in patients with suspected pelvic congestion syndrome.

P-455

Anatomic findings of recurrent postsurgical varicocele: role of endovascular transcatheter embolization

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Learning Objectives: To describe venographic findings in patients with post-surgical recurrent varicoceles and to assess the efficacy of the following minimally invasive endovascular treatment.
Background: Laparoscopic and microsurgical techniques, currently used for varicocele treatment, are associated with a recurrence rate of up to 9%. The main cause of treatment failure in varicocele patients has been reported to be the presence of collateral gonadal veins, pre-existing or formed after intervention.
Clinical Findings/Procedure: Fifteen men (age range, 16-33 years; mean age, 20 years) with recurrent varicoceles after failed surgical treatment of left-sided varicoceles were examined between 2011 and 2014, using retrograde venography to assess the anatomy of varicoceles draining veins before the attempted trans-catheter embolization. Anatomic variants of gonadal veins were categorized according to the classification of Bahren et al. Pushable coils were used as the embolic agent. In 14 of 15 patients, venography demonstrated incompetence of the gonadal vein or veins draining varicoceles after failed surgical treatment. The most frequent venographic finding was gonadal vein duplication – 66% of cases (39% in its mid-portion). Technical success of embolization was achieved in all 14 patients. No major complications were observed.
Conclusion: Recurrence after surgical varicocelectomy is associated with increased inguinal collaterals. Retrograde varicoceles embolization may be superior to surgery because of its ability to detect gonadal vein variants. In our study group, transcatheter embolization with pushable coils allowed successful, minimally invasive treatment of post-surgical varicoceles.

P-456

Percutaneous treatment of varicocele with pushable coil embolization: comparison of treatment outcome with laparoscopic varicocelectomy

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Learning Objectives: We aimed to report the treatment outcome of percutaneous embolization treatment versus laparoscopic varicocelectomy in patients with symptomatic varicoceles.
Background: Varicocele is defined as the dilatation of the veins of the pampiniform plexus. It is a well-known clinical entity that may result in mass effect, pain, testicular atrophy, and infertility. A variety of treatment approaches, including surgical and interventional strategies, have been used for varicocelectomy. Selective embolization of the gonadal vein and its collateral vessels and laparoscopic varicocelectomy are two different treatment options for symptomatic varicoceles. Both have comparable recurrence/persistent rate, with an even lower rate for the selective embolization.
Clinical Findings/Procedure: In a 2-year period, we analyzed the treatment outcome of two minimally invasive varicocele treatments by comparing laparoscopic varicocelectomy and percutaneous varicocele embolization using pushable coils. Procedural complication, recurrence rate, and treatment outcome were analyzed between these two minimally invasive treatment strategies. We selected 30 patients who underwent either endovascular or laparoscopic treatment of just as many varicoceles: 15 patients received catheter-based embolization for varicoceles, whereas 15 underwent laparoscopic treatment. Embolization treatment resulted in recurrent varicoceles in one patient (6.5%) compared to two (13.3%) following laparoscopic repair. This difference was not significant. Embolization treatment was associated with a lower complication rate than was laparoscopic repair (8% vs 18%).
Conclusion: Both laparoscopic varicocelectomy and coil embolization are effective treatment modalities for varicoceles. With lower treatment complication rates in the interventional treatment group, coil embolization of the testicular veins offers treatment advantage compared with laparoscopic repair in patients with varicoceles.

P-457

Basket case – when filters go bad: a pictorial review of complications related to IVC filters

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Learning Objectives:
1. Be able to list the complications that can occur with IVC filters.
2. Be cognizant of the imaging findings associated with IVC filter complications.
3. Have an understanding of variant IVC anatomy that is important for procedure planning.
4. Have a basic understanding of proper IVC filter placement technique to avoid complications.

Background: The placement of both retrievable and non-retrievable IVC filters has become the mainstay of treatment to prevent emboli in patients who cannot be administered anticoagulants. It is important for radiologists to be able to identify and assess the potential complications of indwelling IVC filters in order to direct clinicians as to the appropriate management.
Clinical Findings/Procedure:
The presentation will review the following:
1. Angiographic pictorial review of possible variant anatomy with correlation to various cross-sectional imaging modalities.
2. Discussion of proper IVC filter placement for each of the discussed variations in anatomy.
3. Identification of possible complications after IVC filter placement, including strut embedment/penetration, filter fracture/strut embolization, filter migration, and filter angulation.
4. Discussion of the clinical significance of the various IVC filter complications and determination of further intervention.

Conclusion: After completing this educational exhibit, the viewer will be able to identify variant anatomy, determine appropriate IVC filter placement location, and identify/manage potential complications that may need further intervention.

P-458

Adrenal vein sampling in patients with Conn's syndrome: a primer

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Learning Objectives: Implement adrenal vein sampling in a safe and easy way in your day-to-day practice.
Background: Primary hyperaldosteronism (Conn's syndrome) is the overproduction of the hormone aldosterone by the adrenal glands. Aldosterone causes an increase in sodium and water retention and potassium excretion in the kidneys, leading to arterial hypertension. There is a growing awareness that a large number of patients with therapy-resistant hypertension actually have Conn's syndrome. Estimates range between 15% and 20%. As the disease can be unilaterally or bilaterally located and as therapy is significantly different for unilateral or bilateral disease, it is of utmost importance to make this distinction. Adrenal vein sampling (AVS) is the gold standard, and it is to be expected that AVS will become a procedure routinely performed by interventional radiologists. Sampling, however, is known to be a difficult procedure, with reported success rates ranging from 50% to 95%.
Clinical Findings/Procedure: In our hospital, which hosts the Adrenal Expert Center for the Netherlands, around 50-60 samplings are performed on a yearly basis. Success rates are close to 100%. This high success rate is closely related to organization, sampling technique, ACTH stimulation, and direct cortisol measurements during the procedure. All the different aspects of AVS will be extensively discussed. Also, new techniques, which might be helpful for the novice in sampling, will be illustrated.
Conclusion: It is of utmost importance to implement AVS in more European centers. We will demonstrate that this is possible with new techniques.

P-459

Complications associated with coils during embolization of incompetent pelvic and gonadal veins

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Learning Objectives: To know the complications associated with coils during pelvic and gonadal vein embolization. Review venous anatomy, variations, and techniques to recover migrated coils.
Background: Pelvic and gonadal vein embolizations are common at our center. Complications are rare, and some are coil related.
Clinical Findings/Procedure: During 5 years, 760 gonadal and pelvic vein embolizations were performed. Nine patients had complications related to coils. Three coils migrated from the left gonadal vein to renal vein and were rescued using snares. Four coils migrated to the pulmonary circulation: three were left in pulmonary arteries without complications and one migrated to the pulmonary circulation from an anomalous collateral vein between the internal and external iliac veins; immediately, the coil was rescued using a snare but a transmural perforation occurred during the advancement of the guidewire and catheter by the right atrium, with pericardial effusion, and was managed conservatively with no clinical sequelae. In another case, three coils migrated from the right internal to external iliac vein by an anomalous communication, which were removed using a snare. In yet another case, a coil protruded from a side hole of a multipurpose catheter and was extracted by retracting the catheter during continuous suction.
Conclusion: Complications associated with coils during venous pelvic and gonadal embolizations are rare but can cause permanent injury in patients. There is no consensus about what to do when they migrate to the pulmonary circulation. The practitioner using these procedures should know widely the venous anatomy, variants, and different techniques to recover intravenous foreign bodies.

P-460

Pelvic venous anatomy: all that we need to avoid complications during venous pelvic or gonadal embolization

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Learning Objectives: By comparison of diagrams and angiographic images of the pelvic venous anatomy, we describe the normal venous anatomy and the communications between internal and external iliac veins and between gonadal pelvic and femoro-saphenous veins.
Background: The communications between internal and external iliac venous systems are not well described. It is important to have an anatomic knowledge based on the indication of performing the embolization, i.e., for incompetent pelvic veins with recurrence of varicose veins or for pelvic congestion syndrome, to avoid coil placement in a deep vein, which could have serious consequences.
Clinical Findings/Procedure: Reviewing the images of the pelvic or gonadal embolization performed on our patients, we chose those showing normal anatomy and those showing the communications between the internal and external iliac veins or between the gonadal veins and pelvic and deep veins. Different variations are described, and demonstration schemes are developed based on these anatomies. The internal iliac vein is formed on the floor of the true pelvis from sacral and visceral tributaries and tributaries with origins outside the pelvis: the gluteal, internal pudendal, and obturator veins. The visceral tributaries communicate via the presacral, pelvic, and superficial pubic plexuses, which may form routes of communication between contralateral external and internal iliac venous systems.
Conclusion: Adequate knowledge of pelvic venous anatomy, its variants, and communications enables those who practice embolization to avoid malpositioning or unwanted coil migration, which could have serious consequences.

P-461

Pitfall of left femoral IVC filter deployment – caval perforation

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Right internal jugular and femoral veins are preferred routes for IVC filter insertion due to the anatomical "line of sight." We describe a complication of deployment via the left femoral vein, with perforation of filter apex and body through the caval wall.

P-462

Spondylodiscitis and psoas abscess as a delayed complication of inferior vena cava filter strut failure

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We present a case of severe spondylodiscitis and psoas abscess, which developed as a delayed sequelae of IVC filter strut fracture and subsequent migration into an intervertebral disc space.

P-463

Coil embolisation of orbital venous varix: a new treatment option

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A 28-year-old female presented with a history of left eye proptosis. MR orbit revealed an ill-defined lesion with variable signal intensity in the intraconal space and dilated SOV. DSA showed that the lesion was venous varix, and coil embolisation was done.

P-464

Deep vein thrombosis in congenital absence of the inferior vena cava

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A 20-year-old female was admitted to the hospital because of swollen left lower extremity. US showed deep venous thrombosis. Venography confirmed thrombosis. Absent IVC and occluded collaterals were found. After thrombolysis was successful, PTA was performed. She was followed-up with MRI.

P-465

Stenting of IVC and both renal veins

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IVC and renal vein (RV) stenoses were found in a 45-year-old man after a surgical procedure of IVC (sarcoma) and renal function impairment. Transluminal biopsy of IVC was negative. Stenting of IVC and both RVs ("kissing stent") was performed. Renal function improved.

P-466

Crux IVC filter – first use in Europe: our experience

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Crux™ IVC filters have spiral configuration and automatically centre in the vessel lumen. They can be retrieved through either jugular or femoral approach. We are the first in Europe to use these filters and present our initial experiences with them.

P-467

A pragmatic approach to treating oropharyngeal venous malformation

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We present a pragmatic approach to treating high-risk oropharyngeal venous malformation in a Jehovah's Witness patient. She underwent a 2-stage intervention under general anaesthesia. This involved an elective tracheostomy and oropharyngeal packing, followed by fluoroscopy-guided foam sclerotherapy.

P-468

Transvenous occlusion of an intrahepatic Abernathy malformation in a 5-week-old infant using a new microcatheter occlusion device (MVP)

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A 5-week-old baby presented with high-output cardiac failure due to an intrahepatic Abernathy malformation of the left lobe with two large portosystemic shunts. Both were occluded by a transjugular approach using the new Micro Vascular Plug (MVP®).

P-469

Successful removal of iatrogenic transrenal thoracic tube insertion into the inferior vena cava by intrarenal tract coil embolization

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A 63-year-old female developed acute pancreatitis complicated with retroperitoneal walled-off necrosis. A 32-Fr thoracic tube for endoscopic necrosectomy was inserted accidentally into the inferior vena cava by transrenal route. The thoracic tube was successfully removed by intrarenal tract coil embolization.

P-470

"Pretty tied up": retrieval of a knotted Swan-Ganz catheter

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A case of a Swan-Ganz catheter that got knotted around an adjacent sheath was referred to us. We describe successful retrieval of the catheter along with a pictorial review. It provides valuable learning points for those faced with similar cases.

P-471

Removal by the femoral approach of a filter retrievable by the jugular approach

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Among 6 of 456 retrievals, the attempt to retrieve an ALN filter by the jugular approach was unsuccessful.
Using the lasso technique alone or associated with the dedicated retrieval device, it has been possible to perform retrievals by the femoral approach.

P-472

IVC filter insertion and transjugular removal in left-sided IVC with azygous continuation

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A 40-year-old male with right femoropopliteal DVT and suspected PE whilst on anticoagulation. Aberrant left-sided IVC with azygous continuation was discovered on venography. Temporary IVC filter deployed and successfully retrieved several months later via transjugular access and azygous vein.

P-474

Portacath-related complications: a pictorial review

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Learning Objectives:
1. To review the potential medium- and longterm adverse events related to portacath placements.
2. To be able to recognise the radiographic appearances of such adverse events on plain radiographs, fluoroscopy and CT.
3. To demonstrate some of the techniques available to manage such adverse events.

Background: Central venous access is becoming more important with the constant advent of new chemotherapy agents, with increasing success rates and with oncology patients living longer. A portacath central line provides an excellent route for treatment over prolonged periods but is not without complications, which can lead to significant morbidity, as well as interruption of vascular access.
Clinical Findings/Procedure: We describe in detail, with accompanying imaging, 8 different portacath-related complications: some specific to portacath and others generically applicable to central lines.
We describe how we managed these (sometimes unexpected!) complications and reflect on the lessons we learnt. Lastly, we describe techniques on how to manage selected complications with accompanying case examples and imaging.
These cases include port rotation, catheter displacement, catheter tip migration, fibrin sheath formation and equipment failure.
Conclusion: Central venous access is vital for an ever-longer-living oncology community. Hopefully, this case series will provide additional learning points and techniques for identifying and managing specific portacath- and generic central line-related complications.

Lisbon, Portugal
September 26-30

CIRSE 2015

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PART 1

Abstracts of
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CIRSE Cardiovascular and Interventional Radiological Society of Europe

Lecture Session
Abdominal aorta

905.1

Device evolution and impact on EVAR outcomes

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Learning Objectives

1. To learn about the different devices available on the market
2. To understand the technical aspects of the new generation of endoprosthesis
3. To analyse EVAR outcomes associated with the different devices

Since the introduction of endovascular aneurysm repair (EVAR) in 1991, endovascular therapy with newest stent-grafts has assumed a prominent role in the clinical management of abdominal aortic aneurysms (AAA), with a superior perioperative mortality of EVAR and an equivalent mid-term outcome compared with open surgery. Newest techniques using chimney or periscope grafts and customized fenestrated and branched stent-grafts allow the endovascular treatment of complex pararenal AAA. We will review current devices of EVAR available for AAA treatment, evidence-based results, and advanced indication by newest interventional techniques and technical developments. At present, there is a wide range of modular stent-grafts available that includes multiple configurations and sizes of components to better suit various challenging anatomies including proximal neck angulation of >30 degrees, neck extension of <15 mm, conical morphology and neck diameter of >28mm, iliac angulation of >90 degrees, diameter of >18 mm or <6 mm, and presence of stenotic lesion of >50%. Delivery systems have also progressed. Catheters that were initially rigid and bulky have become narrower and much more flexible, allowing improved access in tortuous vessels and low-profile devices, which facilitates a percutaneous approach. In addition, stent-graft material and design have changed in various ways to improve conformability, minimize device migration rates, reduce fracture, and reduce leak rates. As medical technologies evolve, a greater number of challenging anatomies will be tackled with greater durability. We will demonstrate a number of advanced technologies offering solutions to challenging anatomy. Workhorse grafts are still available, which provide a broad range of solutions; however, endografts on the horizon propose interesting improvements in profile, fixation, and aneurysm exclusion.

References

1. Ohrlander T, Dencker M, Acosta S. Morphological state as a predictor for reintervention and mortality after EVAR for AAA. Cardiovasc Intervent Radiol 2012; 35:1009.
2. Brown LC, Greenhalgh RM, Powell JT, et al. Use of baseline factors to predict complications and reinterventions after endovascular repair of abdominal aortic aneurysm. Br J Surg 2010; 97:1207.
3. Greenberg RK, Chuter TA, Sternbergh WC 3rd, et al. Zenith AAA endovascular graft: intermediate-term results of the US multicenter trial. J Vasc Surg 2004; 39:1209.
4. Matsumura JS, Brewster DC, Makaroun MS, Naftel DC. A multicenter controlled clinical trial of open versus endovascular treatment of abdominal aortic aneurysm. J Vasc Surg 2003; 37:262.
5. Peterson BG, Matsumura JS, Brewster DC, et al. Five-year report of a multicenter controlled clinical trial of open versus endovascular treatment of abdominal aortic aneurysms. J Vasc Surg 2007; 45:885.
6. Rutherford RB. Open versus endovascular stent graft repair for abdominal aortic aneurysms: an historical view. Semin Vasc Surg 2012; 25:39.
7. Prinssen M, Verhoeven EL, Buth J, et al. A randomized trial comparing conventional and endovascular repair of abdominal aortic aneurysms. N Engl J Med 2004; 351:1607.
8. Blankensteijn JD, de Jong SE, Prinssen M, et al. Two-year outcomes after conventional or endovascular repair of abdominal aortic aneurysms. N Engl J Med 2005; 352:2398.
9. De Bruin JL, Baas AF, Buth J, et al. Long-term outcome of open or endovascular repair of abdominal aortic aneurysm. N Engl J Med 2010; 362:1881.
10. EVAR trial participants. Endovascular aneurysm repair versus open repair in patients with abdominal aortic aneurysm (EVAR trial 1): randomised controlled trial. Lancet 2005; 365:2179.
11. United Kingdom EVAR Trial Investigators, Greenhalgh RM, Brown LC, et al. Endovascular versus open repair of abdominal aortic aneurysm. N Engl J Med 2010; 362:1863.
12. United Kingdom EVAR Trial Investigators, Greenhalgh RM, Brown LC, et al. Endovascular repair of aortic aneurysm in patients physically ineligible for open repair. N Engl J Med 2010; 362:1872.
13. Lederle FA, Freischlag JA, Kyriakides TC, et al. Outcomes following endovascular vs open repair of abdominal aortic aneurysm: a randomized trial. JAMA 2009; 302:1535.
14. Veith FJ, Lachat M, Mayer D, et al. Collected world and single center experience with endovascular treatment of ruptured abdominal aortic aneurysms. Ann Surg 2009; 250:818.
15. Tambyraja AL, Fishwick NG, Bown MJ, et al. Fenestrated aortic endografts for juxtarenal aortic aneurysm: medium term outcomes. Eur J Vasc Endovasc Surg 2011; 42:54.
16. Greenberg RK, Sternbergh WC 3rd, Makaroun M, et al. Intermediate results of a United States multicenter trial of fenestrated endograft repair for juxtarenal abdominal aortic aneurysms. J Vasc Surg 2009; 50:730.
17. Amiot S, Haulon S, Becquemin JP, et al. Fenestrated endovascular grafting: the French multicentre experience. Eur J Vasc Endovasc Surg 2010; 39:537.
18. Greenberg RK, Haulon S, O'Neill S, et al. Primary endovascular repair of juxtarenal aneurysms with fenestrated endovascular grafting. Eur J Vasc Endovasc Surg 2004; 27:484.
19. O'Neill S, Greenberg RK, Haddad F, et al. A prospective analysis of fenestrated endovascular grafting: intermediate-term outcomes. Eur J Vasc Endovasc Surg 2006; 32:115.
20. Verhoeven EL, Vourliotakis G, Bos WT, et al. Fenestrated stent grafting for short-necked and juxtarenal abdominal aortic aneurysm: an 8-year single-centre experience. Eur J Vasc Endovasc Surg 2010; 39:529.
21. Anderson JL, Berce M, Hartley DE. Endoluminal aortic grafting with renal and superior mesenteric artery incorporation by graft fenestration. J Endovasc Ther 2001; 8:3.
22. Kristmundsson T, Sonesson B, Malina M, et al. Fenestrated endovascular repair for juxtarenal aortic pathology. J Vasc Surg 2009; 49:568.
23. Cross J, Gurusamy K, Gadhvi V, et al. Fenestrated endovascular aneurysm repair. Br J Surg 2012; 99:152.
24. Cross J, Raine R, Harris P, et al. Indications for fenestrated endovascular aneurysm repair. Br J Surg 2012; 99:217.
25. Greenberg RK, Qureshi M. Fenestrated and branched devices in the pipeline. J Vasc Surg 2010; 52:15S.
26. Brown LC, Greenhalgh RM, Kwong GP, et al. Secondary interventions and mortality following endovascular aortic aneurysm repair: device-specific results from the UK EVAR trials. Eur J Vasc Endovasc Surg 2007; 34:281.
27. Ouriel K, Clair DG, Greenberg RK, et al. Endovascular repair of abdominal aortic aneurysms: device-specific outcome. J Vasc Surg 2003; 37:991.
28. Vandy F, Upchurch GR, Jr. Endovascular Aneurysm Repair. Current status. Circ Cardiovasv Interv. 2012; 5:871.

905.2

Is there still a role for AUI stentgrafts in EVAR?

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Learning Objectives

1. To learn when to use and when not to use an AUI
2. To analyse the results of AUI stentgrafts
3. To review the complications of AUI

In general, the majority of stent-graft procedures are performed with bifurcated devices. Aorto-uni-iliac (AUI) stent-graft procedure combined with femoro-femoral cross-over bypass is an alternative treatment option in patients with very small distal aortas and/or with severe iliac artery disease on one side. The latter include occlusion of one iliac artery, heavy calcification combined with a stenotic lumen throughout the iliac artery, and a severe kinking.[1-5] Other applications for AUI stent-grafts include treatment of complications after previous EVAR with a bifurcated endograft,[6] para-anastomotic aneurysms after previous open reconstruction with a bifurcated graft,[7] and ruptured abdominal aortic aneurysms.[8]

In recent literature, anatomical/pathological criteria influencing the use of AUI configuration vary widely. The application range for AUI endoprosthesis differs between 4% and 30% in patient cohorts treated electively by endovascular techniques.[4-6] Overall, the deployment success in primary aneurysm exclusion with AUI stent grafts is high and achieves 100% in the majority of studies.[1,3,5-6] It is shown that patients with challenging iliac artery anatomy have a relatively greater risk of perioperative morbidity[1,3-4]; however, early- and mid-term outcomes are comparable with those after treatment with bifurcated endografts.[3,4-5]

A drawback of AUI stent-graft procedures is the required adjunctive extra-anatomical cross-over bypass, and concerns were raised regarding the complications and patency rates; however, some authors conclude that this bypass did not independently increase the risk of major adverse events during follow-up.[4]

An advantage of the AUI stent-graft is the simple release without the need for cannulation of a contralateral limb, which makes the procedure easier and quicker; this can be beneficial in treating ruptured abdominal aortic aneurysms.[8]

To conclude, despite technical innovations and lower profile devices, AUI stent grafts remains an option for patients unfit for open repair and with anatomy unsuitable for bifurcated endovascular repair.

References

1. Kiguchi MM, Forbes TL, Teijink JAW, et al. Clinical application and early outcome of the aortouni-iliac configuration for endovascular aneurysm repair. J Vasc Surg 2014;60:1452-9.
2. Dortch JD, Oldenburg WA, Farres H, et al. Long-term results of aortouniiliac stent-grafts for the endovascular repair of abdominal aortic aneurysms. Ann Vasc Surg 2014;28:1258-65.
3. Tang T, Sadat U, Walsh S, et al. Comparison of the Endurant bifurcated endograft vs. aortouni-iliac stent-grafting in patients with abdominal aortic aneurysms: Experience from the ENGAGE registry. J Endovasc Ther 2013;20:172-81.
4. Jean-Baptiste E, Batt M, Azzaoui R, et al. A comparison of the mid-term results following the use of bifurcated and aorto-uni-iliac devices in the treatment of abdominal aortic aneurysms. Eur J Vasc Endovasc Surg 2009;38:298-304.
5. Lazaridis J, Melas N, Saratzis A, et al. Reporting mid- and long-term results of endovascular grafting for abdominal aortic aneurysms using the aortomonoiliac configuration. J Vasc Surg 2009;50:8-14.
6. Prusa AM, Wibmer AG, Schoder M, et al. Secondary modification into aortouniiliac configuration to salvage failed endovascular aneurysm repair is safe and effective but not associated with higher intervention rates during long-term follow-up. Am J Surg 2014;208:435-43.
7. Ten Bosch JA, Waasdorp EJ, de Vries JPM, et al. The durability of endovascular repair of para-anastomotic aneurysms after previous open aortic reconstruction. J Vasc Surg 2011;54:1571-9.
8. Peppelenbosch N, Geelkerken RH, Soong C, et al. Endograft treatment of ruptured abdominal aortic aneurysms using the Talent aortouniiliac system: An international multicentre study. J Vasc Surg 2006;43:1111-22.

905.3

Is thrombus in the neck a contraindication for EVAR?

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Learning Objectives

1. To review the inclusion criteria for EVAR
2. To analyse the correlation between technical evolution and proximal neck morphology
3. To understand the potential complications associated with presence of thrombus in the proximal neck

Endovascular aneurysm repair (EVAR) is a valid alternative to open repair for abdominal aortic aneurysms (AAA), with several advantages in terms of perioperative morbidity and mortality.[1-2] However, some morphologic aneurysm features, particularly at the level of the proximal aneurysm neck, limit its use. The quality of the proximal aortic neck is crucial for the fixation and sealing of endovascular devices, and consequently, it is the most frequent constraint for EVAR. Neck length, diameter, angulation, and presence of calcification or thrombus have all been considered important determinants for outcome after EVAR. Current opinion associates thrombus in the proximal AAA neck with greater risk of proximal type I endoleak, stent graft migration, and renal embolic complications, thus considering it a relative contraindication for EVAR.[3] However, no robust scientific evidence supports this concept: all major trials studying EVAR have excluded patients with significant neck thrombus, and this opinion is essentially based on concerns expressed by experts and manufacturers. Of interest is a comparative analysis between thrombus and non-thrombus neck in EVAR patients reported by two Dutch centers.[4] The authors conclude that the presence of thrombus in the proximal aortic neck has no significant influence on migration, proximal type I endoleak, and decline of renal function. In addition, they noted a significant decrease in neck thrombus volume after EVAR, while postoperative neck dilatation, up to the main-body diameter of the originally implanted endograft, was more common in thrombus neck patients. Although no concrete evidence is reported about type of endograft fixation, oversizing, and ballooning, it is common practice in the management of AAA with thrombus neck to prefer endograft with infrarenal fixation and minimum oversizing rate and to not perform ballooning at the end of the procedure in order to avoid any dislodgement of thrombus to renal arteries. In conclusion, with careful patient selection, planning, and device manipulation, the presence of thrombus at level of aneurysm neck has no significant influence on outcomes after EVAR.

References

1. Greenhalgh RM, Brown LC, Kwong GP, Powell JT, Thompson SG, EVAR trial participants. Comparison of endovascular aneurysm repair with open repair in patients with abdominal aortic aneurysm (EVAR trial 1), 30-day operative mortality results: randomised controlled trial. Lancet 2004;364:843-8.
2. Prinssen M, Verhoeven EL, Buth J, Cuypers PW, van Sambeek MR, Balm R, et al. A randomized trial comparing conventional and endovascular repair of abdominal aortic aneurysms. N Engl J Med 2004;351:1607-18.
3. Gitlitz DB, Ramaswami G, Kaplan D, Hollier LH, Marin ML. Endovascular stent grafting in the presence of aortic neck filling defects: early clinical experience. J Vasc Surg 2001;33:340-4.

4. Bastos Gonçalves F, Verhagen HJM, Chinsakchai K, van Keulen JW, Voûte MT, Zandvoort HJ, Moll FL, van Herwaarden JA. The influence of neck thrombus on clinical outcome and aneurysm morphology after endovascular aneurysm repair. J Vasc Surg 2012;56:36-44.

905.4

Is there a need to preserve internal iliac arteries?

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Learning Objectives

1. To better understand how to manage the internal iliac artery in patients with AAA
2. To analyse the different techniques to keep the internal iliac artery patent
3. To compare surgery and endovascular option for the internal iliac arteries

Endovascular aortic repair (EVAR) is a well-established procedure for abdominal aortic aneurysm (AAA) repair.

AAA is accompanied by aneurysms or ectasia of the common iliac artery in approximately 40% of the patients. In an ectatic iliac artery (<23 mm), most currently available AAA stent-graft systems provide bell-bottom iliac limbs to allow sealing in the common iliac arteries. In the setting of irregular iliac arteries, one option is to land above or below the ectatic portion of the artery to allow for limb sealing. However, one must be aware that the ectatic iliac artery (>15 mm) is prone to dilate during follow-up. This might compromise the distal seal leading to migrations, endoleaks, and repressurization of the aneurysm.

If an actual common iliac artery aneurysm exists or the vessel measures >22 mm, this precludes the landing of the stent-graft in this zone. EVAR then has to be extended into the external iliac artery. In this situation, the internal iliac artery can either be sacrificed by simple coverage or embolization, or it can be revascularized by endovascular or surgical means.

In up to 25%–30% of patients undergoing EVAR, internal iliac artery coverage is necessary. Pelvic arterial flow is then dependent on the existing collateral flow to be sufficient to avoid pelvic ischemic complications.

The most common complication to internal iliac artery coverage or embolization is buttock claudication, which after unilateral sacrifice, occurs in up to 30% of patients. For bilateral repair, this number is significantly higher. Other ischemic complications such as impotence, bowel ischemia, and scrotal slouching are much less studied and likely more uncommon but do occur, particularly after bilateral internal iliac artery sacrifice.

The strategy for AAA with concomitant common iliac artery aneurysms is clear:

First, identify patients at risks such as those with contralateral hypogastric disease, previous abdominal or groin surgery, or previous aortic repair. Also keep in mind that a majority of AAA cases present with asymptomatic disease; thus, the effect of iatrogenic pelvic ischemic disorders, as described above, is particularly upsetting for the patient.

The options available for internal iliac revascularization are as follows:

A staged procedure, if embolization is necessary in order to build collateral supply to the occluded side. The embolization must be as proximal as possible to recruit the collaterals. However, the proof of this concept is not well documented.

B Surgical external-to-internal bypass

C A branched iliac stent-graft

905.5

A fit 65-year-old patient with AAA suitable for EVAR should undergo open surgery

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In 1991, a new technique in the treatment of infrarenal abdominal aortic aneurysm was introduced: the endovascular aneurysm repair (EVAR). The good early results achieved and the less invasive nature of this technique compared to the conventional surgical repair has led to the proliferation of studies reporting its clinical feasibility and benefits. The anatomic suitability for EVAR, patient's life expectancy, and most of all patient's fitness are the variables predicting the outcomes of an AAA treatment. Nowadays, during decision making, the vascular surgeon must take into account the risk–benefit balance: even though EVAR has lower perioperative mortality and better 30-day outcomes than open repair, recent reports have raised some doubts about its clinical and economic benefits in young patients.

The main concern is the technical failure of endovascular grafting for AAA at mid-term (2 years) and long-term (>4 years) follow-up. The overall rate of reinterventions for graft-related complications is four times higher in patients who underwent EVAR than in those who underwent open repair (12-16% vs. 3-4%). Furthermore, because of EVAR's complication rate (15-25% endoleak; 7% graft kinking, branch stenosis, or thrombosis; 2.5% device migration; and 1% AAA rupture) patients require care and, even if expensive, constant monitoring.

In regard to his/her long life expectancy, a fit 65-year-old patient with an AAA should undergo open surgery: the traditional technique is associated with a 10-year survival of 80% and has a lower postoperative complication rate.

Finally, as the graft used for EVAR is very expensive and involves a continuing need for surveillance and reintervention, the traditional technique is less expensive.

References

1. EVAR trial participants. Endovascular aneurysm repair versus open repair in patients with abdominal aortic aneurysm (EVAR trial 1): randomised controlled trial. Lancet. 2005; 365: 2179-86.
2. United Kingdom EVAR Trial Investigators, Greenhalgh RM, Brown LC, Powell JT, Thompson SG, Epstein D, Sculpher MJ. Endovascular versus open repair of abdominal aortic aneurysm. N Engl J Med. 2010; 362:1863-71.
3. Blankensteijn JD, de Jong SE, Prinssen M, van der Ham AC, Buth J, van Sterkenburg SM, Verhagen HJ, Buskens E, Grobbee DE; Dutch Randomized Endovascular Aneurysm Management (DREAM) Trial Group. Two-year outcomes after conventional or endovascular repair of abdominal aortic aneurysms. N Engl J Med. 2005; 352: 2398-405.
4. EVAR trial participants. Endovascular aneurysm repair and outcome in patients unfit for open repair of abdominal aortic aneurysm (EVAR trial 2): randomised controlled trial. Lancet. 2005; 365: 2187-92.
5. Conrad MF, Crawford RS, Pedraza JD, Brewster DC, Lamuraglia GM, Corey M, Abbara S, Cambria RP. Long-term durability of open abdominal aortic aneurysm repair. J Vasc Surg. 2007; 46: 669-75.
6. Kouvelos G, Koutsoumpelis A, Lazaris A, Matsagkas M. Late open conversion after endovascular abdominal aortic aneurysm repair. J Vasc Surg. 2015, Mar 26 (published online).
7. Ilyas S, Shaida N, Thakor AS, Winterbottom A, Cousins C. Endovascular aneurysm repair (EVAR) follow-up imaging: the assessment and treatment of common postoperative complications. Clin Radiol. 2015; 70: 183-96.

905.6

A fit 65-year-old patient with AAA suitable for EVAR should not undergo open surgery

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Endovascular abdominal aneurysm repair (EVAR) has gained popularity over the last decades as a minimally invasive alternative to open repair. It has become a well-accepted technique, with a significantly lower short-term mortality compared with that for open surgery. However, in several earlier randomised controlled trials, this benefit was reported not to persist over time. Intention-to-treat analyses found no difference in all-cause mortality at intermediate and long-term follow-up between the two treatment options. The early benefit from EVAR is annulled by the number of late deaths from cardiac and other unrelated causes. Furthermore, earlier trials reported a significantly higher incidence of additional interventions for procedure-related complications in participants undergoing EVAR compared with those receiving open surgical repair. The incidence of endograft-related complications has been reported to be as high as 25%. The majority of these re-interventions were catheter-based interventions associated with a relatively low mortality.
However, many of the patients in these initial studies received first- or second-generation endovascular device. A majority of these devices have now been withdrawn from the market or are being withdrawn on the basis of the identified imperfections, which are partly of fully modified. With the current third- and fourth-generation endovascular devices, the repair-associated morbidity and aneurysm-related and all-cause peri-operative mortality are reduced in comparison with open surgical repair. Moreover, there is growing evidence that endograft complications are related to aortic morphology rather than comorbidity or physiology. These data show a significant increase in graft and/or procedure-related mortality in patients with adverse anatomy. Based on modern three-dimensional imaging techniques, it is often possible to assess the risk of developing endograft complications pre-operatively. This makes it possible to prevent complications and inform patients prior to their intervention about risks of different techniques. Not surprisingly, endovascular repair has become a mainstay in the treatment of abdominal aortic aneurysms, accounting for over 60% of elective repairs. Therefore, in this endovascular era, a fit 65-year-old patient with EVAR-suitable AAA should be treated by endovascular means.

References

1. Paravastu SCV, Jayarajasingam R, Cottam R, Palfreyman SJ, Michaels JA, Thomas SM. Endovascular repair of abdominal aortic aneurysm. Cochrane Database Syst Rev 2014;23;1:CD004178.
2. Moll FL, Powell GT, Fraedrich G, Verzini F, Haulon S, Waltham M, van Herwaarden JA, Holt PJE, van Keulen JW, Rantner B, Schlösser FJV, Setacci F, Ricco J-B. Management of abdominal aortic aneurysms clinical practice guidelines of the European society for vascular surgery. Eur J Vasc Endovasc Surg 2011;41:S1-S58.
3. Schermerhor ML, O'Malley J, Haveri A, Cotterill P, Pomposelli F, Landon BE. Endovascular vs. open repair of abdominal aortic aneurysms in the Medicare population. N Engl J Med 2008;358:464-474.

Lecture Session
Aortic dissection

1006.1

Outcomes of endovascular treatment of complicated type B dissection (IRAD)

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Learning Objectives

1. To understand the criteria for complicated type B aortic dissection
2. Impact of complications in type B dissections
3. How complications change the outcome

The International Registry of Acute Aortic Dissection (IRAD) was established in 1996 with the aim to better understand and report observations on a high number of aortic dissected patients. Over the past two decades, IRAD publications have increased our knowledge and understanding about aortic dissection. At present, IRAD includes more than 5000 dissected patients, enrolled at 30 hospitals across 10 different countries, with additional centers that are in the process for joining the registry.
The optimal treatment strategy of aortic dissection is continuously evolving, especially regarding type B aortic dissection (ABAD). Current guidelines recommend conservative medical management in uncomplicated ABAD patients, presenting without rupture/hypotension, malperfusion, periaortic hematoma, or refractory pain/hypertension. In ABAD patients, medical management is associated with excellent results, with in-hospital survival between 90% and 98%.
IRAD showed, in a group of 550 ABAD, that the percentage of uncomplicated patients includes about 55% of ABAD, of which in-hospital mortality is 6.1%, compared to 20% of complicated ABAD, regardless of the type of management[1]. Importantly, the lowest in-hospital mortality was for the group of uncomplicated ABAD that was medically treated (3.7%). Among this cohort of initially uncomplicated ABAD, higher risk of mortality was observed within those presenting with migrating pain and affected by Marfan syndrome.
In patients presenting with complicated ABAD, interventions are needed to prevent definitive malperfusion and aortic rupture. IRAD showed that open surgical repair is associated with almost 30% rate of in-hospital mortality, which is significantly higher compared to endovascular management (10%)[2], although, in such cohort, older age looks associated with poor outcome, irrespective of the treatment[3].
A recent analysis of IRAD ABAD patients treated with TEVAR[4], enrolled using the IRAD Interventional (IVC) dataform (n=172) showed that indications for intervention included malperfusion (33.3%); visceral, limb, or renal ischemia (19.5%, 17.1%, and 4.9%, respectively); refractory pain (12.2%); refractory hypertension (7.3%); and type B dissection with diameter >5.0 cm (4.9%). Endovascular patients who required visceral artery stenting (including the celiac, superior mesenteric, and renal artery) showed postoperatively more often malperfusion (53.8% vs. 16.7%, p<0.001) and acute renal failure (66.7% vs. 17.4%, p<0.001). Overall early mortality was 12%; patients died from multiorgan failure (26%), rupture (21%), neurologic complications (11%), visceral ischemia (11%), cardiac (11%), or other complications (21%).

References

1. Influence of clinical presentation on theoutcome of acute B aortic dissection: evidences from IRAD. Trimarchi S, Tolenaar JL, Tsai TT, Froehlich J, Pegorer M, Upchurch GR, Fattori R, Sundt TM 3rd, Isselbacher EM, Nienaber CA, Rampoldi V, Eagle KA. *J Cardiovasc Surg (Torino). 2012;53(2):161-8.*

2. Complicated Acute Type B Dissection: Is Surgery Still the Best Option?: A Report From the International Registry of Acute Aortic Dissection. Rossella Fattori, Thomas T. Tsai, Truls Myrmel, Arturo Evangelista, Jeanna V. Cooper, Santi Trimarchi, Jin Li, Luigi Lovato, Stephan Kische, Kim A. Eagle, Eric M. Isselbacher, and Christoph A. Nienaber. *J Am Coll Cardiol Intv. 2008;1;395-402.*
3. The Role of Age in Complicated Acute Type B Aortic Dissection. Jonker FH, Trimarchi S, Muhs BE, Rampoldi V, Montgomery DG, Froehlich JB, Peterson MD, Bartnes K, Gourineni V, Ramanath VS, Braverman AC, Nienaber CA, Isselbacher EM, Eagle KA. *Ann Thorac Surg. 2013;96(6):2029-34.*
4. Insights from the International Registry of Acute Aortic Dissection (IRAD), Interventional Cohort (IVC) G. H.W. van Bogerijen, MD, H. J. Patel, MD, G.R. Upchurch Jr., MD, D. Montgomery, BS, C.A. Nienaber, MD, E.M. Isselbacher, MD, R. Fattori, MD, N.D. Desai, MD, J.E. Bavaria, MD, M. Di Eusanio, MD, PhD, T.M. Sundt, III, MD, T.G. Gleason, MD, D.M. Williams, MD, K.A. Eagle, MD, S. Trimarchi, MD, PhD. *Presented at AHA 2014.*

1006.2

"Petticoat" technique: indications and results

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Learning Objectives
1. Differential need for more complex TEVAR to manage malperfusion
2. When an open stent configuration is needed
3. Additional risk or benefit of the PETTICOAT

The incidence of aortic dissection averages 4/100,000 persons. As of today, uncomplicated acute type B dissections (TBD) are managed medically, with a mortality rate of 10% and the need for surgery in 25% at 4 years.[1,2]Surgical treatment is reserved for complicated TBD. Endovascular techniques have emerged as promising alternatives to open surgery with lower 30-day mortality rates (4.2% vs. 17.8%; p<0.001), shorter hospitalization length (p=0.001), higher mid-term survival rate (92% vs. 76% at 1 year, 86% vs. 73% at 2 years, 82% vs. 71% at 3 years), lesser postoperative respiratory failure (p=0.022), and fewer wound complications (p=0.008),[3] making aortic dissection the second most common investigational application of thoracic stent-graft technology.[4–8]

The first procedures were performed with "off-label" devices, which were initially designed for the treatment of aneurysms. Unfavorable consequences such as retrograde dissection, device-induced new-entry tear, and stent-graft infolding were observed, leading to the development of dedicated material.

Clinical indications to endovascular treatment of TBD include the following: persistent refractory pain, periaortic hematoma, evidence of clinical manifestation of dynamic malperfusion or radiologic evidence of true lumen (TL) collapse, transaortic growth of ≥10 mm within 3 months, and transaortic diameter of ≥40 mm. To be eligible for the dedicated devices, the following anatomic criteria have to be met: primary entry tear at >20 mm below the left subclavian artery and at >20 mm above the celiac trunk and proximal and distal landing zone diameters of >24 mm and <38 mm, respectively.

The endovascular stent-graft repair strives to seal entry tears when avoiding coverage of >20 cm of the aorta to lower the risk of spinal cord ischemia.[9,10] However, even after successful thoracic stent-graft sealing of the entry tear, the distal abdominal aorta fails to remodel in 50%–80% of cases.[11] It is highly suspected that distal re-entry sites between the TL and the false lumen (FL) associated with the flapping motion of the lamella prevent FL thrombosis. Sustained FL flow and pressurization exposes patients to increased risks of dissection progression and organ malperfusion as well as late aneurysmal degeneration and rupture.[12-14] To promote TL expansion and FL thrombosis, extended bare stent scaffolding of the dissection beyond the stent-graft and down to the distal aorta has been developed. It helps in repositioning and fixating the distal lamella along with preserving blood flow to all abdominal side branches. The first report of an adjunctive measure to a primary stent-graft insertion was made by Mossop *et al.* in 2005.[15] A year later, Nienaber *et al.* reported a series of staged procedures with provisional stent-graft extension by distal bare metal stents and introduced it as the «Petticoat» technique (provisional extension to induce complete attachment).[16]

In the literature, successful entry closure was possible in 85%–100% of cases. Since most primary entry tears begin immediately distal to the left subclavian artery, intentional coverage of its origin with expectant management was commonly used. Successful entry tear coverage induced complete or partial FL thrombosis in 85% to 100% of patients. A significant immediate increase (98%) in TL volume could be achieved in both the thoracic and abdominal aorta with immediate postoperative resolution of all cases of dynamic malperfusion and TL collapse. Retrograde dissection was observed in 5% of cases. Progressive remodeling of TL (increase of 131% at 1 year and 140% at 2 years) was recorded over time, with reduction of FL volume mainly in the thoracic segment (35% at 1 year and 38% at 2 years).[17]

Initial results are encouraging. The Petticoat technique appears to be feasible and safe, with no risk to side branches fed from either the TL or FL, and it could be beneficial to improve aortic remodeling of both the TL and FL in the thoracic and abdominal aorta. Unfortunately, the literature often mixes outcomes from applications in different clinical contexts in terms of age of dissection, extent of disease, and presence of complications; further follow-up is still needed.

References

1. Umana JP, Miller DC, Mitchell RS. What is the best treatment for patients with acute type B aortic dissections–medical, surgical, or endovascular stent-grafting? *Ann Thorac Surg.* 2002;74:S1840–63.
2. Onitsuka S, Akashi H, Tayama K, et al. Long-term outcome and prognostic predictors of medically treated acute type B aortic dissections. *Ann Thorac Surg.* 2004;78:1268–73.
3. Chou HP, Chang HT, Chen CK, et al. Outcome comparison between thoracic endovascular and open repair for type B aortic dissection: a population-based longitudinal study. *J Chin Med Assoc.* 2015;78:241–8.
4. Nienaber CA, Eagle KA. Aortic dissection: new frontiers in diagnosis and management. Part II: therapeutic management and follow-up. *Circulation.* 2003;108:772–8.
5. Lopera J, Patino JH, Urbina C, et al. Endovascular treatment of complicated type-B aortic dissection with stent-grafts: midterm results. *J Vasc Interv Radiol.* 2003;14:195–203.
6. Nienaber CA, Ince H, Weber F, et al. Emergency stent-graft placement in thoracic aortic dissection and evolving rupture. *J Card Surg.* 2003;18:464–70.
7. Szeto WY, McGarvey M, Pochettino A, et al. Results of a new surgical paradigm: endovascular repair for acute complicated type B aortic dissection. *Ann Thorac Surg.* 2008;86:87–93; discussion 93–4.
8. Lombardi JV, Cambria RP, Nienaber CA, et al. Prospective multicenter clinical trial (STABLE) on the endovascular treatment of complicated type B aortic dissection using a composite device design. *J Vasc Surg.* 2012;55:629–40.e2.
9. Nienaber CA, Fattori R, Lund G, et al. Nonsurgical reconstruction of thoracic aortic dissection by stent-graft placement. *N Engl J Med.* 1999;340:1539–45.
10. Fattori R, Nienaber CA, Rousseau H, et al. Results of endovascular repair of the thoracic aorta with the Talent Thoracic stent graft: the Talent Thoracic Retrospective Registry. *J Thorac Cardiovasc Surg.* 2006;132:332–9.
11. Eggebrecht H, Nienaber CA, Neuhauser M, et al. Endovascular stent-graft placement in aortic dissection: a meta-analysis. *Eur Heart J.* 2006;27:489–98.

12. Sueyoshi E, Sakamoto I, Hayashi K, et al. Growth rate of aortic diameter in patients with type B aortic dissection during the chronic phase. *Circulation*. 2004;110:SII256–61.
13. Bernard Y, Zimmermann H, Chocron S, et al. False lumen patency as a predictor of late out-come in aortic dissection. *Am J Cardiol*. 2001;87:1378–82.
14. Tsai TT, Evangelista A, Nienaber CA, et al. Partial thrombosis of the false lumen in patients with acute type B aortic dissection. *N Engl J Med*. 2007;357:349–59.
15. Mossop PJ, McLachlan CS, Amukotuwa SA, et al. Staged endovascular treatment for complicated type B aortic dissection. *Nat Clin Pract Cardiovasc Med*. 2005;2:316–21; quiz 322.
16. Nienaber CA, Kische S, Zeller T, et al. Provisional extension to induce complete attachment after stent-graft placement in type B aortic dissection: the PETTICOAT concept. *J Endovasc Ther*. 2006;13:738–46.
17. Melissano G, Bertoglio L, Rinaldi E, et al. Volume changes in aortic true and false lumen after the "PETTICOAT" procedure for type B aortic dissection. *J Vasc Surg*. 2012;55:641–51.

1006.3

Management of distal re-entry tear: when and how

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Learning Objectives
1. Differential need for more complex TEVAR to manage distal backflow via re-entries
2. Options to seal distal re-entries
3. Risks to consider when closing distal re-entries

Benefits from early endovascular treatment for acute type B aortic dissection have been demonstrated for both complicated and uncomplicated, even asymptomatic, patients. The aim of the procedure is to seal the entry tear and thus to promote false lumen thrombosis with subsequent aortic remodeling and true lumen expansion. In acute setting, re-entry tears are usually treated if they determine a complication such as organ malperfusion. However, the extent of the distal coverage and whether to treat other uncomplicated re-entry tears are still debated topics. Moreover, when the primary treatment proves to be insufficient and when the dissection is not acute or subacute but chronic, there is no general consensus on what should be the patient management. In chronic dissections, there is limited response to endovascular coverage of the proximal entry tear. This is probably due to a lack of vessel compliance to remodeling because of the already consolidated process of thickening and stiffening of the aortic wall and intimo-medial flap. In this scenario, the persistent retrograde flow occurring through multiple distal tears at the origin of arterioles (intercostal and bronchial) and visceral and iliac arteries might determine a continuous perfusion of the false lumen. This process of pressurization not only prevents complete thrombosis of the false lumen but also leads to its expansion, which has been demonstrated to be the main cause of mortality in these patients. Therefore, the suggested treatments consist of either occluding the false lumen or re-entry tears or stenting the aortic branch vessels in order to interrupt the false lumen perfusion. Several techniques have been proposed. False lumen occlusion has been obtained with different embolic materials such as plugs, coils, and glue. Customized stent grafts have been created for this purpose, but they are not yet commercially available. Fenestration or rupture of the intimal flap to create a suitable landing zone for TEVAR has been described. However, in chronic dissection, the true lumen might be so narrow that stent-graft placement is not feasible. In this case, the stent graft can be implanted in the false lumen with proximal communication with the true lumen via the entry tear and distally via a fenestration in the descending thoracic aorta. Re-entry tears at visceral branches can be occluded by means of stent-graft placement through the false lumen to the visceral vessel. This method is technically difficult to perform as the tear is not easy to locate during the procedure. Other procedures that require advanced endovascular skills and hybrid techniques are respectively distal extension by fenestrated endografts and distal extension by visceral hybrid repair. The former has showed promising results but with practical limitations to broad diffusion, while the latter is more easily performed but still presents significant mortality and morbidity rates. However, all these endovascular, surgical, and hybrid procedures might present some risks such as organ malperfusion, continuous dilation, and aortic rupture and therefore must be tailored for each patient, considering the anatomic, hemodynamic, and clinical peculiarities in different settings. In the near future, a broader diffusion of advanced imaging techniques, such as functional imaging with 4D MRI, may provide a more accurate risk stratification and a more comprehensive choice of the best management.

References

1. Kölbel T, Tsilimparis N, Wipper S, et al. TEVAR for chronic aortic dissection. Is covering the primary entry tear enough? J Cardiovasc Surg (Torino) 2014;55:519-27.
2. Mani K, Clough RE, Lyons OT, et al. Predictors of outcome after endovascular repair for chronic type B dissection. Eur J Vasc Endovasc Surg 2012;43:386-91.
3. Kölbel T, Carpenter SW, Lohrenz C, et al. Addressing persistent false lumen flow in chronic aortic dissection: the knickerbocker technique. J Endovasc Ther 2014;21:117-22.
4. Kölbel T, Lohrenz C, Kieback A, et al. Distal false lumen occlusion in aortic dissection with a homemade extra-large vascular plug: the candy-plug technique. J Endovasc Ther 2013;20:484-9.
5. Dake MD, Thompson M, van Sambeek M, et al; DEFINE Investigators. DISSECT: a new mnemonic-based approach to the categorization of aortic dissection. Eur J Vasc Endovasc Surg 2013;46:175-90.
6. Rohlffs F, Tsilimparis N, Diener H, et al. Chronic type B aortic dissection: indications and strategies for treatment. J Cardiovasc Surg 2015;56:231-8.

1006.4

Fenestrated and branched grafts to treat post-dissection aneurysm

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Learning Objectives
1. Identify patients with chronic dissection for branched and fenestrated TEVAR
2. Case selection issues
3. Procedure-related issues and potential benefits

Approximately 20%–30% of patients suffering an uncomplicated, acute type B dissection will develop a secondary thoracic (TAA) or thoracoabdominal (TAAA) aneurysm. The goal in the treatment of a post-dissection aneurysm is to exclude the aneurysm from blood flow and pressure. In case of TAAA formation, a fenestrated/branched endovascular repair (F/Br-EVAR) is mandated.

Our experience in the treatment of post-dissection aneurysms with F/Br-EVAR includes 26 patients (22 males; mean age, 64.6 ± 8.1 years) treated from October 2010 to October 2014. All cases were technically successful, but in one case, a retroperitoneal approach was needed for renal artery catheterization. Two (7.7%) patients died within 30 days post-operatively; one due to multiple organ failure and the other due to cardiac decompensation. Renal function impairment occurred in one (3.8%) patient. Perioperative spinal cord ischemia (SCI) occurred in four (15.4%) patients. One (3.8%) patient

suffered paraplegia with significant improvement prior to discharge, and three (11.5%) patients suffered transient paraparesis with complete recovery prior to discharge. One (3.8%) patient developed late (6 months) SCI with urinary incontinence and lower limb weakness due to the regression of a type II endoleak. Mean follow-up (FU) was 16.2 months (range, 1–54 months). One late death was graft-related, and it occurred 26 months post-operatively due to an aorto-esophageal fistula. Three target vessel occlusions were noticed (two renal arteries, one celiac trunk) during FU. In one case, an iliac-renal bypass was performed, and the remaining two cases were asymptomatic and did not require treatment. Endoleaks were diagnosed in 14 (53.8%) patients during FU. These included three (11.5%) type Ib endoleaks, all from the left renal artery (LRA). Three (11.5%) patients had distal type Ib endoleaks from the dissected iliac arteries. Eight (30.8%) patients had type II endoleaks. Reintervention was required in three (11.5%) patients for type Ib endoleak from the LRA. These were successfully treated with stent-graft extension deeper into the target vessel. Aneurysm sac regression during FU was significant ($p = 0.007$) from 67.4 ± 6.4 mm to 59.1 ± 7.5 mm, with a false lumen thrombosis rate of 83.3% for patients who completed 12-month FU.
Conclusions: F/Br-EVAR is a feasible option to achieve complete exclusion of post-dissection TAAA. Early and mid-term FU seem promising. Despite the higher need for reintervention, F/Br-EVAR leads to favorable aneurysm remodeling, with aneurysm shrinking and high rates of complete false lumen thrombosis.

1006.5

Uncomplicated acute type B dissections should be treated by TEVAR in the majority of cases: For the motion

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No abstract available.

1006.6

Uncomplicated acute type B dissections should be treated by TEVAR in the majority of cases: Against the motion

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Introduction
Type B aortic dissection is probably underdiagnosed. The condition has been defined in terms of chronology and in terms of whether it leads to complications or not. It is clear that patients with early complications need corrective treatment, and that TEVAR has advantages compared with open surgery. The case of the so-called uncomplicated patient is less clear.
Prognosis
For those patients who do not have an early major complication, good medical treatment with aggressive hypertension control will prevent the majority from developing any further problems; however, a minority will develop an aneurysm, and this may have been prevented by TEVAR at an earlier stage. This hypothesis relies on TEVAR, leading to complete remodeling with false lumen thrombosis to prevent further enlargement. We now know of some risk factors to predict as to which patients will follow this course, and IRAD would suggest that it is no more than 25%–40%, meaning that the majority would not benefit from TEVAR.
Evidence
There have been two RCTs (INSTEAD and ADSORB), which studied a small number of patients treated with medical treatment alone compared with those treated with TEVAR plus medical treatment. Both have flaws, but there is some evidence building to suggest that some *uncomplicated* patients may benefit from treatment with TEVAR. Both studies revealed positive aortic remodeling associated with TEVAR treatment, and it is tempting to suggest that this will result in fewer aneurysms and late deaths as a result of rupture. However, as yet, we have no proof of this.
Conclusions
Although an attractive concept, the data do not add up to prove that TEVAR is a viable option for most of these patients. There is not enough evidence to extrapolate late outcomes from one small trial (there are no results from ADSORB) to apply to all (or even the *majority*) of the patients presenting with type B dissection without initial complications. All need medical management and surveillance, and a few will need early TEVAR; however, this will be the minority rather than the *majority*. Exposing the vast *majority* to TEVAR is, at best, gross overtreatment and, at worst, reckless intervention with perioperative consequences for patients not needing such intervention. The motion cannot be proven with the data available in 2015.

Hot Topic Symposium
Aortic intervention – quo vadis?

1302.1

Thoracic aortic trauma

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Thoracic aortic injury (TAI) is, after brain injury, the second most common cause of death in blunt trauma patients. With improved rescue processes and rapid detection of TAI, patients who initially survive are more likely to undergo successful repair.
Rapid deceleration results in torsion and shearing forces at relatively immobile portions of the aorta, such as the aortic isthmus, in up to 90% of cases. Computed tomography is quick and reproducible, with sensitivity and specificity close to 100% for TAI. A classification scheme for TAI has been proposed: Type I (intimal tear), Type II (IMH), Type III (pseudoaneurysm), and Type IV (rupture).
The appropriate timing of treatment in patients with TAI is still controversial. Patients with free aortic rupture or large periaortic haematoma should be treated as emergency cases. For all other conditions, the intervention may be delayed for up to 24 hours to allow for patient stabilization and the best possible conditions for the aortic intervention. An initial conservative management, with serial imaging, has been proposed for patients with minimal aortic injuries (intimal tear/Type I lesions), as most lesions remain stable or resolve.
As a whole, available data indicate that TEVAR, in suitable anatomies, should be the preferred treatment option in TAI. A recently published review, including 7768 patients enrolled for TAI, found a significantly reduced mortality for TEVAR when compared with OR (9% vs 19%; $p < 0.01$). In the same study, no significant difference in event rate across the two groups was noted for stroke, whilst the risk of spinal cord ischaemia (SCI) and end-stage renal disease (ESRD) were higher in OR (9% vs 3%; $p = 0.01$ for SCI and 8% vs 5%; $p = 0.01$ for ESRD). OR was also associated with an increased risk of graft and systemic infection, whilst endovascular repair was associated with an increased need for secondary procedures (5.4%; $p = 0.07$), mostly due to endoleak (60%), followed by stent collapse (11%).
Long-term surveillance by CT is currently considered the standard imaging modality for follow-up; however, given the frequent young age of patients with TAI, concerns arise with regard to cumulative exposure to radiation and iodinated contrast medium. For these reasons, MRI is the best alternative for surveillance when magnetic resonance-compatible stent grafts are employed.

References

1. Neschis DG, Scalea TM, Flinn WR, Griffith BP. Blunt aortic injury. N Engl J Med 2008;359:1708-16.

2. Murad MH, Rizvi AZ, Malgor R, Carey J, Alkatib AA, Erwin PJ, Lee WA, Fairman RM. Comparative effectiveness of the treatments for thoracic aortic transection. J Vasc Surg 2011;53:193-199 e1-21.
3. Jonker FH, Verhagen HJ, Lin PH, Heijmen RH, Trimarchi S, Lee WA, Moll FL, Atamneh H, Rampoldi V, Muhs BE. Open surgery versus endovascular repair of ruptured thoracic aortic aneurysms. J Vasc Surg 2011;53:1210-6.
4. Lee WA, Matsumura JS, Mitchell RS, Farber MA, Greenberg RK, Azizzadeh A, Murad MH, Fairman RM. Endovascular repair of traumatic thoracic aortic injury: clinical practice guidelines of the Society for Vascular Surgery. J Vasc Surg 2011;53:187-92.
5. Azizzadeh A, Charlton-Ouw KM, Chen Z, Rahbar MH, Estrera AL, Amer H, Coogan SM, Safi HJ. An outcome analysis of endovascular versus open repair of blunt traumatic aortic injuries. J Vasc Surg 2013;57:108-14.

1302.2

Complicated acute type B dissection

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No abstract available.

1302.3

Malperfusion syndromes in acute aortic dissection

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State of the art. Patients with aortic dissection (AoD) do not die from the presence of an intimal tear and two channels into the aorta; they die because of two complications: rupture and malperfusion syndromes. Principles of the management are to detect and to treat these complications before it becomes too late. If rupture of the aorta is relatively easy to diagnose in the acute phase (< 2 weeks from initial onset of symptoms), malperfusion syndromes are relatively new entities.

Definition. Malperfusion syndrome is a complication of AoD, encountered in 25% to 50% of patients, defined as end-organ ischemia caused by branch-vessel involvement and resulting in clinical symptoms and functional impairment in a wide range of arterial beds that spans a spectrum between mid-dysfunction to tissue necrosis, resulting in organ damage. Symptoms related to the heart (coronaries, myocardial infarct), brain (supra-aortic vessel, stroke), spine (paraplegia), bowel (ischemia, necrosis, death), kidneys (renal failure, anuria, refractory hypertension), and lower limbs (ischemia, claudication) are some of the possible symptoms of the malperfusion syndromes.

How to detect malperfusion? Because of improvements in technology, a complete thoraco-abdomino-pelvic CT scan of the aorta is now mandatory. Aorta should be considered as an organ, and limited thoracic analysis should be avoided (analysis of only 50% of the organ), leading to insufficient information and mistreatment algorithm. Detection of AoD is not sufficient, and radiologists have to describe the location of AoD on the aorta and its branches, entry tears, possible ruptures, organ ischemia, mechanism of the malperfusion, thrombi, ….

Impact on treatment. Diagnosis of malperfusion syndrome evidenced the remaining mortality after classical AoD management. Because complications were observed and because of improvements of endovascular tools (fenestration, TEVAR, peripheral stents) to repair the arteries, patients could be suitable for an alternative strategy compared to the classical medical or surgical approach.

Classification for management. If De Backey or Stanford classification is well known, AoD management should be performed depending of the presence or absence of complications. If a complication is present, it should be treated first before performing the preventive treatment, regardless of the location of AoD on the aorta.

And now? The main challenge remains to understand the mechanism of the malperfusion and to adapt the best treatment. Questions of when and how to treat patients depend on CT scan analysis, which in turn depends on the quality of the acquisition protocol and the experience of the radiologist.

References

1. Willoteaux S, Lions C, Gaxotte V, Negaiwi Z, Beregi JP. Imaging of aortic dissection by helical computed tomography (CT). Eur Radiol. 2004;14:1999-2008.
2. Midulla M, Fattori R, Beregi JP, Dake M, Rousseau H. Aortic dissection and malperfusion syndrome : a when, what and how-to guide. Radiol Med. 2012;118:74-88.
3. Midulla M, Renaud A, Martinelli T, Koussa M, Mounier-Vehier C, Prat A, Beregi JP. Endovascular fenestration in aortic dissection with acute malperfusion syndrome: immediate and late follow-up. J Thorac Cardiovasc Surg. 2011;142:66-72.
4. Beregi JP, Mounier-Vehier C, Koussa M, Goyault G, Prat A, Martinelli T, Midulla M. Chronic aortic syndrome: how to follow patients, which complications and when to treat? Presse Med. 2011;40:88-93.
5. Kaya A, Heijmen RH, Rousseau H, Nienaber CA, Ehrlich M, Amabile P, Beregi JP, Fattori R. Emergency treatment of the thoracic aorta: results in 113 consecutive acute patients (the Talent Thoracic Retrospective Registry). Eur J Cardiothorac Surg. 2009;35:276-81.
6. Gaxotte V, Thony F, Rousseau H, Lions C, Otal P, Willoteaux S, Rodiere M, Negaiwi Z, Joffre F, Beregi JP. Midterm results of aortic diameter outcomes after thoracic stent-graft implantation for aortic dissection: a multicenter study. J Endovasc Ther. 2006;13:127-38.
7. Gaxotte V, Cocheteux B, Haulon S, Vincentelli A, Lions C, Koussa M, Willoteaux S, Asseman P, Prat A, Beregi JP. Relationship of intimal flap position to endovascular treatment of malperfusion syndromes in aortic dissection. J Endovasc Ther. 2003;10:719-27.
8. Beregi JP, Haulon S, Otal P, Thony F, Bartoli JM, Crochet D, Lacombe P, Bonneville JF, Besse F, Douek P, Heautot JF, Rousseau H; Societé Fraçaise d'Imagerie Cardio-Vasculaire (SFICV) Research Group on Aortic Dissection. Endovascular treatment of acute complications associated with aortic dissection: midterm results from a multicenter study. J Endovasc Ther. 2003;10:486-93.
9. Beregi JP, Prat A, Gaxotte V, Delomez M, McFadden EP. Endovascular treatment for dissection of the descending aorta. Lancet. 2000;356:482-3.

1302.4

Ruptured abdominal aortic aneurysm

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Ruptured abdominal aortic aneurysms (RAAAs) are a catastrophic condition with high morbidity and 30-day mortality when treated by open surgical repair (OSR) procedures. The introduction of endovascular graft repair (EVAR), first performed in 1994, combined with other endovascular adjuncts, offered the possibility of better outcomes.

Numerous single-center reports, population-based studies, and the collected world experience with the use of EVAR for RAAAs demonstrated better early outcomes after EVAR than after OSR. Some of these reports emphasized the importance of several strategies and

adjuncts in achieving these better outcomes. These included having a protocol or system for managing RAAAs, fluid restriction or hypotensive hemostasis prior to and during repair, properly performed use of supraceliac aortic balloon control for hemodynamic collapse, and open abdomen treatment for abdominal compartment syndrome when detected (1).

However, the superiority of EVAR over OSR for the treatment of RAAAs remains controversial. This controversy is sustained by several reports of controlled studies showing no better outcomes for EVAR than for OSR with RAAAs and the claim that reports of better outcomes for EVAR were based on case selection with patients treated by EVAR having more favorable anatomy, being more hemodynamically stable, and less risky.

Recently, 3 randomized controlled trials comparing EVAR and OSR for the treatment of RAAAs have been published or presented. These are the AJAX, EVAR, and IMPROVE trials, all of which demonstrated no better 30-day mortality with EVAR than with OSR. All these trials have serious flaws that render them misleading (2). In addition, one report has demonstrated the ability to treat all RAAAs seen at 2 centers with EVAR, provided some adjuncts like chimney grafts are employed (3). A low 30-day mortality (24%) and turn-down rate (4%) were observed. It can therefore be concluded that EVAR is better than OSR for the treatment of RAAAs, provided EVAR capability exists in an institution and an EVAR procedure can be performed.

References

1. Veith FJ, et al. Collected world and single center experience with endovascular treatment of ruptured abdominal aortic aneurysms. Ann Surg 2009;250:818-824.
2. Veith FJ, Rockman CB. The recent randomized trials of EVAR versus open repair for ruptured abdominal aortic aneurysms are misleading. Vascular 2015;23:217-219.
3. Mayer D, et al. Complete replacement of open repair for ruptured abdominal aortic aneurysms by endovascular aneurysm repair: a two-center 14-year experience. Ann Surg 2012;256:688-696.

Lecture Session
Complex thoracic aorta

1705.1

Technical issues in thoraco-abdominal branched grafting

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Learning Objectives

1. To learn about the technical complications of thoraco-abdominal aneurysms
2. To learn the technical aspects of branched endograft
3. To describe how to avoid complications in branched grafting

Technical success in thoraco-abdominal branched grafting requires correct indication, meticulous stent-graft planning, and technical execution of the procedure. A setup including a hybrid operating room, a dedicated multidisciplinary team approach, and a large stock of back-up materials is of utmost importance. Specific anatomical issues need to be addressed during planning, with alternative solutions depicted.

With regard to access vessels, potential technical issues include narrow/calcified/angulated iliac arteries and/or the aorta. Bilateral femoral cutdown and a stable "upper" access (the left axillary artery with long 12-F flexor sheath) are crucial while facing difficult access issues. Adjunctive balloon angioplasty and "through- and-through or buddy" wires are some options in challenging access.

A secure proximal landing zone is essential for durable aneurysm exclusion. In case of TAAA that extends proximally, sealing of the aortic arch is frequently required. Surgical arch debranching or the use of a proximal fenestrated stent-graft for the arch (the left carotid artery and the left subclavian artery) followed by a branched component for TAAA offers a solution. Rule 1: plan the graft as such to have a stable and durable proximal landing zone.

Achieving distal sealing is usually not difficult, but the use of iliac bifurcation devices (IBD) to preserve hypogastric artery flow is mandatory, to reduce the risk of paraplegia. Rule 2: use an IBD whenever possible!

Difficult anatomy of target vessels (take-off angle, kinking, stenosis) may result in catheterization problems. Use of alternative catheters and wires (0.018" & 0.014") is sometimes necessary. In the rare scenario of failure with antegrade target vessel catheterization, a retrograde approach via lumbotomy or laparotomy as a bail-out can be used. The target vessel can then be punctured and a wire advanced retrogradely, to be snared through the fenestration/branch. Rule 3: always check that you catheterized the correct vessel!

Deployment of the bifurcated component seems the easiest part at the end of the procedure, but mistakes are possible! Check adequate overlap with the branched tube graft, correct position below the lowest renal artery fenestration/branch, and correct orientation and level of the contralateral gate. Rule 4: double-check that you correctly catheterized the gate!

To summarize, technical difficulties are inherent to TAAA branched grafting and have to be expected. Be prepared and have all options available!

1705.2

Off-the-shelf endografts for TAAA: benefits and limitations

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Learning Objectives

1. To learn about the advantages of these devices
2. To describe the difficulties of using off-the-shelf endograft
3. To review the technical aspects of TAAA

Fenestrated and branched grafts are playing an increasing role in the treatment of aneurysm repair. The major criticism of these stent grafts is the delay and cost of bespoke production, which means they are unsuitable for urgent/emergency cases. Therefore, the concept of an 'off-the-shelf' graft technology is very attractive. There are now devices for short-necked infrarenal and juxtarenal cases, as well as for thoracoabdominal aneurysm repair.

The early outcomes from treatment of patients (who are anatomically suitable) with these devices has been promising, and our experience is that the early results are acceptable. Early publications have documented excellent 30-day outcomes for both juxtarenal and thoracoabdominal aneurysm repair [1-3].

Few vascular specialists would challenge the premise that this technology will play a major role in the future. However, there are many unanswered questions. The main question is regarding tolerance of different anatomical configurations. With bespoke manufacturing, fenestrations/branches can be matched exactly to the required height and clock-face orientation. However, if the fenestration/branch is misaligned, there may be significant difficulties. Double diameter-reducing ties and, certainly, intelligent catheter technologies will smooth the cannulation of vessels and introduction of branch stents, but the long-term durability of misaligned branches is yet to be understood due to aortic remodelling and the potential for fracture, kinking and dislocation.

Consideration must also be given to how applicable these devices are in day-to-day practice. With dome-shaped fenestrations, wide coeliac artery scallops and branch technology, the number of patients

that may be treated with a few graft configurations is thought to be acceptable in morphological studies [4]. There should be some caution, however, as these anatomical studies are from specialized centres, and urgent/emergency cases are well accepted to be significantly larger and have more complex anatomical configurations.
These off-the-shelf grafts are a much-needed addition to the range of treatment options for more complex aneurysms. Early results are promising, but the number of patients that may be treated and long-term success of off-the-shelf grafts is yet to be proven.

References

1. Custom-made versus off-the-shelf multibranched endografts for endovascular repair of thoracoabdominal aortic aneurysms. Bisdas T, Donas KP, Bosiers MJ, Torsello G, Austermann M. J Vasc Surg. 2014 Nov;60(5):1186-95.
2. Zenith p-branch standard fenestrated endovascular graft for juxtarenal abdominal aortic aneurysms. Kitagawa A, Greenberg RK, Eagleton MJ, Mastracci TM. J Vasc Surg. 2013 Aug;58(2):291-300.
3. Early experience with the first commercially available off-the-shelf multibranched endograft (t-branch) in the treatment of thoracoabdominal aortic aneurysms. Bosiers MJ, Bisdas T, Donas KP, Torsello G, Austermann M. J Endovasc Ther. 2013 Dec;20(6):719-25.
4. Off-the-shelf fenestrated endografts: a realistic option for more than 70% of patients with juxtarenal aneurysms. Sobocinski J, d›Utra G, O›Brien N, Midulla M, Maurel B, Guillou M, Azzaoui R, Roeder B, Resch TA, Haulon S. J Endovasc Ther. 2012 Apr;19(2):165-72.

1705.3

Current status of arch branched repair

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Learning Objectives

1. To review the surgical options in the aortic arch
2. To learn technical aspects of branched stent-graft for the aortic arch
3. To describe different endovascular technique for the aortic arch

Endovascular treatment has become the first choice for most of the descending thoracic lesions. In the arch, the origin of the supra-aortic vessel till now represented a problem for an adequate landing zone that was solved with surgical or endodebranching (chimney).
The need to treat more and more often high-risk patients with lesions involving the distal ascending aorta and the arch pushed the companies to create new fenestrated/branch devices to deal with these complex situations.
The branch device from Cook is the most used in Europe. Satisfactory results from a global registry on 38 patients were recently published. All the treated patients were considered at high risk; there was a 13% mortality rate, 40% complications, and 10% early secondary procedures. Technical failure occurred in 6 cases and was the cause of death in half of them.
At the 12-month follow-up, there was no related death and 9% secondary procedures.
Learning curve is of utmost importance with these new complex devices, and in fact the rate of complications in the second part of the experience was significantly lower than the previous one (1).
There is even an ongoing arch device from Gore with a broad range of graft and branch graft diameter that was tested till now only in zone 2 in 11 patients in 6 centres in the USA, with no mortality and no stroke. There is an ongoing study for zones 1 and 0. However, this graft is not available out of the trial.
The Bolton device also demonstrated good results in the first 15 patients, with no migration, endoleak, or collapse. This graft was used in sporadic cases published as case reports with good results (3,4).
Medtronic's Mona Isa is another option, although not still on the market, in which preliminary results on 10 patients, recently presented in oral communications, were very good with 100% technical success and no endoleak.
Other options come from the east: the Najuta is a fenestrated arch device from Japan that recently received the CE mark approval. The graft was used in Japan in more than 300 cases with good results.
Another branch is used in China and is not available in Europe, this graft was used in zone 2 in 73 patients, with 97.2% technical success and 4.1% mortality.
Lastly, there is a graft from endospan with an innovative concept, the branch for the innominate is the tip of the main module and the graft is inserted on a through and through wire from the common femoralto the right brachial so that is impossible to loose the target vessel. There is an ongoing first-in-man study in Europe, and the graft has been used in some compassionate cases.
The outcomes of these branch grafts is not well known but seem to be slightly better than those of the chimney technique (4).

References

1. S. Haulon, R.K. Greenberg, R. Spear, M. Eagleton, C. Abraham, C. Lioupis, E. Verhoeven, K. Ivancev, T. Kolbel, B. Stanley, T. Resch, P. Desgranges, B. Maurel, B. Roeder, T. Chuter, T. Mastracci: Global experience with an inner branched arch endograft. J Thorac Cardiovasc Surg 2014;-:1-8.
2. G. Piffaretti, N. Rivolta, F. Fontana, G. Carrafiello, G. Mariscalco, A. Castelli: Aortic arch aneurysm repair with a new branched device. J Vasc Surg 2013;57:1664-7.
3. L. Botta, P. Fatto, A. Cannata, G. Bruschi, A. Rampoldi, L. Martinelli: Aortic arch reconstruction with Bolton Medical branched thoracic stent graft. Eur Soc for Vasc Surg 2013;25:39-41.
4. A. O'Callaghan, T.M. Mastracci, R.K. Greenberg, M.J. Eagleton, J. Bena and Y. Kuramochi: Outcomes for supra-aortic branch vessel stenting in the treatment of thoracic aortic disease. J Vasc Surg 2014;60:914-20.

1705.4

Hybrid procedures for aortic arch disease

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Learning Objectives

1. To review the technical difficulties of the aortic arch
2. To learn the technical aspects of hybrid procedure
3. To describe advantages and disadvantages of hybrid technique

The aortic arch represents perhaps the most challenging area to treat surgically. Considerations for open repair include aortic valvular function, concomitant coronary artery disease, and atherosclerotic disease of the great neck vessels. Although contemporary results of open aortic arch repair have been significantly improved, it still represents a major surgical intervention requiring cardiopulmonary bypass, hypothermia, and circulatory arrest, with significant morbidity and mortality. As in other areas of aortic repair, significant interest has been focused on endovascular repair options for the aortic arch in the hope of reducing perioperative morbidity and mortality. Development of aortic arch stent grafts has been implemented alongside the widespread utilization of parallel graft techniques ("chimney repair"), but it is still in its infancy. Although promising results are seen with endovascular approaches in select patients, the risk of cerebrovascular complications remains significant. In the case of chimney repairs, these are plagued by high rates of endoleaks as well as CNS complications. Anatomical limitations for complete endovascular approaches also remain significant, particularly in the ascending aorta, which is often unsuitable as a landing zone of an endovascular stent graft due to aneurysmal degeneration.

The use of combined surgical and endovascular approaches to tackle the aortic arch has been extensively described. These approaches can obviate the need for circulatory adjuncts perioperatively and can be a viable option for high-risk patients. Hybrid procedures involve aortic arch debranching, creating a landing zone, combined with stentgrafting. Arch debranching can involve zones 0-3 (Ishimaru classification) as well as the proximal descending aorta.
Hybrid repair is often classified into types 1-3 according to lesion extent: 1) brachiocephalic bypass and endovascular repair of the aortic arch, 2) open repair of the ascending aorta to create a proximal landing zone, revascularization of the great vessels and endovascular repair of the aortic arch, and 3) elephant trunk repair with endovascular repair of the descending or thoracoabdominal aorta.
The most common debranching procedure is re-routing of the left subclavian artery (LSA) to create a proximal landing zone for TEVAR in zone 2. In 40% of cases, LSA needs to be covered to achieve a suitable landing zone. LSA coverage without revascularization can lead to an increased risk of cerebrovascular events as well as spinal cord ischemia in select patients. LSA revascularization can be performed as a left carotid-to-LSA bypass or LSA-to-left carotid transposition. LSA re-routing can be performed as a separate stage or in the same setting as the TEVAR.
The outcomes of hybrid arch repair have been reported extensively. A meta-analysis by Moulakakis et al from 2013 describes 956 cases of hybrid arch repair with a primary success rate of 92.8%. The endoleak rate was 16.6%, and the rate of retrograde type A dissection was 4.5%. The 30-day mortality was 11.9%, with a CNS event rate of 7.6% and irreversible spinal cord ischemia in 3.6%; 12.6% of the patients had pulmonary complications.
In summary, hybrid repair of the aortic arch represents a viable treatment option for patients at high risk for open surgical repair who are not suitable for complete endovascular treatment. As in other fields of aortic repair, hybrid repairs most likely represent transitional techniques during the development of a wider suitability for complete endovascular options.

References

1. Moulakakis K, Mylonas S, Markatis F, Kotsis T, Kaksis J, Liapis C. A systematic review and meta-analysis of hybrid aortic arch replacement. Ann Cardiothorac Surg. 2013 May; 2(3): 247–260.

1705.5

The left subclavian artery can be covered in most TEVAR cases without revascularisation: pro

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Endovascular stent-graft therapy is a widely accepted alternative to open surgery for the treatment of patients with a variety of thoracic aortic pathologies, including aneurysms and type B dissections.
In terms of the current generation of devices, if the proximal neck is too short (<20 mm), an incomplete seal due to inadequate circumferential apposition of the graft to the aortic wall, especially along the lesser curve of the aortic arch, can cause an endoleak. Moreover, as reported by Ivancev, a stent graft that is not co-axially positioned and asymmetrically apposes to the aortic arch may erode the aortic wall with creation of a type A aortic dissection, retrograde extension of a dissection with conversion of type B to type A anatomy, pseudoaneurysm formation, or even rupture of the aorta. In this regard, certain anatomic configurations of the aortic arch require covering the LSA origin to ensure optimal co-axial alignment between the endograft and the aortic wall and the ideal contour of the proximal end of the device within the aortic arch to avoid complications.
If intentional occlusion of the LSA is planned, an accurate pre-stenting evaluation of both vertebral arteries with duplex ultrasound, catheter arteriography, CT angiography, and/or MR angiography is required to analyse their anatomic characteristics.
In addition, the potential for ischaemia of the left arm after the procedure may be predicted before stent-graft deployment by performing a test occlusion with inflation of a balloon in the proximal left subclavian artery for 20 minutes.
Several papers document the safety of intentional occlusion of the LSA by an aortic stent-graft without prophylactic surgical transposition.
On the basis of thoracic aortic endograft results reported in the literature, collateral perfusion of the left arm after LSA coverage is sufficient in most patients to prevent the development of left arm symptoms. Moreover, in cases where symptomatic subclavian steal syndrome or left arm ischaemia occur, subsequent LSA revascularisation can be performed easily with very low mortality and morbidity rates.
In addition to the potential risk of developing ischaemic arm symptoms, intentional occlusion of the LSA by the endoprosthesis can be associated with type II endoleak.
In patients with a short proximal neck, it is possible to limit any ischemic complications associated with LSA exclusion by adjunctive operative strategies of surgical transposition of the LSA or LCCA to LSA surgical bypass. However, these surgical revascularisation procedures are not well tolerated in very sick patients.
We are confident that future strategies for these patients will include branched stent grafts because these techniques maintain antegrade perfusion of the LSA while avoiding ischemic complications and endoleak.

References

1. Fattori R, Napoli G, Lovato L, et al. Descending thoracic aortic diseases: stent-graft repair. Radiology 2003;229:176-183.
2. Rehders TC, Petzsch M, Ince H, et al. Intentional occlusion of the left subclavian artery during stent-graft implantation in the thoracic aorta: risk and relevance. J Endovasc Ther 2004;11:659-666.
3. Hausegger KA, Oberwalder P, Tiesenhausen T, et al. Intentional left subclavian artery occlusion by thoracic aortic stent-grafts without surgical transposition. J Endovasc Ther 2001;8:472-476.
4. Görich J, Asquan Y, Seifarth H, et al. Initial experience with intentional stent-graft coverage of the subclavian artery during endovascular thoracic aortic repairs. J Endovasc Ther 2002;9 Suppl 2:II 39-43.
5. Caronno R, Piffaretti G, Tozzi M, et al. Intentional coverage of the left subclavian artery during endovascular stent graft repair for thoracic aortic disease. Surg Endovasc 2006;20:915-918.
6. Riesenman PJ, Farber MA, Mendes RR, et al. Coverage of the left subclavian artery during thoracic endovascular aortic repair. J Vasc Surg 2007;45:90-95.
7. McWilliams RG, Murphy M, Hartley D, et al. In situ stent-graft fenestration to preserve the left subclavian artery. J Endovasc Ther 2004;11:170-174.
8. Saito N, Kimura T, Odashiro K, et al. Feasibility of the Inoue single-branched stent-graft implantation for thoracic aortic aneurysm or dissection involving the left subclavian artery: short to medium term results in 17 patients. J Vasc Surg 2005;41:206-212.
9. Chuter TA, Schneider DB, Reilly LM, et al. Modular branched stent graft for endovascular repair of aortic arch aneurysm and dissection. J Vasc Surg 2003;38:859-863.
10. Vos AW, Linsen MA, Wisselink W, et al. Endovascular grafting of complex aortic aneurysms with a modular side branch stent-graft system in porcine model. Eur J Vasc Endovasc Surg 2004;27:492-497.
11. Stone DH, Brewster DC, Kwolek CJ, et al. Stent-graft versus open-surgical repair of the thoracic aorta: mid-term results. J Vasc Surg 2006;44:1188-1197.

1705.6

The left subclavian artery can be covered in most TEVAR cases without revascularisation: con

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No abstract available.

Lecture Session
Complex abdominal aorta

1806.1

Adverse neck anatomy is progressive despite initial successful EVAR: implications for technique and device selection

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Learning Objectives
1. To learn about the concept of adverse neck anatomy
2. To learn about correct technique selection
3. To learn about individualised follow-up in patients with hostile necks

No abstract available.

1806.2

Fenestrated grafts vs. open surgery in juxtarenal AAA

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Learning Objectives
1. To learn about the different techniques for complex abdominal aortic aneurysms
2. To understand the limitations of each technique
3. To learn about the outcomes of both techniques

Fenestrated and/or branched grafts (F/b EVAR) are an attractive option for patients presenting with juxtarenal aneurysms. Recent improvements in stent-graft technology, proper planning performed with dedicated softwares such as the Terrarecon system, improved intra operative imaging provided by Hybrid rooms, better patient selection based on anatomical criterion along with general risk assessments, pre-operative rehearsal on models built from patient's CT, and improved operators skills and knowledge have improved the overall results of the endovascular approaches. However, complications, some of them lethal, may still occur even after straightforward procedures. On the other hand, surgery for juxtarenal AAA still provides excellent and durable results in good- to moderate-risk patients.

We have recently published the results of a French Study comparing F/b EVAR for patients considered high risk for surgery and surgery for patients eligible for open procedures. F/b EVAR was performed in selected well-trained academic centers, while open surgery results were collected from the National Database. The mortality was 4.3% for F/b EVAR and 5.8% for open repair (p=0.26), but the costs were significantly higher with F/b EVAR.

The choice between the two procedures should be based on how to provide the best and most durable treatment in a given patient. High-risk patients would probably benefit most from F/b EVAR, while low-risk patients can sustain either procedure. But irrespective of the patient's fitness, anatomy remains the critical criterion. Angulated aorta in the visceral segment; thrombus in the landing zones or close to the target vessels; angulated, small, or diseased renal arteries; and compromised iliac accesses make the endo-approach more challenging; and even if it might not be infeasible, it increases the risk of intra-operative complications and post-operative mortality. In those cases, open repair is a more appropriate choice. In our series, we found that 40% of patients were not good candidates for F/b EVAR for anatomical reasons.

Recent developments of chimney, snorkel, and sandwich techniques have enlarged the feasibility of the endo-approach, and although long-term results are awaited, these possibilities should be kept in mind for patients in whom none of the previous approaches are suitable.

In summary, in our view, high-risk patients with suitable anatomy should be offered f/b EVAR and low-risk patients with unsuitable anatomy should be treated with open repair; in between the two, the choice remains open.

References

1. Marzelle J, Presles E, Becquemin JP; the WINDOWS trial participants. Results and factors affecting early outcome of fenestrated and/or branched stent grafts for aortic aneurysms: a multicenter prospective study. Ann Surg. 2015 Jan;261(1):197-206.
2. Raux M, Patel VI, Cochennec F, Mukhopadhyay S, Desgranges P, Cambria RP, Becquemin JP, LaMuraglia GM. A propensity-matched comparison of outcomes for fenestrated endovascular aneurysm repair and open surgical repair of complex abdominal aortic aneurysms. J Vasc Surg. 2014 Oct;60(4):858-63.
3. Banno H, Cochennec F, Marzelle J, Becquemin JP. Comparison of fenestrated endovascular aneurysm repair and chimney graft techniques for pararenal aortic aneurysm. J Vasc Surg. 2014 Jul;60(1):31-9.
4. Banno H, Kobeiter H, Brossier J, Marzelle J, Presles E, Becquemin JP. Inter-observer variability in sizing fenestrated and/or branched aortic stent-grafts. Eur J Vasc Endovasc Surg. 2014 Jan;47(1):45-52.
5. Quiñones-Baldrich WJ, Holden A, Mertens R, Thompson MM, Sawchuk AP, Becquemin JP, Eagleton M, Clair DG. Prospective, multicenter experience with the Ventana Fenestrated System for juxtarenal and pararenal aortic aneurysm endovascular repair. J Vasc Surg. 2013 Jul;58(1):1-9.
6. Coscas R, Becquemin JP, Majewski M, Mayer J, Marzelle J, Allaire E, You K, Desgranges P, Kobeiter H. Management of perioperative endoleaks during endovascular treatment of juxta-renal aneurysms. Ann Vasc Surg. 2012 Feb;26(2):175-84.

1806.3

Tips and tricks for FEVAR

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Learning Objectives
1. To learn about the basic technical steps in FEVAR
2. To learn how to prevent complications
3. To learn how to treat unexpected complications in FEVAR

Understand the anatomy of the target vessels before the case. Fluoroscopy time and contrast medium should not be wasted during the case in trying to understand the anatomy, which was clearly demonstrated on the pre-FEVAR CT scan.

High-quality fluoroscopy is needed for FEVAR. Fluoroscopy of lower quality may seem adequate until the procedure becomes difficult.

The target vessel stent diameter, length and delivery system length should be noted for each vessel during planning. Failure to make all the required consumables available can add much time to the procedure and may compromise its success.

The proximal fenestrated component generally occupies most of the operator's thoughts during planning and deployment; however, the operator must continue to concentrate on the **distal component,** which is often seen as of secondary importance. Lazy deployment of the distal component risks inadequate engagement of iliac arteries or miscannulation of the contralateral limb.
Avoid excessive manipulation of the proximal component when there is significant atheroma/thrombus in the seal zone. Double diameter-reducing ties in such cases can minimise contact between the proximal graft and the aortic wall until these are removed after successful positioning and vessel cannulation.
If the graft is planned and deployed well, then **target vessel cannulation** is often easy. If there is difficulty in cannulating a vessel, then check that the height and rotational alignment are maintained rather than wasting time with futile attempts to achieve the impossible.
Achieving stable access to the target vessels is a well-understood process. The difficulty of this depends on the three-dimensional angulation of the target vessel. There is a hierarchical approach to building up the strength of the platform in the visceral circulation. The right renal artery and SMA are often close neighbours, and it is possible to cannulate the SMA via the right renal fenestration or vice versa. This potential pitfall needs to be remembered.
These can be **long cases,** and this has implications for blood loss, heparinisation and lower limb blood flow.
Monitor ACT during the procedure.
Lower limb perfusion may be significantly compromised, and strategies to reduce this will be discussed.
Small proximal endoleaks may be seen on the completion angiogram, particularly with high-quality fluoroscopy. Endoleak at 1-month CT is very rare with fenestrated grafts.
Secondary interventions are rare but have particular challenges because of multiple visceral artery stents, which protrude into the aortic lumen.

1806.4

EVAR with short neck: the role of chimney technique

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Learning Objectives
1. To learn about the technical considerations in Ch-EVAR
2. To learn about the indications and contra-indications for Ch-EVAR
3. To learn about complications in Ch-EVAR

No abstract available.

1806.5

Short necks can be treated by standard EVAR using new devices

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In the form of a debate, I would refer to the published outcomes of EVAR devices and results according to the length of the neck. It is already clear that this is not set up exactly as a debate but as two separate statements. It is entirely possible that each speaker is correct, in that short necks can be treated by standard EVAR using new devices, and that some short necks need more advanced endovascular techniques. If there was a single motion with the speakers for and against, there would be a single outcome for that. As it is, I expect the speakers to put before the audience the factors that would determine which method to use.

1806.6

Short necks need more advanced endovascular techniques

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No abstract available.

Lecture Session Ruptured AAA

2310.1

Organisational requirements for effective endovascular RAAA treatment

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Learning Objectives
1. To learn when and how to perform imaging
2. To learn how to organise a team for a 24/7 service
3. To learn how to cope with material logistics

The first reports on the treatment of ruptured abdominal aortic aneurysms (RAAA) endoluminally (REVAR) appeared in the mid-nineties (1,2), and since the turn of the century, REVAR has been increasingly implemented for treating RAAA (3,4). In non-randomised studies, lower mortality rates, shorter stays in the intensive care unit, and shorter overall hospital stays have been reported, favouring REVAR over open repair (5-9). To ensure consistently good results, however, certain organisational requirements have to be adhered to stringently and a certain infrastructure has to be omnipresent (10). These include the following:
Round-the-clock, immediate access to good-quality ultrasound and multi-slice CT, preferably in the immediate vicinity of the emergency room.
24/7 availability of experienced interventionalists, surgeons and anesthetists, as well as operating room (OR) staff and radiology technicians.
An adequate stock of appropriate catheters, guide wires and endografts. Endografts with proximal diameters ranging between 24 and 36 mm are mandatory. Stent-grafts with distal diameters between 12 and 24 mm should be readily available to ensure proper sealing in the iliac segments. Aortouniiliac endografts require contralateral occluders varying in diameter between 16 and 24 mm. Furthermore, tubular stent-grafts with diameters between 6 and 9 mm and lengths between 4 and 10 cms are essential, should the "chimney" approach become necessary for peri-renal RAAA. Aortic occlusion balloons that can be introduced percutaneously can be life saving in critical cases.
Availability of a hybrid OR with an integrated operation table and angiography unit simplifies and accelerates patient management. This, however, is not mandatory if good understanding and coordination exists between the various members of the endovascular team and if the transfer of the patient between the emergency room, CT, angiography suite and OR can be managed without undue loss of time.
Should such an organisational set-up exist, REVAR could, with increasing experience of the interventionalist, very well become the mainstay of management of RAAA in the time to come.

References
1. Yusuf SW, Whitaker SC, Chuter TA, et al. Emergency endovascular repair of leaking aortic aneurysms Lancet 1994; 344:1645.
2. Marin ML, Veith FJ, Cynamon J, et al. Initial experience with transluminally placed endovascular grafts for the treatment of complex vascular lesions. Ann Surg 1995; 222:449-465.

3. Egororova N, Giacovelli J, Greco G, et al. National outcomes for the treatment of ruptured abdominal aortic aneurysm: comparison of open versus endovascular repairs. J Vasc Surg 2008; 48:1092-1100.
4. Mehta M, Taggert J, Darling RC, et al. Establishing a protocol for endovascular treatment of ruptured abdominal aortic aneurysms: outcomes of a prospective analysis. J Vasc Surg 2006; 44:1-8.
5. Veith FJ, Lachat M, Mayer D, et al. Collected world and single center experience with endovascular treatment of ruptured abdominal aortic aneurysms. Ann Surg 2009; 250:818-824.
6. Eefting KHJ, Ultee GCI, von Meijenfeldt SE, et al. Ruptured AAA: state of the art management. J Cardiovasc Surg 2013; 54(1 Suppl. 1):47-53.
7. Nedeau AE, Pomposelli FB, Hamdan AD, et al. Endovascular is open repair for ruptured abdominal aortic aneurysm. J Vasc Surg 2012; 56:15-20.
8. Hinchliffe RJ, Bruijstens L, MacSweeney ST, et al. A randomized trial of endovascular and open surgery for ruptured abdominal aortic aneurysm- results of a pilot study and lessons learned for future studies. Eur J Vasc Endovasc Surg 2006; 32:506-513.
9. Amsterdam Acute Aneurysm Trial Collaborators. Amsterdam Acute Aneurysm trial: background, design and methods. Vascular 2006; 16:130-135.
10. Willigendael EM, Cuypers PW, Teijink JAW, et al. Systematic approach to ruptured abdominal aortic aneurysm in the endovascular era: Intention-to-treat eEVAR protocol. J Cardiovasc Surg 2012; 53:77-82.

2310.2

What is the evidence for permissive hypotension in rAAA?

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Learning Objectives
1. To learn the risks in patients with acute arterial bleeding
2. To understand the benefits of permissive hypotension
3. To learn the limitations and risks of permissive hypotension

The mortality rate for elective abdominal aortic aneurysm repair is now less than 2%, but that for ruptured abdominal aortic aneurysm (rAAA) remains in excess of 80%, with a vast majority of patients dying before they reach hospital[1]. Permissive hypotension or delayed fluid resuscitation has been suggested as a strategy to improve morbidity and mortality, but its role in the treatment of rAAA is not clearly defined. Data from trauma studies and animal models of controlled haemorrhage have shown that permissive hypotension (systolic blood pressure (BP) of ≤80 mmHg) is associated with improved tissue perfusion and survival. This is due to the avoidance of dilutional anaemia, coagulopathy and hypothermia as well as increased blood flow and perfusion pressure, causing clot disruption and further bleeding. The situation with rAAA is less clear-cut, and it is complicated by the fact that vascular patients are usually elderly with multiple co-morbidities and thus less likely to tolerate low BP. Vascular patients tend to require higher than normal BP at rest to maintain adequate cerebrovascular, myocardial and renal perfusion, but it is impossible to ascribe an 'optimum' group BP as there is considerable inter-individual variation[2]. The situation is further complicated by haemodynamic instability, which accompanies rupture. There is a dearth of clinical trials addressing this issue, and many trials are limited by small patient numbers, heterogeneous groups of patients, protocol violations and retrospective nature of some studies. Furthermore, there is no standard definition of what constitutes an acceptable lower limit of BP, and whether we should be examining systolic or mean arterial BP (MAP). Nevertheless, there appears to be a trend towards aiming for systolic BP of 80–100 mmHg or MAP of greater than 55 mmHg, and this appears to be associated with improved outcomes in terms of peri-operative and 30-day mortality figures. Large-scale prospective studies to address this issue are urgently needed[3].

References

1. Dick F, Erdoes G, Opfermann P et al. Delayed volume resuscitation during initial management of ruptured abdominal aortic aneurysm. J Vasc Surg 2013; 57: 943-50.
2. Brady K, Hogue CW. Intraoperative hypotension and patient outcome: does "one size fit all?" Anesthesiology 2013; 119: 495-7.
3. Moll FL, Powell JT, Fraedrich G et al. Management of abdominal aortic aneurysms clinical practice guidelines of the European society for vascular surgery. Eur J Vasc Surg 2011; 41: S1-S58.

2310.3

SWEDVASC Registry: primary EVAR or primary open strategy for ruptured AAA

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Learning Objectives
1. To learn about the current evidence for EVAR vs. OSR in rAAA
2. To learn the results of the SWEDVASC registry
3. To learn when to do EVAR and when OSR in rAAA

Background

In elective AAA repair, EVAR is now the established treatment most often offered to patients[1]. However, the role of EVAR in the treatment of ruptures is still disputed. The proponents of EVAR emphasise the benefit of this minimally invasive technique in acutely ill patients[2]. Rupture patients often have multiple comorbidities, including pulmonary disease, and the benefits of an operation performed in local anaesthesia without laparotomy is obvious. On the other hand, treatment with EVAR may be associated with a delay when compared with open repair due to the need for a CT scan to assess aneurysm anatomy prior to repair. In addition, while all aortic centres have 24/7 availability of operative skills, access to an endovascular theatre and know-how may be limited.

Endovascular repair has been compared with open surgery for ruptured AAA in two randomised trials[3, 4]. The two trials had major differences in setup. The AJAX trial only randomised patients eligible for EVAR to either open or endovascular treatment. The IMPROVE trial assessed the strategy for ruptured AAA repair, and it aimed to randomise patients prior to the knowledge of aneurysm anatomy. The short-term survival after rupture was equal after open and endovascular repair in both.

The Swedvasc registry

National population-based registries offer an opportunity to assess how the results of the randomised trials are reflected in real-world practice. The Swedvasc registry is a national vascular registry in Sweden, with excellent internal and external validity[5]. The Swedvasc registry was established in 1987, and it reached national coverage in 1994. It includes more than 90% of all AAA repairs in the country with complete survival data. It is therefore an excellent tool to analyse trends in AAA repair on a national basis.

Trends in ruptured AAA repair in Sweden

Over the past decade, the peri-operative mortality after ruptured AAA repair has decreased significantly. Historically, the mortality rate after surgery for rupture has been reported at 40%–50%. This has been reduced to 25%–30%, which is a remarkable development[1]. The improved outcome occurred at the same time as the increase in the mean age of patients treated for rupture, indicating that repair is performed in patients who were previously not regarded as eligible for surgical repair. The introduction of EVAR as a minimally invasive treatment possibility for frail patients has supported this development. Interestingly, the rate of rupture repair has decreased on a national level, while the number of elective repairs has increased.

The reduction in the number of ruptures may be due to a general decrease in AAA prevalence[6-8].

Since 2009, more than half of all elective AAA repairs in Sweden have been performed with EVAR[1]. However, the uptake for endovascular repair has been less drastic. Only one-third of the rupture repairs were performed with EVAR in 2013[9]. Among 29 vascular centres in Sweden performing AAA repair, most centres treated all or a majority of ruptures with open repair. Selected centres were early adapters of EVAR for ruptures, thereby treating more than 60% of all ruptures with EVAR.

Outcome after primary EVAR and primary open repair

Patients treated with EVAR for rupture have lower peri-operative mortality in the Swedvasc registry. In 2013, the 30-day mortality after rupture was 32% for patients treated with open repair compared with 18% for those treated with EVAR[9]. This is in accordance with previous retrospective reports comparing EVAR and open repair for ruptures[2]. However, the result of this analysis is affected by selection bias; patients treated with EVAR may be more stable and have a friendly aortic anatomy, thereby making direct comparison with open repair irrelevant.

The difference in strategy for rupture repair on a centre level in Sweden offers an opportunity to assess the outcome of rupture repair based on primary treatment strategy in a national cohort. The results of rupture repair were therefore compared between centres with primary EVAR strategy and centres with primary open repair strategy. Patients treated at centres with primary EVAR strategy had a higher rate of pulmonary disease. However, the overall survival rate was equal in both groups. These results echo the findings of the IMPROVE trial in a national population-based cohort.

Conclusion

The results of rupture AAA repair have improved significantly over time, despite increasing age among treated patients. This development is supported by the introduction of EVAR as a minimally invasive treatment option for patients not eligible for open aortic repair. The analysis of the outcome of AAA repair based on primary treatment strategy for ruptures indicates similar peri-operative mortality among centres that primarily perform EVAR to those that opt for open repair.

References

1. Mani K, Bjorck M, Wanhainen A. Changes in the management of infrarenal abdominal aortic aneurysm disease in Sweden. *Br J Surg* 2013;100(5): 638-644.
2. Veith FJ, Lachat M, Mayer D, Malina M, Holst J, Mehta M, et al. Collected world and single center experience with endovascular treatment of ruptured abdominal aortic aneurysms. *Ann Surg* 2009;250(5): 818-824.
3. IMPROVE trial investigators; Powell JT, Sweeting MJ, Thompson MM, Ashleigh R, Bell R, et al. Endovascular or open repair strategy for ruptured abdominal aortic aneurysm: 30 day outcomes from IMPROVE randomised trial.*BMJ* 2014;348: f7661.
4. Reimerink JJ, Hoornweg LL, Vahl AC, Wisselink W, van den Broek TA, Legemate DA, et al. Endovascular repair versus open repair of ruptured abdominal aortic aneurysms: a multicenter randomized controlled trial. *Ann Surg*2013;258(2): 248-256.
5. Troeng T, Malmstedt J, Bjorck M. External validation of the Swedvasc registry: a first-time individual cross-matching with the unique personal identity number. *Eur J Vasc Endovasc Surg* 2008;36(6): 705-712.
6. Svensjo S, Bjorck M, Gurtelschmid M, Djavani Gidlund K, Hellberg A, Wanhainen A. Low prevalence of abdominal aortic aneurysm among 65-year-old Swedish men indicates a change in the epidemiology of the disease.*Circulation* 2011;124(10): 1118-1123.
7. Anjum A, Powell JT. Is the incidence of abdominal aortic aneurysm declining in the 21st century? Mortality and hospital admissions for England & Wales and Scotland. *Eur J Vasc Endovasc Surg* 2012;43(2): 161-166.
8. Conway AM, Malkawi AH, Hinchliffe RJ, Holt PJ, Murray S, Thompson MM, et al. First-year results of a national abdominal aortic aneurysm screening programme in a single centre. *Br J Surg* 2012;99(1): 73-77.
9. Swedvasc. Annual report 2014; 2014.

2310.4

Is there a role for chimney and periscopes in short-necked ruptured AAA?

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Learning Objectives

1. To learn when chimney and periscope grafts are needed
2. To learn the technique of chimney and periscope grafting in rAAA
3. To learn the results of chimney and periscope grafting in rAAA

Endovascular aneurysm repair (EVAR) has become the mainstay in the treatment of abdominal aortic aneurysm (AAA) in the majority of vascular centers. For patients with a short aneurysm neck, fenestrated devices are now available to extend the sealing zone by incorporating the visceral and renal vessels. Fenestrated systems have to be custom-made to fit the anatomy of each individual patient, which may take several weeks. This delay is impracticable, especially in emergency settings. In order to extend the proximal sealing zone by other means, the concept of chimney grafts was introduced. Placing (covered) stents in visceral vessels that run parallel and outside of the aortic stent graft allows for a higher placement of the main body, thus lengthening the proximal sealing zone without compromising blood flow to vital organs. The periscope technique is used to extend the distal sealing zone in a similar fashion and is applied predominantly in endovascular treatment of TAAs. Mandatory for chimney graft placement is uni- or bilateral brachial or axillary access. Manipulation in a diseased aortic arch caries a high stroke risk and may represent a contraindication for this procedure. For the periscope technique, both iliac arteries have to be patent. The Achilles heel of this technique, at least intuitively, is the gutter between main body and the chimney (periscope) graft, which may create a type I endoleak. This may be prevented by generously oversizing of the stent graft. Also, chimney grafts should overlap at least 20 mm with the stent graft since long gutters are likely to thrombose more easily than short ones. A recent systematic review, combining data from 24 studies describing 234 patients who underwent EVAR with one or more chimney or periscope grafts for aortic branch vessels, showed an overall 30-day mortality rate of 5%, which is comparable to that of open surgical AAA repair. It is, however, higher than the reported 30-day mortality rate for standard EVAR (3.4% vs. 1.8%) of TEVAR (10% vs. 9.3%). Procedural success was high (98%), with immediate and 6-month visceral branch patency of almost 100%. Type I endoleak was seen on completion angiography in 7.4% of AAA patients, increasing to 18% on first post-op CTA (TAA patients: 10% and 9%, respectively) requiring reintervention in 10 patients. Although mid- and long-term data are currently lacking, these techniques show a potential value in patients with challenging aortic aneurysm morphology.

References

1. Wilson M, Zhou S, Bachoo P, and Tambyraja AL. Systematic Review of Chimney and Periscope Grafts for Endovascular Aneurysm Repair. British Journal of Surgery 2013; 100: 1557–1564.
2. Dias NV, Jabr AB, Sveinsson M, Björses K, Malina M, and Kristmundsson T. Impact of Renal Chimney Grafts on Anatomical Suitability for Endovascular Repair in Ruptured Abdominal Aortic Aneurysm. Journal of Endovascular Therapy 2015; 22(1): 105–109.

3. Pecoraro F, Pfammatter T, Mayer D, Frauenfelder T, Papadimitriou D, Hechelhammer L, Veith FJ, Lachat M, and Rancic Z. Multiple Periscope and Chimney Grafts to Treat Ruptured Thoracoabdominal and Pararenal Aortic Aneurysms. Journal of Endovascular Therapy 2011; 18: 642–649.

2310.5

Endovascular treatment is equal to open surgery

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The endpoint for the treatment of a ruptured aortic aneurysm is mortality. Only when mortality is equal for both treatments, secondary endpoint should be taken into consideration for making a treatment decision. Secondary endpoints are overall morbidity and costs. Currently, there are data available from three RCTs investigating endovascular versus open treatment for acute ruptured abdominal aneurysms. Data from an RCT are considered to be the highest scientific proof; however, data from any RCT can only be generalized if the patient population for which these data are used is compatible with the study group. When a study group is heterogenic, a multivariate analysis might identify those subgroups that will benefit more than others will. A combined data analyses from all three RCTs (IMPROVE, AJAX, and ECAR) demonstrate that EVAR confers no survival benefit over open repair.

2310.6

Endovascular treatment is not equal to open surgery

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In non-emergency treatment, endovascular aneurysm repair (EVAR) has demonstrated a significant reduction of 30-day mortality rates in comparison with those for open repair (OR). In the OR of ruptured AAA (rAAA), mortality rates have been traditionally 40%–50%.
Meta-analyses of observational studies comparing EVAR with the OR of rAAA have shown a significant reduction of 30-day mortality rates after EVAR (26%–30% vs. 39%–42%; p<0.001) (1,2,3). However, in observational studies, the risk of bias is higher.
In three RCTs (AJAX, IMPROVE, and ECAR), there was no significant mortality difference (EVAR, 18%–35% vs. OR, 24%–37%) (4,5). However, ICU and ventilation times, blood loss, renal failure, and hospital stay were reduced. Unfortunately, all RCTs were markedly flawed by several factors. The AJAX trial excluded hemodynamically unstable patients unfit for CT or surgery, and 10/57 patients randomized for EVAR underwent OR but were analyzed in the EVAR group (ITT); three patients in the OR arm had no rAAA but were analyzed as OR patients. The ECAR trial was small (n=107), and unstable patients were excluded. In the IMPROVE trial of 316 patients randomized to EVAR, only 154 had EVAR with a mortality rate of 25%, 112 had OR with a mortality rate of 38%, and 16 died before aneurysm repair. According to ITT analysis, all were analyzed to have EVAR, resulting in a mortality rate of 35%. In the OR group, 220 had OR with a mortality rate of 37%, 36 had EVAR with a mortality rate of 22%, 19 died before surgery, and 22 had no aneurysm at all with a mortality rate of 3%, but all were counted for OR (ITT). Looking at patients as treated, the 30-day mortality rate for EVAR vs. OR was 25% vs. 37%. This outcome compares well to the reported mortality rates of observational studies (1,2,3) and shows that EVAR is superior to OR.

References

1. Endovascular repair for ruptured AAA confers an early survival benefit over open repair. Antoniou GA, et al. J Vasc Surg. 2013;58:1091-105.
2. Comparative effectiveness of endovascular versus open repair of ruptured AAA in the Medicare population. Edwards ST, et al. J Vasc Surg. 2014;59:575-82.
3. Comparison of endovascular and open repair of ruptured AAA in the United States in the past decade. Mohan PP, Hamblin MH. Cardiovasc Intervent Radiol. 2014;37:337-42.
4. Endovascular repair versus open repair of ruptured AAA: a multicenter randomized controlled trial. Reimerink JJ, et al. Ann Surg. 2013;258:248-56.
5. Endovascular or open repair strategy for ruptured AAA: 30 day outcomes from IMPROVE randomised trial. Powell JT, et al. BMJ. 2014;348:f7661.

Lecture Session Imaging of the aorta

2505.1

Should we use 3D ultrasound for AAAs?

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Learning Objectives

1. To learn about the concept of 3D ultrasound in AAA
2. To learn key 3D imaging features that influence AAA treatment strategies
3. To learn about the technical limits of 3D ultrasound for AAA

Objectives: Patients after endovascular aneurysm repair (EVAR) need lifetime follow-up to avoid post-EVAR complications and late rupture. Multislice computed tomography angiography (CTA) with delayed images is still the gold standard. However, repetitive use has raised concerns related to the use of nephrotoxic agents and cumulative radiation exposure. Compared to CTA, ultrasound has a lower sensitivity in identifying endoleaks and underestimates aneurysm size but contrast-enhanced ultrasound (CEUS) has a strong recommendation and high evidence for endoleak detection. Latest ultrasonographic imaging techniques include 3D and 4D (real-time 3D) CEUS techniques.
3D ultrasonographic imaging techniques: Creation of a 3D volume data set is possible by freehand technique using special software, by automatic technique using special transducer and special software, or by an add on-system, which transforms standard contrast-enhanced 2D images into a high-definition 3D format using a motion tracking mini-GPS (global positioning system). So far, several groups state that these novel 3D and 4D ultrasound techniques are clinically reliable for diameter measurement and volume quantification and improve accuracy of measurement[1-4]. In the trans-atlantic debate, it is discussed if aneurysm diameter or volume is the best prognostic parameter[5]. Other studies demonstrate that 3D and 4D CEUS detect endoleaks missed by CTA, are more sensitive than DSA, and might replace CTA during follow-up[6-8]. Our study group compared the different new 3D imaging methods for EVAR surveillance in daily practice compared to the already established 2D techniques.
Conclusions: 2D CEUS has already proven evidence for EVAR surveillance and should be a crucial part of every follow-up protocol after EVAR. Easy to apply is the freehand 3D ultrasound technique. Additional equipment is just special software. The add-on Curefab® system for 3D ultrasound offers the broadest range of possible measurements, including diameter and volume measurement, and endoleak diagnostics. Aneurysm volumetry will have to be addressed in future studies. 3D and 4D CEUS can improve endoleak characterization in selected cases.

References
1. Bredahl K, Taudorf M, Long A, Lonn L, Rouet L, Ardon R, et al. Three-dimensional ultrasound improves the accuracy of diameter measurement of the residual sac in EVAR patients. Eur J Vasc Endovasc Surg. 2013;46(5):525-32.
2. Bredahl K, Long A, Taudorf M, Lonn L, Rouet L, Ardon R, et al. Volume estimation of the aortic sac after EVAR using 3-D ultrasound - a novel, accurate and promising technique. Eur J Vasc Endovasc Surg. 2013;45(5):450-5; discussion 6.
3. Causey MW, Jayaraj A, Leotta DF, Paun M, Beach KW, Kohler TR, et al. Three-dimensional ultrasonography measurements after endovascular aneurysm repair. Ann Vasc Surg. 2012;27(2):146-53.
4. Long A, Rouet L, Debreuve A, Ardon R, Barbe C, Becquemin JP, et al. Abdominal aortic aneurysm imaging with 3-D ultrasound: 3-D-based maximum diameter measurement and volume quantification. Ultrasound Med Biol. 2013;39(8):1325-36.
5. Kitagawa A, Mastracci TM, von Allmen R, Powell JT. The role of diameter versus volume as the best prognostic measurement of abdominal aortic aneurysms. J Vasc Surg. 2013;58(1):258-65.
6. Abbas A, Hansrani V, Sedgwick N, Ghosh J, McCollum CN. 3D contrast enhanced ultrasound for detecting endoleak following endovascular aneurysm repair (EVAR). Eur J Vasc Endovasc Surg. 2014;47(5):487-92.
7. Gargiulo M, Gallitto E, Serra C, Freyrie A, Mascoli C, Bianchini Massoni C, et al. Could four-dimensional contrast-enhanced ultrasound replace computed tomography angiography during follow up of fenestrated endografts? Results of a preliminary experience. Eur J Vasc Endovasc Surg. 2014;48(5):536-42.
8. Ormesher DC, Lowe C, Sedgwick N, McCollum CN, Ghosh J. Use of three-dimensional contrast-enhanced duplex ultrasound imaging during endovascular aneurysm repair. J Vasc Surg. 2014;60(6):1468-72.

2505.2

Does MR have a role in pre- and post-procedural imaging?

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Learning Objectives
1. To define under which circumstances MR imaging of the patient is appropriate
2. To learn when and how to use MR imaging for your patient
3. To learn about the key imaging features and technical limits of aortic MR imaging

Transfemoral endovascular stent-graft placement in patients with abdominal aortic aneurysms is a less invasive alternative to conventional surgery.

Preoperative planning:

Imaging is crucial to determine appropriate stent type and dimensions of key preoperative parameters. MDCT is the most commonly used technique to obtain those accurate measurements.

Recent studies demonstrated that nonenhanced MR angiography (triplanar two-dimensional single-shot turbo field-echo) appears equally accurate to MDCT.

Moreover, some recent publications suggest as preliminary experience that it could be interesting to study haemodynamic imaging with computational fluid dynamics (CFD) and 4D flow imaging as well as the intimate components of the aneurysmal wall to predict the evolution of the sac. The goal would be to detect in advance the potential nonshrinking aneurysms to propose EVAR for the best candidates.

Postoperative planning:

EVAR procedures necessitate a regular follow-up, with the lowest possible risk for patients. MRI and MRA, especially with 3D CEMRA and the most recent techniques of 4D acquisitions (temporal resolution), are rapidly emerging as an attractive, noninvasive alternative to MDCT. MRA provides the relevant information for follow-up of endovascular treatment with a high sensitivity and specificity in detection and classification of endoleaks.

It could be an interesting alternative for a small selected population: the youngest patients and those with renal impairment or anaphylactoid reactions (no X-rays, no IV iodine contrast material).

However, MRI may be problematic in patients with metallic implants due to concerns related to ferromagnetism, heating and image artefacts.

Most of the devices are safe at 1.5 T, but metal artefacts may affect image quality and the interpretation of the diagnostic information.

To our knowledge, only a small number of actual stent-graft models are adequately assessed by MRA, and even in those cases, MRA seems to be at least as good as MDCT to detect slow-flow endoleaks; this advantage is significant only for a limited percentage of patients.

References
1. Hilfiker P, Quick H, Schmidt M, Debatin G. In Vitro Image Characteristics of An Abdominal Aortic Stent-graft: CTA versus 3DMRA. MAGMA Magnetic Resonance Materials in Physics, Biology and Medicine 1999; 8: 27-32.
2. Engellau L, Olsrud J, Brockstedt S, Albrechtson U, Norgren L, Stahlberg F, Larsson EM. MR Evaluation Ex Vivo and In Vivo of a Covered Stent-Graft for Abdominal Aortic Aneurysms: Ferromagnetism, Heating, Artifacts and Velocity Mapping. Journal of Magnetic Resonance Imaging 2000; 12: 112-121.
3. Gawenda M, Gossmann A, Krüger K, Zaehringer M, Hahn M, Wassmer G, Brunkwall J. Comparison of Magnetic Resonance Imaging and Computed Tomography of 8 Aortic Stent-Graft Models. Journal of Endovascular Therapy 2004; 11: 627-634.
4. Krämer S, Wall A, Maintz D, Bachmann R, Kugel H, Heindel W. 3.0 Tesla Magnetic Resonance Angiography of Endovascular Aortic Stent-Grafts Investigative Radiology 2004; 39: 413-417.
5. Kranokpiraska P, Kaufman J. Follow-up of Endovascular Aneurysm Repair: Plain Radiography, Ultrasound, CT/CT Angiography, MR Imaging/ MR Angiography, or What? Journal Vascular and Interventional Radiology 2008; 19: S27-S36.
6. Cohen E, Weinreb D, Siegelbaum R, Honig S, Marin M, Weintraub J, Lookstein R. Time-Resolved MR Angiography for the Classification of Endoleaks After Endovascular Aneurysm Repair. Journal of Magnetic Resonance Imaging 2008; 27: 500-503.
7. Nchimi A, Defawe O, Brisbois D, Broussaud TK, Defraigne JO, Magotteaux P , Massart B, Serfaty JM, Houard X, Michel JB, Sakalihassan N. MR Imaging of Iron Phagocytosis in Intraluminal Thrombi of Abdominal Aortic Aneurysms in Humans. Radiology 2010; 254(3): 973-981.
8. Wolf F, PlankC, Beitzke D, Popovic M, Domenig C, Weber M, Loewe C. Prospective Evaluation of High-Resolution MRI Using Gadofesveset for Stent-Graft Planning: Comparison with CT Angiography in 30 Patients. AJR 2011; 197: 1251-1257.
9. Resta E, Secchi F, Giardino A, Nardella V, Di Leo G, Flor N, Sardanelli F. Non-contrast MR Imaging for Detecting Endoleak after Abdominal Endovascular Aortic Repair. The International Journal of Cardiovascular Imaging 2013; 29: 229-235.
10. Cornelissen S, van der Laan M, Vincken K, Vonken EJ, Viergever M, Bakker C, Moll F, Bartels L. Use of Multispectral MRI to Monitor Aneurysm Sac Contents after Endovascular Abdominal Aortic Aneurysm Repair. Journal of Endovascular Therapy 2011; 18: 274-279.
11. Midulla M, Moreno R, Baali A, Chau M, Negre-Salvayre A, Nicoud F, Pruvo JP, Haulon S, Rousseau H. Haemodynamic Imaging of tStent-Grafts by Computational Fluid Dynamics (CFD): Presentation of a Patient-Specific Method Combining Magnetic Resonance Imaging and Numerical Simulations. European Radiology 2012; 22: 2094-2102.

12. Goshima S, Kanematsu M, Kondo H, Kawada H, Kojima T, Sakurai K, Watanabe H, Shimabukuro K, Matsuno Y, Ishida N, Takemura H, Bae K. Preoperative Planning for Endovascular repair of Abdominal Aortic Aneurysms: Feasibility of Nonenhanced MR Angiography versus Contrast-enhanced CT Angiography. Radiology 2013; 267(3): 948-955.

2505.3

The use of robotics to perform EVAR

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Learning Objectives

1. To learn about robotic technology
2. To understand the possibility of robotic applications in endovascular procedures
3. To learn about the results and possible complications

It has been over three decades since the first appearance of robot in surgical and medical fields. The advantages of this technology in a number of minimally invasive surgical interventions have been demonstrated in several clinical studies. The endovascular robot is the most recent arrival with the first case demonstrated in 2007. In less than a decade, the technological development and the uptake of robotic applications in a wide range of IR procedures have been remarkable.
Precision, steerability, catheter stability and controlled catheter shaping are the main advantages of endovascular robot. These benefits have been suggested by extensive pre-clinical research as well as by early clinical results from several centres in the world.
Nevertheless, workflow in the angio suite, high cost and lack of haptic feedback remain unresolved issues for the time being.
Although there is definite reduction in radiation dose to the operator, minimizing radiation to the patient needs further development of image navigation and guidance. Well-organized clinical trials and further research work are needed to define the exact role of endovascular robotics and to guide future directions.

References

1. Riga C, Bicknell C, Cheshire N, Hamady M. Initial clinical application of a robotically steerable catheter system in endovascular aneurysm repair. J Endovasc Ther. 2009 Apr;16(2):149-53.
2. Riga CV, Bicknell CD, Hamady MS, Cheshire NJ. Evaluation of robotic endovascular catheters for arch vessel cannulation. J Vasc Surg. 2011 Sep;54(3):799-809.
3. Riga CV, Rolls A, Rippel R, Shah C, Hamady M, Bicknell C, Cheshire N. Advantages and limitations of robotic endovacular catheters for carotid artery stenting. J Cardiovasc Surg (Torino). 2012 Dec;53(6):747-53.
4. Riga CV, Bicknell CD, Rolls A, Cheshire NJ, Hamady MS. Robot-assisted fenestrated endovascular aneurysm repair (FEVAR) using the Magellan system. J Vasc Interv Radiol. 2013 Feb;24(2):191-6.
5. Rippel RA, Rolls AE, Riga CV, Hamady M, Cheshire NJ, Bicknell CD. The use of robotic endovascular catheters in the facilitation of transcatheter aortic valve implantation. Eur J Cardiothorac Surg. 2014 May;45(5):836-41.
6. Rolls AE, Riga CV, Bicknell CD, Regan L, Cheshire NJ, Hamady MS. Robot-assisted uterine artery embolization: a first-in-woman safety evaluation of the Magellan System. J Vasc Interv Radiol. 2014 Dec;25(12):1841-8.

2505.4

The increasing role of fusion imaging in endovascular aortic procedures

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Learning Objectives

1. To learn about the key concept of image registration
2. To learn about the technical limits of image fusion
3. To discuss results and potential widespread clinical application

No abstract available.

2505.5

Duplex ultrasound should replace CTA for post-EVAR surveillance

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No abstract available.

2505.6

Low-dose CTA is superior to CDUS for post-EVAR surveillance

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Reasons for follow-up after EVAR

Contrary to patients after surgical repair, patients after endovascular treatment of their aortic aneurysms require lifetime follow-up imaging. The need for this follow-up is due to different reasons: the life expectancy of materials used for endovascular treatment might be limited; the first generation of stent-grafts has shown severe fractures of the used material. Additionally, the chronic and progressive character of atherosclerosis can cause the progression of aortic dilatation, leading to the movement of prosthesis or insufficient aneurysm exclusion with time. Furthermore, endoleaks can cause further growth of the aneurysmal sac, even years after stent-graft placement. Finally, additional unexpected findings such as tumors should be detected during follow-up.

Reasons for using CT angiographies (CTA) for follow-up after EVAR

CT angiographies of the aorta using state-of-the-art multislice scanners represent very robust and easy-to-perform imaging studies, allowing for exact and reliable intrapatient comparisons during follow-up time as well as comparison with baseline examination, which is usually performed using CTA as well. CTAs of large imaging volumes (for example, the entire aorta) can be acquired with high spatial resolution in a very short acquisition time of less than 20 seconds. The advantages of CTA compared with those of other imaging modalities include high reliability and good comparability to previous CTA studies and high spatial resolution. By applying CTA, not only changes in aortic diameter but also direct visualization of the device itself and aortic perfusion can be achieved. In case of detection of any pathological findings (including endoleaks, device dislocation, device fracture, and aneurysm progression), therapeutic options can be evaluated, and treatment can be planned based on CTA without any need for further imaging tests. Furthermore, possible progression of atherosclerosis (aneurysm growth, atherosclerotic changes at visceral arteries) or of unexpected diseases (for example, cancer) is detected at first attempt. On direct comparison, the risk of CTA caused by radiation exposure and the use of iodinated contrast

agents could dramatically be reduced during the last years by the introduction of dual-energy, low-dose CT protocols.
In conclusion, CTA represents a very safe, robust, easy-to-apply, and reliable imaging test for surveillance after EVAR with a positive risk-benefit profile, whereas low-dose CTA represents the one and only imaging test after EVAR.

Lecture Session
Endoleaks and complications

2706.1

EndoAnchors to fix type I endoleaks: can they replace Palmaz stents and/or cuffs?

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Learning Objectives
1. To learn about the concept of Endoanchors
2. To learn the technique of insertion
3. To learn the indications and outcomes

Type 1a endoleak (EL) and migration continue to occur after EVAR, particularly in patients with hostile neck anatomy. According to the 3-year results of the ENGAGE registry, the incidence of type I EL is 0.4%. ESVS Guidelines recommend treatment (Level 2b, class B). There are several options for the repair of type I EL: cuff extension, balloon-expandable stents (e.g., Palmaz), endoanchors, embolization, open conversion, or even surveillance. The objective of this presentation is to compare Palmaz stents with endoanchors.
The concept behind Palmaz stenting is proximal neck enforcement to increase graft-neck apposition, improving sealing. It requires the availability of sufficient native aorta to support the stent. Palmaz stent for the treatment of type 1 EL is "out of IFU."
Qu and Raithel published a study on a series of 114 patients, with 3.4% continuing type I EL after a mean of 2.6 years (Perspect Vasc Endovasc Ther 2008). This was in line with Byrne et al. (Ann Vasc Surg 2013) who reported an 8.6% persistent type I EL rate after Palmaz placement. Another retrospective study by Rajani et al. (JVS 2011) reported 72 out of 1209 patients (5.9%) with type I EL, of whom 24 (33%) received sole placement of a Palmaz stent with an initial success rate of 100%. Limitations of these studies were small numbers without follow-up. Another potential drawback is difficult target vessel catheterization for fenestrated stentgrafting through stent struts.
Endoanchors have a length of 4.5 mm and a diameter of 3.0 mm. The concept is to provide active fixation and augmented sealing of stentgrafts to the aortic wall by direct locking. There is an official indication to treat type 1 EL. Radial fixation is supposed to prevent later aortic neck dilatation. Endoanchor placement can be tailored to target leak paths or areas of concern. It requires neck without excessive thrombus or calcium. Success rate is more than 98% for primary acute type 1 EL and 90% for late type 1 EL in the Anchor Registry. In the Staple-1 & 2 IDE trial, there was no late EL after 5-year follow-up. Rate of persistent type 1 EL is 2.2%.
Limitations are severe neck dilatation, more than 2-mm thrombus, and more than 180° circumference as well as more than 2-mm distance between the stentgraft and the aortic wall.
Although there are no randomized trials comparing Palmaz versus endoanchors and long-term results are missing for both options, the results are in favor for endoanchors. There are advantages for endoanchors, which treat type 1 EL.

2706.2

Type II endoleaks: management options

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Learning Objectives
1. To learn about the natural history and indications for the treatment of type 2 endoleaks
2. To learn about the methods of treatment for type 2 endoleaks
3. To learn the outcomes of treatment

1. Type 2 (T2) endoleak (EL; T2EL) is defined as the maintenance of blood flow through collaterals (inferior mesenteric artery and/or lumbar arteries) outside the stent graft but inside the aneurysmal sac after endovascular abdominal aorta repair (EVAR) [1]. It is the most frequent cause of EL, with percentages varying between 15% and 40% [2,3], and its management is still a question of debate. Differently from T1ELs and T3ELs, which are considered to be at high risk of sac rupture, T2ELs have a "low-risk" history of rupture, but this event is not totally excluded [4]. For the majority of them, a "non-aggressive" management is recommended. Recent meta-analysis on this topic suggests that spontaneous sealing may be observed in 35% to 70% of cases, while aggressive treatment can fail in 10% to 80% [3,5].
2. The main indication for treatment of T2EL is evidence of size increase of the sac at follow-up. Before treatment, it is fundamental to try to confirm diagnosis of T2EL and exclude other types of EL (T1 or T3). Concerning the treatment strategy, different approaches are available:
- Transarterial catheterization of the feeding artery or of the nidus of the EL [6]. This is often complicated to perform, especially when a lumbar artery must be catheterized. A good experience with microcatheters and microguidewires is recommended. These procedures are time consuming and not always successful but have a low rate of complications.
- Direct sac puncture by translumbar approach [7] or transcaval approach [8]. Translumbar approach is usually done with the patient in the prone position under CT guidance, but the best way is to use modern angio-equipment provided with cone-beam CT technology that combines CT-like images with fluoroscopic guidance. Transcaval approach is usually done in the angiosuite with the patient in the supine position. These approaches are faster than transarterial approach, but they potentially carry a superior risk of complications (sac infections, rupture) and necessitate a longer learning curve to become confident with the cone-beam technology.
- Transealing approach. It is an alternative way of approaching the sac, with few reports in the literature [6]. It is generally attempted if there is an incomplete apposition of the iliac limb of the stent graft to the iliac artery wall. It involves an attempt to track a hydrophilic wire and catheter directly into the aneurysmal sac between the stent graft and iliac artery wall.
Concerning the materials to use for embolization, many options are reported in the literature, from liquid embolic materials such as glue or ethylene-vinyl-alcohol copolymer (Onyx) [6,9,10] to metallic devices such as coils or microcoils.
3. Data from literature on T2EL show conflicting results from heterogeneous studies which, however, failed to support an optimal threshold for intervention [3,11,12]. Considering the reported relatively benign natural course of most T2ELs and the fact that most T2ELs seal spontaneously, conservative management of persistent T2EL in the absence of sac expansion might be appropriate [11]. Where intervention is indicated, imaging should exclude occult T1 and T3 ELs as ⊠25% are not simple T2ELs. Translumbar embolization of T2ELs is associated with higher success rates than that obtained with transarterial approach. Following a successful intervention, continued long-term surveillance is necessary due to the high risk

(25-80%) of recurrence [5]. Current evidence indicates that aneurysmal rupture due to an isolated T2EL is rare [4]. Many factors are involved in the genesis of T2EL (aneurysmal sac size, patency of collateral vessels, thrombus size, etc.), but one of the most important factors influencing persistence of T2EL is maintenance of multiagent antiplatelet therapy [13]. Long-term prospective studies may provide better evidence to define the optimal threshold for intervention.
At present, strategies based on preliminary embolization of feeding vessels as IMA has shown conflicting results in reducing T2EL and sac shrinkage [14-16]. An alternative treatment, proposed by some groups [17-19], is intraoperative intrasac injection of thrombin or fibrin glue and a standard number of coils during EVAR. Only few papers have investigated this treatment modality with encouraging results.
A promising alternative is the introduction of a new generation of stent-graft system based on an innovative "concept" consisting on the use of "endobags" fixed on the stent-graft which are filled with a polymer during EVAR in order to fill the aneurysmal sac and prevent T2EL [20]. Preliminary data in term of reduction of T2EL are very encouraging, but long-term results are not yet available.

References

1. Stavropoulos SW, Clark TW, Carpenter JP, Fairman RM, Litt H, Velazquez OC, Insko E, Farner M, Baum RA. Use of CT angiography to classify endoleaks after endovascular repair of abdominal aortic aneurysms. J Vasc Interv Radiol. 2005 May;16(5): 663-7.
2. Maeda T, Ito T, Kurimoto Y, Watanabe T, Kuroda Y, Kawaharada N, Higami T. Risk factors for a persistent type 2 endoleak after endovascular aneurysm repair. Surg Today. 2014 Nov 12.
3. Hajibandeh S, Ahmad N, Antoniou GA, Torella F. Is intervention better than surveillance in patients with type 2 endoleak post-endovascular abdominal aortic aneurysm repair? Interact Cardiovasc Thorac Surg. 2015 Jan;20(1): 128-34.
4. Gunasekaran S, Funaki B, Lorenz J. Ruptured aortic aneurysm from late type II endoleak treated by transarterial embolization. Cardiovasc Intervent Radiol. 2013 Feb;36(1): 255-8.
5. Sarac TP, Gibbons C, Vargas L, Liu J, Srivastava S, Bena J, Mastracci T, Kashyap VS, Clair DJ. Long-term follow-up of type II endoleak embolization reveals the need for close surveillance. Vasc Surg. 2012 Jan;55(1): 33-40.
6. Massis K, Carson WG 3rd, Rozas A, Patel V, Zwiebel B. Treatment of type II endoleaks with ethylene-vinyl-alcohol copolymer (Onyx). Vasc Endovascular Surg. 2012 Apr;46(3): 251-7.
7. Uthoff H, Katzen BT, Gandhi R, Peña CS, Benenati JF, Geisbüsch P. Direct percutaneous sac injection for postoperative endoleak treatment after endovascular aortic aneurysm repair. J Vasc Surg. 2012 Oct;56(4): 965-72.
8. Mansueto G, Cenzi D, Scuro A, Gottin L, Griso A, Gumbs AA, Pozzi-Mucelli R. Treatment of type II endoleak with a transcatheter transcaval approach: results at 1-year follow-up. J Vasc Surg. 2007 Jun;45(6): 1120-7.
9. Abularrage CJ, Patel VI, Conrad MF, Schneider EB, Cambria RP, Kwolek CJ. Improved results using Onyx glue for the treatment of persistent type 2 endoleak after endovascular aneurysm repair. J Vasc Surg. 2012 Sep;56(3): 630-6.
10. Bosiers MJ, Schwindt A, Donas KP, Torsello G. Midterm results of the transarterial use of Onyx in the treatment of persisting type II endoleaks after EVAR. J Cardiovasc Surg (Torino). 2013 Aug;54(4): 469-75.
11. Mees B, Voute M, Bastos Gonçalves F, Mota Capitão L, Verhagen H. Intervention for type II endoleaks? "Primum non nocere": appraisal for the conservative management of low-pressure endoleaks after endovascular aneurysm repair. J Cardiovasc Surg (Torino). 2013 Aug;54(4): 477-84.
12. Karthikesalingam A, Thrumurthy SG, Jackson D, Phd EC, Sayers RD, Loftus IM, Thompson MM, Holt PJ. Current evidence is insufficient to define an optimal threshold for intervention in isolated type II endoleak after endovascular aneurysm repair. J Endovasc Ther. 2012 Apr;19(2): 200-8.
13. Aoki A, Suezawa T, Sangawa K, Tago M. Effect of type II endoleaks and antiplatelet therapy on abdominal aortic aneurysm shrinkage after endovascular repair. J Vasc Surg. 2011 Oct;54(4): 947-51.
14. Alerci M, Giamboni A, Wyttenbach R, Porretta AP, Antonucci F, Bogen M, Toderi M, Guerra A, Sartori F,Tutta P, Inglese L, Limoni C, Gallino A, Von Segesser LK. Endovascular abdominal aneurysm repair and impact of systematic preoperative embolization of collateral arteries: endoleak analysis and long-term follow-up. J Endovasc Ther. 2013 Oct;20(5): 663-71.
15. Axelrod DJ, Lookstein RA, Guller J, Nowakowski FS, Ellozy S, Carroccio A, Teodorescu V, Marin ML, Mitty HA. Inferior mesenteric artery embolization before endovascular aneurysm repair: technique and initial results. J Vasc Interv Radiol. 2004 Nov;15(11): 1263-7.
16. Nevala T, Biancari F, Manninen H, Matsi P, Mäkinen K, Ylönen K, Perälä J. Inferior mesenteric artery embolization before endovascular repair of an abdominal aortic aneurysm: effect on type II endoleak and aneurysm shrinkage. J Vasc Interv Radiol. 2010 Feb;21(2): 181-5.
17. Ronsivalle S, Faresin F, Franz F, Rettore C, Zanchetta M, Olivieri A. Aneurysm sac "thrombization" and stabilization in EVAR: a technique to reduce the risk of type II endoleak. J Endovasc Ther. 2010 Aug;17(4): 517-24.
18. Piazza M, Frigatti P, Scrivere P, Bonvini S, Noventa F, Ricotta JJ 2nd, Grego F, Antonello M. Role of aneurysm sac embolization during endovascular aneurysm repair in the prevention of type II endoleak-related complications. J Vasc Surg. 2013 Apr;57(4): 934-41.
19. Pilon F, Tosato F, Danieli D, Campanile F, Zaramella M, Milite D. Intrasac fibrin glue injection after platinum coils placement: the efficacy of a simple intraoperative procedure in preventing type II endoleak after endovascular aneurysm repair. Interact Cardiovasc Thorac Surg. 2010 Jul;11(1): 78-82.
20. Böckler D, Peters AS, Pfeiffer S, Kovacs B, Geisbüsch P, Bischoff MS, Müller-Eschner M, Pfeiffer S. Nellix® endovascular aneurysm sealing (EVAS) - a new technology for endovascular management of infrarenal aortic aneurysms. Zentralbl Chir. 2014 Oct;139(5): 562-8.

2706.3

Re-intervention after fenestrated and branched endovascular repair

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Learning Objectives

1. To learn about complications after FEVAR and BEVAR
2. To learn how to treat complications after FEVAR
3. To learn how to treat complications after BEVAR

Complications of fenestrated and branched endografts can be subdivided into general complications of aortic endografting and complications specific to fenestrated and branched devices.
Complications of aortic endografting that require re-intervention include proximal and distal type 1 endoleaks; endograft disconnection or fabric tears leading to type 3 endoleaks; endograft migration proximally or distally leading to type 1 endoleaks; sac enlargement due to type 2 endoleaks; endograft limb stenosis or occlusion and iliac artery and common femoral artery access site stenoses, occlusions, dissections, pseudoaneurysms, rupture and haemorrhage.
Complications specific to fenestrated aortic endografts are stenosis or occlusion of the target vessel endograft, leading to ischaemia or infarction of the target vessel territory. An incomplete seal between the target vessel endograft and fenestration may lead to a type 3 endoleak. Disconnection of the target vessel endograft from the fenestration may occur and also causes type 3 endoleak, and in some cases, it causes impaired or occluded flow to the target organ. Inferior migration of the aortic endograft may alter the relationship of the

fenestration (therefore, the target vessel endograft) with the target artery and may cause pseudostenosis or occlusion of the target vessel endograft, or the migration may cause the displacement of the target vessel endograft out of the fenestration or the target artery.
Complications specific to branched aortic endografts are similar to fenestrated endografts. In addition, stenosis or kinking of one or more of the endografts supplying the target arteries between the aortic endograft and the target artery ostium may occur.
In general, occlusions of the target vessel endografts cannot be treated by recanalisation or stenting. Some acute occlusions may respond to intra-arterial thrombolysis and overstenting. However, target vessel endograft occlusion is usually discovered by serendipity at follow-up imaging by which time, the time window for thrombolysis has passed. Also, in general, stenosis of the target vessel endografts (by whichever aetiology) can often be treated by overstenting. Finally, type 3 endoleaks due to an inadequate seal or disconnection between the endograft and the fenestration or branch can usually be treated by angioplasty and/or overstenting.
In summary, interventional radiologists are important for the management of specific complications of fenestrated and branched aortic endografts. The success of endovascular treatment is high for the stenosis of the target vessel endograft and for the inadequate seal between the fenestration/branch and the target vessel endograft, and it is dismal for target vessel endograft occlusion.

2706.4

Treatment of limb occlusions and how to prevent them

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Learning Objectives
1. To learn how to prevent limb occlusions
2. To learn how to treat limb occlusions
3. To understand the complications of endograft limbs and the outcomes of treatment

Limb thrombosis in abdominal aortic endografts is a known complication after endovascular aneurysm repair (EVAR), especially in unsupported endografts in which it can occur in as many as 40% of cases (1,2). In the last-generation supported endografts, limb occlusion rate is between 1% and 5%, depending on the type of endograft used. The underlying mechanism of limb thrombosis might be kinking of the endograft limb, small limb diameter, or extension of the stent-graft limb into external iliac arteries. These thrombotic events typically occur within the first 2–6 months after the initial EVAR. If limb occlusion occurs later than 6 months after EVAR, other underlying causes, such as migration and dislocation of endograft limbs, may play a role (3).
Rarely, partial limb occlusion, presenting as a floating thrombus in the limb of an endograft, might become symptomatic; it has only been identified in Endurant endografts but is not associated with stent-graft extensions, small stent-grafts, or kinks within the limbs of a stent-graft (4).
Treatment options for endograft limb occlusion are multiple and include surgical techniques, such as Fogarty thrombectomy or femorofemoral crossover, and interventional techniques, such as catheter-directed thrombolysis, with or without additional stent placement. In case of mild or no symptoms, conservative management might be an option.

References

1. Fairman R, Baum R, Carpenter J, Deaton D, Makaroun M, Velazquez O, Phase II EVT Investigators. Limb interventions in patients undergoing treatment with an unsupported bifurcated aortic endograft system: a review of the phase II EVT Trial. J Vasc Surg 2002; 36: 118-126.
2. Amesur N, Zaiko A, Orons P, Makaroun M. Endovascular treatment of iliac limb stenosis or occlusions in 31 patients treated with the Ancure endograft. J Vasc Intervent Radiol 2000; 11: 421-428.
3. Maleux G, Koolen M, Heye S, Nevelsteen A. Limb occlusion after endovascular repair of abdominal aortic aneurysms with supported endografts. J Vasc Intervent Radiol 2008; 19: 1409-1412.
4. Maleux G, Van Camp L, Heye S, Houthoofd S, Fourneau I. Endurant endograft limb occlusion associated with a floating thrombus: A word of caution. J Vasc Intervent Radiol 2015 Jun;26(6):918-20.

2706.5

EVAR rarely needs follow-up: For the motion

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The argument for no follow-up after AAA endograft repair:
The academic argument that follow-up is not needed after AAA repair with endografts has been made in order to illustrate several points. Clearly, in reality, no argument could be made for no follow-up of the patients, but we may be able to argue in the context of conducting too much follow-up. At present, in 2015, CT scanning is the most accurate and common form of follow-up imaging. CT scanning is expensive and delivers radiation doses to patients, which may have deleterious effects in the future. Rather than arguing for no follow-up at all, I think an argument for changing follow-up protocols and decreasing the need for follow-up is required. If after an initial scan, there is no evidence of an endoleak, further follow-up in a 1-year period is probably not necessary. If high-quality Duplex ultrasound is available, it can replace CT imaging in a majority of instances. A CT scan without contrast may be able to replace a CT scan with contrast if Duplex ultrasound supplements the non-enhanced CT scan. This will greatly reduce the radiation to the patient. If there is no evidence of leak at 1 year, it may be possible to skip yearly follow-up in selected patient populations. Certainly, there are some high-risk populations, such as patients with short, tapered, or angled necks, who would mandate close follow-up. By excluding these subsets and those who are on the younger end of the age spectrum, it may be reasonable to eliminate follow-up within a majority of patients. Certain older devices are prone to separate and migrate, and some newer devices do not have established follow-up intervals to allow for limited follow-up; however, a majority of approved devices in the market would allow for limited follow-up.
In summary,
- follow-up in low-risk patient treated with a device with acceptable long-term follow-up (majority of patients)
- one-month imaging with baseline CT; if normal, then 1-year imaging with CT (non-enhanced) and Duplex
- if normal, no follow-up or, at the most, Duplex ± non-enhanced CT
- if abnormal (either leak identified or growth detected), then back to routine follow-up with enhanced CT
- follow-up in high-risk patients
- CT at 1 month; if normal, then follow-up with Duplex and non-enhanced CT at 1 year and then yearly or every alternate year follow-up

2706.6

EVAR rarely needs follow-up: Against the motion

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