Lisbon, Portugal
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ABSTRACTS & AUTHOR INDEX

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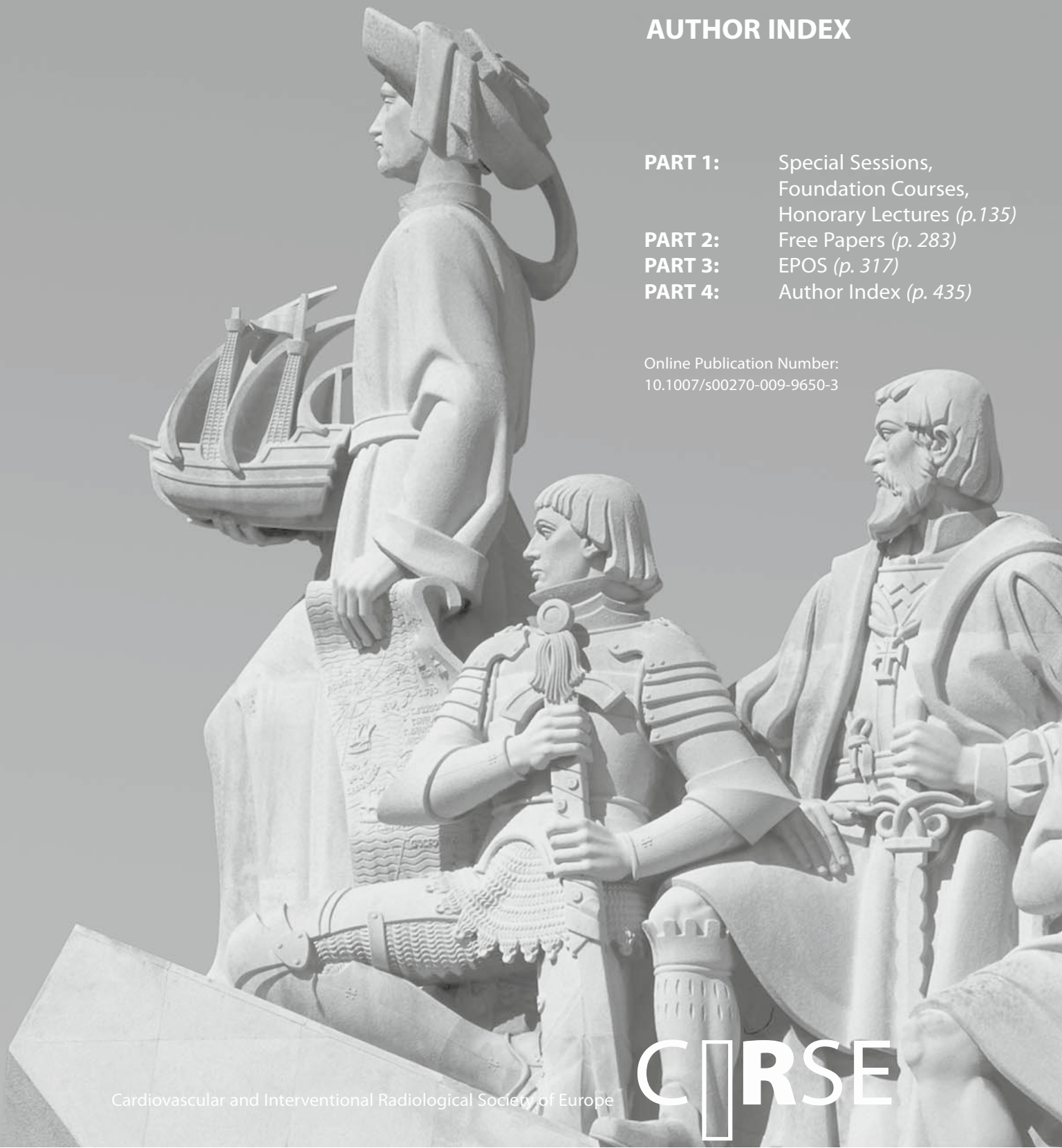

Cardiovascular and Interventional Radiological Society of Europe

CIRSE

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PART 1

Special Sessions
Foundation Courses
Honorary Lectures

Abstracts of
special session,
foundation course and
honorary lectures
sorted by presentation numbers

Cardiovascular and Interventional Radiological Society of Europe

CIRSE

Foundation Course
GI bleeding

101.1

Clinical features and imaging

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Department of Interventional Radiology , University School of Medicine , Lublin, Poland.

Learning Objectives

1. To describe the different clinical presentations of upper and lower GI bleeding
2. To summarise the main causes of upper and lower GI bleeding
3. To summarise patient triage, diagnostic imaging, and indications for angiography

Gastrointestinal bleedings (GIB) are responsible for a great number of hospital admissions (2% of all hospitalizations) - its incidence highly increases with age. Clinical presentation of GIB ranges from mild symptoms to a life-threatening conditions (mortality rate up to 15%). GIB is categorized as upper or lower bleeding by its localization - proximal or distal to the ligament of Treitz. Upper GIB is mostly caused by oesophageal and gastroduodenal erosions or ulcers (55-74%), variceal bleedings (5-14%) and vascular lesions or neoplasms. The most common cause of lower GIB is diverticular disease (20-55%) and bowel angiodysplasia (13-40%). Neoplasms and colitis cause up to 25% of lower GIB, respectively. Pancreatitis and trauma (external and iatrogenic) must not be forgotten. GIB can be acute or chronic - in both situations it may occur as active or obscure but in many cases bleeding occurs intermittently or ceases spontaneously. Patients with acute, active GIB frequently need resuscitation at first - blood pressure stabilization and euvolemia. Further localization of bleeding source is the next step. Endoscopy is considered as a first-line diagnostic and therapeutic procedure - its sensitivity reaches 100% in upper GIB but in case of lower GIB only probable bleeding source can be found (60% of cases). In stable patients, radionuclide and CT imaging plays a great role. Tc-99m RBC scintigraphy is more than 90% sensitive and specific in detecting a bleeding site anywhere in GI tract. However, its limited resolution does not allow precise GIB localization. Recent advances in CT technology (MDCT, 3-D imaging) greatly expanded the role of CT-angio in diagnosing GIB - active bleeding is found when hyperattenuation of extravasated contrast medium is seen in a bowel lumen. Obscure GIB is still a great challenge for imaging diagnosis because it has a wide spectrum of symptoms (acute or chronic, intermittent or active). Furthermore, the majority of obscure GIB causes are located in the small bowel, where endoscopic access is limited. Thus, for many years enteroclysis played a major role. Recently, wireless capsule endoscopy has been used for obscure GIB evaluation (detection sensitivity 40-80%). Among CT techniques, multiphase CT enterography with neutral enteric contrast material is promising. Considering referrals for arteriography, they usually occur in acutely unstable patients after a negative or failed endoscopy or as a first-choice examination for acute lower GIB. In patients with obscure GIB, arteriography goes mainly for intervention, when bleeding site is already diagnosed.

101.2

Anatomy

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Dotter Interventional Institute, Vascular and Interventional Radiology , Oregon Health Sciences University , Portland, OR, United States.

Learning Objectives

1. To review the angiographic anatomy of the upper GI tract
2. To review the angiographic anatomy of the lower GI tract
3. To explain the vascular anatomy relevant to embolization, including existing and potential collateral pathways

No abstract available

101.3

Tools and techniques

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Learning Objectives

1. To review the available embolic materials used for GI bleeding
2. To review the catheters and guidewires used during GI embolization procedures
3. To explain how to match the embolic material with the goal of the procedure

Tools: The basis tools are divided into those required for diagnosis and those required for embolisation. a. Tools for diagnostic angiography: • Catheters - Sidewinder 1 and 2, 100 cm long, 5 or 7 Fr. - Cobra 1, 2 and 3, 65 or 80 cm long, 5 or 7 Fr. - An IMA catheter may be helpful for selective cannulation of the inferior mesenteric artery. (Cordis, Europe). - Sos Omni catheter (5Fr). a. Tools for embolisation: • Catheters - Standard catheters similar to the previous may suffice. - Microcatheters are usually used to access distal locations for embolisation. E.g., Progreat (Terumo), FasTracker (Boston Scientific Corp.). • Guidewires - The Progreat is packaged with its own guidewire. - Several wires are available for use with the Tracker wire e.g., Taper 18. • Embolic agents: o Permanent or temporary o Permanent: - Coils: A variety is available: 0.035 vs 0.018 inch, stainless steel or platinum, helical vs straight. - Particles: PVA, Embospheres. - Glue: less commonly used in haemorrhage. o Temporary: - Gelfoam, available as sheets, or ready to use as pledgets or as a slurry.
Techniques: The following are key points in the embolisation of GI haemhorrage: • Aim to embolise as close to the site of haemorrhage as possible. • Avoid embolising vessels a long distance from the site of haemorrhage. • Use a microcatheter to access small vessels. Do not force a 5 Fr catheter into small branches. • If you use particles, do not use the smallest size (100-200 um) as the risk of bowel infarction increases. • Do not use alcohol. • It is impossible to inject gelfoam through a microcatheter. • In upper GI haemorrhage, there is usually a rich collateral circulation. As a result, it is important to try to embolise proximal and distal to the site of haemorrhage i.e. "close the front and back door". • In lower GI haemorrhage, the vessels are generally end-arteries and occlusion of the vessel immediately proximal to the site of haemorrhage is usually adequate. • In lower GI haemorrhage, avoid embolising a large vascular territory as this increases the risk of bowel infarction. • If patients rebleed after embolisation, a repeat procedure may be successful. Consider leaving the arterial sheath in situ if there is a high risk of recurrent haemorrhage, or if the bleeding has stopped at the time of the procedure and if the risk of further bleeding is thought to be high.

101.4

End points

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Learning Objectives

1. To explain when to stop a GI embolization procedure
2. To describe what to do in case of a negative diagnostic angiogram in patients with GI bleeding
3. To describe the main causes of recurrent bleeding after embolization

By nature, end point of embolization for GI bleeding depends

on complete abolishment of vascular supply, be it normal or abnormal vasculature. This can often be accomplished but not without a risk of compromise to adjacent normal tissue. Adhering to meticulous technique and attention to details are crucial during the embolotherapy to minimize non-target embolization. For upper GI bleeding, if a bleeding source is identified, a superselective catheterization of the bleeding vessel with coil embolization on both sides of the bleeding site ("coil-sandwich" technique) is the technique of choice because of the collateral blood supply. Complications after embolization of UGI bleeding are infarction, pancreatitis, or severe gastroduodenal tissue ischemia and friability, which can markedly limit or complicate subsequent surgical options. Embolotherapy is a valuable modality in the management of hemobilia resulting from trauma, pancreatitis, iatrogenic injury or tumors. Gallbladder infarction, bile duct necrosis, pancreas or spleen infarction can complicate embolization for hemobilia. Splenic abscess and overwhelming sepsis can occur following splenic embolization. In lower GI bleeding, proximal embolization should be avoided, and selective micro catheter catheterization and micro coil embolization, at the level of the arcade or vasa recta, is preferred. This may be technically challenging in vasoconstricted shocky vessels or if vasospasm develops from repeated instrumentations. Flow limited particle embolization has been successfully reported in those situations. The use of vasopressin although effective in 50% of patients is associated with intestinal and cardiac ischemia. Bowel infarction can complicate splanchnic embolization targeting bleeding or could result from inadvertent non-target embolization. When no bleeding site is identified angiographically, the use of RBC scan, repeated angiograms, identifying the bleeding site by endoscopy and provocative maneuvers have been associated with some success in identifying the bleeder. Some have advocated empiric embolization of either the left gastric or gastroduodenal artery in UGI bleedings; however, this should be reserved as a last resort option.

Special Session
Radiation protection

102.1

Risks of radiation exposure for patients and staff

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Learning Objectives

1. To review the radiation risk for patients undergoing IR procedures
2. To review the risks to staff
3. To learn how to measure radiation during procedures, to categorise them according to radiation dose

Stochastic and deterministic risks: Radiation exposure involves two types of risks for patients and staff: stochastic and deterministic [1]. The relevant stochastic risk during interventional radiology procedures is cancer induction. The probability increase of developing cancer per unit of dose is 3-4 times higher for young people than for adults. So, it is particularly important to take into account stochastic effects in risk-benefit considerations when treating paediatric and young adult patients and when procedures involve substantial dose to radiosensitive organs, such as breast or gonadal tissue. A major intervention, such as transcatheter embolization, can deliver an effective dose of 100 mSv to the patient, while a typical radiographic chest examination only delivers 0.1 mSv [2]. But, the probability of a radiation-induced malignancy caused by fluoroscopy or CT guided procedures is low compared to the "natural" frequency of malignancies.

Dosimetric quantities (for more detail see reference [2]): *"Absorbed dose"* is the energy imparted per unit mass at a specified point (sometimes it is also used the quantity "kerma"). It is measured in Gray (Gy). The old unit "rad" is equivalent to 0.01 Gy. For assessing dose or risk to humans, the quantity normally calculated is the mean absorbed dose in an organ or tissue. In these cases, the quantity "equivalent dose" can also be used and in this case, the unit is the Sievert (Sv). *"Cumulative dose"* is the air dose (or kerma) accumulated at a specific point in space relative to the fluoroscopic gantry during a procedure. This value is approaching the accumulated skin dose. It is typically measured in mGy. *"Peak skin dose"* is the highest dose at any portion of a patient's skin during a procedure. It is tipically measured in mGy. *"Dose Area Product"* (or Kerma Area Product) is the product of air dose (or kerma) by the irradiated area. It is typically measured in $Gy.cm^2$. *"Effective dose"* measures the global risk run by the person exposed to ionising radiation by taking into account the doses in the different tissues and the radiosensitivity of those tissues. This quantity can be related with the increases of cancer and hereditary effects. It is measured in Sv. The old unit "rem" is equivalent to 0.01 Sv.

Skin and lens injuries: Deterministic effects have a threshold and their severity increases with dose (dose dependent). Skin injuries (erythema and epilation) have been observed in patients (with a threshold of 2-5 Gy). The skin at the site where radiation enters the body receives the highest radiation. Once the threshold dose is exceeded, the injury becomes progressively more severe with increasing dose (dry or moist desquamation, telangiectasia, dermal atrophy and/or induration, etc), although the true severity of major injuries will only become apparent weeks or even months after the exposure. Very high doses usually produce some symptoms within 24 hours of the exposure. Lens opacities are also considered to be deterministic effects with a threshold for detectable opacities in human lenses of 0.5-2.0 Sv received during one brief exposure or a total dose of 5 Sv received during highly fractionated or protracted exposures [1]. Lens opacities have been reported in interventional radiologists and other staff (radiographers and nurses) working for several years without the routine use of standard radiation protection equipment [3, 4].

Patient dosimetric display in the X-ray systems: Modern X-ray systems used in interventional radiology display two dosimetric quantities inside the interventional suite: dose area product (DAP) (or kerma area product) and cumulative dose [5]. With specific software, it is also possible to estimate the "peak skin dose". From these quantities, one can estimate the stochastic and deterministic risks for patients. In addition to this, a patient radiation dose report can usually be printed or archived in electronic format to be included in the clinical report allowing the follow-up of radiation risk for patients or (in the future) stored as an integral part of the imaging file in PACS systems.

Personal dosimeters: Staff doses are measured using personal dosimeters and the International Commission on Radiological Protection (ICRP) recommends the use of two dosimeters, one over the apron and one under the apron [6]. With both dose records, it is possible to estimate the dose received by non protected organs (e.g., the lens of the eyes) and the "effective doses" to the operators and thus calculate the increase of cancer risk after several years of work in an angiography suite. Personal dosimetry services usually provide monthly estimates of Hp (10) (the dose equivalent in soft tissue at 10 mm depth), which is then compared with the annual limit of effective dose (20 mSv) and with the eye lens annual limit (150 mSv) (if an over apron dosimeter is used) [1].

Annual limits and diagnostic reference levels: The ICRP recommends the use of annual dose limits for staff but does not recommend the use of such limits for patients [1] because they may reduce the effectiveness of the patient's diagnosis or treatment. Instead of limits, in the case of patients, the ICRP recommends the use of "diagnostic reference levels" (DRLs) to help in the optimization of the IR procedures. In practice, the values are selected on the basis of a percentile point on the observed distribution of doses to patients

or to a reference patient. DRLs are supplements to professional judgement and do not distinguish between 'good' and 'bad' medical practice. They do contribute to the good imaging practice in medicine. According to ICRP [1], for fluoroscopically guided interventional procedures, DRLs could be used to promote the management of patient doses in order to avoid unnecessary stochastic radiation risks. However, the observed distribution of patient doses can be very wide, even for a specified protocol, because of the duration and complexity of the procedures. A good recommended approach is to take into consideration not only the standard clinical and technical factors, but also the relative 'complexity' of the procedure. DRLs are indicative of good practice and for IR, are being used based on several dosimetric and operational parameters: DAP, fluoroscopy time and number of images. Cumulative dose values are used to alert on the possibility to reach the threshold of deterministic effects. All these data are included in the patient dose reports and a process of standardization (DICOM format) is being finalised and will include such reports in the RIS and PACS.

SIR CIRSE guidelines on patient radiation dose management: The Society of Interventional Radiology (SIR) in USA and CIRSE in Europe have approved guidelines on "Patient Radiation Dose Management" [2]. These guidelines recommend including radiation risks in the informed consent process for patients and several aspects of patient monitoring, appropriate documentation and follow-up. These measures should result in the assessment of the radiation risk for each patient and a clinical follow up whenever radiation injuries are to be expected. High patient dose values may be produced due to patient factors (body mass index, pathology, etc), equipment factors (dose settings of the X ray system, availability of dose reduction techniques, etc) and operator factors. The trigger values for patient follow-up proposed by SIR-CIRSE guidelines are: Cumulative dose 5000 mGy. Peak skin dose (if available) 3000 mGy. Dose Area Product 500 $Gy.cm^2$. Fluoroscopy time 60 min. It is recommended that patients who have received a significant radiation dose should be given written radiation follow-up instructions on their discharge instruction sheet.

Estimation of effective doses and risks: The estimation of effective doses from DAP is subject to important inaccuracies but some conversion factors have been used in the literature ($mSv/(Gy.cm^2)$): 0.21 for thoracic procedures and 0.27 for abdominal procedures [7]. Thus, procedures involving 100 $Gy.cm^2$ represent about 21 mSv and 27 mSv if they irradiate organs in the thoracic or in the abdominal area, respectively. The estimation of cancer risk from effective doses is also subject to important inaccuracies as it depends on the age and gender and it should never be applied to individual patients. With the nominal adjusted risk factor of fatal cancer proposed by ICRP [1], an effective dose of 20 mSv could mean an induced mortality of around 1 in 1000. Several mean values of DAP in the RAD-IR study [8] are higher than 300 $Gy.cm^2$ (meaning 60-90 mSv): TIPS, pelvic embolization, neuroembolization, etc. In some of these procedures, the mean cumulative skin dose is also higher than 3 Gy requiring clinical follow up for skin injuries. The BEIR VII report [9] provides data for estimating lifetime attributable risk (LAR) of cancer incidence and mortality associated with radiation exposure, using the most current data available on the health effects of radiation. Using these data, Venneri et al. [10] have estimated the median risk of cancer in a sample of interventional cardiologists with median effective doses of 46 mSv along their professional lives, as resulting in 1 in 192. As for the deterministic effects on the lens of interventionalists (opacities and cataracts), several studies have reported a relevant percentage of incidence [3]. A recent paper by Vano et al [11] reported lens dose estimations from experimental data, using the values of fluoroscopy time and number of images obtained in USA during the RAD-IR study [8] and concluding that if radiation protection tools were not used it is possible to receive from 1-3 mSv (lens dose) per procedure.

Conclusions: In conclusion, in most cases, stochastic risks for patients could be irrelevant when compared to the expected benefits of the interventional procedures but they should be taken into account in order to optimize the procedures, especially for young patients. For complex procedures, the patients should be submitted to clinical follow-up in order to identify potential skin injuries. For staff, the cumulative professional radiological exposure is associated with a non-negligible lifetime attributable risk of cancer and the threshold of lens opacities may be exceeded if the radiation protection principles are not applied carefully at the interventional suites.

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102.2

Does new technology (e.g., flat panel) affect the dose?

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Learning Objectives

1. To review the theory of FPD as a dose reduction tool
2. To give the results of dosimetric study using FPD
3. To discuss the dosimetry of rotational angiography

Advances in equipment, technique, and radiographic contrast used for diagnostic and interventional angiography have markedly improved the safety and efficacy of interventional procedures guided by fluoroscopy [1]. Angiographic techniques that limit contrast use and reduce both patient and personnel exposure to radiation is desirable. The risk to the patient of significant radiation exposure during a single diagnostic angiogram is small. However, many of the adverse effects are dose-dependent and cumulative over the entire lifespan [2] [3]. This is potentially important as patients are increasingly undergoing repeat interventional angiographic procedures. Furthermore, cumulative radiation exposure is of concern for physicians and staff who regularly

perform interventional procedures. Pulsing and filtration are already standard features of current angiographic equipment reducing radiation exposure [4]. There are two major developments, which potentially account for a reduction in radiation exposure, rotational angiography (RA) and flat panel detector (FPD) [5] [6]. Both techniques may be used alone or combined. While rotational 2D angiography has been available for some time not providing a major breakthrough, more recent advances expand the technique to 3D applications and a CT-like technique. FPD technology is gaining considerable interest and most vendors offer single or dual C-arm system with this technology. Rotational angiography with image intensifier television systems or FPD helps reducing the number of acquisitions needed to perform a full assessment of a complex vascular anatomy by setting the gantry to complete a rapid right-to-left rotation during an angiographic injection. This technique obviates the acquisition of multiple projections to obtain a working position in complex anatomy. A learning curve is involved when starting with rotational angiography getting used to the combination of gantry coverage, contrast timing, contrast volume and rotation time. Proper isocentering and magnification are prerequisites for controlling radiation exposure by avoiding additional runs. The availability of 3D reconstructions has boosted RA technology for interventional radiology. Compared with an image intensifier television system, an angiography system using the FPD has several theoretic advantages. These obvious advantages are high spatial resolution, wide dynamic range, square field-of-view, and real-time imaging capabilities with no geometric distortion, which may be used for improved image quality, reduced patient exposure, or both [7]. The good performance of the direct conversion type FPD system seems to be a result of a combination of spatial resolution and signal-to-noise ratio expressed as the detective quantum efficiency (DQE) [8]. Modulation transfer function (MTF) is generally accepted as the most important parameter of spatial resolution for characterizing the performance of a detector system. A higher MTF is indicative of superior image quality. The FPD, due to its high DQE, has the potential for dose reduction while maintaining diagnostic accuracy. In the FPD of direct conversion type, absorbed X-ray photons are directly converted to electron hole pairs in a conversion layer (e.g., amorphous selenium), and then collected as electric charges on storage capacitors. The capability of performing a simple conversion process with the FPD of direct conversion type reduces the scatter fraction of electrons and light photons within the detector in the under-penetrated regions of the image, and improves signal-to-noise ratio. Image blurring in image intensifier television system can result from the scattering of X-ray beams, light, or both in the detector. Veiling glare, which has been a term to describe the scatter of electrons and light photons within an X-ray image intensifier television system, reduces image contrast. One of the major advantages of the FPD is the wide dynamic range, which improves contrast throughout the image and allows better visualization of low-contrast regions. Hatakeyama [9] reported that a FPD system allows a considerable dose reduction during 2D DSA without loss of image quality. Their combined subjective and observer performance study demonstrated that, with a radiation dose reduction of 50%, the diagnostic performance of the FPD system is still superior to that of the image intensifier television system. Furthermore, there is combination of both technologies evolving reducing radiation exposure and contrast volume even more effectively. Gosch and colleagues demonstrated that radiation exposure for unsubtracted 3D RA using a flat panel detector was significantly lower than for biplanar DSA. Using 3D RA in place of 2D DSA potentially reduces the radiation exposure of patients in neuroradiology procedures [10]. Akhtar and colleagues performed a randomized trial of the safety and clinical utility of rotational vs. standard coronary angiography using FPD [11]. Their study demonstrated rotational angiography as a safe and efficient method of diagnostic coronary angiography that provided comparable clinical information to standard coronary angiography. Rotational angiography was associated with a significant reduction in contrast medium exposure, which may provide benefit to those patients at increased risk for CIN. Rotational and standard angiography had comparable levels of radiation exposure and procedure time. The radiation exposure from either rotational or standard angiography using FPD was significantly lower than prior reports that used an image intensifer system. Most recent advancements are focusing on combining FPD with C-arm technology towards FPD-CT during angiography reducing CT dose index compared to conventional CT [12].

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102.3

Key points in reduction of radiation exposure

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Learning Objectives

1. To review the available passive protection methods
2. To review the available active protection methods
3. To review the results of active and passive protection methods

The definition between various methods of radiation protection is based on:

The means that are provided with and by the angiography system and known as “passive methods”. These methods are operator independent and represent any possible active consented protection. Passive methods are of no use if they are not utilized in daily practice. We as IRs are obligated to protect ourselves from ionizing radiation using any available passive means as well as dose reduction methods, and adjust our behavior to the hostile setting of the angiography

system. The "active methods" are those that would allow proper performance of the interventional procedures with the lowest amount of radiation for patients and staff.
There is an ongoing process of improvement and endorsement of the radiation protection (RP) in interventional radiology (IR) practice. The European Commission ratified the Directive 97/43/EURATOM on Medical Exposures, considering IR as a special practice that requires quality assurance programmes including patient dose assessments and specific training in RP. The International Electrotechnical Committee (IEC) produced several standards advising the radiology industry to improve the safety of interventional X-ray systems. The International Commission on Radiological Protection (ICRP) published in 2000 a document on Avoidance of Radiation Injuries from Interventional Procedures. Moreover, in 2002 the International Atomic Energy Agency (IAEA) initiated an „Action Plan on Radiation Protection of Patients" with special emphasis to the interventional practices. CIRSE has clearly stated in its 2008 European Interventional Radiology Syllabus that "Image interpretation and radiation protection are the foundation on each good practice in IR is built". A realistic review of the available passive and active methods of radiation protection will be presented, including various basic practical tools to improve radiation protection in the IR suite and to clarify their efficiency. Staff doses in IR can be high enough to exceed regulatory limits, and even to produce radiation injuries if RP tools are not used appropriately. There is a weak correlation between patient and staff radiation doses and it is very difficult to foresee staff doses from dosimetric parameters shown by modern X-ray systems during the procedures. Yet, it is crucial to identify, to understand and to implement the key methods to reduce radiation risks. Radiation-induced cataracts in interventionalists or alerts on lens doses close to the limit of 150 mSv per year during angiographic procedures have been reported. The ICRP, in its recent recommendations from 2007, states that "new data on the radiosensitivity of the eye with regard to visual impairment are expected". Recent publication in the American Journal of Epidemiology is challenging the National Council on Radiation Protection and International Commission on Radiological Protection statement that the „lowest cumulative ionizing radiation dose to the lens of the eye that can produce a progressive cataract is approximately 2 Gy, and they support the hypothesis that the lowest cataractogenic dose in humans is substantially less than previously thought". One can find very useful the following list of key methods and tools to reduce radiation risks during interventional procedures.

Passive protection methods:

- Availability of pulsed fluoroscopy.
- High filtration in the X-ray beams.
- Virtual collimation.
- Selection of areas for AEC (automatic exposure control).
- Patient dose in room displays.
- Possibility to archive fluoroscopy runs.
- Possibility to set personalized procedure protocols.
- Patient dose reports (IEC-DICOM structured doses report).
- Availability of patient dose reference values and possibility for on line comparisons.
- Use of rotational acquisition to select the good C-arm angulations avoiding extra DSA series.
- Suspended ceiling protective screens.
- Table mounted protective lead curtain.
- Protective aprons, thyroid, hands and goggles.
- Electronic personal dosimetry.
- Scatter doses maps.
- In room information of the scatter level (available in the future).
- **Active protection methods:**
- The proper use of all the available passive methods/tools.
- Exposure time, distance to the radiation source (patient) and shielding are always the main factors to be taken into account. Working at 80 cm from the isocentre instead of 40 cm can decrease scattered dose to approximately a quarter of the original dose.
- Avoid the hands in the direct X-ray beam.
- Recognize the most irradiating C-arm angulations. Scattered radiation is higher at the side of the X-ray tube and less important at the side of the image intensifier during lateral projections.
- Use appropriate collimation.
- Recognize that magnification usually increases patient skin dose.
- Obtain the needed diagnostic information but not the best information (reduce fluoroscopy time, use low dose fluoroscopy modes, reduce the number of DSA series, reduce the number of images in the series, etc).
- Image detector should always be closed to the patient.
- X-ray focus should not be closed to the patient's skin.
- Use the feedback on the values of patient and staff doses after comparison with available references indicative of good practice.
- Require frequent audits on RP including reports on the reliability checks of your X-ray system and on your patient and staff dosimetry database.
- Request noninvasive pre-procedural imaging (CTA or MRA) when available and base the intervention including the devices (balloons, stents) on the imaging findings.
- Use medical simulators in order to improve the performance time (fluoroscopy time).
- Last, but not the least: protect your patient from radiation and you will improve your own occupational protection.

Special Session Hepatocarcinoma

103.1

Bland embolization

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Learning Objectives

1. Rationale for bland embolization and indications
2. Techniques of bland embolization (materials, particles)
3. Results of bland embolization

Introduction: Only 20 to 30% of patients with hepatocellular carcinoma (HCC) are candidates for curative treatments and most of them are suitable only for locoregional therapies or palliative care. Intra-arterial treatment as transarterial chemoembolization (TACE) and transarterial embolization (TAE) are considered as palliative therapy for multifocal HCC in advanced stage. Several alternative minimally invasive treatments have been proposed but recently only TACE has been shown to improve survival compared with best supportive care in meta-analyses of randomized trials. However, it is not clear whether TAE alone gives the same survival advantage nor whether specific patient characteristics affect outcome or any particular technique in performing transarterial therapy is better than any other. Some authors have reported experience in treating liver tumor by mean TAE by using different materials and techniques: not selective, selective and superselective injection of fibrine sponge, glue, particles and so on. The main purpose of this study is to assess feasibility and local response in patients affected by unresectable HCC, treated with TAE using microparticles sized 40 and 100 microns. Rationale for using well calibrated small sized microparticles for treating liver tumors is mainly based on the evidence that all hepatic malignancies are mainly or exclusively fed by arterial blood flow. Vessels within the tumor have been reported to have a size ranged between 20 to 120 microns and it should be, in

our opinion, the target for achieving a deep ischemia and necrosis by using TAE. Bigger particles will embolize bigger vessels outside the target nodule: the more bigger the particles used, the more far from the tumor will be the embolization.

Methods: Between October 2007 and April 2008, 22 patients underwent TAE. Diagnosis of HCC was based on radiological findings (MDCT scan), alfa-fetoprotein level and biopsy according to the Barcellona criteria. Inclusion criteria were HCC nodules not suitable for surgical resection or percutaneous therapies. Exclusion criteria were patients older than 80 years, advanced liver disease (Child Pugh class-C), active gastrointestinal bleeding, encephalopathy, refractory ascites, portal branch occlusion and documented artero-venous hepatic shunts. All patients underwent upper-abdomen multi-phase MDCT before treatment. MDCT scans were also used for defining vascular anatomy supplying the liver and for assessing tumor feeding vessels. A total of 32 target lesions were embolised using 40 and/or 100 µ micro-spheres (Embozene /Celonova); average treated nodule diameter was 5.7 cm. Angiography of celiac trunk and superior mesenteric artery were always obtained before every treatment, in order to assess arterial anatomy and possible variants and for detecting the feeding vessels to the target lesions. Super-selective catheterization of tumor feeding arterial branches was obtained by using micro-catheters (Renegade High Flow/Boston Scientific). When it was not possible to detect the feeding vessels to the lesion, CO_2-microbubbles-enhanced liver ultrasound has been performed; it consists into the intra-arterial injection of CO_2 micro-bubbles through the micro-catheter, by changing the positions of the tip within different arterial branches feeding the tumour area. Right vessel to be used for TAE was detected when the target lesion enhanced during micro-bubbles injection. Hepatic perfusional scintigraphy with intrarterial injection via the main hepatic artery of macro-aggregates of albumine (TC99-MAA) was performed just before TAE, in order to exclude pulmonary shunting. Just before the embolization, 5 mg of levobupivacaine was injected via the micro-catheter in order to obtain local parenchymal analgesia; then, microspheres were gently injected under fluoroscopy, until blood flow was stopped. Upper abdomen MDCT was performed 24 hours after treatment, for assessing early local result and for detecting any possible complication. MDCT scan was then repeated at 30 days, three and every six months. Local efficacy of the treatment was defined according to RECIST criteria on CT follow-up imaging: complete response was defined as the disappearance of treated target lesion. Moreover, post TAE amount of tumour devascularisation (i.e. necrosis) has been also evaluated: complete response (=devascularisation) was defined as the absence of any contrast enhancement during arterial phases in MDCT, massive response as the necrosis of the huge portion of the lesion and partial response as the necrosis of a portion of the lesion. We considered a complication due to the treatment if it occurred within 3 weeks from TAE.

Results: Patients received a total of 29 sessions of TAE. Technical success was achieved in all TAE procedures. Only one pt within the study had a 6% pulmonary shunting detected at MAA liver scintigraphy. Minor complications were observed in 2 patients: 2 pancreatitis restored in few days. Major complication occurred in one patient who died within 24 hr after TAE. This 74-y.o. patient had a previous history of breast cancer, CRC and heart infarction due to chemotherapy. She had even liver surgery for HCC two years before (S2-S3 resection), with early recurrence within S4, just between the right and the median hepatic vein. Post-mortem examination showed the presence of a large necrotic portion of the lesion and the presence of necrotic emboli in the right pulmonary artery. Microspheres were observed in arterial and portal liver vessels, but also into both lungs. Pathologists supposed that a massive tumor necrosis and wall rupture of the tumor involved hepatic vein occurred few hours after TAE with passage of necrotic tissue and microspheres to the lungs via the median hepatic vein. Complete necrosis (hypodensity) was observed in 30 nodules at 24 h CT, while 2 nodules showed poor response. All patients included have at least one month FU (average: 10 months) and evaluation based on RECIST criteria shown 2 progressive disease (PD), 13 stable disease (SD), 6 partial response (PR= ranging between 33 and 78% of diameter reduction) and 1 complete response (CR).

Discussion: There is no standard therapy for patients with HCC unsuitable for surgical treatment. Cirrhotic patients with HCC have a poor prognosis, mainly influenced by hepatic reserve function and tumor staging. In these cases, TAE and TACE are the most used treatments with proven improvement on survival in selected patients with well preserved liver function. Actually, there is no absolute evidence that TACE is better than TAE. Six randomised trials of arterial embolizations, with or without chemotherapy, have shown a strong antitumoral effect, but none detected survival benefits in comparison with conservative management or suboptimum treatments. Some authors describe an important rule represented by survivin, a member of family of inhibitors of apoptosis protein and promoter of mitosis and therefore cancer cell survival and growth. Theoretically, TACE, combining the effect of drug with hypoxia, should be more effective than TAE. Survivin expression, increase under anticancer drug and further increase over, after the administration of a combination of hypoxia and anticancer drug. No survivin protein expression is observed in the hypoxia condition without drug. There is no evidence of an additive or synergistic antitumoral effect of TACE vs TAE alone. Three different randomized trial studies have failed in demonstrating a significant difference in survival between the two different treatments. Probably, ischemia resulting from embolization might be the main factor inducing reduction in tumour size after TACE. Conversely, hypoxia and inflammation, as they are powerful stimulators of angiogenesis, might inadvertently promote tumour growth. Kobayashi et al. showed an increasing of serum concentration of vascular endothelial growth factor in patients who underwent TACE, suggesting a direct link between the degree of embolization, tumour hypoxia, and the stimulation of new blood vessel growth. Moreover, it has been suggested that TACE may facilitate the hematogenous dissemination of malignant cells in the systemic circulation by disrupting cell-cell adhesion, and by damaging the endothelium. In the major part of the studies concerning HCC treatment with TAE, the embolizing agent is gelatine sponge that induces hypoxia only temporarily. In some studies, polyvinyl alcohol (PVA) particles were used to cause a permanent or semi-permanent vessel occlusion. Nowadays, there are few studies on the new embolizing agents, such as resin or gelatine microspheres. There is no consensus about which is the most effective embolizing agent. Theoretically, an embolizing agent that has a standardized particle size and that can be delivered into smaller arteries and cause permanent thrombosis should be more effective than temporary or eterogeneous sized embolizing agents. Moreover, smaller particles will effect within the tumor vessels, avoiding any possible arterial blood relapse as it can occur if more distal vessels are occluded. In this scenario, some other new vessels from outside the nodule will develop and feed the tumor. The new microparticles (Embozenes) we used for TAE have some distinctive features, which may lead some other advantages in obtaining tumor necrosis than other materials. Precise and well calibrated small size and anti-inflammatory effect (due to the coating film with Polyzene-F) are the most important characteristics, which may allow for deep ischemia without inflammatory reaction of surrounding tissue. According to the RECIST criteria, we had one patient with complete response (tumor disappearance) at 14 months follow up. This is an unusual outcome for intrarterial treatments and represents the proof of concept that deep and definitive ischemia may allow for complete destruction of tumor parenchyma. Six patients with partial response, however, had tumor shrinkage ranged between 33 and 78%. Most of patients with stable disease and/or progression have been treated at the beginning of our experience by using this new material and it could represent a sensitive bias for data collecting. For the clinical

point of view, patients with stable disease (13) had some objective benefits from the procedure, as the reduction of tumor-related pain, fatigue and weight loss. However, it is well known that evaluation of tumor size is not adequate for assessing local results of TAE and TACE; the assessment of tumor contrast enhancement seems to be much more reliable for evaluating local outcome after intrarterial procedure. Our rate of necrosis is reported only based on MDCT and we need a correlation with histology to confirm our feeling but the specimen of embolized hepatic tissue of the dead patient, showing a complete embolization of arterial and portal vessels, represent a very interesting detail. 40 microns particles should allow for segmental or subsegmental complete embolization. In case of artero-venous shunting, a bigger diameter microspheres (100 or 250 μ) would have been used for embolization, as the shunt's diameter, generally, is lower than 100 microns, according to pathologists.

Conclusion: Our preliminary experience in treating HCC with TAE by using a new material available in the market is really interesting and our results are good enough to justify further studies for assessing the real local and mainly clinical value of this minimally invasive approach for managing patients without any standardized really affective therapy.

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103.2

TACE

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Learning Objectives

1. To discuss indications and contraindications of TACE
2. To analyse the results of multicentre or single centre trials with

conventional TACE and DEB-TACE in HCC
3. To compare the results with those of other types of treatment for HCC

Introduction: hepatocellular carcinoma (HCC) is the fifth most common cancer in men and its incidence is increasing worldwide. In HCC patients, the tumour develops in cirrhotic livers in about 80% of individuals and, thus, their outcome is related to both cancer and cirrhosis (1). For HCC therapy, surgical and non-surgical procedures are available. Potentially curative procedures are resection, liver transplantation and percutaneous radiofrequency ablation (RF) which, however, are restricted to patients at an early stage of the tumour. Curative therapies are applicable in only 30-40% of patients with HCC. If the tumour is at a more advanced stage, palliative therapy options exist such as local interventional percutaneous and transarterial procedures. In general, HCC is highly chemotherapy resistant. A possible explanation is the overexpression of multi-drug resistance related proteins (2). To date, neither systemic chemotherapies (e.g. doxorubicin) nor other systemic therapy approaches such as octreotid, anti-androgens or tamoxifen have been able to improve the prognosis of patients with advanced tumour disease. Initial results with substances from the class of targeted therapeutic drugs such as bevacizumab, cetuximab and imatinib have also remained disappointing. Recently, sorafenib, an oral multikinase inhibitor of the vascular endothelial growth factor receptor, the platelet-derived growth factor receptor, and Raf have shown to be effective in patients with advanced hepatocellular carcinoma but preserved liver function (Child-Pugh A). Median overall survival was 10.7 months in the sorafenib group and 7.9 months in the placebo group (P<0.001). However, only 2% of patients achieved partial response (6).

Indications for TACE: transarterial chemoembolization (TACE) is recommended as a non-curative first-line therapy for non-surgical patients with large or multifocal HCC without vascular invasion or extrahepatic spread. The indication for TACE should be based on a combination of tumor extent (tumor size <50% of liver volume, no portal vein thrombosis and extrahepatic manifestation), severity of liver disease (Child-Pugh score A and <B7), and health status (Karnofsky score, ECOG Performance Status). The BCLC staging system recommends patients in the early stage if there are contraindications to surgery, RF ablation or on the waiting list for transplantation and in the intermediate stage. Contraindications should be advanced liver disease (Child-Pugh C), encephalopathy, refractory ascites, presence of vascular invasion or portal vein occlusion due to liver tumour, extrahepatic metastases, portosystemic shunt, hepatofugal blood flow, any contraindication to angiography (impaired clotting tests and renal failure), a reduced performance status (ECOG 2), and an end-stage tumour disease (Okuda III, >50% involvement of liver) (3-5).

Technique of TACE: transarterial chemoembolisation (TACE) involves the periodic injection of a chemotherapeutic agent, mixed with the oily contrast agent lipiodol and an embolic material, into selected branches of the hepatic arteries feeding a liver tumour. Normal liver receives 70-80% of its blood supply from the portal vein and 20-30% from branches of the hepatic artery. In contrast, HCC tumours are hypervascular and receive their blood supply from almost the hepatic artery only. The rational for TACE is that the infusion of a chemotherapeutic drug followed by occlusion of the blood vessel will result in a higher drug concentration within the tumour and will stop the arterial blood supply of the tumour. Therefore, two anti-tumoral mechanisms are acting: the cytotoxic insult because of the targeted delivery of the cytotoxic agent and the ischemic insult related to the mechanical occlusion of the feeding arteries. Monotherapy is used in the majority of patients, double or triple therapy in less than a quarter of patients reported. The most common sole-agent anticancer drug used is doxorubicin, followed by cisplatin, epirubicin and mitomycin C. Reported doses per session were: doxorubicin 20-150 mg and cisplatin 10-120 mg. Two different types of double therapy were used: doxorubicin (or epirubicin) with mitomycin C and doxorubicin (or epirubicin) associated with cisplatin. However, there is no evidence of the superiority of any drug or any mono-versus combination therapy so far. The median dose used of lipiodol was 2-25 mg (median 10 mg). For embolization a variety of agents can be used. Most commonly gelatin sponge is used, which causes temporarily an occlusion for about 2 weeks. Degradable starch microspheres provide transient occlusion for 1-2 hours. Polyvinyl alcohol (PVA) particles and beads, trisacryl gelatin spheres, drug-eluting Beads (DC Bead) and glue cause permanent occlusion of hepatic artery branches. However, hypoxia is an extremely potent stimulator of angiogenesis. Serum concentration of vascular endothelial growth factor was markedly increased in patients following embolization. Therefore, a combination therapy of TACE and antiangiogenesis agents is currently evaluated in various randomized controlled trials (RCTs). There is an agreement that selective TACE achieves better antitumor results. It is generally accepted that TACE achieves maximal tumor response when repeated multiple times (2 to 3 therapy cycles at least). The interval between two consecutive courses should be 1 or 2 months depending on lab values and clinical course.

Results of treatment: it has been shown that TACE achieves complete response in 0-35%, partial response in 3-62% and objective response using WHO criteria was documented in 3-86% (7-15). Moreover TACE significantly delays tumour progression and vascular invasion. Recently, two studies have reported survival benefits for TACE in selected patients. Llovet *et al.* reported 1 and 2 year survival probabilities of 82 and 63% with objective response sustained for at least 6 months in 35% of cases (13). A systematic review and meta-analysis of randomised clinical trials for unresectable HCC has shown a survival benefit of TACE in comparison to control (14). The best candidates for TACE are those with preserved liver function and asymptomatic multinodular tumors without vascular invasion or extrahepatic spread. TACE improves median survival to 19-20 months in RCTs and is considered the standard of care (12-14). The reported survival rate at 1, 2, 3, and 5 years was 62±20%, 42±17%, 30±15% and 19±16%, respectively, and a mean survival time of 18±9 months. Recently, Graziadei *et al.* (Liver Transplantation, 2003) demonstrated that TACE can be highly effective in preventing tumor progression in patients listed for liver transplantation. The most commonly reported adverse events are the post embolization syndrome, hepatic and renal failure, cholecystitis, pancreatitis, abscess, sepsis and death. The post embolization syndrome (transient abdominal pain, fever, elevated transaminases) is reported in 60-80% of patients and may last for 3-4 days. Transient liver failure was reported in 20-50%, irreversible in 3-8%. Risk factors for hepatic failure are Child-Pugh B/C cirrhosis, large tumours, bilobar involvement, portal vein thrombosis and large quantities of lipiodol (>20 ml). Renal failure was reported in 0-13%. Death within 30 days was reported in 0-9.5% (15).

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103.3

Radioembolization

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Learning Objectives

1. To describe the main technical aspects of radioembolization with Yttrium 90
2. To analyse the indications for treatment and the role of radioembolization with respect to other treatment modalities
3. To report results from available literature as well as from personal experience

Intra-arterial radiotherapy with 90yttrium (90Y) microspheres (radioembolization) is a therapeutic procedure, exclusively applied to the liver that allows the direct delivery of high-dose radiation to hepatic tumours, by means of endovascular catheters, selectively placed within the tumour vasculature. Like other regional treatments for liver tumours, this procedure utilizes the well-characterised dual vasculature of the liver to selectively target tumours larger than 5 mm that are almost exclusively supplied by blood from the hepatic arterial branches. The small microspheres (<30 microns in diameter), loaded with 90Y, preferentially lodge within the tumour microvasculature, delivering high-energy, beta-radiation over a limited range (mean penetration of radiation into tissues is 2.4 mm), thereby confining the tumouricidal dose (>70 Gy) to the immediate proximity of the tumour and sparing the normal liver parenchyma. Although radioembolization is, technically, an embolization procedure since particles are administered intra-arterially, and vascular occlusion is expected, the aim of the procedure is not to occlude vessels but to deliver a lethal dose of radioactivity in the tumour via its arterial/arteriolar network. Maintaining an adequate oxygenation of the tumour tissue increases the lethal effect of the radiation and an important ischemia, due to a large tissue embolization, could then limit the efficacy of the treatment. Additionally, it is important that particles reach the peritumoural and intratumoural vessels, in order to deliver 90Y as close as possible to the tumour cells and to limit proximal occlusion and extra-tumoural irradiation. For these reasons, particles must be small enough (<30 microns) to reach the tumour microvasculature. Radioembolization is a complex procedure that requires multidisciplinary management; for safety and success, then, a close cooperation between oncologists, radiologists, hepatologists, nuclear medicine specialists and interventionalists is required. Radioembolization is an effective method for inducing liver tumour regression. The results of several clinical studies have supported its use and confirmed its efficacy in the treatment of primary and metastatic liver neoplasm. Alone or in combination with chemotherapy (radiosensitizer agents), a significative increase in survival, as well as in downstaging tumors in order to allow a curative surgical treatment, have been reported. According to our series of 72 consecutive patients with hepatocellular carcinoma, median overall survival was 12 months (95% CI 8.8-15.1). Survival was significantly better in patients with less than five lesions (22 vs. 8 months, $p<0.005$) and in patients with an alpha-fetoprotein <40 ng/ml (18 vs. 11 months, p 40 ng/mL, and their survival was significantly worse (7 vs. 18 months, $p<0.05$)). According to the results presented by Jacobs et al. in cases of colorectal liver metastases, at a median interval of 2.9 months after radioembolization, partial response, stable disease, and progressive disease were demonstrated in 7, 25, and 4 patients, respectively. Median overall survival was 10.5 months, with improved survival for patients with a decrease in carcinoembryonic antigen level (19.1 vs 5.4 months) and imaging response (29.3 vs 4.3 months; $p=0.0001$). The incidence of complications after radioembolization is low, if patients are selected appropriately and target delivery is performed meticulously. Gastrointestinal complications have been reported to occur in 3-29% of the patients treated with radioembolization. As in other intraarterial liver procedures, this risk can be minimized by occluding extra hepatic visceral arteries prior to the administration of the microspheres. Radiation induced liver diseases has been published (0-20% of the cases) as a complication of radioembolization. It presents at 4 to 8 weeks as jaundice and ascites. Veno-occlusive disease was the histologic hallmark observed in the most severe cases. This form of sinusoidal obstruction syndrome was not observed among patients who never received chemotherapy or in those in whom a single hepatic lobe was treated. Relevant to treatment planning, a possible risk factor was a higher treatment dose in relation to the targeted liver volume.

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103.4

RFA

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Learning Objectives

1. To define indications for RF ablation of HCC as compared to other treatments
2. To describe technique, follow-up and main complications of RFA
3. To present results of RF ablation for HCC (series and trials)

Hepatocellular carcinoma is considered to be one of the most common malignancies worldwide, and the most common one in Africa and Asia. In the Western world, a rising incidence of up to 10 - 15/100.000 per population is seen over the last decade, with an estimate of more than a million deaths worldwide per year. The treatment of HCC is based on four options: transplantation, resection, ablation, and embolization. Liver transplantation is considered the only curative treatment because the tumor and the cause for the paraneoplastic disease - i.e., the cirrhotic liver - is removed. According to the Milan criteria, the best long-term outcome rates can be achieved in patients with a single tumor less than 5 cm or with up to 3 tumors with less than 3 cm in diameter. Applying this criteria, 5-year survival rates of 70-80 % with recurrences less than 15 % can be achieved. However, transplantation is still limited by the worldwide shortage of organs, by tumor progression and/or deterioration of liver function during the waiting time, and by the consecutive drop-out rate of 20-50 % if the waiting time exceeds more than a year. The 5-year survival rate of 70 % in transplantation is comparable to hepatic resection suitable in only 5-30 % of patients. Since the vast majority of patients with HCC are not suitable for any surgical treatment, adjuvant, less invasive treatments represent valuable therapeutical options. Depending on the tumor stage and in comparison to other local ablative techniques as percutaneous ethanol injection (PEI) and transarterial chemoembolisation radiofrequency ablation (RFA) provides superior response and local control rates. In general, there is no difference between the different probe designs regarding primary technical success rate. The most frequent complications of RFA in HCC are peritoneal hemorrhage, neoplastic seeding, intrahepatic abscesses and intestinal perforation. The incidence of complications is related to the number of RFA-sessions performed in the individual patient, whereas minor complications according to the SIR classification are observed in less than 5% of the patients. Tumor seeding after RFA of HCCs is a very crucial issue that is reported up to almost 1% potentially triggered by prior biopsy. The primary success rate of RFA depends in most studies mainly on the size of the HCC, while the recurrence rate depends on the number of lesions - reflecting most likely the multilocular inflammatory activity of the underlying disease. Best results can be achieved in early HCC in mild and moderate cirrhosis (Child A and B). Comparable to surgical results, 1-, 3-, and 5-year survival rates of up to 100, 89 and 61% in Child A patients with solitary HCC after RFA can be gained, whereas the 1-, 3-, and 5-year recurrence rates may reach 14, 49, and 81%. In consequence, RFA is a superior and powerful treatment in unresectable and recurrent HCC, which can be considered as bridging therapy before liver transplantation, and as a primary treatment in competition with partial hepatectomy for resectable small HCC.

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103.5

The role of adjunctive therapy

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Learning Objectives

1. To introduce medical therapy to interventional radiologists and describe its role in the management of HCC
2. To describe the potential role of adjunctive therapy together with loco-regional treatments in HCC
3. To report on ongoing trials

The treatment of hepatocellular carcinoma (HCC) is rapidly evolving as developments in both loco-regional and systemic therapies continue to improve. Loco-regional therapies are established as the best treatment option for patients with HCC when surgery is precluded. Most patients with HCC, however, have two diseases - liver cirrhosis and HCC - and complex interactions between the two have major

implications for prognosis and treatment choice. Several scoring systems have been developed in the past few years in attempts to stratify patients according to expected survival. However, the only system that links staging with treatment modalities is the Barcelona Clinic Liver Cancer (BCLC) staging system. The BCLC staging system includes variables related to tumor stage, liver functional status, physical status, and cancer related symptoms and provides an estimation of life expectancy that is based on published response rates to the various treatments. In the BCLC system, early-stage HCC includes patients with Eastern Cooperative Oncology Group (ECOG) performance status of 0, preserved liver function (Child-Pugh class A or B), and solitary tumor or up to 3 nodules smaller than 3 cm in size each. If the patient has Child-Pugh class A cirrhosis and a solitary tumor smaller than 2 cm in size, the stage may be defined as very early. Patients with multinodular HCC with neither vascular invasion nor extrahepatic spread are classified as intermediate-stage, provided that they have a performance status of 0 and Child-Pugh class A or B cirrhosis. Patients with portal vein invasion or extrahepatic disease are classified as advanced stage. The terminal stage includes patients who have either severe hepatic decompensation (Child-Pugh class C) or performance status greater than 2. Patients with early-stage HCC can benefit from curative therapies, including surgical resection, liver transplantation and percutaneous ablation. Resection is currently indicated among patients with solitary HCC and extremely well-preserved liver function, who have neither clinically significant portal hypertension nor abnormal bilirubin. Liver transplantation benefits patients who have decompensated cirrhosis and one tumor smaller than 5 cm or up to three nodules smaller than 3 cm, but donor shortage greatly limits its applicability. Image-guided percutaneous ablation is the best therapeutic choice for nonsurgical patients with early-stage HCC. While ethanol injection has been the seminal percutaneous technique, radiofrequency ablation has emerged as the most effective method for local tumor destruction and is currently used as the primary ablative modality at most institutions. Transcatether arterial chemoembolization (TACE) is the standard of care for patients at the intermediate stage. Cumulative meta-analysis of all published randomized trials indicates that patient survival is significantly improved. However, there is no evidence that TACE is effective in patients who present with a more advanced stage because of tumor growth with vascular involvement or extrahepatic spread. Despite the advances in loco-regional treatments, long-term outcomes of treated patients remain unsatisfactory because of the high rate of tumor recurrence. Early tumor recurrences are mostly due to the spread of the original tumor rather than to the development of a second "de novo" HCC independent of the previous cancer. Recently, increased understanding of the molecular signalling pathways involved in HCC has led to the development of targeted therapies aimed at inhibiting tumour cell proliferation and angiogenesis. Sorafenib, a multi-kinase inhibitor with anti-angiogenic and antiproliferative properties, is the only targeted agent approved for the treatment of HCC. This approval was based on data from SHARP (Sorafenib HCC Assessment Randomized Protocol), a randomised, placebo-controlled, double-blind, phase III trial (1). In SHARP, 602 patients with advanced HCC received either oral sorafenib 400mg twice daily (b.i.d.) or placebo. Compared with placebo, sorafenib significantly prolonged median overall survival (OS; 10.7 versus 7.9 months; $p<0.001$) and median time to radiological progression (TTP; 5.5 versus 2.8 months; $p<0.001$). Sorafenib-related adverse events were mostly mild-moderate, predictable and manageable. A similar phase III study was conducted in 226 patients from the Asia-Pacific region. Consistent with results obtained in SHARP, sorafenib prolonged OS and TTP compared with placebo, despite patients from the Asia-Pacific region having more advanced disease (2). To date, studies of sorafenib have demonstrated its efficacy in advanced HCC; however, there may also be a role for this agent in earlier-stage disease. Tumour recurrence following TACE is characterised by increased vascular endothelial growth factor (VEGF) production and subsequent angiogenesis. Therefore, combination of sorafenib (which inhibits the VEGF receptor and Raf kinase) with TACE is being investigated in intermediate-stage HCC (3). In particular, a phase IIb randomized trial will start soon, comparing Precision TACE with DC Bead plus placebo - i.e., the standard of care for this patient population - versus Precision TACE with DC Bead plus sorafenib. This is the first significant study in which an interventional radiology treatment is evaluated in combination with a systemically active drug in HCC. Sorafenib will also be studied in early-stage HCC in the phase III STORM (Sorafenib as adjuvant Treatment in the prevention Of Recurrence of hepatocellular carcinoMa) trial. In STORM, patients who have undergone prior curative therapy will be randomised to receive sorafenib 400 mg b.i.d. or placebo to determine the effect of treatment on time to recurrence (3). The outcomes of combination studies with sorafenib and locoregional therapies are eagerly awaited, as they have the potential to revolutionise treatment of HCC.

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Special Session
Paediatric intervention

104.1

General challenges in paediatric intervention

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Learning Objectives

1. To define differences between paediatric and adult IR
2. To describe how to set up a paediatric IR service
3. To describe problems and solutions regarding paediatric IR

Paediatric interventional radiology (PIR) is now essential for the safe and effective practice of many clinical services in hospital paediatrics. Although various obstacles exist to the establishment and development of PIR services, it is a rapidly-growing subspecialty in many centres in Europe and North America. As of 1 March 2009, the recently formed Society for Pediatric Interventional Radiology (www.spirweb.org) had recruited 74 members from 12 countries. Techniques performed by interventional radiologists include central venous access, gastrointestinal intervention (such as gastrostomy and oesophageal dilatation), aspiration or drainage of fluid collections including nephrostomy, angiography including arterial embolization, and the treatment of vascular malformations.

Methods of providing a PIR service: PIR is provided in different ways in different hospitals. These models of service include: 1. A full PIR service in a specialist children's hospital. This may be provided by radiologists trained in both paediatric and interventional radiology, by interventional radiologists with an interest in paediatrics, and/or paediatric radiologists with a special interest in intervention. Interventional neuroradiologists are also often involved. Nurses and radiographers can also successfully perform many delegated procedures as part of a PIR team. 2. A limited PIR service in a specialist children's hospital. This is usually provided by diagnostic paediatric radiologists with a special interest in intervention, often with support from interventional radiologists who work at a nearby adult hospital. 3. PIR performed by non-radiologists. Paediatric surgeons and anaesthetists and other paediatricians occasionally provide image-guided interventions and often do so successfully in a limited

way, for example central venous access. 4. PIR services in general hospitals are usually provided by "adult" interventional radiologists. Various challenges exist in the development of a PIR service. These may include recruiting staff (either because of financial issues or difficulty finding qualified personnel), obtaining hospital floor space and facilities, maintaining an adequate budget for consumables and providing adequate cover for anaesthesia and/or sedation. There may be resistance to the introduction of PIR from the traditional suppliers of competing techniques (e.g., paediatric surgeons). This seems to be more common when medical remuneration is on a fee-for-service basis than in salaried healthcare systems.

Requirements of a successful PIR service: the number and type of medical staff required will depend on the nature of the service and the volume of work carried out. Designated nursing and radiographic staff will be required for all but the smallest service. All individuals working in PIR must have appropriate paediatric training. Staff who work full-time in paediatrics will presumably have been trained, and will normally have a requirement to update certain skills (e.g., paediatric resuscitation) regularly. "Adult" interventional radiologists who do part-time or occasional work in children's hospitals may need additional training, for example in child protection, resuscitation and communication skills, and will rely to some extent on the support of paediatricians. They may have to spend some time with an experienced paediatric interventional radiologist to gain initial experience, and may have to update their skills from time to time. When non-radiologists wish to perform PIR procedures they will need to undergo training, which will vary according to which procedures they intend to perform and what basic skills they already possess. If these procedures involve the use of ionising radiation, they will need to show that they have undertaken appropriate accredited training in radiation protection, preferably with special emphasis on the requirements of children. The organizational aspects of a busy PIR service are particularly demanding, and strong administrative support is essential. Dedicated rooms, typically angiography or fluoroscopy suites, are required, and these facilities must be carefully planned with PIR procedures in mind. They should where possible contain equipment specifically designed for paediatric use, including appropriate anaesthetic and monitoring equipment. Other clinical infrastructure such as outpatient clinic space may also be desirable. The balance of non-sedation, sedation and general anaesthetic cases varies widely between centres, depending partly on casemix but mostly on institutional preferences. Most PIR services rely on non-radiologists, usually anaesthetists, for support in this respect. Because patients from a few hundred grams to over 100 kg may undergo interventional procedures in a children's hospital, any PIR service requires a range of equipment of all sizes. This is an expensive commitment. The consumables budget for PIR at Great Ormond Street Hospital in London, for example, is approximately €500,000 per annum, in addition to service contracts on angiography and ultrasound equipment. For most vascular and non-vascular interventional procedures, suitable medical devices are available in all necessary sizes. In some cases, "off label" use is necessary as no appropriate devices are available for paediatric applications. In other circumstances, "adult" devices can be used for different indications in children. For example, adult coronary angioplasty balloons and stents can be used in the renal arteries of children, which are often of a similar size to adult coronary arteries. There are some applications, however, for which no ideal device currently exists for small children. In currently available permanent haemodialysis catheters, for example, the distance between the openings of the two lumens is longer than would be ideal for use in infants, and this may compromise effective dialysis. Collaboration between professional bodies and industry may improve this problem in the future. Overall, however, the expansion of PIR is not significantly limited by availability of appropriate equipment.

104.2

Renal angioplasty in children

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Learning Objectives

1. When is renal angioplasty indicated in children.
2. Special techniques and tools for renal angioplasty in children.
3. Results and complications of renal angioplasty in children.

Systemic hypertension in children is usually the consequence of an underlying disease or anomaly; on contrary in adults, systemic hypertension is usually idiopathic. Stenosis of the renal artery (RAS) is the most common cause and potentially treatable etiology of reno-vascular hypertension in children. The most frequently encountered cause is the fibro-muscular dysplasia (FMD) followed by idiopathic arteritis, neurofibromatosis, rarely by polyarteritis nodosa, external compression or sequel of trauma or radiation.

FMD: a) Medial type of dysplasia: Most common type of FMD is the medial fibroplasia with the typical picture of aneurysms on the main renal artery usually described as "string of beads". These aneurysms are typically wider that the normal caliber of the renal artery and can also involve more distal braches of the renal artery. This type of FMD is only rarely diagnosed in children most likely because at this age does not show any clinical symptoms. Perimedial fibroplasia is of much rarer occurrence. It is more common in women; again on the renal artery we see small aneurysms, but this time they are smaller than the expected diameter of the artery. This type of FMD is usually diagnosed in children and has the tendency to progress up to the complete occlusion of the renal artery. Medial hyperplasia is rare; on angiography, it has an appearance of focal band and it is usually seen on more peripheral branches of the renal artery. In children, this type of FMD is not exceptional. All these types of FMD when the media of the artery is involved react very favorable to simple angioplasty; long term prognosis of PTA is very good. b) Intimal fibroplasia: In its majority, this type of FMD is the disease of main renal arteries. Morphologically the lesions have either "hour-glass" appearance or they present as long tubular stenoses (they can be ostial as well) and occasionally it is impossible to distinguish them from arteritis. In most cases, intimal FMD does not react favorably to PTA. There is increased resistance to the dilatation pressure and frequent re-stenoses. Stents can be used if the PTA fails or in early re-stenosis.

Arteritis: arteritis is more frequently seen in Asia or in Near East regions, but it is not so rare in Europe. Arteritis can involve any vascular territory, but most frequently it is the carotid territory, which is involved. The diseased vascular segments are long, usually starting at the ostium of the artery and not infrequently the wall of the aorta is involved as well. Arteritis reacts reasonably well to angioplasty, but relatively frequently stenting is required. Interventional treatment has to be done in the non active phase of the disease, eventually after steroid or immune-suppressive therapy.

Neurofibromatosis: diagnosis is usually easy due to the extra-renal symptomatology. Bilateral renal artery involvement is not unusual. Lesions are usually extensive and they can start at the ostium. Stenoses are often resistant to dilatation pressure. Long results are uncertain.

Middle aortic syndrome: anatomical entity described in 1966. Occasionally, it is called coarctation of the abdominal aorta. There is a narrowing of the abdominal aorta, renal and visceral branches without clinical signs of inflammation. Etiology in unknown; occasionally, viral infection of the mother during the pregnancy is suspected as etiological factor. Sequel of the previous arteritis, at the time of diagnosis inactive, is considered as well. Stenoses of this type do not react well to PTA.

Diagnosis of RAS and technique of PTA: after ruling out all other possibilities of hypertension, such as hormonal causes, endocrine

active tumors, parenchymatous renal symptomatology, we suspect RAS induced hypertension. Primary diagnosis is based on Duplex sonography. Morphologically MRA and CTA can be diagnostic. On the other hand, we have to take into the account that 30-50% of stenoses in children are located on peripheral branches of the renal arteries and that the renal artery lesions need not be accurately visualized using above mentioned methods. So, the situation can arise that we suspect reno-vascular hypertension in spite of the fact that the non-invasive methods do not concur. In these circumstances, in spite of negative MRA or CTA, these patients should be subjected to angiography. Angiography should be performed only in departments where, in the case of positive findings, the interventional treatment - angioplasty can be performed. The question arises if especially in young children, in whom MRA or CTA requires general anesthesia, angiography should not be the method of primary choice.

Technique of the intervention: angiography and PTA are almost exclusively performed using femoral approach and depending on the age and cooperation of the child in general anesthesia or consciences sedation. Diagnostic angiography (both non-selective and selective) has to be performed in several oblique projections to optimally visualize the peripheral vasculature of both kidneys. In the case of positive findings, PTA is performed using equipment for small arteries or coronary equipment.

Stent are primarily not used; they are indicated in failed PTA, circumstances such as dissections, instantaneous recoil or early restenosis post PTA. There is a described case of "additional dilatation" of the stent several years after stent placement to re-open the stent to the normal diameter of the growing artery. There are several reports describing the successful usage of "cutting balloon" in lesions resistant to PTA pressure; however, ruptures of the renal artery, using this method, were described as well. Long-term results depend on the selection of patients. (PTA in FMD lesions has better results than in patients with neurofibromatosis.) In general, if the result of PTA is morphologically satisfactory, there is a significant hope of normalization of the hypertension without or perhaps with minimal medication.

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104.3

Hepato-biliary interventions

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Learning Objectives

1. To review the indications and the types of various hepato-biliary interventions in infants
2. To review the technique of hepato-biliary interventions in infants
3. To review the results and complications

Hepato-biliary diseases are rare occurrence in children but interventional radiology plays a critical role in their management. Our experience of hepatic and biliary interventions has been acquired by working in Hospital Bicêtre, the largest center for pediatric liver diseases and liver transplantation in France, in collaboration with pediatric hepatologists, surgeons and anesthesiologists. The topics covered will include interventions for hepatic hemangiomas, vascular malformations, portal hypertension, biliary and vascular complications of liver transplantation.

Infantile hepatic hemangioma is the most common liver tumour in newborn and infant, having a natural history of rapid growth before spontaneous involution. Many cases are fortuitously discovered and need no treatment whereas in some cases life-threatening complications may occur in the first months of life, indicating treatment but still controversial. Arterial embolization may be proposed to decrease arteriovenous shunting in case of congestive heart failure, consumptive coagulopathy or tumour rupture. Presence of portovenous fistula has to be searched for in case of pulmonary arterial hypertension or liver failure and may be occluded via a transjugular approach with coaxial catheterisation.

Vascular malformations are rare disorders and have to be differentiated from hemangioma as they do not tend to resolve spontaneously. Congenital arterio-portal fistula usually presents with severe portal hypertension. Prognosis depends on the number of arterial pedicles feeding the fistula. Treatment may be achieved by interventional radiological procedure but recurrence and portal vein thrombosis have been reported indicating surgical resection or even transplantation. Congenital portacaval fistula may present with complications such as liver tumours, hypoxia due to hepato-pulmonary syndrome, pulmonary arterial hypertension, and hepatic encephalopathy or mental retardation due to hyperammoniema, which can regress after closure by surgery and/or embolization. In our experience, the choice of the treatment depends on the type of the fistula and on the presence and size of intra hepatic portal vein branches and thus on the possibility to close the fistula in one step.

Interventions in **portal hypertension** mainly include treatment of stenosis or even thrombosis of surgical porto-systemic shunts and creation of transjugular intrahepatic porto-systemic shunt (TIPS). Indications of TIPS in children are cirrhosis with severe portal hypertension as a bridge to liver transplantation and Budd-Chiari syndrome. In order to improve patency of TIPS in the long term and to avoid the risk of hepatic encephalopathy in young children, the use of custom made endoprosthesis with two overlapping bare and covered stents is feasible.

Liver transplantation heavily involves the interventional radiologist team for the treatment of vascular and biliary complications, allowing delaying or avoiding repeated surgery in these multioperated and fragile children. Main vascular interventions include recanalization of portal vein thrombosis, angioplasty of portal vein stenosis, treatment of Budd Chiari syndrome and angioplasty of hepatic artery stenosis. Biliary complications are the most frequent complications, occurring in the early post operative period as well as years after transplantation. Percutaneous access to the dilated intra hepatic bile ducts is made possible in reduced-size grafts by means of ultrasound guidance. Biliary stenoses can be catheterized and treated with balloon angioplasty. In case of rapid recurrence of the stricture, internal-external percutaneous drainage may be helpful.

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104.4

Enteral nutrition

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Learning Objectives
1. To review the indications of enteral nutrition in infants
2. To review the specificity on enteral nutrition in infants
3. To review the techniques and results of enteral nutrition

The main indication for enteral access in adults is weight loss due to chronic illness, mainly malignancy. In children, the most common clinical indications include progressive or static encephalopathy, chronic aspiration, gastroesophageal reflux, cystic fibrosis or other chronic pulmonary conditions, metabolic disorders, failure to thrive from any cause, and cancer. Delivery of enteral feedings to nutritionally deprived patients may be achieved by several means. If short-term (<6-8 weeks) nutritional support is required, peripheral intravenous hyperalimentation, nasogastric or nasojejunal feeding is recommended. Frequently, children are given a trial of naso-jejunal feeding to ascertain if a more permanent access is suitable. In our practice, we place a modified 6/8F Frederick Miller jejunal feeding tube just past the Ligament of Trietz using fluoroscopic guidance with the assistance of a directional catheter. When longer assistance (>8 weeks) is necessary, however, a more permanent means of providing nutritional supplementation is desirable i.e., a percutaneous gastrostomy tube (PGT) or gastrojejunostomy tube (PGJT) placement. In 1980, Gauderer and colleagues introduced a technique for percutaneous placement of a gastrostomy tube using endoscopic guidance (1) and in 1988 Towbin et al. developed a technique for antegrade insertion of a gastrostomy tube (2), which is the technique of choice in our practice. The technique is possible in the pediatric situation due to the fact that the esophagus in most disease states in children is intact. The most common clinical indications include progressive or static encephalopathy, chronic aspiration, gastroesophageal reflux, cystic fibrosis or other chronic pulmonary conditions, metabolic disorders, and failure to thrive from any cause including cancer. Few absolute contra-indications to our technique of PGT insertion exist. However, an uncorrectable coagulopathy, pathology of the gastric wall (e.g., gastric varices), severe cardiac or respiratory problems, or unstable clinical condition are reasons to postpone or exclude PGT placement. Other problems that may limit or exclude PGT insertion are ascites, obesity, pathology of the esophagus such as stricture, severe inflammation, or tumor, previous abdominal surgery, or anatomic variations or anomalies such as scoliosis, a high or horizontally positioned stomach, hepatomegaly, splenomegaly or a transverse colon that is situated anterior to the greater curvature of the stomach, preventing access. In patients with these types of problems, a surgical gastrostomy is the preferred option, although a PGT can be successfully performed in the vast majority patients.

Patient preparation: the clinical and imaging evaluation of children who are being considered for percutaneous feeding depends to some extent on the underlying issue(s) that brings the patient to the attention of the pediatrician or other physician. The work-up prior to performing a PGT includes a thorough history and physical examination and in some institutions a trial period of nasogastric or nasojejunal feeds is required before the patient is considered a candidate for PGT. An upper gastrointestinal series examining the esophagus, stomach and the small intestines to the level of the proximal jejunum must be performed in order to assess the diameter of the esophagus, the presence of any esophageal pathology, the presence of gastroesophaeal reflux, gastric motility, the presence of gastric outlet obstruction, the anatomic position of the stomach relative to the costal margin and transverse colon and the position of the ligament of Treitz. In some instances, nuclear gastric scintigraphy, pH probe study and/or upper endoscopy may be necessary. Routine laboratory tests, such as a coagulation profile, are not usually performed unless the patient's underlying problems indicate a need. This procedure is most often performed with intravenous sedation only, although in specific cases general anesthesia is used. The patient is made NPO for at least 6 hours prior to the procedure (8 hours for general anesthesia). Prophylactic antibiotics may be used but are only absolutely necessary in immunocompromised patients and in patients who have ventriculoperitoneal shunts in place.

Procedure: placement of a PGT can be approached in two ways: the antegrade or "pull" technique and the retrograde or "push" technique. Currently, the retrograde is the most commonly used. However in our opinion, in the pediatric population, the antegrade approach has several major advantages over the retrograde approach. This technique is technically easy, has a lower risk of intraperitoneal contamination with gastric contents, and avoids the need for track dilatation or other tube manipulation during the procedure. More importantly, this technique provides a very stable tube that has almost no chance of inadvertent loss during the immediate post-procedure period or even later, usually has a shorter and more stable track, and allows for easy conversion to a gastrojejunostomy tube. If contrast has not been given orally, a limited enema using water soluble cntrast is performed to opacify the splenic flexure and transverse colon. A limited ultrasound of the abdomen is performed to identify the left edge of the liver and the skin overlying the edge is marked. A nasogastric tube is inserted and positioned with the tip of the tube in the gastric fundus, to be used later for insufflation of the stomach. The insertion site is chosen and marked on the skin. The optimum position for the insertion site is at least one finger breadth below the costal margin and lateral to the rectus abdominis muscle. Once the site is chosen, the skin is prepped and draped sterilely. Local anesthetic is infused at the insertion site and a 1 to 2 centimeter incision is made. Via the nasogastric tube, the stomach is inflated with air. If the air does not stay in the stomach but starts filling proximal small bowel, then Glucagon (0.05 to 0.1 mg/kg/dose, maximum dose 1 mg) can be given intravenously to decrease gastric peristalsis and stop the air in the stomach from emptying too quickly into the small bowel. The stomach is then punctured with an 18 gauge needle using a quick darting motion. This darting motion helps the needle penetrate the gastric mucosa, which can be quite difficult to penetrate. With the antegrade approach, in addition to

the NG tube, an orogastric tube is placed and exchanged for an 8 French goose neck sheath and a 35 mm Nitinol snare (Microvena, White Bear Lake, MN). The snare is advanced into the stomach in an open position and may be used as a target for the gastric puncture. Once the stomach has been punctured, a looped wire is advanced through the needle into the stomach and is captured by the snare. The wire is then pulled up the esophagus and out of the mouth. The gastrostomy tube 12 or 16 French Corpak G tube (Viasys) has a long self-dilating portion with a fixed loop at its tip. With this fixed loop, the gastrostomy tube is attached to the looped wire. The wire and tube are then pulled into the mouth, down the esophagus and into the stomach. Once the wire is seen at the skin incision, counter traction is applied with a hand on the abdominal wall as the tube is pulled into its final position with the internal retention bumper up against the anterior abdominal wall. An external fixation device is fitted over the tube and advanced to the skin insertion site to stabilize the stomach firmly against the abdominal wall. No sutures are needed to fix the tube in position. A little play is left between the external fixator and the skin to allow for a gauze dressing and any post-procedure edema that may occur. The catheter is then cut to an appropriate length and an adaptor that allows hook up of the gastrostomy tube to the feeding pump tubing is inserted into the cut end. Contrast is injected to confirm intragastric position. In general, infants less than 3 kgs will have a 12F G tube placed, all others a 16F. In patients with significant gastroesophageal reflux (GER), with abnormalities of gastric emptying or with partial UGI obstruction (superior mesenteric artery syndrome), a jejunal tube is then placed coaxially through the G tube and secured. When to begin feeding differs with institutions and medical services. We generally begin 8 hours post procedure. We start feeding with Pedialyte for 2-4 hours, and if there have been no problems, then begin the infusion of full strength formula at a 24-hour rate. Patients with a PGJT are kept at this rate to avoid problems with dumping. Children with a PGT can either be advanced to intermittent bolus feeds or the rate may be advanced as desired.

Gastrostomy, jejunostomy and gastrojejunostomy buttons: a gastrostomy button (GB) is a low profile device, with a one-way valve to prevent leakage of gastric contents, made to replace a primary gastrostomy tube (GT). There is also a gastrojejunostomy button (GJB) and a jejunostomy button (JB) designed to replace a primary gastrojejunostomy tube (GJT). As a result of its low profile design, the GB (GJB or JB) is often preferred by patients and their parents. It is our policy to replace a primary gastrostomy or gastrojejunostomy three months after initial insertion. This time period is selected because it provides significant time for the track to heal and the stomach to adhere to the anterior abdominal wall. Prior to insertion of a button, the PGT must be removed. Most of the time, removal is accomplished with a moderate amount of traction on the tube and some counter traction on the abdominal wall around the site. Once removed, all that remains is a track spanning the distance from the skin to the gastric lumen. The length of the track is measured and used to choose the appropriate length of the button shaft. The operator has two basic types of GB from which to choose: ones with a balloon retention tip or ones with a mushroom retention tip. Today, the GB that is most often chosen is the type with a balloon tip. The balloon type is preferred because of its ease of insertion and removal. In most situations, the parent or guardian can replace the tube if it accidentally comes out. This potentially avoids trips to the primary care physician, the emergency room or to interventional radiology and results in cost savings. The G, GJ and J button are more recent developments. These tubes have the same basic design as the GB: they are low profile, have an anti-reflux valve(s) to prevent leakage when not in use, and are held in position by a retention balloon. However, unlike the GB, they have a long distal tube component that can be cut to the individual patient's length. The JB does not have a gastric lumen. Thus, this tube is extremely valuable for children who require jejunal feeding but who do not need gastric venting or intragastric access. The GJB or JB is inserted using a directional catheter and guide wire system as described for the insertion of a JT. The JB is also held in position by a balloon. Like the GB, the GJB and JB are dependable, safe and effective. In all three cases, the major problem is balloon rupture or premature deflation of the balloon with tube loss. A GB can be replaced at home, in a doctor's office or in GI clinic. Unlike the balloon type GB, the GJB or JB cannot be replaced at home and require fluoroscopic guidance and a directional catheter and guide wire system to reinsert. During this lecture, I will also describe the retrograde method of G tube placement and discuss the merits and disadvantages of this technique. I will also discuss "troubleshooting" a number of GI issues such as: 1. Biliary reflux; 2. G Tubes positioned at pyloric outlet; 3. G tube access angled to fundus and requiring J access - difficult trajectory; 4. Tortuous jejunal access - such as post-op gastroschisis and omphalocele; 5. J tube fracture and retrieval; and 6. J tube related intussusception.

Foundation Course
UFE

201.1

Clinical features and imaging

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Learning Objectives

1. To review the epidemiology and the main symptoms of fibroids
2. To review the different surgical techniques
3. To review MR imaging features of fibroids and main differential diagnosis

Uterine fibroids are the most common benign tumors of the female genital tract. These are monoclonal tumors of the smooth muscle cells of the myometrium, composed of large amounts of extracellular matrix containing collagen, fibronectin and proteoglycan. Etiology of uterine fibroids in unknown but several factors are possibly responsible for the initiation of genetic changes found in myomas. Among them are intrinsic abnormalities of the myometrium, congenitally elevated estrogen receptors in the myometrium, hormonal changes or a response to ischemic injury at the time of menses. The incidence of fibroids ranges from 30 to 70% in premenopausal women. African-American women have a 2.9 times greater risk of having myomas then Caucasian women. Incidence among African-American women is 30% by the age 35 and increase to over 80% by the age 50. Caucasian women have an incidence of 40% by age 35 and 70% by age 50. Several factors influence the growth of uterine fibroids. These include ovarian steroids, growth factors, angiogenesis and also the process of apoptosis. Fibroids are symptomatic in about 25% of women. The most common symptoms are: prolonged and heavy bleeding during menstruation, which can lead to anemia, pelvic pain and pressure, feeling of heaviness in the abdomen, frequent urination or the urge to urinate, dyspareunia, constipation. Large fibroids may reduce fertility and increase pregnancy complications and delivery risks. Diagnostic imaging include ultrasonography, hysteroscopy and MRI. Transvaginal sonography is the most readily available procedure. Fibroids appear as symmetrical, well-defined, hypoechoic and heterogenous masses, which may have areas of calcification and hemorrhage. In MRI imaging, fibroids typically appear as sharply marginated masses of low signal intensity relative to myometrium on T2-weighted sequences. Fibroid larger than 3 to 5 cm in diameter may demonstrate heterogeneous areas of increased signal intensity representing degeneration. MRI has proved useful in differentiating fibroids from other solid pelvic masses when sonographic findings are indeterminate. Fibroids should be differentiated from endometrial polyps, myometrial contraction and adenomyosis. Malignant degeneration of a fibroid occurs

rarely. MRI signal characteristics are not reliable in differentiating fibroids from leimyosarcomas. Many treatment options of fibroids exist: medication, surgery, uterine artery embolization, focused ultrasound surgery, endometrial ablation, myolisis. Medications include: gonadotropin-releasing hormone antagonist, androgens, progestin and oral contraceptives. Surgical options consist of myomectomy and hysterectomy. Myomectomy techniques include: vaginal or hysteroscopic, laporoscopic or abdominal myomectomy. Hysterectomy can be performed vaginally, abdominally or assisted by laparoscopy.

201.2

Anatomy

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Learning Objectives

1. To review the anatomy of the uterine artery and its most common variations
2. To explain the relation between the uterine and ovarian artery
3. To explain the potential role of cervicovaginal branches and possible dangerous anastomosis

No abstract available

201.3

Tools and techniques

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Learning Objectives

1. To review the embolization material available
2. To explain when a microcatheter should be used
3. To explain the step-by-step UFE procedure

1. Step-by step UAE procedure: today, the technique of uterine artery embolization (UAE) for treating fibroids is fully standardized and, usually, is performed via single right common femoral artery access. The key points are the following: 1- Initial abdomino-pelvic aortography at the level of renal arteries; 2- Selective left internal iliac artery entry with a hydrophilic 4-Fr Cobra 2 catheter; 3- Identify the origin of the uterine artery (whether normal or variant) using the "road mapping " tool of the angiographic equipment; 4- A microcatheter is advanced routinely into the uterine artery in a coaxial fashion and the 4-Fr angiographic catheter is pulled back into the internal iliac artery to prevent spasm; 5- With the tip of the microcatheter in the ascending portion of the uterine artery distal to its cervico-vaginal branch, the embolization is performed slowly and carefully in order to achieve a correct end-point according to the embolic agent used; 6- Complete or near-stasis of flow in the main uterine artery with occlusion of the perifibroid plexus are the classical angiographic end-points for conventional PVA particles or spongostan, whereas occlusion of the perifibroid plexus with stasis of the flow in the distal part of the uterine artery but only reduced flow in the proximal part of it are the main goals in microspheres use; 7- With the same 4-Fr Cobra catheter, on most occasions one can achieve a good catheterization of the right internal iliac artery (anterior trunk) and, with the microcathether, embolization is performed with the same technique used in the left uterine artery; and 8- Finally, pelvic-abdominal angiography is performed to complete the procedure.

2. When should a microcatheter be used: in our opinion, it is mandatory and must be used in all cases.

3. Reviewing the embolization material available: embolic agent selection has been a point of controversy among interventional radiologists. UAE works perfectly with non-spherical polyvinyl particles, Gelfoam, and embospheres. Conventional PVA and spongostan has a tendency to clump and obstruct microcatheters and particle size varies extensively within a sample and this has led to its replacement with calibrated microspheres such as tris-acryl gelatin microspheres (Embosphere®), spherical PVA or, most recently, Bead Block® (Acrylamide PVA microspheres). We present briefly the advantages and limitations of the most common embolic agents and, as well, our experience with a promising new type of embolic agent (Embozene® microspheres). Independently of the embolic agent selected, the concept of "limited embolization" is very important and, as well, the need to define a correct end-point for each type of agent.

201.4

End points

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Learning Objectives

1. To explain what the accepted end-points for UFE are
2. To explain the difference between stasis and total occlusion
3. To explain what to do when there is a visible anastomosis to the ovarian (before, during and after the intervention)

In the early years of UFE, embolization consisted of complete occlusion of the uterine vessels by particle polyvinyl alcohol (PVA) particles, supplemented by a gelfoam plug. Less extensive occlusion of the uterine artery was first suggested with the introduction of tris-acryl gelatin microspheres (Embospheres, Biosphere Medical, Rockland MA). By the time of its introduction, supplemental embolics were no longer standard and the PVA end point was stasis or near stasis, which was characterized by a standing column of contrast medium in the uterine artery with reflux toward the origin or into the hypogastric artery. A less extensive end point was advocated by Pelage for tris-acryl gelatin micropsheres, with a sluggish forward flow in the uterine arteries maintained and a pruned-tree appearance of the final angiogram, with the primary trunks still patent and all the distal portions occluded. This has been characterized by the "5 beat rule", in which an injection of a small amount of contrast opacifies the uterine artery, with sluggish forward flow, but with the main uterine artery remaining opacified for 5 cardiac beats during fluoroscopic observation. When using particle PVA, the corresponding end point for flow in the uterine artery is continued opacification for 10 cardiac beats and "to and fro" flow in the curves of the vessels. No one currently advocates the use of supplemental embolics to completely occlude the vessels and these should not be used as they may promote permanent occlusion of the uterine artery, a situation that would prevent re-embolization. Similarly, overembolization with microspheres should also be avoided as they pack very tightly in the vessel and this can lead to ischemic injury. While there is considerable data to support the efficacy of these endpoints (6-9), other products have less well-defined endpoints. Despite early hopes, spherical PVA (Contour SE, Boston Scientific, Natick MA) has not proven to be an effective embolic for uterine embolization (8, 10) and it should not be used. There are no published data recommendations or data on appropriate end points for PVA hydrogel (Beadblock, Terumo Inc., Somerset NJ) and polyzene F-coated hydrogel microspheres (Embozene Microspheres, Celo Nova Biosciences Inc., Newnan, GA) with imaging outcomes and there is also no comparative effectiveness data on those materials for uterine fibroid embolization.

Special Session
Primary and secondary risk prevention in PAD

202.1

Management of co-morbidity

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Learning Objectives

1. To review the co-morbidity that can influence the long-term survival in patients with PAD
2. To discuss the management of coronary disease before and after peripheral angioplasty
3. To discuss the management of carotid disease before and after peripheral angioplasty

Peripheral arterial disease (PAD), as diagnosed by ankle-brachial index (ABI), is a frequent condition in selected populations such as elderly, smokers and diabetics. Because this disease is frequently asymptomatic, this condition is frequently under-diagnosed. In comparison with populations with coronary heart disease (CHD) or populations with cerebrovascular disease (CVD), populations with peripheral arterial disease are less frequently correctly pharmacologically treated for their cardiovascular (CV) risk factors. Many surveys all over the world have shown that only a small minority of patients with peripheral arterial disease has the association of antiplatelet agents (aspirin or clopidogrel) ACE inhibitors and a statin; all three drugs indicated in such patients with a high level of proof. For example, in the ATTEST study, a survey performed in primary care in France, we have shown that only 13% of the patients with isolated PAD had the association of those three drug classes (Blacher J, et al. J Vasc Surg 2006). In terms of cardiovascular risk prediction, it is important to note that patients with PAD have a similar cardiovascular risk as patients with CHD or CVD. Furthermore, in a recent meta-analysis published in the JAMA, which included almost 50,000 patients, it has been shown that the presence of PAD, as diagnosed by ABI, provides significant improvement in predicting cardiovascular risk, independently of established CV risk factors (Fowkes FG, et al. JAMA 2008). In patients with PAD who have no other clinical evidence of CHD or CVD, the annual risk of myocardial infarction, stroke, and vascular death is approximately 3% per year. However, adding clinical coronary disease to PAD increases the event rate to approximately 6% per year, and in patients with all three territories affected, the event rate is as high as 9% per year. In a recent survey, Criqui et al. have shown that progressive PAD (ABI decline >0.15 between two visits) was significantly and independently associated with increased cardiovascular diseases risk. In this study, 16.7% of the whole cohort had decreased ABI between two visits and presented an annual 12% combined risk of myocardial infarction, stroke and cardiovascular death (Criqui MH, et al. J Am Coll Cardiol 2008). The PAD patients who are treated by interventional radiologists should probably be considered as PAD patients with evolutive atherosclerosis and should, therefore, be considered as patients with very high CV risk. Of course, these patients should extensively benefit from proven CV risk reduction strategies, namely quitting smoking, prescription of antiplatelet agents, antihypertensive treatment with an ACE inhibitor, statin treatment and, if diabetic, intensive anti-diabetic drug strategies. Concerning detection of CHD and CVD, no consensus exists in the different guidelines but one could reasonably propose case-by-case medical discussion and a systematic multidisciplinary approach.

202.2

Basics of cholesterol management for IR

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Learning Objectives

1. To review the role of cholesterol as a risk factor and the results of clinical trials on primary and secondary prevention
2. To review the role of diet in cholesterol management
3. To review the basics of cholesterol lowering drugs and their role in cholesterol management

Optimal reduction of cardiovascular risk requires both identification of highest risk subjects as well as optimal therapeutic regimens. With respect to 'biomarkers' for CV-risk, LDL-c and HDL-cholesterol are still important, although their discriminative ability is rather limited. Novel markers, particularly in the inflammatory arena, may improve risk prediction. With respect to optimal CV risk lowering interventions, the relevance of intensive LDL-lowering as compared to moderate LDL lowering has been overwhelmingly demonstrated. Yet, only 25-25% of events can be prevented during statin therapy. To further reduce cardiovascular burden, novel therapeutic strategies include novel ways to further reduce LDL-c using e.g. apoB synthesis inhibition, increasing HDL-c as well as first steps to directly attenuate the inflammatory reaction in the vessel wall. Both biomarkers developments as well as current and future developments with respect to optimal cardiovascular prevention will be discussed.

202.3

Update on anti-platelet in PAD and intervention

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Learning Objectives

1. To describe the basic physiological effect of aspirin and clopidogrel
2. To review the results of its use in PAD and peripheral intervention
3. To give an insight into the future research and product development

The use of multiple cardiovascular (CV) risk modifying therapies reduces long-term mortality in PAD [1] and is recommended in the Transatlantic Inter-Society Consensus Document for the Management of Peripheral Arterial Disease (TASC II) [2]. Antiplatelet therapy is a key part of such a strategy and yet CV event rates remain high: although 82% of PAD patients enrolled in the REACH registry (n = 8273) were receiving an antiplatelet agent at baseline [3], 21% suffered a CV death, myocardial infarction (MI), stroke, or were hospitalized for an arterial event within 1 year [4]. Furthermore, type 2 diabetes is common in PAD and increases the risk of mortality above that seen in patients with PAD without diabetes [5]. One characteristic of both PAD patients and diabetics patients is their clinical resistance to aspirin [6-7]. At the end of the 90s a new large trial was designed to evaluate if aspirin and antioxidant therapy, combined or alone, are more effective than placebo in reducing the development of cardiovascular events in patients with diabetes mellitus and asymptomatic PAD. And again, similar to the older trials evaluating aspirin in this context, this trial with better adapted methodology and associated therapeutics of current practice did not provide evidence to support the use of aspirin or antioxidants in primary prevention of cardiovascular events and mortality in the population with diabetes studied [8]. One possible factor contributing to the high CV event rates in PAD patients (particularly diabetic patients) is low platelet response to aspirin, which has been observed both in PAD [7-8] and

in patients with diabetes [6,9]. We undertook an original approach in the field of aspirin resistance. In two pilots consecutive studies involving 38 and 52 patients with coronary artery disease (CAD) (55 and 38% with diabetes), recommended low-dose aspirin (either 75 or 100 mg/day for at least 10 days) was found to inhibit platelet aggregation adequately within the first 2 h of administration, but did not maintain 24-h inhibition in a significant proportion of patients [12-13]. At 24 h after the last administration, low response to aspirin (residual platelet aggregation ≥20% with 0.5 mg/mL arachidonic acid) was present in 48 and 23% of patients receiving 75 and 100 mg/day, respectively. Subsequent analysis suggests that low response is present more frequently in CAD patients with co-morbid PAD than in those without PAD. Indirect markers suggest that low response is related to high platelet turnover. Previous personal data have shown that PAD patients are characterized by a high platelet turnover. This ongoing research promises to shed light on the causes of low platelet response to aspirin, and will be applicable to the treatment of PAD especially with co-morbid diabetes. Strategies designed to mitigate low response to aspirin may include variation of aspirin dose, dosing frequency, or use of an alternative antiplatelet agent. It is hoped that future research into the potential differential response to antiplatelet therapies in PAD and diabetes will enable more selective and effective CV risk modification strategies.

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202.4

Basic treatment of metabolic syndrome

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Learning Objectives

1. To review the basics of metabolic syndrome
2. To review medical treatment
3. To review non-medical treatment

Basics of metabolic syndrome: the metabolic syndrome (MetSy) is a clustering of components that reflect overnutrition and a sedentary lifestyle. The MetSy includes insulin resistance, abdominal obesity, atherogenic dyslipidemia and elevated blood pressure and is associated with other comorbidities such as a proinflammatory state, prothrombotic state, non-alcoholic fatty liver disease (NAFLD) and reproductive disorders. The MetSy is associated with increased risk for cardiovascular morbidity and mortality and in most parts of the world the prevalence of the MetSy in increasing to epidemic proportions.

Non-medical treatment: considerable knowledge has accumulated for prescribing weight reduction and lifestyle modification as first-line therapy, and prevention, for MetSy. Thus, primary management for the MetSy is healthy lifestyle promotion including calorie restriction, changed dietary composition and increased physical activity.

Medical treatment: in subjects who are at high risk for cardiovascular disease, drug therapies may be required to treat the MetSy. Since it is unclear whether there is a unifying pathophysiological mechanism resulting in the MetSy, specific pharmacological therapy is not yet available. Instead, the individual components of the syndrome must be treated according to established guidelines involving for example low dose aspirin, antihypertensives, statins and/or fibrates and anti-diabetic drugs. In 1988, the current concept of the metabolic syndrome (MetSy), or "Syndrome X" was introduced by Reaven, who described a clustering of insulin resistance, glucose intolerance, hyperinsulinemia, raised triglyceride concentration, low high density lipoprotein cholesterol concentration and hypertension (1). Together these form an essential part of the clinical features of the MetSy (2-3). The first most widely spread definition was the one coming from the WHO in 1999, adding central obesity to the cluster (2). In the following years, the scientific focus on central obesity increased and the definition from National Cholesterol Education Programme Adult Treatment Panel III (NCEP ATP-III) in 2001 (3) reflects this, using waist circumference as a measure of central obesity instead of waist-to-hip ratio used by the WHO. Other definitions have followed and in 2004 the International Diabetes Federation (IDF) produced a new set of criteria for use both epidemiologically and in clinical practice world-wide (2,4). IDF MetSy world-wide definition: Central obesity plus any two of the four following: 1) raised triglycerides, 2) reduced HDL-cholesterol, 3) raised blood pressure, 4) raised fasting plasma glucose or previously diagnosed type 2 diabetes. The core problem of MetSy is thought to be insulin resistance and obesity. For patients with the MetSy but without diabetes there is a drastically increased risk for developing the disease. Approximately 20-30% of the population in industrialized countries have the MetSy. The prevalence of NAFLD is up to 31% in the population, 50% in people with diabetes and 74% in obese individuals. It has been suggested that NAFLD should be a feature of the metabolic syndrome. NAFLD is usually limited to steatosis but it can develop into the more serious condition of non-alcoholic steatohepatitis (NASH) and to end-stage liver disease. Even if obesity is recognised as an independent predictor of coronary artery disease, its importance in peripheral artery disease (PAD) is less clear. The MetSy has been shown to be an important determinant of endothelial function in patients with PAD. There are also studies indicating that the MetSy worsens physical function,

health-related quality of life and peripheral circulation in patients with PAD. It might be speculated that there is an earlier and more rapid development of leg symptoms in PAD associated with MetSy. Several studies have confirmed that the risks of developing CVD, and of both cardiovascular and all-cause mortality, are increased by the presence of the MetSy. Nonetheless, other studies have questioned whether the MetSy gives any additional information over and above the individual well-known CVD risk factors. This may relate to the definition of the syndrome. Further research is needed to identify the best and most predictive definition of the MetSy and its components. The ultimate importance of MetSy is that it helps identify individuals at high risk of type 2 diabetes, atherosclerosis, hypertension and PAD. Identification should lead to lifestyle changes and pharmacotherapy if persistent risk factors are still present.

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Special Session
High intensity focused ultrasound

203.1

Update on techniques available

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Learning Objectives

1. To present current available techniques for focused US
2. To describe the advantages and disadvantages of each technique
3. To give perspectives on future developments

High intensity focused ultrasound (HIFU) is a technique to destroy tissue at depth within the body, selectively and without harming overlying and adjacent structures within the path of the beam because the ultrasonic intensity at the beam focus is much higher than that outside of the focus. In 1942, Lynn et al. first reported the investigations into the use of HIFU to produce coagulative necrosis in target tissue. In 1950s, Fry et al. demonstrated that HIFU could be used after a craniotomy to target deep-seated areas of the basal ganglia of the brain in primate models, but the technique was not developed clinically at that time because of inadequate targeting methods. The advent of more sophisticated imaging has led to a resurgence of interest in HIFU. Up to date, the ultrasound guided HIFU and MRI guided HIFU devices are available in the market. Diagnostic ultrasound was the first method used for guiding HIFU ablation. In 1997, the first patient with osteosarcoma was successfully treated with ultrasound imaging-guided HIFU in China. Over last decade, thousands of patients with uterine fibroids, liver cancers, breast cancer, pancreatic cancer, bone tumours, renal cancer have been treated with ultrasound imaging-guided HIFU. This ultrasound imaging-guided HIFU system [Chongqing Haifu (HIFU) Tech Co., Ltd., Chongqing, China] first equipped in Asia, now in Europe. Several research groups reported their results showing that HIFU ablation is safe, effective and feasible in treating human solid tumours. The Group from Chongqing has reported the largest series of HIFU clinical applications to date, in which 1038 patients were treated with US guided HIFU in ten centers with both curative and palliative purposes. Zhang et al. reported HIFU can achieve complete tumor necrosis even when the lesion is located adjacent to the major hepatic blood vessels. Indeed, there is no discernible damage to the major vessels, even though the adjacent tumor has been completely ablated. In Oxford, UK, a total of 22 patients with liver metastases were treated with USgHIFU. Using either radiological images such as MRI and contrast ultrasound, or histological examinations, 20 of 22 patients were assessed. The results revealed that the adverse event profile was favorable when compared to open or minimally invasive techniques. Recently, the HIFU treatment results from Italy, Spain, Russia are encouraging. With improvements in magnetic resonance image (MRI), MRI guided HIFU device was developed. In 2004, the ExAblate 2000 System, a new medical device that uses magnetic resonance image guided focused ultrasound to target and destroy uterine fibroids was approved by the Food and Drug Administration (FDA). Magnetic resonance imaging-guided focused ultrasound surgery (MRgFUS) is mainly performed in the U.S., and also in Asia, Europe and Australia. Many results have shown that MRgFUS for uterine fibroids is feasible and safe. Although the ablation volume is only around 30% of the targeted fibroids, patients reported either significant or partial improvement in symptoms, and the long-term follow-up also demonstrated the patients have sustained symptom relief. Currently, more studies have shown that a larger volume of ablation could be achieved in a relatively short time. After the bowel was compressed with a degassed water balloon, MR imaging-guided high intensity focused ultrasound treatment is also safe and feasible in ablating uterine fibroids in patients with bowel lies anterior to uterus. Compare with other techniques, HIFU is a relatively new. The main limitation of this technique is time-consuming. The future developments of this technique should focus on better navigation and more powerful transducer. We conclude that HIFU is a promising technique. The clinical results have shown this relatively non-invasive technique is safe and effective in treating solid tumors. Both USgHIFU and MRgHIFU have its own advantages in treating tumors in different organs.

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203.2

Liver and pancreas

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Learning Objectives

1. To define indications for focused US ablation of liver and pancreatic tumours compared to other treatments
2. To describe technique and main complications of focused US
3. To present results of phase I and phase II studies

Introduction: high intensity focused ultrasound (HIFU) is a highly precise medical procedure using focused ultrasound energy for burning and destroy the tumor tissue at depth within the body, selectively and without harming overlying and adjacent structures within the path of the beam. v:textbox>Unlike radiofrequency or cryoablation, which are also used to ablate tumors, HIFU is completely non-invasive and can be used to reach tumoral areas that are deep within the body, if there is an acoustic window for allowing for the transmission of ultrasound energy. Preliminary reports underline a reduced toxicity with HIFU ablation compared with other ablation techniques because of the non-invasive nature of the procedure. First, devices never used widely in clinical practice were trans-rectal probes, which have been used predominantly to treat the prostate cancer. Extracorporeal devices are significantly larger and can be used to treat a variety of problems, most commonly intra-abdominal solid tumors. As a result, these extracorporeal devices use transducers with a longer focal length and use both ultrasound and MRI for targeting the organ.

Background: the JC HIFU system (which has been installed since 2007 at IEO) is an extracorporeal device using a 20-cm-diameter plane lead-zirconate-titanate disc transducers with an aluminium alloy lens with focal length of 16 cm, driven at 0.8 MHz. It operates at relatively high intensities up to 20,000 W/cm^2. The imaging probe is situated in the centre of the high-intensity focused ultrasound transducer allowing for real-time US image monitoring during treatment. Ultrasound is a form of vibrational wave that penetrates through soft tissues and can be focused with the described spherically curved transducer to target sites that represents the Acoustic Focal Region (AFR). Guidance and monitoring of acoustic therapy is most important to ensure that the desired region is treated and to minimize damage to adjacent structures. Real-time imaging, such as ultrasound, ensures that HIFU beam targeting is maintained within the correct area throughout the procedure. Sonographic guidance provides the benefit of using the same form of energy that is being used for therapy. The significance of this is that the acoustic window can be verified with sonography. Imaging methods to assess HIFU treatment are similar to those used to assess the response to other methods of ablation such as radiofrequency ablation and include contrast enhanced CT and MRI. In addition, the use of micro-bubbles ultrasound contrast-enhanced is also being examined as a method for evaluating efficacy of HIFU treatment. These methods all examine the change in vascularity of the treated volume. PET scan is another diagnostic tool currently used for oncologic applications; it is used for assessing changes in metabolic activity after HIFU treatment. Several mechanisms are involved in the tissue damage induced by HIFU. Localized heat generation due to absorption of the acoustic energy is the main biological effect in tissues. The heat rapidly raises high temperatures at the AFR from 55 to 100°C, causing **coagulation necrosis** within a few seconds. The precise and well delimited US focusing (e.g., 1 mm diameter and 9 mm length), minimizes the potential thermal damage to the tissue located along the acoustic pathway, because the energy is much lower outside the focal region. Mechanical phenomena, in addition to thermal effects, are associated only at high energies. **Cavitation** is the most important mechanical phenomenon; it can be defined as the creation or motion of gas bubbles within an acoustic field due to alternating compression and expansion of tissue as ultrasound waves propagate through it. It seems difficult to distinguish the thermal effects from either acoustic cavitation or vessel damage in HIFU ablation. Actually, they can occur simultaneously within the targeted tissue. Therefore, the coagulation necrosis induced by HIFU can be considered as the result of **biological effects** from a combination of **heat**, **cavitation** and **vascular destruction** on tissue. Combination between imaging and technologies for local therapy has made ablative procedures more reliable and practical, allowing for safe and feasible application of HIFU treatments in clinical practice. US-guided extracorporeal high-intensity focused ultrasound has been recently used to treat patients with various kinds of malignancies, including liver, breast, kidney, bone, and soft tissue both in Asia and Europe. Investigation and applications of HIFU are growing rapidly worldwide. Although major clinical application for HIFU is in treatment of benign and malignant solid tumors, several other potential therapeutic applications of HIFU are being investigated, including thrombolysis, arterial occlusion for the treatment of tumors and bleeding, haemostasis of bleeding vessels and organs.

Liver: several studies on HIFU treatment of HCC and secondary liver metastases in human clinical trials have been already published. Wu et al. used an extracorporeal HIFU device to treat 68 patients with liver malignancies showing complete tumor ablation in 30 cases in which surgical excision followed HIFU treatment. HIFU has also been used for palliation in patients with advanced-stage liver cancer by Li CX et al. They observed that after treatment, 87% of patients reported symptomatic improvement. In Oxford, UK, in 2005 a total of 22 patients with liver metastases were treated with HIFU. Twenty of 22 patients were assessed by using both radiological images such as MRI and contrast ultrasound, and histological examinations. The results revealed that the adverse event profile was favourable when compared to open or minimally invasive techniques. The only randomized clinical trial is from Wu et al. that randomized patients between transarterial chemoembolization (TACE) alone and HIFU after TACE. The median survival times were 11.3 months in the combined HIFU-TACE group and 4 months in the TACE-only group ($p = 0.0042$). To date, both animal and human subject investigations show significant promise in the treatment of hepatic malignancies with HIFU. Recently (Jan 2009), Lian Zhang, from Chongqing University, observed that ablation with HIFU can safely achieve large areas of coagulation necrosis in tumors close to major blood vessels, without damage to vascular integrity. Hence, this therapy can be applied to treat many patients who cannot undergo conventional treatment techniques either absolute and relative contraindication or tumor location focusing the capability to perform a conformational treatment respect to lesion borders.

Pancreas: HIFU for palliative treatment of pancreatic cancer may be useful in patients who develop symptoms that would benefit from local tumor control. Results from an open-label study in China in 251 patients with advanced pancreatic cancer (TNM stages II-IV) suggested that HIFU treatment can reduce the size of pancreatic tumors without causing pancreatitis and thus prolonging survival. An interesting finding was that 84% of patients with pain due to pancreatic cancer obtained significant relief of their pain after treatment with HIFU. Symptomatic relief was universal, imaging showed a significant reduction in ablated tumor size, and survival benefit has been observed in all the treated patients.

EIO experience: at EIO, the first study on coagulative lesion formation by high intensity focused ultrasound on ox liver in vitro tests started in 2007; it included a sequence of experiments under different exposure conditions followed by tissue sectioning. We confirmed previously published data about the development of HIFU-induced tissutal lesions, by changing different parameters as acoustic propagation, absorptive heating, power and intensity of sonication in bovine liver as a laboratory model. At the end of "in vitro Phase" we concluded that HIFU is a feasible and a safe technique to perform a precise tissue ablation at different power and intensity of sonication. As a comprehensive cancer center, from November 2007 and December 2008 at EIO, 41 patients (age range 16-75 years) have been treated with ultrasound-guided HIFU, within a feasibility study phase. All patients included in this study were deemed not candidates for surgery, nor suitable for local ablative techniques such as radiofrequency ablation (RFA), transcatheter arterial chemoembolization or embolization (TAE), or were unwilling to have any of those treatments. Among the 37 patients, five with HCC, 10 with liver metastases from colorectal cancer (CRC), two with chest wall metastasis from CRC, one with liver and lung metastasis from CRC, two with soft tissue metastasis from CRC, one with liver and lung metastases from CRC, one patient with liver metastasis and rib recurrences from breast cancer, one patient with sternum metastasis from breast cancer, one patient with liver metastasis from breast cancer, two patient with 2 liver metastases from neuroendocrine tumor (NET), one with osteosarcoma, one patient with leg metastasis from lung cancer, one with iliac metastasis from multiple myeloma, one with abdominal liposarcoma, one patient with pancreatic tail NET. With the aim of palliation we have treated six patients with pancreatic cancers, five at the advanced stage with no indication for surgical resection; one patient had local relapse after surgery. In these patients, we observed disappearance of visceral pain. All of them had chemotherapy and radiotherapy with progressive local disease at the time of HIFU treatment. Conventional liver biochemical tests, prothrombin time, and complete blood cell counts, chest radiography, abdominal US, electrocardiogram (ECG), and lung function were evaluated before treatment. MDCT or/ and PET-CT or MRI were performed as baseline-imaging. Specific bowel preparations were required for patients with pancreatic cancers and for patients with abdominal tumors close to the bowel. The patients were asked for fasting overnight the day before HIFU treatment. For this study, HIFU therapy has always been performed under general anaesthesia. General anaesthesia with endotracheal intubation and mechanical ventilation also had the supplementary benefit of permitting provisional suspension of breath with controlled pulmonary inflation, as needed for ablating liver lesions behind the rib cage, through the intercostal space. All patients were monitored for tracking breath and heart rate, blood pressure and oxygen and carbon-dioxide saturation level during the procedure. v:textbox>As a feasibility study, IR team considered procedure timing as fundamental. Room time, which including preparation time and treatment time, defined as the time from patient came in the HIFU unit to patient went out the HIFU room, ranged from 2 hours 30 minutes to 7 hours 5 minutes. The overall treatment time, defined as the time from the beginning of localization to the last sonication, ranged from 59 minutes to 318 minutes. The sonication time is defined as the exposure time, which was related to the tumor size, tumor site and blood supply, which ranged from 1 minute 38 seconds to 166 minutes. Sonication time was 23% over treatment time. 38 patients had one session of treatment; three patients had a second session after a mean period of 6 months from first treatment. PET-CT or/and MDCT showed complete response in about 88% liver metastases; bone lesions were palliated in symptoms and PET-CT detection; MDCT and PET-CT showed lesions of chest wall, leg muscle, abdominal wall and lung completely ablated; the huge liposarcoma has been almost completely ablated at MRI; pancreatic lesions were palliated in symptoms and at PET-CT or MRI. Local oedema was observed in 3 patients. No other side effects were observed. All the patients returned home 1-3 days after treatment.

Conclusion: as a "so called" non-invasive technology, HIFU approach may play a key role in the future management of solid malignancies. The preliminary research activity and application of this new technology in patient care started more than one year ago and was limited to a small number of patients with short-term follow-up, in focusing the feasibility and safety of this new technique. Based on the preliminary results, US imaging-guided focused ultrasound treatment appears to be feasible and safe to ablate primary and metastatic liver tumors, primary and metastatic bone tumors, pancreatic cancers and soft tissue tumors, without significant side effects, and can have a role in "multi-modal" management of patients with tumor disease. The research activity is deeply integrated with the daily clinical work and the principal purpose arising from our 2008 studies are addressed to follow up all patients to ascertain which patient group would be the best suited to this non-invasive treatment. Over this main issue, ongoing research is focused also on implementation of HIFU technology in order to optimize the patient's approach technique.

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203.3

Uterus

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Learning Objectives

1. To define indications for focused US ablation of uterine fibroids as compared to other techniques
2. To describe technical details of fibroid management with focused US
3. To present results of fibroid ablation (series and trials)

Uterine fibroids are an important problem for women of reproductive age. Fibroids can cause significant bleeding, as well as pelvic pressure and pain, urinary frequency, urinary incontinence, constipation, obstetrical complications, and infertility. Hysterectomy has been the traditional treatment for fibroids, but many women are interested in a less invasive therapy. MR guided Focused Ultrasound (MRgFUS) is a new technique and has been tested and approved by the FDA for the treatment of uterine fibroids. One device (ExAblate® 2000, InSightec, Haifa, Israel) received a CE mark in 2002 and was approved for clinical use by the FDA in 2004. There are several other devices that are currently being tested. MRgFUS combines MR imaging to define the target and to control and monitor the ablation, and an ultrasound transducer that controls and delivers the focused ultrasound beam, allowing a non-invasive approach.

Candidates for MR guided focused ultrasound: the patient should have symptoms referable to fibroids, most commonly menorrhagia, or bulk symptoms such as urinary frequency. Patients should be pre-screened with an MRI performed without and with contrast enhancement. The MRI is performed with the patient in the prone position, mimicking the treatment position. There should be a limited number of fibroids, preferably 1-4. Fibroids that are homogeneous and hypointense (dark) on T2 seem to respond better than fibroids that are heterogeneous and hyperintense (bright) on T2 [1,2]. Patients cannot have contraindications to MR imaging. Abdominal scarring or bowel loops in the path of the ultrasound beam are contraindications. Patients with adenomyosis and no fibroids probably should not be treated although there is a report of adenomyoma treatment [3]. Obese patients may have so much subcutaneous tissue that the fibroid is largely out of the range of the ultrasound beam. The ultrasound focus depth is limited to 12 cm for standard protocol or to 7 cm if enhanced sonications are to be performed. Patients cannot be pregnant, and should not have any other pelvic pathology that requires treatment or further investigation. There has been no study of performing MRgFUS in patients who have previously undergone UAE. There is concern that interaction between the ultrasound beam and the particles used for UAE may lead to a poor result or potentially cause complications if the beam is scattered by the particles. Patients ideally should not desire future fertility since there remain substantial questions regarding the effects on fertility.

MR guided focused ultrasound procedure: the skin on the lower abdominal wall is shaved to prevent air bubbles being trapped in the hair, increasing the risk of skin burns. The skin is cleaned with alcohol to remove any lotion, oils or powder on the skin that might cause burns. An intravenous line is placed for sedation. A catheter is placed to keep the bladder empty; filling of the bladder will displace the uterus and change the positioning of the fibroids. The patient is in a prone position with her pelvis positioned over the transducer. The abdomen is in a water bath, in contact with an acoustic gel pad. Images are obtained to determine if the patient is properly positioning over the transducer. Baseline images in axial, coronal and sagittal planes are obtained. The treatment area is manually defined and drawn, and the target volume is analyzed with superimposition of ultrasound beam paths in all three planes. The beam pathway is evaluated to avoid any structures that would be in the path such as bowel, pubic bone, bladder, or nerves. The path is also examined to make sure there are no scars, surgical clips or air bubbles present. Fiducial markers are placed on the uterus so any patient motion causing the uterus to shift in its position can be recognized. If the fibroid is at the serosal surface of the uterus, a 0.5 cm margin of non-targeted tissue should be maintained. This is to prevent the possibility of thermal damage of tissues in close proximity to the serosal surface of the uterus. Once the treatment area is defined, preliminary low-energy, sub-therapeutic sonications are performed to determine the accuracy of the system targeting. Once verification of the system has been determined, and then the treatment begins with a gradual ramping up of the ultrasound to full therapeutic power. The ultrasound parameters of acoustic power, spot size, sonication frequency, and length of the sonications can be modified to produce the appropriate therapeutic heating. It is desirable to try and reach 70-80°C, which ensures tissue necrosis [1]. Sonications last 20-40 seconds, there is a cooling period between sonications. The goal is to obtain a sufficient thermal dose without causing discomfort [4]. The ultrasound transducer beam can be tilted as much as 20° in multiple directions in order to avoid bowel, pubic bone, or sacrum. Following the treatment, contrast-enhanced images are obtained in the sagittal, coronal, and axial planes to evaluate the extent of the ablated area. The volume of ablated tissue can then be calculated, and a percentage of treated vs. non-treated fibroid tissue is determined. If there remains a substantial amount of perfused (non-treated) tissue, the patient may undergo a second treatment to try and ablate the remaining fibroid tissue.

Complications: skin burns may occur from air being trapped between the transducer and the patient's skin; such burns are usually small and superficial. Skin burns are more common and most serious when there is an abdominal scar present. A burn of the bowel is a serious complication, which would require laparotomy and resection of bowel. It is extremely important to evaluate the space between the abdominal wall and the uterus to make sure that no bowel is trapped

in front of the uterus. If there is any indication of a change in bowel position, it may be necessary to rescan the patient to make sure that the treatment path is clear of bowel. Sciatic nerve damage is caused by heating of the bone close to the nerves and may take months to resolve. One case of DVT in the lower extremity has been reported.

Results: pelvic pain and pressure symptoms seem to resolve most quickly with women commenting that the fibroid feels softer and the pressure particularly on the bladder seems decreased. Improvement in menstrual bleeding seems to take longer, commonly taking 3 menstrual cycles before noticing improvement [5]. It maybe 3-4 months before the patient notices any change in the size of the fibroid. Nonperfused tissue volume (NPV) should be as high as possible (greater than 60%), as there is a close relationship between the NPV and outcomes [1]. If the NPV is greater than 40%, the percentage of patients having an alternative therapy is 17%. As the NPV decreases, the percentage of patient having an alternative therapy increases [6]. A mean percent ablation volume of 54 and 51% for menstrual and bulk-related symptoms seemed to allow alleviation of those symptoms at 12 months, but if only 37% mean ablation volume reduction was obtained then symptoms were not alleviated at 12 months [7]. A study by Funaki et al. [8] evaluated the signal intensity of the T2-weighted images and the therapeutic results. Before treatment, the fibroids were categorized on the basis of the signal intensity of the T2-weighted images. They categorized the fibroids as: Type 1, low signal intensity on T2; type 2, intermediate intensity; and type 3, high intensity. The type I fibroids had the best results with 31%, type 2 was 20.5% and type 3 was 16.5%. A study by Mikami et al. [7] also demonstrated a higher technical success (treatment of the planned target zone) in patients with low intensity fibroids when compared to high intensity fibroids. When enrolling patients in a study, it was found that a number of patients who were interested in the study were not eligible [9]. Of those who were interested in the procedure, 63% were clinically eligible. Most of the ones not clinically eligible had fibroids that were insufficiently symptomatic (35%), were not in the appropriate age range (age <40 or >60) (19%) or desired pregnancy (16%). There were 24% who were ineligible because of abdominal scarring. Of the patients who were clinically eligible 25% were anatomically eligible. Of the ones who were anatomically ineligible, the top 3 reasons were too much fibroid volume (19%), bowel present in the pathway between the ultrasound treatment beam and the dominant fibroid(s) (13%) and significant adenomyosis (12%). Overall, only 14% of the patients were clinically and anatomically eligible for the MRgFUS study. Studies have primarily been done evaluating Quality of Life (QOL) using the Uterine Fibroid Symptom and Quality of Life (UFS-QOL) questionnaire. The initial studies, primarily aimed at obtaining marketing approval, only required an improvement of the QOL scores of 10 points. In those studies, over 70% had such score changes [1]. This degree of score improvement is a very low bar, although the FDA only allowed 100-150 cm^3 of the fibroid to be treated, a very conservative protocol. As the guidelines have been liberalized, the results have improved. The symptom severity scores (SSS) improved in all of the non-perfused volume groups with the most significant improvement (79%) in the group having more than 40% NPV. In the group with 0-10% NPV the improvement was only 38%. The average SSS at 24 months was 31.5 in the >40% NPV, while it was 57.6 in the group with 0-10% NPV. The average change in SSS was 31.9 in the >40% NPV group and 21.4 in the 0-10% NPV.10 One of the most important concerns regarding MRgFUS is what will happen with areas of the fibroid that continue to have perfusion. It seems clear that few of the treated fibroids are completely infarcted following even a successful procedure. From the initial study group, it seems that only 13.4% had more than 40% NPV, with an average NPV in that group of 53%. Volume reduction may mask residual viable tissue and so the percentage of volume reduction maybe less useful than assessing the perfusion outcome of the fibroids [11]. At this time, most of the follow-up for MRgFUS is based on symptom improvement, without confirmatory MRI volume measurements and without reported perfusion measurements. In some cases follow-up MRIs have been done, but at the most, volume measurements are recorded [4,7,12,13]. It is not clear if fibroid tissue treated by MRgFUS responds differently than fibroid tissue that has been embolized, but it would seem unlikely. If there is no difference, then one would assume there would be regrowth of fibroids and potentially recurrence of symptoms, but data is lacking on the long-term durability results for MRgFUS.

Future Directions

Gonadotrophin-releasing hormone agonists: large uterine fibroids are difficult to treat with MRgFUS primarily because of the time required to perform the procedure and/or the requirements for multiple treatments. One approach that has been proposed to try and solve this problem is to pre-treat the patients with large fibroids with gonadotrophin-releasing hormone (GnRH) agonists. One study evaluated the use of GnRH agonists prior to MRgFUS. Following treatment with MRgFUS, the median symptom severity score at 6 and 12 months was significantly reduced by 45 and 48% respectively [14].

Desire for future fertility: At this time, desire for future fertility is considered a contraindication to an MRgFUS procedure in the US. There have been several pregnancies reported following MRgFUS procedures [15-17]. There is a trial underway for patients with symptomatic uterine fibroids who would like to become pregnant after undergoing MRgFUS treatment [16]. InSightec indicates that there have been 41 pregnancies in 38 patients. There have been 17 deliveries, 10 vaginal and 7 c-sections. There have been 6 elective pregnancy terminations, and 11 spontaneous abortions with 7 ongoing pregnancies. (Source: InSightec Website http://www.extranet.insightec.com slide presentation).

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203.4

MR guided focused ultrasound (MRgFUS) treatment of painful bone metastases

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Learning Objectives
1. To review the conventional treatment of bone tumours
2. To describe the technique, follow-up and main complications of focused US
3. To present results of focused US in bone tumours as compared to other techniques including radiation therapy

The treatment of painful bone metastases remains a difficult undertaking with multidisciplinary treatment approaches often achieving the greatest success. External beam radiation remains the treatment of choice for palliative treatment of painful bone metastases but up to 30% of patients do not achieve adequate pain palliation when treated with this modality. Other treatment options include chemotherapy, hormonal therapy and bisphosphonates, which when added as adjuvant therapy can have beneficial effects. More recent developments include focal image guided therapies including radiofrequency ablation, cryotherapy, laser and microwave ablation in which energy delivered locally to the focal lesion results in diminished pain. MRgFUS is a new alternative method for the palliative treatment of painful bone metastases incorporating MR imaging coupled with a tumor ablating apparatus (focused ultrasound). The focused ultrasound apparatus consists of a multiarray ultrasound transducer situated in a water bath incorporated into a standard MR table. This transducer is able to produce high energy ultrasound waves, which can be focused on specific tissues in the body; this results in local temperature elevation and thermal necrosis of the area targeted by the ultrasound wave otherwise known as a "sonication." Treatment of a pathological mass is achieved by a 3D computer driven map that calculates the exact number and position of sonications needed to destroy the mass lesion. Each sonication results in a small area of necrosis, approximately 3X1 cm in dimension. The 3D images are provided by the MR scanner and obtained just prior to treatment initiation and are crucial in the computer driven mapping of multiple overlapping sonications necessary to achieve total tumor destruction. The unique feature of the system is the MR driven thermography. MR thermography allows accurate temperature estimate of the region treated with MRgFUS following each sonication, hence, allowing a true closed loop feedback treating method. If temperature measurements following a sonication are below a critical level (i.e., 60°C for 1 second), that region can be immediately retreated to assure necrosis has occurred. This is in contradistinction to all other ablation technologies where image guided ablative procedure is performed and the result is evaluated with imaging after the fact, in this scenario if treatment is suboptimal, another ablation session must be performed. Our initial series of patients with painful bone metastases included 12 painful bone lesions in 11 patients treated over a period of 14 months. This series included 7 women and 4 men with an average age of 58 years and primary tumors including breast, kidney, lung and liver. The large majority of lesions were located in the pelvic bones but lesions in the scapula ischium and clavicle were also treated. One patient had 2 lesions treated in close proximity; all other patients had a single lesion treated. All patients had a single treatment session with the exception of one patient in whom treatment had to be postponed due to a concomitant medical problem during the procedure setup; the treatment was completed on the next day without incident. Because bone readily absorbs ultrasound energy, the treatment of bone metastases requires fewer sonications (in our series varied between 12 and 18 sonications) and the energy necessary to achieve therapeutic effect is also diminished (approximately 1000J as compared to 3000J typically to achieve soft tissue ablation with this technology). Radiological features of the lesions treated included 8 purely osteolytic, 1 mixed and 2 osteoblastic. All treatment procedures were completed with the aid of conscious sedation delivered intravenously (on average 2.5 mg midazolam, 125 ug of fentanyl). The hypothesis of the study was energy directed at the bone overlying the painful metastasis would result in heating of the bone above 60°C; this would result in destruction of the periosteal innervation and hence render the patient pain free from the lesion. All patients underwent contrast enhanced MR, unenhanced CT as well as completing both a pain scale score (0-10, 0 no pain, 10 excruciating unrelenting pain) and a quality of life survey prior to treatment and then these studies were repeated following treatment with MRgFUS. Average pain score in our patient population was 6 on a scale of 10 and this diminished to 0.5 on the three month follow up of our patient population. Most patients were completely pain free and almost all had ceased taking pain medications. Several patients had resumed light activity and were significantly more mobile following treatment. No adverse events were recorded in this small patient population; physical exam and imaging studies also were free of any occult adverse events. The imaging studies performed prior to and after treatment revealed interesting findings. The majority of patients in our series had purely osteolytic expansive lesions with cortical thinning overlying the metastasis. These lesions demonstrated homogeneous enhancement prior to treatment on contrast enhanced MR studies. Following treatment with MRgFUS, all lesions demonstrated areas of decreased enhancement on MR contrast studies suggesting energy had in fact penetrated the thinned cortex and induced thermal necrosis of the enhancing metastases. On follow up, uninfused CT varying degrees of sclerosis was noted in these previously purely osteolytic lesions suggesting new bone was being laid down in response to the necrosis of the tumor mass. The imaging findings suggest that energy does in fact traverse the thinned cortical bone into the medullar region. Palliation is in fact being achieved by the energy absorbed by the thinned cortical bone but theoretically local tumor control could also be achieved if enough energy could be transmitted through the bone to achieve total necrosis of the medullary mass. Future research protocols for MRgFUS include a pivotal study in North America, which will include at least 8 sites and up to 150 patients. More aggressive treatment protocols with goal to achieve as much ablation of the medullary component could result in a change in the goal of treatment, i.e., to ablate and control tumor growth locally and to achieve adequate palliation. Another exciting development being evaluated is the utilization of a portable treating transducer. This transducer type can be fixed on any part of the body and hence allow better access to difficult

locations and can further increase the number of patients amenable to this treatment. MRgFUS is an exciting new method for palliative treatment of painful bone metastases. This treatment method has proven to be effective, rapid, with little or no adverse events and can be completed in one treatment session. With further development and evaluation, MRgFUS may become a first line treatment for the palliative treatment of painful bone metastases.

Special Session
Image guided pain management

204.1

Image guided pain management for UFE

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Learning Objectives
1. To review the issues involved in pain management in UFE
2. To present the techniques used in image guided pain management
3. To analyse the results of image guided pain management as compared to other technique of pain control

Introduction: uterine fibroid embolization (UFE) has evolved to a mainstream treatment option for symptomatic fibroids. Unfortunately, UFE is associated with quite significant post-procedural pelvic pain. The pain follows the consistent pattern over time: the pain typically starts right after finishing embolizing the second uterine artery followed by a sharp increase of pain peaking 2-6 hours after the procedure. Then, the pain steadily decreases over the next several hours to reach acceptable levels the next morning (about 18-24 hours after the procedure). Therefore, a pain control strategy that minimizes the first 12-24 hours after UFE is desirable. Today, in most practices, patient-controlled analgesia (PCA) with opiates or even an epidural catheter/ spinal anesthesia is used for pain control. A major drawback of the PCA is nausea/vomiting caused by the opiates. An epidural catheter placement is as invasive as the entire UFE procedure and therefore does not fit to the minimal invasive concept. The goal is a regional nerve block, which is safe and effective and applicable by the interventionalist during UFE.

Superior hypogastric nerve block (SHNB): the use of a SHNB for pain management after UFE was first described by Rasuli et al. in JVIR 2004; 15:1423-1429. Despite good results in a prospective single arm clinical trial with 139 patients, this technique has not yet been used by many interventionalists. I have been using the SHNB for more than three years in every UFE with very good success. The superior hypogastric nerve plexus is part of the sympathetic nervous system and collects the sympathetic nerves from the pelvis including the innervations of the uterus. The superior hypogastric plexus is typically located in front of the 5^{th} lumbar vertebral body just below the aortic bifurcation. The idea/concept of the SHNB is to block this nerve plexus with a long-acting local anesthetics such as ropivacain 0.75% (Naropin) or bupivacain 0.5% (Carbostesin). Both anesthetics provide a regional nerve blockage of 6-10 hours. The advantage of ropivacain is a lower cardiotoxicity compared to bupivacain. The technique of the SHNB is quite straight forward. During the pre-procedural preparation, not only the groin area, but also the anterior part of the abdomen is prepped. After embolisation of the contralateral uterine artery, the catheter is filled with contrast to mark the aortic bifurcation. Then a whole is cut in the drape just below the umbilicus. A 21G needle is advanced "down-the-barrel" in the midline aiming below the aortic bifurcation. The needle is advanced till it hits the anterior aspect of L5. A 21G needle is preferred over a 22G needle because the latter is too flexible and therefore hard to steer. Prior to needle advancement, local anesthesia should be used for the skin and the peritoneum for better comfort. Once the needle reaches the bone of L5, contrast is injected to confirm the correct location of the needle in the pre-vertebral space. It is very helpful to confirm the position in a lateral view. Then, 20 ml of local anesthetics is injected under fluoroscopic control. The initial contrast is pushed to the side and diluted. At the end of the injection, the needle is removed. During needle insertion, bowel and/or a large uterus has to be traversed, which does not seem to cause any problems. It is important to obtain a symmetrical distribution of the local anesthesia of both sides of midline for a good pain control. The time needed for the SHNB, starting with cutting the whole in the drape till pulling the needle, is only 7-10 minutes. Rasuli et al. found that all patients could be discharged home within 6 hours of the procedure with only 6% re-admission. I tend to keep the patients overnight for better observation. Typically, the women have no pain for several hours following UFE. After the SHNB wears off, patients start to have mild to moderate pain. The next morning, the pain is similar to the pain of patients without SHNB. The only adverse effect of the SHNB in my experience was a temporary hypoesthesia in one foot, which went away a few hours later without any intervention. In addition to the SHNB, all patients receive ketorolac (Toradol) 60 mg during UFE and 30 mg every 6 hours while in the hospital followed by ibuprofen (Brufen) 4 x 600 mg for 5 days. If more analgesia is needed, patients are given paracetamol (Panadol, Tylenol) up to 4 x 500 mg or for more severe pain metamizol (Novalgin) up to 4x 500 mg.

Possible impact of SHNB on UFE: UFE is a minimal invasive treatment for symptomatic fibroids with a proven good clinical outcome. Post-procedural pain is perceived as one of the main drawback of UFE: A reduction of pain fits well to the paradigm of a minimal invasive, modern procedure. SNHB can significantly reduce the pain of UFE, which dramatically increases the comfort for women after UFE. In addition, the SNHB is very well received by the nursing staff transforming UFE in their eyes into a very attractive minimal invasive treatment. SNHB is easy, quick and safe and therefore should be adapted by IR.

Reference

1. Rasuli et al in JVIR 2004; 15:1423-1429.

204.2

Coeliac plexus block

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Learning Objectives
1. To review the indications of coeliac plexus block
2. To present the techniques used in IR for coeliac plexus block
3. To analyse the results and complications of coeliac plexus block

Percutaneous neurolytic celiac plexus block (PNCPB) is an effective therapeautic modality used to manage chronic abdominal pain unresponsive to large doses of narcotic agents. The most common application of PNCPB is in the treatment of pancreatic cancer. Successful treatments have also been described with gastric, oesophageal, metastatic liver cancer, gall bladder carcinoma, cholangiocarcinoma and other malignancies associated with lymphatic spread to para-aortic lymph nodes (1). Anatomically, the celiac plexus consists of sympathetic celiac, superior mesenteric and aorto-renal ganglions derived from the greater, lesser and least splanchnic nerves, and the parasympathetic nerve supply from the abdominal branches of the posterior trunk of the vagus nerve. It is distributed in the retroperitoneum anterior to the T12/L1 intervertebral disc space and can extend anywhere down to the middle of the L2 vertebral body. More reliably, it is often found on average 0.6 cm caudal to the celiac artery on the right side and 0.9 cm caudal to the celiac artery on the left (2). The technique of celiac plexus neurolysis is often attributed to Kappis (3) who in 1919 was the first to demonstrate that percutaneous splanchnic nerve block can

be used to alleviate upper abdominal pain. The original technique has since been modified and refined by several authors and in the 1970s fluoroscopy replaced blind injections. In the present day, CT or uncommonly ultrasound are used to precisely localize the celiac plexus, which has led to greater efficacy of the technique with fewer complications. Successful results have also been reported with the endoscopic ultrasound guided technique (5). In comparison with ultrasound, CT more precisely localizes the needle tip in relation to the celiac artery and reduces the risk of penetration or injection into the spinal cord, major vascular structures, liver, kidneys, bowel and other organs. It is for these reasons that in the recent years, CT guided PNCPB has become the more popular technique. The mechanism of pain relief is by direct block of the visceral sympathetic nerve pathways. The two agents commonly used to achieve this are ethanol and phenol. Ethanol acts by degrading endoneural protein and mucin as well as extracting cholesterol, phospholipids and cerebroside from the celiac plexus neurolemma (6). Ethanol concentrations greater than 50% are required to cause irreversible neuronal damage (6). Alcohol is commonly mixed with a long acting anaesthetic such as bupivocaine in order to relieve pain from the injection. Most authors would advocate injecting 40-50 mls of 50-100% alcohol for the posterior approach (2). Iodinated contrast medium is included in the mixture to observe the distribution of the neurolytic agent in tissues around the celiac plexus. Some authors advocate the use of phenol although it is less practical to administer because of its higher viscosity. The needle entry site can be divided into the anterior and posterior approaches. The anterior technique has an advantage of reducing the risk of neurological injury, as the needle tip is further away from the spinal canal and spinal arteries. The anterior approach invariably involves traversing several abdominal organs and has the potential to lead to complications such as gastric perforation, pancreatic fistula and chemical peritonitis. For these reasons, most interventional radiologists would reserve the anterior approach for cases where the posterior approach is technically difficult. With the posterior approach, there are several possible sites for injection. Most commonly used is the bilateral blocking anterior to the diaphragmatic crus at a level between the celiac axis and the SMA. Alternatively, retrocural injection can be used but with this approach only splanchnic nerve neurolysis is achieved. To perform the anterocrural injection via the posterior approach, the patient is positioned prone on the CT scanner. Appropriate image slices are selected to avoid the rib and the transverse process posteriorly and to demonstrate the space containing fat between the celiac axis and the root of the superior mesenteric artery. Using an aseptic technique and local anesthesia, a 22G Chiba needle is introduced through the skin and the subcutaneous tissues passing lateral to the relevant vertebral body so that the needle tip is placed in the area anterior to the diaphragm and posterior to the pancreas. A mixture of contrast agent and local anaesthetic is injected to check the needle tip position. A mixture of ethanol and long acting local anesthetic is subsequently injected and the diffusion of contrast in the post pancreatic space is confirmed with CT. Whilst maintaining position, the needle is then flushed with a small volume of normal saline. This reduces the risk of ethanol leak into the back muscles or peritoneal cavity during withdrawal. This procedure is then repeated on the contra-lateral side. The posterior transaortic approach involves a single needle pass through the posterior and anterior walls of the aorta via a left posterior paramedian approach. Using this method, the entire celiac plexus can be blocked with a single injection and the possibility of spinal nerve injury is reduced as the neurolytic agent will not be able to flow in the intervertebral foramen. The disadvantages, however, are that there is a risk of haematoma and iatrogenic vascular injury and this approach is contraindicated in patients with an abdominal aortic aneurysm due to an increased risk of dislodging thrombus and causing a dissection. CT guided trans-intervertebral disc blocking technique has been used in patients where the paravertebral approach is difficult due to the position of transverse processes or the ribs. This can, however, be difficult to perform in patients with severe spinal degenerative disease and has the potential to lead to disk injury and infection (7). Several studies have shown a decrease in the requirements for conventional analgesia and a consequent reduction in the opioid side effects following PNCPB (8,12). Marra et al. reported excellent results in a series of 150 patients with 79% of patients experiencing pain relief in the first two weeks following the procedure (13). A meta-analysis, composed mainly of retrospective studies, suggests that PNCPB has durable (at least 3 months) partial or complete pain relief in approximately 90% of patients with pancreatic and other intra-abdominal cancers (9). Assuming that the needle has been placed correctly and an appropriate volume of neurolytic agent administered, failure of pain relief may occur in cases of advanced tumour or where there has been significant anatomical distortion of the celiac region leading to inadequate distribution of the agent. The common adverse effects of diarrhea and hypotension are reported mostly as transient phenomena and appropriate measures including giving intravenous crystalloid fluids should be taken in such cases (10). Paralysis is the most severe complication arising from PNCPB. This is rare, and in one study involving 2730 coeliac plexus blocks, developed in only 4 (0.15%) patients (11). The injuries are thought to have been a consequence of accidental injection into the spinal artery during the posterior approach. Other less uncommon complications include: impotence, gastroparesis, SMV thrombosis, pneumothorax, chylothorax, chemical peritonitis, chemical pericarditis, aortic pseudoaneurysm, aortic dissection, retroperitoneal haemorrhage and retroperitoneal fibrosis (ref). In summary, percutaneous neurolytic celiac plexus block is a useful adjunct to conventional analgesia in the control of abdominal pain in advanced pancreatic cancer and other malignancies. CT is most commonly used to guide the injection of neurolytic agent into the celiac plexus via the posterior approach. Endoscopic and ultrasound guided techniques have also been described but are less commonly used. The CT guided PNCPB has few complications most common of which are transient diarrhoea and hypotension as a consequence of the sympathetic blockade. A number of studies have shown this technique can produce a significant reduction in the post procedural analgesia requirements with a long lasting effect.

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204.3

Upper and lower back pain

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Leanring Objectives

1. To describe common causes of back pain that can be treated by IR
2. To present the different techniques used in upper and lower back pain
3. To analyse the results and the complications

Interventional radiology of the spine consists of minimally invasive techniques for the treatment of some spinal diseases proposed before or in addition to an open spine surgery. By using imaging guidance, one can significantly increase accuracy and decrease complication rates. This presentation will discuss physiopathology, indications, methods, complications and results of performing percutaneous spine procedures for upper and lower back pain in different levels (cervical, thoracic, lumbar and sacroiliac) and different kind of treatments (nerve block, nerve radiofrequency, disc treatment and bone treatment). Finally we will review the current literature on the controversial issues involved.

Neck, dorsal or lumbar pain due to radiculopathy, are a common problem, which is quite costly to society. Effective management is a challenge. Most cases are successfully treated conservatively (analgesics or physical therapy), but in a small percentage of cases, surgery may also be performed. **Infiltrations** are a minimal image guided technique, proposed before surgery. By using imaging guidance, one can significantly increase accuracy and decrease complication rates [1]. This presentation will discuss different kind of treatment involved in back pain, due to nerve entrapment such as foraminal, epidural and facet injections. These injections are adapted to the pathology and usually foraminal or peridiscal injections are used for disco-radicular conflict, intra-articular injection are used for facet syndrom and epidural for narrowing canal. These injections have two major role, treatment by anti-inflammatory action and pain block to confirm the origin of pain. Local steroid injection are usually preceded by a contrast agent injection to prove the good anatomical distribution and to avoid an intra-arterial injection, especially at cervical level. Long acting steroid are linked to microcrystal and vascular injection have to be avoid. Depending of clinical data and result of pain block second minimal invasive therapies have to be discussed like discal treatment and dorsal nerve ablation. Intradiscal or peridiscal O3 injection especially used for discoradicular conflict have a close action to steroid by an anti-inflammatory effect. This injection could be performed in the disk because of the antiseptic effect of O3.

For facet pain, dorsal nerve ablation could be perform using radiofrequency or cryotherapy. Technique will be presented.

For discal pain or disco-radicular conflict, today there is a multitude of different percutaneous techniques proposed. Percutaneous approaches under fluoroscopy and CT have really evolved in recent years. In **disc generated pain,** The most popular, such as percutaneous disc ablation (PDA), percutaneous laser disc decompression (PLDD) and electrothermal therapy (IDET) and the most recent ones such as ethanol cellulose will be presented and analyzed. These techniques are based on the theory published by Hijikata et al. [2] in 1975 on the role of intradiscal pressure. The authors stated that: "Reduction of intradiscal pressure, reduced the irritation of the nerve root and the pain receptors in the annulus and peridiscal area." All of the above techniques use similar postero-lateral approach to puncture the disc, the purpose being to place the canula with the ablative system at the center of the disc. Each technique had advantages and disadvantages, which will be presented. Standard indications are contained herniation determined by imaging (CT or MRI), combined with neurological response (leg pain, motor response and tendon reflex) which persist after six weeks of conservative treatment [3].

Bone related lesions

The first case of **Vertebroplasty (Vp)** using poly-methyl-methacrylate (PMMA) was reported in 1985 by Gallibert and Deramond for treating vertebral body instability with aggressive forms of vertebral body hemangioma [4]. Soon, other indications, such as bone metastasis and secondary osteoporotic collapses showed favorable results with the same technique.

Nowadays Vp has become a main alternative option for treating back pain related to vertebral fractures either due to benign or malignant disease [5]. Vp can also be associated with bone biopsy, usually performed just before cement injection, during the same procedure. A variant technique, kyphoplasty, consist to introduced a balloon or a cavity device before cement embolization and have a particularly interest in treatment of fresh fracture and used of biocement.

Other lesions can be treated with the same technique, including pedicular, sacral and pelvic lesions due to benign and malignant disease **(osteoplasty)** [6]. The overall good success in relieving pain and recovering mobility justifies the interest to promote the use of this treatment concept, mostly for the comfort of patients.

Approach to the vertebral body is similar to bone biopsy, using a postero-lateral or transpedicular approach, and can be performed under fluoroscopy or CT. Injection of cement is mandatory to be performed under fluoroscopy, as it is the only means of real time imaging, covering the height of the injected vertebral body. The procedure can be performed, under local or general anesthesia, depending on the number of levels to be treated and the patient's general condition. Strict aseptic techniques are mandatory, as for any percutaneous spine procedure. The use of prophylactic antibiotherapy is suggested, although not proven mandatory by any study.

In conclusion, management of upper and lower back pain has become an intricate part of interventional radiology of the spine and has found its own niche, after conservative treatment and before major surgical operations [7].

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204.4

Cervical sympathectomy

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Learning Objectives
1. What is cervical sympathectomy and when do you need it?
2. In which cases can an IR offer this procedure?
3. Technique, results and complications?

No abstract available

Foundation Course Embolic materials

301.1

Particles and gel foam

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Learning Objectives
1. To review the different available formulations of gel foam, their preparation and delivery
2. To review the distinguishing features of embolization particles and their different handling and embolic characteristics
3. To discuss the differing clinical indications for gelfoam and particle use in varying clinical applications, distinguishing results, and relevant technical tips

Embolotherapy is an evolving field of interventional radiology in which occlusive agents play a major role. The choice of the optimal occlusive agent is of utmost importance for planning an embolization procedure. Particles are the most commons agents used for small vessel permanent distal occlusions. Traditional amorphous polyvinyl alcohol (PVA) is an inert injectable plastic particle of 45 to 1180 µm, which incites an inflammatory reaction, rendering it highly thrombogenic. Supplied as a dry coarse powder, PVA particles must be suspended in contrast medium or saline before injection through the delivery catheter. Clumping is a common problem when using the amorphous form of PVA. Particle size poorly matched to a chosen catheter can lead to catheter occlusion. PVA particles are difficult to calibrate and their behavior can be unpredictable during embolization, which leads to difficulties when performing targeted embolization[1,2]. Calibrated microspheres have drastically changed the conditions of embolization since the radiologist may adapt the size of microspheres to the size of the vessels to be occluded, so that an accurate targeting can be obtained. Extruded PVA (Contour SE Microspheres, Boston Scientific) is regular in shape and it is slightly compressible when injected through a catheter[3]. Embosphere Microspheres are particles made of trisacryl gelatin, perfectly round and slightly compressible, delivered suspended in an aqueous solution. This product is colorless and radiolucent and must be mixed with a contrast medium before injection[4]. BeadBlock (Biocompatibles UK) microspheres are another small embolic particle made from PVA hydrogel. They are hydrophilic and compressible, decreasing the risk of clumping. Unlike amorphous PVA or spherical PVA, BeadBlock is suspended in sterile water in prepackaged syringes[5]. Gelatin sponge particles are agents used for small or large vessel temporary occlusions. Gelfoam is a water-insoluble hemostatic agent prepared from purified skin gelatin. The potential to induce the clotting cascade results from the close contact of the platelets when entrapped in the porous gelatin sponge. The overall use of gelfoam is related to its temporary effect and then attempted mainly either to stop a bleeding or to devascularize a lesion before surgical removal[6]. Gelfoam has been used in a variety of clinical indications, such as trauma, gastrointestinal bleeding, postpartum hemorrhage[7], and also preoperative tumor embolization, including uterine artery embolization for fibroids[8] and portal vein embolization to induce hepatic hypertrophy of one lobe before surgical resection of the other lobe[9].

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301.2

Liquids

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Learning Objectives
1. To review the range of liquid embolization materials, their tissue response characteristics, and technical tips for handling
2. To compare the case selection and clinical uses for these agents and attendant results
3. To discuss technical tips for using liquid embolics to achieve embolic endpoints and minimize complications

Liquid agents including ethanol and other sclerosing agents are discussed herein. Sclerosing agents generally induce endothelial damage and subsequent thrombosis leading to vessel occlusion. It is essential to achieve adequate contact between the agent and endothelium, and they are more often used in veins than in arteries. When there is significant out-flow, blood-flow control (compression, tourniquet, or balloon) is helpful to prevent escape of the agent into systemic circulation. Indications in veins are varicose veins, varicocele, GI varices, and venous malformations. Ethanol has stronger effects and works in arterial embolization and portal vein embolization as well. Excessive use of these agents may induce hemolysis and hemoglobinuria resulting in acute renal failure. When gross hemoglobinuria occurs, hydration and urine alkalization are recommended.

Ethanol: Ethanol causes vessel occlusion by denaturing blood proteins, endothelial damage, vasospasm, and acute thrombosis. Ethanol is commonly used in portal vein embolization and in renal artery embolization for tumors (RCC and AML), AVMs, and functional ablation. It is also used in transcatheter or direct puncture embolization of peripheral vascular malformations. As it can reach

capillaries and diffuse into the adjacent tissue, ethanol has a risk of ischemic local tissue or nerve injury. It can also give serious CNS and cardiopulmonary toxicities.
Detergents: Sodium tetradecyl sulfate (STS) and polidocanol are most commonly used. Both agents can be used as foam by mixing with air or CO_2. Advantages of the foam are that they displace the blood, give longer contact with endothelium, minimize the actual dose of agent, and have echogenecity on ultrasound. Systemic complications are rare; however, visual disturbance appears more likely to occur with foam compared with liquid. There was a report of stroke after foam sclerotherapy in case with patent foramen ovale. Polidocanol is painless to inject because it contains local anesthetic; however, there was a report of reversible cardiac arrest in case with venous malformation. Ethanolamine oleate (EO) is a viscous agent of a salt of an unsaturated fatty acid and has high thrombogenecity. EO is commonly used for balloon-occluded retrograde obliteration (BRTO) of gastric varices, and less commonly used for vascular malformations. EO is often mixed with non-ionic contrast material to achieve radioopacity on fluoroscopy or CT. In the presentation, other less common liquid agents will be included in addition to technical consideration and case presentation for each agent.

301.3

Coils and occluders

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Learning Objectives
1. To review the range of detachable and non-detachable embolization coils, their defining characteristics and deployments mechanisms
2. To review the anatomic features, technical tips, and clinical applications that determine coil selection
3. To describe the technical features of vessel occluders and their in vivo uses

Coils are the second most common embolic agent utilized for percutaneous therapy. Many types and sizes are available. The coils are made of either stainless steel or platinum and come with synthetic fibers to increase their thrombogenicity. Platinum coils are more expensive but cause less severe artefacts on MRI. The size of the desired coil should be matched to the size of the vessel. The coils are advanced out of their carrier sheath into the catheter with the back and of the guide wire. The long floppy end of the guide wire is then used to push the coil through the catheter and deliver it into the vessel. Microcatheter coils can actually be injected with high/pressure injection using 1-3 cc syringes. One of the disadvantages of the coil is that they cannot be retrieved after being extruded from the catheter. Recently, this problem has been removed by the use of electrically, hydrostatically or mechanically detachable coils. Tip of the catheter should be near the centre of aneurysm. We can start with appropriate diameter/length 3D framing coil and we should perform angiogram. After the 3D coil is placed, subsequent coils can be placed using a roadmap performed without contrast to subtract-out initial coil mass. With retrievable coils, if there is any reflex, recoil or malposition, the coil can be withdrawn back into the catheter and removed from the body. Indications for use for coils are peripheral arterial and venous vasculature, intracranial aneurysms and other neuro-vascular abnormalities such as arterio-venous malformations and arterio-venous fistulae. The ideal coil: thrombogenic; an easy, precise, rapid, safe, and motion free deployment; easy to see; wide range of shapes and sizes; no jamming; easy reposition and remove; an exchange-detachment system; MR compatible; non-traumatic to the vessel; cheap. Detachable balloons are suitable for treating high flow pulmonary AVM as well as a large vessel AVF. A few homemade occluders were also published for a large AVF´s treatment. The Amplatzer septal occluder is an occlusion device, which was originally intended for non-surgical closure of atrial septal defects as well as for closure of the fenestration in patients after fenestrated Fontan procedure. However, several isolated reports of another usage can be found in recent literature: occlusion of a left atrial appendage for prevention of stroke, occlusion of a pulmonary or aberrant right subclavian artery aneurysm and an intrahepatic veno-venous fistula or closure of a patent ductus arteriosus.

301.4

Glue and Onyx

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Learning Objectives
1. To describe the distinguishing features of glues and Onyx
2. To review the clinical outcomes and indications of glue or Onyx use for vessel occlusion
3. To review technical tips and clinical caveats for using glue or Onyx, define preparation procedures and necessary skills for their safe and effective use

No abstract available

Special Session Simulation

302.1

Simulation: what it is and what it means for IR

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Learning Objectives
1. To identify the terminology used in the world of simulation (haptics, etc.)
2. To describe the different simulator models
3. To summarise the benefits of simulation in terms of enhancing IR training

What is simulation?
Simulation uses the creation of a model to make predictions about some physical process, interaction or event. Indeed, it is 80 years since Edwin Link sought to use simulation to address errors of judgement by aviation crew, still the most important factor in aviation catastrophes today. The origins of his 'Pilot Maker' lay in a fairground game, yet with input from subject experts, psychologists and computer technology, today's aviation simulation has become a tool to train and assess aviation crew in real world conditions. In this way, aviation simulator models are implementing standards for passenger safety. The step from aviation simulation to medicine seems a logical one. The risks of an inexperienced medical trainee, learning new skills in an apprenticeship, may be reduced through 'pre-patient training' [1] that uses medical simulation technologies to improve safety for patients. A simple anatomical model, freestanding or perhaps affixed to an actor (simulated patient), can provide training of visuo-spatial skills and even the context of a real procedure [2]. Animals have been extensively used for skills training, though there are political issues in the UK and USA. Computer-based simulations are also now developing a groundswell of interest, not least through the hegemony of the computer games industry. For interventional radiology (IR), these could provide the perceptions and specific cues encountered, reproduce the effects of an operator's actions in a real patient, and provide an assessment of the trainee's proficiency. Yet

patients are not aeroplanes: their tissues and physiological processes lack the linear, predictable and well defined parameters (airflow, lift, thrust, metallurgy, conductivity etc.) encountered in aviation. Hence, computer modelling of the interactions between instruments and tissues is still, to a greater or lesser degree, an approximation of what would occur in real world practice. What is important is whether the degree of fidelity (faithfulness of replication) provided is appropriate to the task in question.

Simulator models for an IR curriculum

In identifying a simulation to train and assess a specific, curricular, training objective for IR, there is a need to either explore what is currently available, or to design and develop a new device. The design of a simulation that is to correctly replicate the steps of a given procedure should ideally be based on a 'blueprint' of the task as performed in the curriculum. This 'task analysis' uses psychologists to break down video-recorded procedures by subject experts, detailing the operator's perceived cues (visual, tactile, auditory, olfactory etc.) and actions (conscious or subconscious/automatic; gross or fine motor actions). Cues may be specific to the task (the feel of a pulse, observing the location of a dilated calyx), or may relate to the context of that task (a patient cries out, an oximeter beeps). Should an operator decide to respond with an action, it should be possible to perform this correctly or incorrectly in the model. A computer based simulation can then use metrics to objectively assess actions in specific steps that have been graded (by subject experts) as 'critical' to safe completion of the target procedure. Creation of metrics for IR will, for the first time, provide a powerful and discriminatory assessment tool, though clearly there is a need to allow for the range of correct practice encountered. Correct responses of instruments, organs and pathology to an operator's actions requires the non-linear behaviour of human tissues to be modelled. This may be of greater importance where a task, or sub-task, uses subtle visual or tactile (haptics='feel') cues, or particularly fine motor actions. Yet, therein lies the challenge of correctly predicting the behaviour of tissues that respond differently in respect of sex, hydration, disease, age etc. Data to inform such calculations can be provided in detailed studies of tissues and medical instruments in the laboratory and in vivo. Whilst modelling a patient to the same accuracy as the more predictable aeroplane may be some time off, work to define the necessary parameters in tissues is now being performed at a number of institutions.

Identifying effectiveness in simulations

The transfer of skills acquired in a simulation to procedures performed in patients (transfer of training) is more likely where there is an appropriate level of fidelity such that: 1. all possible correct and incorrect steps of the target procedure can be correctly replicated (content validity); 2. the simulation, including its instruments, imaging and context, appear sufficiently realistic to convey a sense of 'presence' to the operator (face validity); and 3. any assessment tool(s) detects errors of, and correctly measures, those steps that have been validated by subject experts as being important to safe completion of the task (construct validity). Arguably the most investigated medical, computer-based simulation to date has been the Minimally Invasive Surgical Trainer (MIST-VR, Mentice, Gothenberg, Sweden). Its development followed detailed task analysis of the target procedures, replicating eight key skills that were common to a number of laparoscopic tasks. Skills transfer to procedures in patients was shown for MIST-VR in a study by Seymour et al. [3] and others. Similar effectiveness of training was shown for colonoscopy skills, with reduced pain scores in patients following simulator training, compared with an apprenticeship trained group [4]. Such effectiveness has been slow to accrue for endovascular simulations, though Chaer et al. [5] claimed skills transfer for cognitive, and some motor skills in a straightforward iliac task using the Vascular Interventional Surgical Trainer (VIST-VR, Mentice, Gothenberg, Sweden). Yet, a number of limitations of this study included an un-validated, observer based assessment tool, which failed to measure lower level behaviours, in particular dexterity, which is critical to safe performance of some key procedural steps in patients. In addition, the simulator trained group received additional cognitive training, which was not delivered to the apprenticeship trained group. Claims that this study of an iliac task provides evidence for effectiveness of carotid procedural simulation appear unfounded. Neequaye et al. [6] claimed to show skills transfer in the VIST-VR, though this related to skills transfer between iliac and renal tasks in the simulation, which is of limited relevance to procedures in patients. Lewandowski et al. [7] evaluated content in carotid, renal and iliac interventions in both the VIST (Mentice, Gothenberg, Sweden) and AngioMentor (Simbionix Ltd, Lod, Israel) endovascular simulations; they concluded that these were suitable to train cognitive steps, which are of great importance to safe completion of complex procedural tasks, but that fidelity was as yet insufficient to train fine motor actions and other means (e.g., apprenticeship in patients) were required to train these skills. For assessment purposes, metrics in current use range from high level, surrogate measures of procedure and fluoroscopy time, and contrast volume to error metrics such as catheter 'dragging' in the aortic arch. An ability for such metrics to discriminate expertise has been shown by some workers, though others found that the use of performance and fluoroscopy times as metrics did not show construct validity [8].

What this means for IR: now and in the future

Simulator based training can reasonably be conducted today with a mentor, within and as a part of a defined curriculum (e.g., Royal College of Radiologists). Current endovascular simulations can be used to train procedural steps and sequencing, and the use of instruments [9]. Indeed such experience is available, with mentors, in the simulator galleries of the annual CIRSE meeting. Yet, there remains a technology gap in computer-based simulator training that seems predicated on the level of fidelity that is currently achievable for fine motor actions and related subtle visual and tactile cues. Other training methods are therefore still required, including mentored training in patients within an interventional apprenticeship. There remains a question as to what constitutes 'appropriate' fidelity for a given task or subtask? Task analysis can identify where higher fidelity is needed for specific actions and cues; attaining this is but a matter of course, using technology developments and informed by studies of the interfaces between operator, equipment, patients and context. This process of evolution will also facilitate the use of metrics to evaluate fine motor actions within critical procedure steps, further enhancing the discriminatory nature of procedural assessments. Within a decade, evidence based development of content and fidelity, along with novel hardware and software solutions for medical virtual environments, will predict and measure procedural outcomes with sufficient accuracy to: enable a novice operator to practice complete skill sets in a range of case scenarios; deliberately create and experience errors and their outcomes in complete safety; use metrics for objective assessment of all relevant cues and actions, providing validated formative and summative feedback; train to criteria rather than for a time period; enable experts to refresh/maintain old skills and learn new ones; practice challenging procedures in a real patient's imaging dataset (mission rehearsal), predicting outcomes before performing the procedure for real; and test new medical devices 'in silico' in a range of clinical case scenarios. At such a time, simulation-generated feedback on development, progress and learning needs will motivate the trainee/operator. Satisfactory assessments will be mandatory before moving to procedures in patients. The logbook will have had its day as an assessment tool; instead, the curriculum will incorporate bespoke, standardised test procedures, which will show stepwise, perhaps more rapid, attainment of required competencies, providing fair, accountable, defensible and blinded evidence for certification and revalidation.

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302.2

Technology challenges

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Learning Objectives

1. To provide an overview of various simulation technology and thier complexity
2. To describe the various approaches to simulate an interventional procedure
3. To summarise the key challenges and the future directions of this technology

Training based on an apprenticeship model has been used effectively by the medical profession for centuries. As technology has progressed, many different tools and techniques have been deployed to provide added value to the training process. In recent years, one of the most exciting developments has been the use of immersive virtual environments to provide structured and flexible training scenarios. Hospitals can already purchase bespoke systems from companies such as Symbionix (Tel Aviv, Israel), Immersion Medical, and Mentice. The first generation of medial simulators targeted laparoscopy procedures but training solutions for other fields of medicine are also starting to appear. Great efforts have also been made to try to increase the fidelity of medical simulation to approach that of training on real patients. However, we are still a long way from replicating the real life environment. This presentation provides an update on the latest technology being used to create a medical training simulator, and highlights issues and trends identified by the research team at Bangor and our collaborators in the CRaIVE (Collaborators in Radiological Interventions in Virtual Environments) network. The impact of advances in software algorithms will be discussed, together with the constraints and advantages of using off-the-shelf hardware components. It is important to note that building a simulator is a multi-disciplinary process. And equally important for success are contributions from experts in computer science, task analysis, validation studies, and guidance from subject matter experts. Case studies will be presented with a focus on the various approaches to deliver training environments for interventional radiology procedures such as the Seldinger technique. The presentation will end with a forward look at the next generation of medical training simulators and summarise the key challenges and future directions of this technology. We predict that the next generation of virtual environments will closely replicate the real world operating room. The trainee interventionalist, anaesthetist, nurses, and other treatment room staff will participate in a collaborative environment that will support both team and individual tasks. Mock-ups of all of the equipment used in real life will be provided with a high fidelity virtual patient replacing the real patient. One enabling technology in achieving this will be new display technology such as interactive autostereoscopic displays, integrated with a haptics user interface. As well as training applications, diagnosis and surgical navigation will benefit from the latest technology advancements in virtual environments. An interesting development in the latter domain is the use augmented reality (AR) so that 3D graphics techniques can be used to augment the reality as we see it with digital content. For example, the view through a surgical microscope can be augmented with information about the location of delicate structures that are normally out of sight below the visible surface. Eventually, ultrasound guided needle puncture could be replaced by an AR system where a 3D rendering of the target anatomy is overlaid onto the actual patient. We are in a critical period for the future development of medical training simulators. There are certainly procedures where a VE can already provide added value to the training process. The price performance of the processing hardware and other components needed has improved dramatically and software algorithms are becoming more sophisticated and efficient. We are witnessing a significant jump up in the number of solutions available from research laboratories and companies. However, there is still a long way to go before the fidelity of training on a real patient can be matched. It is important that comprehensive validation studies accompany any technological development and that full advantage is taken of multi-disciplinary research to achieve the next generation of medical training simulation.

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302.3

Simulation: time for standards?

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Learning Objectives
1. To describe the problems faced in interventional radiology training
2. To indicate presssures for adoption of simulation in medical training
3. To demonstrate problems with wholesale adoption of simulation
4. To indicate how curricula should incorporate simulation
5. To describe the possible approaches that could be used to standardise the use of simulators in IR training

The other presentations in this session describe much about medical simulation from its earliest development to contemporary high technology simulators and the use of simulation in the future. This presentation considers whether there should be standards for simulation. The answer is plainly *YES*! Thus, we need to step back and consider the reasons for desiring simulation. Once again, the answer is clear; it is to ensure patients benefit by improving training of healthcare workers. Besides being self-evident, contemporary postgraduate medical training in interventional radiology provides particular challenges. The number of working hours has been reduced by legislation and traditional training opportunities are being lost to non-invasive imaging techniques. Simulation offers a possibility to help fill this deficit. In addition, patients and politicians are interested in standards of performance and simulation has potential to play a major role in certification and revalidation. Prof. Sir Liam Donaldson, The Chief Medical Officer in England, has recently stated that "Simulation offers an important route to safer care for patients and needs to be more fully integrated into the health service." (1) He draws parallels with the aviation industry and specifically cites the recent incident when Capt. Chesley Sullenberger successfully landed a passenger aircraft in the Hudson River without loss of life! Is it safe then to say: "Contemporary simulators are sufficiently advanced to allow interventional radiology training and certification to be simulator based?" It is notable that the Israel Simulation Centre presently does not have interventional radiology simulation (2). If this were true, then it would also be true to say that a considerable amount of money could be saved if technicians trained on simulators performed interventional radiology. Hopefully, many of you are recoiling in horror at the very thought of this as you recognize that simulators can only provide a portion of the necessary experience. It is clear then that simulation will have an important role to play, and this brings us back to the need for standards. Simulator development is proceeding rapidly and every generation appears more sophisticated and relevant than the last with the incorporation of physiological monitoring and patient specific anatomy. What can there be to complain about? In a nutshell, educational design demands that the educational curriculum should define the knowledge skills and attitudes required and also the methods of assessment (3). There is a major problem in simulator/simulation design - it is being led by the medical devices industry that is driving the simulator industry. This is of concern to educationalists, certifying/credentialing organizations and also the CIRSE/SIR Simulation Task Force. "Ad hoc" simulator design does not relate to a specific educational framework and hence no matter how attractive the simulation appears, it cannot be assumed to have a valid role in training. In fact, if simulation packages as currently presented were valid, this would imply that the educational challenge was purely mechanistic. Sir Liam points out that "Lessons from the aviation industry show that learning increases if the training is designed and taught by pilots. Training pilots teach in the simulators and 'fly the line' - fly as normal commercial pilots. This ensures that they can spread their knowledge to others during routine flights. It also means that training is respected and appreciated. These positions are highly sought after. It is important that senior doctors become trainers in medical simulation and that the role is not just left to more junior enthusiasts." These doctors should not develop simulation in isolation. Rather, they should work with those developing curricula to identify where simulation has a role to play in medical education. They can then jointly develop educational resources linking simulation to the curriculum. This requires setting of standards for the development and use of simulation in specific contexts within the educational framework.

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302.4

Simulation: past, present and future

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Learning Objectives
1. To provide a short historical review of simulation in medicine
2. To describe the possible requirements for using simulation in education
3. To discuss the future impact of this approach for education in medicine and in IR

The use of mechanical training devices to assist in medical training

has been around for almost 40 years. One of the most famous is "Resusci Anne" a CPR training mannequin developed by a Norwegian company, Laerdal, in the early 1960s [1]. By 1969, the first anesthesia simulator, SIM1, was developed as an aide for learning to intubate. This device consisted of a mannequin with an intubatable airway and limited outputs [2]. As digital technology exploded into a full-blown revolution in the late 1980s and 1990s, a new generation of ultra fast microprocessors became readily available, and the largely mechanical training devices evolved. In the early 1990s, two computer-based anesthesia simulators were commercially produced, based on work at Stanford University (David Gaba) and University of Florida (Michael Good and JS Gravenstein) [3]. By the late 1990s and early 2000s, computer-based, high fidelity simulations became commercially available for a number of different minimally invasive procedures such as angiography, angioplasty, cardiac rhythm management, flexible bronchoscopy, colonoscopy, and ureteroscopy. Today, computer based simulation for medicine encompasses a broad spectrum of training devices ranging from relatively simple devices such as blocks of gel used in ultrasound training [4] to computer-based, high fidelity simulations called Human Patient Simulators that attempt, to the maximum extent possible, to simulate a wide range physiological responses for a variety of procedures from anesthesia to trauma [5]. In between these two ends of the spectrum are very advanced simulations of minimally invasive procedures [6] as well as "Serious Games" computer-based training programs based on entertainment game technology [7]. Concurrent with the development of computer-based simulation has been expansion of human-based simulation. The most common example of this is the "Standardized Patient," which uses actors trained to mimic patients with specific clinical conditions. The use of Standardized Patients has gained widespread use in both training and assessment [8]. As the various types of medical simulation have evolved, they have sometimes been combined into hybrid simulations by clinical educators seeking to compliment a given type of simulation with the capabilities of other types of simulations. An example of this is combining the use of computer-based simulations with Standardized Patients [9]. The use of medical simulation is becoming wide spread and has reached a point that there is even a medical professional society, the Society for Simulation in Healthcare, whose mission it is to: "...lead in facilitating excellence in (multispecialty) healthcare education, practice, and research through simulation modalities" [10]. A number of mainstream medical professional societies and boards such as the American Board of Internal Medicine (ABIM), the American College of Surgeons (ACS), the Accreditation Council for Graduate Medical Education (ACGME), the American College of Cardiology (ACC), the Cardiovascular and Interventional Radiological Society of Europe (CIRSE), and the Society for Cardiac Angiography and Interventions (SCAI), to name a few, all have various levels of activities, policy statements, and programs in place to facilitate the integration of medical simulation into curricula [11]. As technology continues to evolve to improve the capabilities of medical simulation, the challenge shifts from how to create the simulation of a given procedure to using the simulation tools available, in the most effective manner, to improve clinical performance. As Scott says in an article on the future of surgical simulation, *"Only recently have detailed training standards been developed, yielding an increased availability of proficiency-based curricula. Accordingly, simulator-based training is receiving a large amount of attention from surgical societies and oversight organizations, and plans now exist for integration of these new training modalities into mainstream surgical education efforts. However, methods for use of simulation-based technology as a means of assuring competency are far from mature and much work is still needed to be able to meet this pressing need satisfactorily. Continued research will undoubtedly unlock the door to promising new frontiers and we will likely see more widespread adoption of standardized curricula, integrated with traditional apprenticeship-type training practices such as residency and fellowship training for postgraduate trainees and minifellowships, preceptorships, and proctorships for practicing surgeons. In this way, patient safety may be maximized and competency may be systematically ensured and verified"* [12]. As new simulation tools become available, such as patient-specific procedure rehearsal [13,14], the focus of medical simulation will expand from training, which is the acquisition and perfection of skills, to performance which is the application of skills in a given situation to accomplish a task. This ability to directly impact clinical performance, in a positive manner, has enormous potential to significantly improve patient care, but as in the case with training simulations, this potential will only be realized when these new tools are used in a thoughtful, systematic manner.

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Special Session
Liver metastasis

303.1

TACE and intra-arterial chemotherapy

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Learning Objectives
1. To describe patient selection for DEBIRI
2. To describe tips and tricks for injection of DEBIRI
3. To present imaging and clinical follow-up after DEBIRI

Colorectal cancer kills 16,000 patients every year in the UK and 56,000 patients a year in the US. At the time of presentation of the primary tumour, 20% of patients will have colorectal liver metastases (CRLM) and a further 50% will develop CRLM. Partial liver resection in the absence of extra-hepatic disease has a 5 year survival of 26-47%, but curative resection depends on the location of the metastases relative to vital vascular structures, and the pattern of disease distribution within the liver. Despite surgical advances, at least 75% of patients with CRLM have either unresectable disease or have extra-hepatic disease, for which the only treatment options are systemic chemotherapy or best supportive care. For those patients with no extra-hepatic disease or liver dominant disease, image-guided ablative or catheter targeted therapies offer palliative debulking of hepatic disease, and may be curative. These procedures are now delivered in a minimally invasive fashion, using percutaneous or endovascular techniques, and performed mostly by interventional radiologists. The basis of using the hepatic arterial circulation to devascularise, or deliver chemotherapy to, CRLM relies on the fact that once the metastases have reached the hepatic sinusoids from the portal vein, they soon develop an arterial supply. They achieve this by parasitizing adjacent arterioloes, and by inducing neo-vascularisation within their immediate environment by secreting angiogenic substances. Arterial devascularisation, therefore, adversely affects CRLM more than the normal liver, which still receives 80% of its blood supply from the portal vein. In order to overcome the problems of TACE where much of the cytotoxic component probably passes straight through the capillary bed, manufacturers of embolisation particles have loaded the cytotoxic drug into the particles prior to embolisation. The particles, or beads, absorb the drug and carry it to the tumour capillary bed, where it is released in a sustained and controlled fashion. The drug is then released into the surrounding tumour at a steady rate to ensure prolonged exposure and minimal systemic side-effects. The size of bead is selected to allow deep penetration into the CRLM, without the risk of shunting into the systemic circulation. Unlike with HCC, shunting of beads is extremely unlikely, even with the smallest range of beads produced. The beads are mixed with the cytotoxic drug, usually in pharmacy, and left to stand for 1-2 hours. Drug is both absorbed osmotically and bound electrically, depending on the charge. As the beads absorb over 90% of the cytotoxic drug during this time, it is possible to administer selected doses of drug to the liver far more accurately than with conventional TACE. Also, because the beads have a uniform size and are less likely to aggregate, the dose will end up in the tumour bed rather than stagnating in the supplying vessel distant from the tumour. 4-5 French (F) catheters are used to access the celiac axis, common hepatic artery, or right or left hepatic arteries, but more peripheral catheterisation requires passage of a microcatheter (2-3 F outer diameter) in a co-axial fashion through the larger catheter. The microcatheter has its own hydrophilic wire to enable selective catheterisation. Although a 4F catheter can often be advanced well into a lobar or even segmental artery, it is likely to fill the lumen and severely affect the laminar flow of blood. This could adversely affect distribution of injected embolic material. Arterial spasm or dissection, caused by the larger catheter, may even prevent further treatment on that occasion. Identifying CRLM on arteriography can be difficult because, despite their increased arterial supply relative to normal liver, they usually only show enhancement peripherally and this may be quite faint on fluoroscopy. It may be necessary to pass the catheter close to the supplying branch before the lesion is well seen. However, it may not be necessary to identify the feeding vessel supplying each and every metastasis if there are multiple lesions, and it is reasonable practice to embolise a whole segment or lobe in this situation. Because the normal liver receives most of its blood supply from the portal vein, it tolerates complete loss of arterial flow, whereas the CRLM are affected far more by the cessation of the arterial supply. Confirmation of portal vein patency has been regarded as mandatory prior to hepatic arterial embolisation to avoid catastrophic hepatic infarction. The alternative approaches to treating colorectal liver metastases are super-selective, segmental or lobar. Some centres treat the whole lobe regardless of the number of metastases while others prefer to treat individual lesions more selectively. Our preference is for selective lesion treatment or segmental treatment. To overcome the problems of correctly identifying the appropriate feeding vessels, we have been using intra-arterial contrast ultrasound prior to injection of the irinotecan drug-eluting beads. This allows simulation of which parts of the tumour will be treated from individual vessels when the beads are injected. If parts of the tumour do not enhance during contrast injection, then it is important to look for extra-hepatic parasitized vessels. Doses ranging between 100 and 200 mg irinotecan are administered in 100-300 micron diameter beads. Our early experience was that many patients had severe pain immediately following treatment but with refinement of our pharmacological protocol, this has improved considerably. Most patients can be discharged the following day. Patients have a CT scan and clinic appointment 4 weeks later when further treatment is planned. Our experience of using irinotecan beads in patients with colorectal liver metastases will be presented and, along with a review of the literature, guidance will be offered for the most successful way to manage these patients and where this treatment may fit into management paradigms for CRLM.

303.2

Radioembolization

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Learning Objectives
1. To present workload for radioembolization in liver metastases
2. To describe tips and tricks for injection of Y90 loaded particles
3. To present results of radioembolization in CRC metastases

Introduction: the liver represents a frequent site for metastatic disease in addition to being a site for primary cancer. Hepatic metastases from various neoplasms, such as colon, neuroendocrine, and melanoma have a distinct predilection to metastasize to the liver, which in many cases may represent the only or dominant site of disease. In these circumstances, cytoreduction via surgery or in situ ablative techniques aim to influence the natural history of disease progression and improve clinical outcomes. Liver directed therapy utilizing 90Yttrium (90Y) resin microspheres represents a recently introduced in situ multidisciplinary cancer therapy that has caught the attention of many physicians faced with the challenges of treating these complex patients, especially in those who failed all other established treatment options.

Principles of transarterial radioembolization: the pathological-anatomical substrate allowing for transarterial therapies, such as transarterial tumor embolization utilizing 90Yttrium resin microspheres, is based on the dual blood supply of the liver and the fact that most hepatic malignancies derive their blood

supply almost exclusively from the hepatic arteries. Beside transarterial chemoembolization (TACE), in otherwise non-treatable hepatocellular carcinomas, most trans-arterial chemotherapy regimens applied to various tumor entities in the past were ineffective or resulted only in a minor response in the majority of the cases. Radiation is tumoricidal if sufficient tumor doses can be delivered selectively without damaging adjacent normal tissue in the process. External beam hepatic radiotherapy is limited in efficacy in the presence of multifocal or large tumors in the liver since the radiation exposure of normal hepatocytes results in liver insufficiency before achieving tumor kill. From the above discussion, it is evident that the dual characteristics of hepatic tumor altered arterial supply and susceptibility to radiation can be exploited. Combining a high energy radiation source to an appropriately sized trans-hepatic arterial administered embolic microscopic particle would allow radiation to be delivered preferentially to the tumor. A beta-emitter, such as 90Yttrium, would create a zone of high radiation exposure confined to the vicinity of the tumor while maintaining non-tumorous hepatic parenchymal exposure to sub-critical levels. This forms the premise behind selective internal radiation therapy or SIRT. Millions of microspheres, measuring about 30 µm in diameter incorporating 90Yttrium, are injected via a hepatic arterial catheter to the arterial supply of the tumor. SIRT is a technique that allows high average doses of radiation (200 to 300 Gy) to be given to liver tumors with minimal serious effect on the nontumorous liver.

90Yttrium: 90Yttrium, an almost pure beta-emitter is produced by neutron bombardment of yttrium-89 in a reactor. 90Y has a physical half-life of 64.2 hours (2.67 days). The average energy of the emissions from the 90Y is 0.9367 MeV, with an average/maximal penetration range of 2.5 and 11 mm, respectively, in tissue. One gigabecquerel (27 mCi) delivers a total absorbed radiation dose of 50 Gy/kg. In therapeutic use in which the isotope decays to infinity, 94% of the radiation is delivered in 11 days.

Multidisciplinary treatment approach: in order to deliver 90Yttrium resin microspheres safely and effectively, harnessing the skills of many different specialties are paramount. Interventional radiologists, surgical oncologists, medical oncologists, nuclear medicine physicians, medical physicists and radiation safety experts bring invaluable expertise to the treatment process.

Pre-therapy investigations: serum chemical analyses are performed to evaluate hepatic and renal function and to determine the presence of tumor markers. By consensus, an elevated serum bilirubin level is considered a relative contraindication to treatment with 90Y microspheres. Treatment with 90Y resin microspheres must be based on cross-sectional images and arteriograms in the individual patient. The work-up should include CT or MR imaging of the liver to delineate the geographical distribution, the volume and the partition between hepatic parenchyma and tumor, portal vein patency, and extent of extrahepatic disease. Furthermore, FDG PET-CT should be performed in order to provide information about viable tumor tissue prior and after radioembolization. Before 90Y embolization treatment, a diagnostic catheter has to be inserted via the femoral route for angiography and selective catheterization of the hepatic arteries. This procedure is important to evaluate the individual vascular anatomy, to identify small visceral branches, which need to be occluded prior to radioembolization. Then, 99mTc-MAA is injected into the hepatic arteries (99mTc-MAA administered into the right and left hepatic artery according to the individual tumor load of each lobe). A thoraco-abdominal gamma scintigraphy is performed to analyse for any unexpected delivery of the activity (based on aberrant gastrointestinal flow) and to estimate the percentage of injected activity shunting into the lungs. Since the particle size of the 99mTc-MAA is comparable to that of the 90Yttrium resin microspheres, the gamma scintigraphy provides valuable information concerning distribution of the dose and allows for quantification of hepato-pulmonary shunts. If hepato-pulmonary shunts exceed 20% of the applied 99mTc-MAA activity, the procedure has to be abandoned.

Resin 90Y microsphere activity calculation and delivery: resin microspheres are received in a vial as a 3 GBq dose, and the individual medical centers remove the prescribed activity. By now, the manufacturer recommends one method for activity determination for the resin microsphere; which is called the Body Surface Area method (BSA) method.

90Y microsphere treatment: solitary or multiple lesions distributed in a lobe or both lobes can be treated with single and multiple microsphere treatments successfully. Nomenclature for the current convention for whole liver treatment by first treating one lobe and then the other in 4-6 weeks is termed "sequential" or "lobar" delivery; as opposed to the whole liver at one setting, in which case it is termed 'bilobar' in the absence of a lobectomy.

Toxicities and post treatment course: the incidence of complications is low if patients are selected appropriately and delivery technique is meticulous. The most common side effect following treatment is mild to moderate fatigue and abdominal pain generally lasting less than 2 weeks. Nausea and vomiting are less common and if severe may be a harbinger for gastrointestinal deposition. Radiation pneumonitis following lung exposure can occur when the dose to the lung exceeds 30 Gy. Radiation gastritis and gastrointestinal ulceration occur in less than 10% of cases; the vast majority of such cases have been managed conservatively without sequelae. Gall bladder wall edema is a common finding following treatment, but cholecystitis requiring a cholecystectomy is rare. Radiation induced liver disease (RILD), erroneously called radiation hepatitis, is a form of hepatic veno-occlusive disease. This presents clinically as a triad of hepatomegaly and anicteric ascites. Steroids have been the mainstay of therapy and have a poor and variable success at altering the natural history of the disease process and in most instances hepatic insufficiency associated morbidity ensues. Fortunately, the reported incidence of RILD is low. Translation of dosimetry research may translate into mitigating this incidence. Cross sectional imaging with CT/MRI is performed between 60 and 90 days following treatment to avoid radiation therapy tumor edema as erroneously being interpreted as progression. These decrease attenuation changes in the hepatic parenchyma may be noted on CT and are largely reversible. PET or PET-CT scans may be of use in cases of discordance where tumor markers are not elevated and CT scans suggest progression or to distinguish the site of progression in the presence of extra-hepatic disease when impossible clinically.

Conclusion: the intra-arterial administration of 90Yttrium resin microspheres (SIRT) is a liver targeted, promising therapeutic approach for patients with otherwise non-responding primary or secondary liver tumors. Initial studies indicate that a combination with modern systemic treatment concepts is feasible and provides favourable tumor response. Patient selection is crucial and has to be carefully considered in a multi-disciplinary setting comprising interventional radiologists, surgical oncologists, medical oncologists, nuclear medicine physicians, medical physicists and radiation safety experts. Standardization of dosimetry and treatment techniques, achievable only in clinical trials, is necessary to arrive at conclusions supportive of therapeutic effectiveness. Registry data will be necessary to provide guidance on therapeutic effectiveness and for disease types for which clinical trials are not feasible. Such efforts are underway.

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303.3

Radio-frequency ablation

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Learning Objectives

1. To present patient selection for RFA
2. To present technical limitations, and possible solutions, of RFA
3. To present results of RFA vs. surgery

The liver is the most common site of metastasis from colorectal cancer. Fifty percent of patients develop liver metastases, which are the major cause of morbidity and mortality in these patients. Without treatment or resection, the 5-year overall survival rate is only 1%, with a median of 6-9 months. Short- and long-term survival after hepatic resection of colorectal cancer metastases derived from surgical case series have been reported to range between 31 and 58% in carefully selected patients [1]. In a nationwide US study, Robertson et al. [2] used Medicare data to investigate operative mortality and long-term survival in 3957 patients who underwent hepatic resection for liver metastases. The 30-day and 90-day mortality rates were 4 and 8.2%, respectively, and the 5-year survival rate was as low as 25.5%. In addition, resection can be offered to only a small number of patients (5-20%). The results of chemotherapy have improved over the last years. However, combinations of chemotherapy with the latest antiangiogenic drugs achieve only a median survival of less than 24 months [3,4]. There is a need to improve treatment approaches for patients with liver-limited disease. RFA is a local curative tumor destruction method by generating heat within the tissue using high-frequency alternating current. It has a relatively low complication and mortality rate [5]. The therapeutic efficiency of radiofrequency ablation of primary and secondary hepatic malignancies has been reported in a number of clinical studies [6-16]. Recently, Gillams and Lees [3,17] published the 5-year survival data in 309 patients treated at 617 sessions. For 123 patients with five or less metastases of 5 cm or less maximum diameter and no extrahepatic disease, median survival was 46 and 36 months from liver metastasis diagnosis and ablation, respectively; corresponding 3- and 5-year survival rates were 34 and 24%. Sixty-nine patients had three or less tumours of below 3.5 cm in diameter and their 5-year survival from ablation was 33%. Significant survival factors were the presence of extrahepatic disease ($p<0.001$) and liver tumour volume ($p=0.001$). Many other studies confirmed that the most important prognostic parameter for local tumour control after RFA is the size of the lesion [9,12,14,15,18,19]. Thus, using the conventional guidance techniques, RFA is currently indicated for irresectable liver metastases <3-4 cms. The likely reason for the high recurrence rate in large lesions is the discrepancy between the geometry of the tumour and the geometry of the necrosis that is induced by RFA. For large tumors, multiple probes have to be positioned in a way to produce overlapping necrotic areas to cover the entire tumor. This is barely achievable by conventional freehand US-, CT-, or MRI-guidance, requiring a change of the current tumor ablation strategies. Mathematical models for the overlapping modes [3,17,20] and the application of stereotaxy [21] have shown to decrease the local recurrence rates of large tumors after RFA.

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Special Session
Renal artery stenosis and the ischemic kidney

304.1

What is a significant stenosis?

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Learning Objectives

1. To learn the physiopathology of renovascular hypertension
2. To learn techniques available to detect "significant stenosis" (including lab tests and duplex)
3. To propose an algorithm to explore clinically suspected patients according current recommendations and for PTA indications

The question of what constitutes a "significant" stenosis in the renal arteries is complex, since one must consider hemodynamic, physiologic, and clinical significances. Clinical significance of a renal artery stenosis (RAS) can be subdivided into at least three elements: perfusion required for renal viability, perfusion needed for renal excretory function, and ischemia thresholds for activation of neuroendocrine systems that promote hypertension.

Hemodynamic significance: conventionally, "hemodynamic" significance is considered stenosis that results in flow restriction at rest. Conveniently, flow has been shown to drop off with approximately 50% diameter stenosis (75% by area). It is important to note that symptoms and results of revascularization are best predicted with translesional pressure gradients rather than angiographic measurements of stenosis. For example, in the 1960s, Flanigan examined femoral-brachial pressure indexes and found that a relative pressure gradient between the two predicted clinical improvement after lower extremity bypass surgery better than angiographic measurements, with a diameter stenosis of 50% being only 92% sensitive and 71% specific for clinical outcomes compared to 100% for both if a 15% relative pressure gradient was present[1]. Similarly, Thiele and Strandness found that angiographic measurements of stenosis were relative insensitive and nonspecific for detecting pressure gradients at rest, with about 69% sensitivity and 75% specificity for detecting a 10 mm Hg systolic gradient at rest or a 20 mm Hg gradient after vasodilation[2]. Similar results have been observed in the coronary circulation[3,45]. There are also physiologic and anatomic variables to consider in the discussion. For example, vasodilation may be more important in detecting clinically important pressure gradients in vascular beds with relatively high resistance at rest and lower resistance during activity, such as the lower extremity or mesenteric arteries, but perhaps less importance in low-resistance vascular beds at rest, like the cerebral circulation. In the renal arteries, pressure gradient has a linear relationship to flow[6] and minimum lumen diameter (MLD)[7]. In another series, translesional systolic pressure gradients were measured for patients with "moderate" renal artery stenoses (30-75%) and showed poor correlation with angiographic measurements of stenosis[8]. In this series, intraarterial injection of acetylcholine significantly increased the systolic pressure gradient, and those with a gradient >20 mm Hg (with or without Ach) all had blood pressure improvement after intervention in this uncontrolled case series[8]. Mitchell et al. supplemented resting pressure gradients by injecting 32 mg of papaverine and repeating measurements for at least 60 sec, then baseline mean, hyperemic mean, and FFR were calculated[9]. Fractional flow reserve (FFR) is defined as the maximum flow through the stenotic artery (hyperemia) divided by the maximum flow through the nonstenotic artery. Maximum flow without a stenosis is calculated as: $Q^n = (P_a - P_v) /R$, where Pa is the arterial pressure, Pv the venous pressure, and R the resistance between the two. With maximal vasodilation, R is minimal; however, with renal artery stenosis, there is vasoconstriction of the post-glomerular arteriole (which helps preserve filtration function), and the maximal flow in the presence of stenosis is expressed as: $Q = (P_d - P_v)/R$, where P_d is the renal artery pressure distal to the stenosis after vasodilation. FFR is then calculated as Q/Q^n. Essentially, this distills down to a ratio of the pressure in the renal artery distal to the stenosis after vasodilation to the aortic pressure (P_d/P_a), or a relative pressure gradient as opposed to an absolute one[9,10]; it has shown good correlation with the resting mean translesional pressure gradient and with clinical improvement where FFR was calculated as <80%[9].

Physiologic significance: RAS ≥50% is present in 14-40% of those with aortoiliac disease or lower extremity PAD[11-16,17,18-20,21]. A II is a potent vasoconstrictor[22] that is implicated in end-organ damage in the heart[23] and kidney[24]. With unilateral renal artery stenosis, and a normally-perfused contralateral kidney, blood pressure elevation is referred to as "renin-dependent" and is characterized by increased peripheral resistance[25-29,30,31], as does denervation of the affected kidney[32,33,34] showed that a renal artery stenosis of 50% is associated with a pressure gradient of 22 mm Hg in the renal artery, a reasonable threshold for hemodynamic significance. But perhaps more importantly, De Bruyne has shown by experimental stenoses and pressure gradient measurements using an 0.014" pressure-sensing wire that when the relative pressure in the renal artery is reduced by as little as 10% that rennin production increases, increasing rapidly up to about 50% pressure gradient[35]. Using Gross' data, the percent diameter stenosis estimated to result in a 10% systolic pressure gradient would be slightly more than 50% for most patients. However, these data argue for using pressure measurements to select patients for revascularization, as opposed to angiograms, because two-dimensional angiograms showing stenoses in the 50% range can show little or conversely substantial pressure gradient.

Clinical significance: renal viability can be preserved with blood flow as low as 10% of normal[36]; however, animal and clinical data suggest that a renal artery stenosis has to be ≥70-75% to result in clinical sequelae[29,37,38,39,40] of 46 surgical patients, none with a trans-lesion pressure gradient less than 40 mm Hg measured using needles placed in the arteries directly improved after surgery, while 78% of those with gradients >40 improved. Ironically, severity of renal artery stenosis has not been shown to correlate well with impairment of renal excretory function[41]. In fact, in one series, measured glomerular filtration rate (GFR) was *higher* in the kidney with the stenotic renal artery compared with the one without renal artery stenosis[42]. The ultimate definition of a significant stenosis is that which causes a clinical syndrome that is improved if reversed. In the renal circulation this poses a problem, since clinical trials have failed to show that reversal of the stenosis results in clinical improvement compared with medical therapy[43-45,46]. Similarly, IVUS measurements have shown good correlation with translesional pressure gradients[47]. MRA and CTA are being evaluated, but still compare less favorably for selecting patients for revascularization than contrast angiography and intravascular pressure measurements.

Conclusions: in terms of hemodynamic significance, there is some consensus on a 70% diameter stenosis being clinically relevant, and probably also on a peak systolic translesional pressure gradient of >20 mmHg measured with a pressure-sensing 0.014" guidewire. However, the overall question of clinical significance remains unanswered, and until resolved largely renders the discussion of hemodynamic significance moot.

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304.2

What is renal reserve (FFR)?

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Learning Objectives

1. To learn what renal reserve is and the techniques to assess it
2. To learn how it could potentially change the indications for PTA
3. To learn the way to integrate this data in an interventional routine

No abstract available

304.3

Update on CTA

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Learning Objectives

1. To learn techniques and recent developments of renal CTA (including stents visualization)
2. To learn problems and limitations of these techniques
3. To learn results of stenosis evaluations and perspectives beyond stenosis assessment with CTA

CT angiography (CTA) is used in the depiction of significant Renal Artery Stenosis (RAS) since the introduction of spiral CT with good results. In 1994, Galanski et al. noted a sensitivity of 100% and specificity of 94% in the evaluation of significant RAS for renal vascular hypertension. In 2001, Boudewijn et al. made a meta-analysis evaluating multiple modalities: the area under the ROC curves was 0.99 for CTA and MRA, 0.93 for sonography and 0.92 for captopril renal scintigraphy. Presently, CT systems allow a rapid acquisition of large volumes of data with isotropic resolution allowing three-dimension data to be reconstructed in any plane. CT technology using submillimeter acquisitions combined with subsecond gantry rotation permit CTA examinations to be obtained more rapidly with improved temporal and spatial resolution in *x*, *y* and *z* axes. RAS is the most common cause of secondary hypertension (5% of all patients with hypertension). The diagnostic modalities and therapeutic strategy are wide. Clinical practices vary considerably across hospitals and physicians. In 2006, van Helvoort-Postulart et al. showed that diagnostic imaging tests appears to be justified, even in a population of patients with hypertension and a relatively low prevalence of renal artery stenosis. They conclude that: immediate tentative revascularization is cost-effective in patients highly suspected of having renovascular hypertension; CTA is cost-effective in patients for whom there is low suspicion; and medical therapy is cost-effective in patients in whom renal artery stenosis is unlikely.
Preservation or improvement of renal function is another important indication for renal revascularization. The results of renal revascularization on renal function are not very good and they seem to be more beneficent if the renal function is declining and not stable. So patients that are likely to benefit from renal revascularization and, therefore, candidates for renal CTA are those with refractory hypertension, progressive azotemia, acute renal failure on angiotensine converting enzyme inhibitors, recurrent flash pulmonary edema and candidates for salvage therapy in the recent onset of end-stage renal disease. The major current advantages of CTA compared with MRA are improved spatial resolution (especially important in the suspicion of fibromuscular dysplasia of renal arteries), the ability to determine the extent of atheromatous calcification, the ability to evaluate intra-stent permeability and the capacity to evaluate simultaneously stone disease. The presence of calcification is better visualized by CTA than any other modality. Evaluation of the extent of the calcified plaque is important for planning the therapy, namely to evaluate the extent of "stenting". In other hand, parietal calcifications can cause problems in the stenosis quantification made by CTA. Its high density can cause difficulty the visualization and the limitation of the contrast opacified lumen. In contrast to catheter angiography, MRI (phase contrast/SSFP) or Doppler evaluation, CTA is not currently used to obtain functional information, regarding elevated pressure gradients or altered flow dynamics. Renal perfusion evaluation, assessed by CT, can be used for functional evaluation, although it requires extra radiation and contrast exposure. Renal CTA is a wide available effective tool, with a high spatial resolution on the evaluation of the renal vasculature.

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304.4

Update of MRA including functional imaging

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Learning Objectives

1. To learn current techniques for renal MRA including MRA without contrast injection
2. To learn problems and limitations (incl. contrast media discussion)
3. To learn about perspectives of functional imaging and how to integrate this data in interventional decision

Renal artery stenosis is a progressive disease; more than half of all high-grade stenoses progress to occlusion within only 2 years. A publication in the New England Journal of Medicine has stressed the fact that renal artery stenosis with the consequences of stenosis-induced hypertension and chronic renal failure represents only a small entity among a number of overlapping disease complexes including atherosclerotic vascular disease, primary hypertension and renal parenchymal disease. Imaging of renal artery stenosis (RAS) requires a comprehensive assessment of the morphologic degree of stenosis, the impact on renal function and the differentiation of any underlying renoparenchymal disease. Conventionally, these diagnostic questions have been partially addressed by the use of a multi-step imaging algorithm including digital subtraction angiography (DSA), renal scintigraphy and duplex ultrasound. Magnetic resonance imaging (MRI) holds the potential to combine morphologic and functional information within a single exam using high-resolution 3D contrast-enhanced MR angiography (3D-CE-MRA), phase-contrast flow measurements (PC-flow), time-resolved perfusion measurements (TR-perfusion), blood oxygen dependent measurements of R2* (BOLD-R2*) and diffusion weighted MR-imaging (DW-MRI). Ideally, a 50% diameter stenosis has been defined as hemodynamically significant which corresponds to a 75% area stenosis. However, it is well known from pathology studies that atherosclerosis of the vascular wall does not spread uniformly but frequently causes eccentric and irregular narrowing of the vessel lumen. This has been overlooked for a long time, and for decades measurement of the diameter stenosis on DSA has been and still is considered the gold standard of stenosis grading. 3D-CE-MRA with isotropic sub-millimetre spatial resolution allows grading of the area stenosis with good correlation to intravascular ultrasound. Recently, 3D MRA techniques also without IV contrast have become available. PC-flow allows to accurately assess the hemodynamic significance of a stenosis. Data from a tricenter study has shown the synergistic value of a combined morphologic and functional grading of renal artery stenosis by 3D-Gd-MRA in combination with phase-contrast flow measurements. In comparison with DSA, the number of correctly graded stenoses could be increased from 82 to 97% on a 2-point scale. TR-perfusion and DW-MRI can detect and differentiate various causes of underlying renal parenchymal disease. This is of particular importance in the case of impaired renal function without presence of a hemodynamically significant stenosis. In one study with intravascular iron oxide contrast agents, substantial differences in renal perfusion were found between normal kidneys (approximately 380 ml/100g/min renal regional blood flow) and those kidneys with parenchymal damage exhibiting only a regional renal blood flow of 170 ml/100g/min. A more easy and robust approach for the clinical routine is dynamic MR perfusion and glomerular filtration measurements with extracellular gadolinium chelates. The availability of high performance cardiovascular MRI scanners with improved gradient performance allows the use of saturation recovery gradient-echo sequences that offer high signal linearity and high temporal resolution. The great advantage of this type of functional imaging of the renal parenchyma is that it can be easily integrated into a comprehensive renal exam since only few milliliters of gadolinium chelates are required for absolute quantification. BOLD-R2* allows to assess impairment of medullary blood flow in diabetic nephropathy under functional stress. The introduction of ultra small particle iron oxide contrast (USPIO) agents offers the possibility to directly image and differentiate inflammatory changes of the kidney, e.g., in the case of glomerulonephritis. Clinical examples for the use of this comprehensive MRI algorithm include assessment of RAS prior to intervention, differentiation between RAS and causes of primary parenchymal diseases such as glomerulonephritis, hypertensive nephrosclerosis and diabetic nephropathy.

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Foundation Course Trauma

701.1

Clinical features

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Learning Objectives

1. To review the various mechanisms of trauma and their effect on body structures (pelvic ring, limbs, mediastinum, base of the skull, solid organs, etc.)
2. To review the most common lesions in which embolization should be proposed
3. To review the indication specific to splenic/renal/hepatic injury

The mechanism of injury can be either a blunt or a penetrating trauma. The lesion pattern of a stab wound or a projectile will depend on its trajectory; therefore, regional imaging by ultrasound or multi-detector computer tomography (MDCT) will suffice to choose and plan interventional or surgical therapies. In blunt high-energy trauma, multiple organs of the torso or the head may be affected contemporaneously and possibly leading to life-threatening hemorrhage. Immediate contrast-enhanced MDCT of the head, the chest, the abdomen and the pelvis allows the assessment of the site of bleeding, the severity of injury of major arteries or solid organs and the quantification of the blood loss. In addition, the presence and the degree on stability of spinal or pelvic fractures are rapidly assessed on MDCT. Hemodynamic and respiratory parameters as well as the MDCT findings essentially determine the multidisciplinary approach ranging from resuscitative thoracotomy or laparotomy to non-operative management. During the past two decades, a shift to non-operative management has occurred with around 70% of blunt hepatic injuries and 80% of blunt spleen injuries being currently treated conservatively or by transarterial embolization or percutaneous drainage in selected cases. Pelvic ring fractures with major ligament disruption (APC II, LC II, vertical shear) or acetabular fractures involving the anterior column require more blood transfusions and embolization may be requested. During this session, the different clinical scenarios and their CT appearance with emphasis on patient selection for interventional hemorrhage control will be discussed.

701.2

Logistics

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Learning Objectives

1. To review the current triage technique (when CTA/echo should be done)
2. To show the main features of CTA findings and how it can help the IR to more efficiently target the appropriate lesion
3. To explain the importance of predefined protocols in the trauma centre

To provide an effective radiology trauma service requires availability of radiologists, CT and vascular radiographers (technicians) and high quality nursing and anesthetic support. CT and IR rooms must be close to the emergency room and designed with the severely injured patient in mind being equipped with all resuscitation and monitoring equipment. The very minimum CT requirement is 16 slice but IR rooms do not necessarily have to have state-of-the-art imaging though CO_2 is occasionally useful. Ultrasound is useful for guidance. All embolisation materials as well as stents and stent grafts may be required and a full range of catheters wires and co-axial catheters need to be available.

701.3

Techniques

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Learning Objectives

1. To discuss how to choose the appropriate embolization material
2. To explain how to adapt the embolization technique to the clinical condition
3. To describe the most frequent and dangerous mistakes that should be avoided

Embolization in trauma is potentially life-saving if you are familiar with selective catheterization and embolization techniques.

Choice of embolic agent/technique: the CT scan is invaluable in assessing anatomy and planning treatment/approach. Embolotherapy therapy is appropriate in patients with a single life threatening focus of bleeding.

Consider: • The site of injury/clinical scenario. • The treatment options available. • Your ability to perform the procedure/use the embolic agents required. The following principles apply: 1. Consider using an occlusion balloon to temporize and allow the patient to be stabilized during treatment. An inflow arterial occlusion balloon can also control venous haemorrhage. 2. Consider the consequences of ischaemia of the target organ. This must be weighed against the risks of continued bleeding and alternative treatment strategies such as stent grafting or surgery. 3. Choose embolic agents appropriate to the clinical scenario. • Coils/microcoils are chosen for focal bleeding where selective catheterization is possible or to embolize proximal to collateral vessels in order to reduce the perfusion pressure to a specific site. • Gefoam is suitable when there is diffuse injury e.g., to the liver • Agents such as cyanoacrylate adhesive, polyvinyl alcohol particles or Apmplatzer vascular plugs are occasionally useful. 4. Be as selective as time allows. 5. Where flow must be preserved, consider stent grafting or surgery. Loss of organ function may be acceptable when the alternative is death.

Pitfalls and dangers

Contraindications: • In patients who are severely unstable, these patients require immediate surgery. Patients with major injury will require physiological support, medical/anaesthetic assistance is mandatory; • When there are multiple sites of haemorrhage without a single dominant bleed.

Lack of preparation: the logistics of the procedure should be discussed with the trauma team and also the vascular nurse and radiographer. Make sure the angiography suite is set up with all anticipated equipment ready. If there is more than one injured patient or the case is particularly complex, consider calling a colleague for assistance.

Coagulopathy: is common due to cooling, multiple transfusion and diffuse intravascular coagulopathy. This is relevant at two points in the procedure; • If the embolic agent requires coagulation to be effective e.g., coils; • At the end of the procedure when it is time to obtain haemostasis. Consider leaving a sheath in situ until clotting is corrected or using a closure device.

701.4

Other options

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Learning Objectives

1. To review the potential of stent graft in large vessel trauma
2. To review the potential of stent graft in medium-sized vessel trauma
3. To describe the aortic balloon occlusion technique for desperate cases

No abstract available

Special Session IVC filters

702.1

Overview of current devices

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Learning Objectives

1. To present the different types of filters available in 2009
2. To describe permanent and retrievable filters
3. To describe the techniques used to remove filters

There is only limited evidence concerning the indications and effectiveness of vena caval filters in preventing pulmonary artery embolism. A recent review of the Cochrane database by Young and collegues [1] yielded only one randomized controlled open trial. This PREPIC trial [2] included 400 patients and published an 8 year follow up. Only permanent filters were used in this trial. While no reduction in mortality was achieved, pulmonary artery embolism was prevented by the vena caval filters at eight years follow up. But there was an increase in deep vein thrombosis seen in the group, which received vena caval filters. Long term complications of vena caval filters can be avoided, when temporary filters or retrievable (optional) filters are being used. Temporary filters require a lasting percutaneous access. Consequently, the risk for infection is very high [3]. Especially since the advent of retrievable filters, which have no permanent connection to the outside of the body this high infection rate is no longer acceptable. Therefore, the use of temporary filters has been widely abandoned. Retrievable or optional vena caval filters can be removed after deployment in the vena cava. In order to be able to perform filter retrieval, two conditions have to be fulfilled. First, there must not be a substantial amount of thrombus

material being caught within the filter. In this case, removal of the filter might cause embolization of the thrombus material and consequently pulmonary artery embolism. Therefore, imaging of the filter before retrieval is mandatory. Second, the filter or parts of the filter must not become too heavily attached to the wall of the vena cava. Wherever the filter is in close contact to the vessel wall, intimal overgrowth will occur. Therefore, the time between filter placement and retrieval is limited. In order to prolong this dwell time interval, rotation and replacement of the filter has been advocated. Furthermore, reports about successful removal of filter systems beyond the allowed or recommended dwell time were reported without any complications. Newer generations of retrievable filters allow for longer dwell times. Filter legs are constructed in a fashion allowing removal of filter hooks and legs without major trauma to the vessel wall even after incorporation of the filter legs into the vessel wall itself [4]. Further developments of vena caval filters try to exploit the possibility of MR guidance for filter placement and filter imaging. Commercially available vena caval filters made out of MR compatible metals can be deployed under MR guidance using the so called passive visualization technique. This technique uses relatively small metal artifacts created in the MR image for localization of the filter and MR guidance during filter deployment. The technique of active visualization requires tuning of the vena caval filter itself to act as a small MR coil. This technique has been shown to allow for MR guidance of first filter prototypes in animal experiments. In addition to vena caval filter, placement the properties of the modified filter can be used for imaging. It was possible to visualize thrombi within active filters, exploiting the enhancement of radiofrequency energy within the tuned filter. There is an ongoing development of new vena caval filters. Without question, these developments lead to improved properties like longer possible dwell times of retrievable filters. Nonetheless, there can be no question that clinical trials are necessary in order to further establish clear indications and to answer the question of effectiveness of vena caval filters.

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702.2

Evidence in 2009

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Learning Objectives

1. To review the evidence for IVC filter placement
2. To discuss the available literature on permanent and retrievable filters
3. To discuss the results of filter removal

The risk of venous thromboembolic (VTE) disease has been recognised for many years, with the first successful vena caval ligation being performed in 1893. Such an open surgical approach carried with it significant morbidity and mortality. In the 1960s, the operative mortality was in the region of 14%. However despite such risks, in some circumstances the risk of harm from VTE was sufficiently high to consider such an option. Anticoagulation became the standard of treatment in the 1960s, with the advent of percutaneously placed filters in the 1970s. When considering the case for and against placement of an IVC filter a risk:benefit analysis needs to be applied for the patient considering the risks of filter placement compared with the likelihood of significant pulmonary embolus (PE). Deep venous thrombosis (DVT) is more likely to embolise if the thrombus extends into the thigh or pelvic veins. Isolated calf DVT is unlikely to result in embolus. Case series data would suggest that between 27 and 60% of DVT in the above knee veins will result in PE[1]. It is also estimated that 90% of fatal PEs are recurrent; thus, there is a potential "window of opportunity" for preventing them. Anticoagulation remains the first line therapy for the prevention of PE; however, there are significant numbers of patients in whom PE occurs despite anticoagulation, or who have a raised risk of anticoagulation precluding its use. The question which needs to addressed by the literature is when an IVC filter is likely to provide benefit for an individual patient, and what risks are to be predicted. More recently, retrievable/optional filters have become available, and the further question arises as to which groups of patients are best served with permanent and which with retrievable devices. When considering literature evidence, the reliability and robustness of that data must be recognised. The Centre for Evidence Based Medicine at the University of Oxford proposed a method for systemically assessing evidence in order that recommendations can be made[2]. This process allocates evidence to: Level 1a - Systematic review of (homogeneous) Randomised Controlled Trials; Level 1b - Individual RCT with narrow confidence intervals; Level 1c - All or none case series; Level 2a - Systematic review (with homogeneity) of cohort studies; Level 2b - Individual cohort study (including low quality RCT e.g. <80% follow-up); Level 2c - "Outcomes research"; Ecological studies; Level 3a - Systematic review of case control studies; Level 3b - Individual case-control studies; Level 4 - Case series (and poor quality cohort and case-control studies); and Level 5 - Expert opinion without explicit critical appraisal, or based on physiology, bench research or "first principles". On the basis of the levels of the evidence, recommendations can be made with varying degrees of confidence (grade A being the most reliable, D the least). Grades were defined as: Grade A - consistent level 1 studies; Grade B - consistent level 2 or 3 studies ***or*** extrapolations from level 1 studies; Grade C - level 4 studies ***or*** extrapolations from level 2 or 3 studies; and Grade D - level 5 evidence ***or*** troublingly inconsistent or inconclusive studies of any level. In the study of IVC filters, there exists a single randomised trial[3]. In addition, this same trial was subsequently published with 8 year follow up data[4]. Inevitably, the data from this trial can only be applied to the patient groups included in the trial. Included in the trial were 400 patients, but to be included the patients needed to: 1. be over 18; 2. have proven acute proximal DVT; 3. NOT have a contra indication to anticoagulation; 4. NOT to have failed anticoagulation therapy; 5. to have a long life expectancy; and 6. NOT to be pregnant. This trial has provided data that has contributed to the usual modern practice of the use of IVC filters in patients who have failed anticoagulation therapy (as evidenced by PE despite adequate anticoagulation), those who have a contraindication to anticoagulants (including pregnancy), and patients with a short life expectancy. In addition, the cohort of patients who were entered into the PREPIC study were not in the other group of patients who often have caval filtration considered, those who have suffered major trauma. The evidence to support, or otherwise, the use of IVC filters comes from outside this single randomised trial. The remainder of the original published data on IVC filters has been in the form of case reports, case series, and cohort studies. In addition, there are reports on the technical developments and potential impact of devices and variations thereof. A recent systematic review of the data has been published[5], and guidelines on their use have been published by associations such as CIRSE (Cardiovascular and Interventional Radiology Society for Europe) [6], SIR (Society of Interventional Radiologists) [7] and the Eastern Association for the Surgery of Trauma[8]. In addition, the relatively recent advent of retrievable ("optional") IVC filters has further altered the landscape, with a whole different potential

approach to IVC filtration. This area too has generated much interest[9], but again there is a dearth of high quality data, and decisions are being made on the basis of low level information. As a result, the recommendations relating to treatment choices must be considered to be grade C or D. The available literature, along with the practice guidance from learned societies, will be reviewed and discussed, with particular emphasis towards the practical information that can be gleaned in terms of potential benefits and risks to patients. This will be used to consider the confidence that can be attributed to the recommendations and how this relates to everyday practice.

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702.3

How to deal with complications

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Learning Objectives

1. To describe possible complications of IVC filters and their management
2. To review in which cases extraction should be stopped because of negative risk/benefit ratio of extraction
3. To describe the complication rate according to the type of filter

No abstract available

Special Session
Controversies in non-vascular intervention

703.1

Vertebroplasty for all?

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Percutaneous vertebroplasty: percutaneous vertebroplasty is a therapeutic, image guided procedure that involves injection of radio-opaque cement into a partially collapsed vertebral body, in an effort to relieve pain and provides stability.

Indications: • Painful osteoporotic VCF refractory to medical treatment. • Painful vertebrae due to aggressive primary bone tumours like hemangiomas and giant cell tumour. In hemangiomas, treatment is aimed at pain relief, strengthening of bone and devascularization. It can be used alone or in combination with sclerotherapy, especially in cases of epidural extension causing spinal cord compression. • Painful vertebrae with extensive osteolysis due to malignant infiltration by multiple myeloma, lymphoma and metastasis. Because PVP is only aimed at treating the pain and consolidating the weight bearing bone, other specific tumour treatment should be given in conjunction for tumour management. • Painful fracture associated with osteonecrosis. • Conditions in which reinforcement of the vertebral body or pedicle is desired prior to a posterior surgical stabilisation procedure. • Chronic traumatic fracture in normal bone with non-union of fracture fragments or internal cystic changes.

Contraindications: ABSOLUTE: • Asymptomatic vertebral body compression fracture. • Patient improving on medical treatment. • Osteomyelitis, discitis or active systemic infection. • Uncorrectable coagulopathy. • Allergy to bone cement or opacification agents. • Prophylaxis in osteoporotic patients. RELATIVE: • Radicular pain. • Tumour extension into the vertebral canal or cord compression. • Fracture of the posterior column - increased risk of cement leak. • Vertebral collapse >70% of body height - needle placement may be difficult. • Spinal canal stenosis - asymptomatic retropulsion of a fracture fragment causing significant spinal canal compromise. • Patients with more than five metastases or diffuse metastases. • Lack of surgical backup and monitoring facilities.

Patient selection: a multidisciplinary team consisting of a radiologist, spine surgeon and referring physician (rheumatologist or oncologist) must come to a consensus on which patients should undergo this procedure and to ensure appropriate adjuvant therapy and follow-up. A detailed clinical history and examination, with specific emphasis on the neurological signs and symptoms, should be performed to confirm the underlying VCF as the cause of debilitating back pain and rule out other causes like degenerative spondylosis, radiculopathy and neurological compromise. This should be correlated with the imaging findings. In osteoporosis and metastatic disease, fractures may be present at multiple levels, not all of which require treatment with PVP. Manual examination under fluoroscopy localises and identifies the painful vertebral body.

Time of intervention: the ideal candidate for PVP is one who presents within four months of a fracture, has midline non-radiating back pain that increases with weight bearing and which is exacerbated by manual palpation of the spinous process of the involved vertebra. Ideally, patients should have at least 3 weeks of conservative treatment, failure of which should prompt one to consider PVP. Intervention within days of a painful VCF is considered in patients at high risk for decubitus complications like thrombophlebitis, deep vein thrombosis, pneumonia and decubitus ulcer. There is increasing clinical data now available on the usefulness of PVP in the treatment of chronic osteoporotic fractures more than a year old.

Imaging: preoperative planning requires radiographic studies to

identify the fracture, estimate the duration of fracture, define fracture anatomy, assess posterior vertebral body wall deficiency and exclude other causes of back pain like facet arthropathy, spinal canal stenosis or disc herniation and determine the relevant level/s in cases of multiple fractures. An MRI is a must in all patients considered for PVP as it provides both functional and anatomical information. T1, T2 and STIR sequences in axial and sagittal planes are required. Bone scans are useful in determining the age of a fracture. An increased uptake of tracer "hot scan," is highly predictive of a positive clinical response following PVP. If there is any doubt regarding the intactness of the posterior vertebral wall, a limited CT scan through the intended level/s should be performed.

Technique: the procedure can be performed under local anaesthesia and sedo-analgesia or general anaesthesia. Strict asepsis is maintained. A prone position is used for the thoracic and lumbar vertebrae and a supine position for the cervical region. The classical transpedicular route is preferred in the thoracic and lumbar vertebrae as it is inherently safe. This can be performed either by a unipedicular or bipedicular approach. An intercostovertebral route is useful in the thoracic spine when the pedicle is too small or destroyed. It is associated with a higher risk of pneumothorax and paraspinal haematoma. The postero-lateral approach is an alternative in the lumbar vertebrae but is seldom used. In the cervical vertebrae, antero-lateral approach is used. The needle path should avoid the carotid jugular complex. Using dual guidance or bi-plane fluoroscopy, the needle is tapped into position using a hammer as it provides better control.

Cement Injection: injection of cement is done under continuous lateral fluoroscopic control. The lateral projection is preferred as it allows for early detection of epidural leak. Intermittent AP screening should be done to rule out lateral leaks. The risk of cement leakage is particularly high at the beginning of cement injection. The cement injection is stopped when the anterior two-thirds of the vertebral body are filled and the cement is homogenously distributed on both sides and between both end plates.

Post-procedure care: an immediate evaluation of the patient's condition must be undertaken if there is any increase in pain, change in vital signs or deterioration of the neurological condition. If neurological deterioration occurs, a detailed neurological examination carried out by a specialist is followed by a thin section CT scan of the level/s treated to look for spinal cord or nerve root compression by extravasated cement, which may require urgent neurosurgical decompression.

Complications: published data has placed the complication rates in osteoporotic fractures treated with PVP at <1% and in malignant fractures at <10 %.

Cement leakage: It is often asymptomatic.

Routes of cement leakage: • Epidural space and neural foramina. • Disc space and paravertebral tissue. • Perivertebral venous plexus.

Infection: it occurs in less than 1%.

Fracture of ribs, posterior elements or pedicle/Risk of collapse of the adjacent vertebral body: it has a reported incidence of 12.4%.

Allergic reaction: it is to the cement and is characterised by hypotension and arrhythmias.

Outcome measures

1. Pain relief

- Acute osteoporotic fracture (within 72 hours): 90% success rate
- Chronic osteoporotic fractures (onset is delayed): 80% success rate
- Malignant fractures: 60-80% success rate
- Haemangiomas: 80% success rate

2. Increased mobility

- Acute osteoporotic fracture: 93% success rate
- Chronic osteoporotic fracture: 50% success rate

3. Reduced requirement for analgesics: 91% success rate

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703.2

Kyphoplasty for all?

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The Interventional treatment of Vertebral Compression Fractures (VCFs) has undergone tremendous and expected evolution since its inception by Herve Deramond in the 1980s. Vertebroplasty was the first type of intervention that demonstrated tremendous success in managing the pain associated with VCFs. This allowed the patient to regain physical activity, which was previously restricted due to pain, which improved the quality of life and prevented further advancement of osteoporosis due to subsequent immobility. First performed in 1998, an additional type of intervention named Kyphoplasty was introduced by an orthopaedic surgeon in the US and marketed by Kyphon Corporation (acquired by Medtronic in 2009). The primary difference from vertebroplasty was the introduction of balloon bone tamps via steering bone cannulas into each hemi vertebra to allow creation of bilateral bone voids and potential elevation of the depressed endplates (fracture reduction). This allows the application of the PMMA cement to be performed in a low pressure (compaction) fashion versus vertebroplasty, which is a high pressure system of cement application to the vertebral body. This distinct difference is postulated as the reason why there is a higher cement extravasation/embolization rate in vertebroplasty (20-40%) versus Kyphoplasty (7-9%). The majority of the reported complications was related to the cement extravasation/embolization and includes radicular neuropathies, pulmonary emboli, renal emboli, femoral neuralgia with sciatica, neurological deficit and posterior column deficit with proprioception loss. The symptomatic complication rate is 1.6-3.0% for vertebroplasty and 0-0.3% for Kyphoplasty. The cement extravasation can also increase patient mortality, extend hospital stay and may even require open surgical removal of symptomatic extravasated cement. Pathological vertebral fractures, with particular emphasis on myelomas, are primarily treated with Kyphoplasty, which is supported by the research literature. This is because of the unpredictability of the integrity of the vertebral body due to the invasive, destructive nature of the neoplasm. Cortical margins may or may not be intact and, therefore, the risk of cement extravasation/embolization increases. Kyphoplasty allows the creation of the bone voids and subsequent low pressure application of the thicker cement into these voids with fine control reducing the risk of leakage from the confines of the vertebral body. With retropulsed fragments, there is a relative contraindication to use of vertebroplasty because of the risk of displacing the fragment further posteriorly and causing cord/nerve root compression. On the other hand, Kyphoplasty has never been shown to ever displace a fragment posteriorly. In fact, reduction of the pressure caused by the compression with elevation of the more anterior fracture endplates has many times been shown to pull the fragment anteriorly into a more anatomic position. This

suggests Kyphoplasty is a safer and therefore more clinically useful procedure than vertebroplasty in these situations. The procedure of vertebroplasty has evolved so that a unipedicle approach with as steep an angle as possible toward the midline is preferred. This unfortunately raises the risk of breaching the medial wall of the pedicle as the operator attempts to get as medial and close to the midline as possible in order to facilitate uniform distribution of cement into both sides of the vertebrae. This steep angulation is not necessary in Kyphoplasty as it is a bipedicle approach and the ideal location for the cannulas and balloon tamps is in each mid hemivertebrae. Initial comparisons of vertebroplasty versus Kyphoplasty suggested that the additional cost of Kyphoplasty did not warrant the additional potential benefits. As the complexity of the vertebroplasty kits and cement have increased, so have the kit costs. On the other hand, the costs of Kyphoplasty have actually decreased over time due to refinement of the access trocars and balloon tamps with reduction of the number of steps and subsequent kit supplies as a result. In some markets, the costs are very comparable currently. Initially, Kyhoplasty patients were mandated (arbitrarily) by Medicare in US to be inpatient status requiring an overnight hospital stay and subsequent costs. This has been rescinded and the vast majority is now out-patient procedures and who can go home two hours after the procedure. These two changes make both procedures quite comparable from a cost standpoint. Another advantage of Kyphoplasty is the ease and completeness of acquiring bone biopsies at the time of the procedure. Since many multiple myeloma patients are surreptitiously diagnosed as a result of bone biopsy at the time of spine intervention, the ability to obtain high quality specimens is critical. Vertebroplasty accesses only one half of the vertebral body typically. Kyphoplasty allows biopsies to be obtained from both sides of the vertebrae. The access cannulas entering the posterior margin of the vertebral body in Kyphoplasy are slightly larger in diameter and a dedicated coaxial bone biopsy device supplied by Kyphon produces excellent, long core, continuous specimens from both sides. This aids in the early detection of multiple myeloma patients allowing them prompt evaluation and subsequent treatment; therefore, we have a low threshold for biopsy at the time of the procedure as finding patients like these is of tremendous value. The ease of doing the biopsies bilaterally through the introducer cannulas in Kyphoplasty helps with this decision making process. In summary, I would suggest that any procedure that can be performed more safely, give the same or better results, has greater depth of indications, potentially produces better diagnostic pathologic material and has similar costs is the correct choice for treatment. For all of these reasons, I vote strongly in favor of Kyphoplasty for treatment of vertebral compression fractures.

703.3

HCC: bland TAE is the primary technique

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Learning Objectives

1. Background for bland embolization in HCC
2. Main important features of new embolizing material for TAE
3. Technical considerations for bland embolization with very small particles

There is no standard therapy for patients with hepatocellular carcinoma unsuitable for resection. Cirrhotic patients with HCC not suitable for surgical therapy have a poor prognosis, which is influenced by both hepatic reserve function and tumor staging. TAE and TACE are the most used treatments with a proven improvement on survival in selected patients with well preserved liver function. Several alternative treatments have been proposed, but recently only chemoembolization has been shown to improve survival compared with best supportive care in meta-analyses of randomized trials. However, it is not clear whether embolization alone gives the same survival advantage, whether specific patient characteristics affect outcome, or whether any particular technique in performing transarterial therapy is better than any other. Six randomised trials on arterial embolizations, with or without chemotherapy, have shown a strong antitumoral effect. There is actually no clear evidence that TACE is better than TAE. Theoretically TACE, combining the effect of drug with hypoxia, should be more effective than TAE. Marelli L et al. performed a meta-analysis showing TAE appeared as effective as TACE in achieving same survival improvement. Three different randomized trial studies have failed in demonstrating a significant difference in survival between the two different treatments. In most of the published studies on TAE for HCC, embolizations were performed by using gelatine sponge, an old embolizing agent, which induces ischemia temporarily, by only occluding proximal vessels. Ischemia resulting from embolization probably might be the main factor inducing reduction in tumour size after TAE as well as TACE. Conversely, hypoxia, as it is a potent simulator of angiogenesis, might inadvertently promote tumour growth if embolization of tumor is not complete. Kobayashi et al. showed an increase of serum concentration of vascular endothelial growth factor (VEGF) in patients who underwent TACE, suggesting a direct link between the degree of embolization, tumour hypoxia, and the stimulation of new blood vessel growth. Moreover, it has been suggested that TACE may facilitate the haematogenous dissemination of malignant cells in the systemic circulation by disrupting cell-cell adhesion, and by damaging the endothelium. Although TACE is considered an effective treatment for hepatocellular carcinoma, one of the factors potentially affecting local result is the hypothetical neo-angiogenetic reaction due to ischemia. A recent study has evaluated the changes on blood levels of two angiogenesis factors, VEGF and b-FGF (basic fibroblast growth factor), and one parameter of invasiveness, uPA (urokinase-type plasminogen activator), in patients treated with TACE. The authors concluded that when an untreated portion of tumour is missed, TACE may induce a significant neo-angiogenetic reaction, as suggested by an increase in VEGF and b-FGF after treatment; it may obviously affect patient survival. VEGF emerges as the most reliable prognostic parameter; so it could be even measured for assessing TACE efficacy. Survivin is another important regulator of mitosis and programmed cell death. It is expressed in HCC as a member of the family of apoptosis protein inhibitors, which has been implicated in both controlling of cell division and inhibition of apoptosis. Specifically, its anti-apoptotic function is associated with the ability to directly inhibit caspases, enzymes that cleave cellular proteins, participating in cell death. The authors compared immunohistochemical expression of survivin in liver tumour and non-tumour tissue specimens. In addition, its expression was determined after the treatment of HCC cells with anti-cancer drugs (cultured continuously with 0.1 µmol/L farmorubicin) under hypoxic culture conditions. Under both normoxia (=normal oxygen concentration) and hypoxia, the survivin mRNA concentrations increased in the presence of anti-cancer drugs in the short-term culture. Nevertheless, the survivin mRNA concentrations only increased in the combination of hypoxic culture and anti-cancer drugs in the long-term culture. No survivin protein expression was observed in the only hypoxia culture. In contrast, the survivin protein concentration increased with the anti-cancer drug concentrations. They concluded that survivin could be used as a therapeutic target in early HCC. Looking at these data, the association of anti-cancer drug and hypoxia could have an opposite effect when devascularisation of the tumour is incomplete because of the stimulation of neo-angiogenetic and anti-apoptotic factors in the viable tumour tissue. During the past decade, there has been an increasing focus on cancer therapies with antivascular drugs. In antivascular therapy, the goal of angiogenesis inhibitors is to cause extensive tumor cell death as a

result of localized vascular shutdown causing hypoxia and metabolic deprivation, which in tumors may cause widespread tumor cell death. Apart from angiogenesis inhibitors that compromise the formation of new blood vessels, a second class of specific anticancer drugs has been developed. These so-called vascular disrupting agents (VDAs) target the established tumour vasculature and cause an acute and pronounced shutdown of blood vessels resulting in an almost complete stop of blood flow, ultimately leading to selective tumour necrosis. It represents absolutely the same aim of bland embolization for liver tumors: a permanent shut down of blood flow to the tumor. It can be only achieved if the right target is reached by using the adequate embolizing material. An embolic agent with standardized, precisely and tightly calibrated small particle size, which can be delivered into the smaller peripheral arteries and may cause permanent ischemia should be theoretically more effective than temporary or heterogeneously sized embolic agents. In order to be most effective, embolization with particles should result the terminal vessel occlusion and blood flow shut down, maximizing permanent ischemia. It is well known that proximal vessel occlusion may result in recruitment of intraparenchymal collateral flow, reconstituting the distal vasculature to the tumor. Geschwind et col., on histopathologic analysis, observed that only 100-300 µm microparticles have been detected within the liver tumor in 70% of the animals; conversely, none of the microparticles sized 300-500 µm were detected within the tumour in any of the embolized animals. Based on this background, very small, precisely and narrowly calibrated microparticles are needed in order to obtain occlusion of the distal intratumoral vessels, if the goal is maximizing vascular shut down of the tumor and achieving permanent anoxia (no oxygen at all) rather than hypoxia of tumor cells. Regarding target vessels, microparticles for embolization should be as small as possible in order to flow within the deeper portion of the tissue and fill up the vascular space and then the more peripheral space. Moreover, embolic particles should be very tightly size-calibrated with a small bandwidth in diameter variations, because, if the size range was broad, during administration, larger particles of the same vial may occlude micro-vessels more peripherally and prevent a deeper penetration of the smaller particles. There are currently few studies on clinical applications of new embolic agents, such as resin or gelatine microspheres for liver embolization on HCC, and there is no consensus on the most effective embolic agent for liver treatment. In a large series of TAE performed by using small (50 µm) polyvinyl alcohol particles at the beginning and then spherical tris-acryl gelatine embolic microparticles (40-120 µm), the authors well demonstrated the efficacy of TAE in treating patients with unresectable HCC, focusing the attention no more on drug to be combined for TACE but only on to the technique for embolization because the lack of evidence-based data for demonstrating that the addition of chemo agents may add any survival benefit versus bland embolization alone. In our series, we observed an overall survival rate at 1-year follow-up of 96%, which is well comparable with the overall survival rates of 84% at 1-year FU, reported by Brown at col. 40 um and 100 µm. Embozenes has been chosen for our study on liver bland embolization because of two major features: their well calibrated small size available and the proven anti-inflammatory reaction compared to the other embolic agents. The latter feature has been recently well demonstrated when different sizes and embolic agents have been compared in an animal model in order to assess specific inflammatory and foreign body reactions after liver embolization in pigs. The authors observed less giant cells surrounding Embozene™ Microsphere particles than in corresponding size of different particles. It probably means that Polyzene® - F coating film reduces the inflammatory reaction after embolization, with a lower stimulation for vascular growth factors. We obtained a persistent devascularisation with a progressive reduction in dimension of the treated lesions with a durable 51% PR and 16% SD at a medium-long term follow-up (i.e., 6-12 months), achieving a complete response in 7% of lesions. Re-treatments were necessary in all those lesions in which feeding vessels were more than those detected and treated at the first treatment, and their existence was revealed at the FU after the first treatment. Following the preference of our oncologists, RECIST criteria has been chosen to assess local results by evaluating only variation in size of treated lesions with no reference to the enhancement at instrumental follow-up. All the lesions that resulted completely devascularised at MDCT after TAE with a relative shrinkage were considered as partial response; while, if the same results are re-evaluated by the European Association for the Study of the Liver (EASL) model, all the lesions completely devascularised will be considered as a complete response to the treatment. Recurrence at EASL evaluation model, on the other hand, is known to occur in 10-30% of patients after having achieved CR as detected at MDCT 4 weeks after treatment (32). However, our objective response rate remains high at 6-12 month follow-up with only 26% of PD. Complete response to the treatment with no evidence of disease was seen in our series only in the late follow-up and up to now no recurrence of disease has been detected in these patients. Moreover, we remarked also a good disease control, even in patients with multi-focal disease, in which multi-session treatment was necessary.

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703.4

HCC: DEBeads for all

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Introduction: hepatocellular carcinoma (HCC) is the fifth most common cancer and the third leading cause of cancer-related deaths in men (1). In HCC patients, the tumour develops in cirrhotic livers in most individuals and thus, their outcome is related to both cancer and cirrhosis. The Barcelona Clinic Liver Cancer (BCLC) staging system (2,3) links tumour stage with treatment strategy and may be applied to the majority of HCC patients. Transarterial chemoembolisation (TACE) is the standard of treatment for unresectable HCC in the intermediate stage. It has been shown that TACE achieves partial response in 15-55% of patients (4-11). A systematic review and meta-analysis of randomised clinical trials for unresectable HCC has shown a survival benefit of TACE in comparison to control (12). Therefore, TACE is considered the standard of care (13).

Drug eluting beads: the DC Bead™ drug eluting beads hydrogel particles based on polyvinyl alcohol are capable of loading doxorubicin. It has been shown in animal studies and clinical phase I/II studies that TACE with DC Bead™ resulted in higher tumour concentrations and lower systemic concentrations of doxorubicin (14-20). The four single arm pilot studies with doxorubicin loaded DC Bead™ showed very promising tumour response rates and low complication rates as well (19-22).

PRECISION V trial: in a multicenter, single blind, prospective, randomised, controlled study designed to assess the clinical performance of doxorubicin TACE with DC Bead™ in the treatment of unresectable HCC in comparison with conventional doxorubicin TACE patients were randomised 1:1 to either doxorubicin TACE with the DC Bead™ (test arm) or the conventional doxorubicin TACE (control arm). Included were patients with HCC not suitable for resection, liver transplantation or percutaneous ablation. Patients with multinodular or bilobar HCC were included, and diffuse HCCs with >50% tumour involvement of the liver were excluded. Patients should have a performance status ECOG 0 (asymptomatic) and 1 (limited restriction of daily activities), and a well preserved liver function (Child-Pugh A and up to B7). Patients were excluded with vascular invasion and extra hepatic spread, with another primary tumour and if previously treated with radiotherapy or doxorubicin.

DC Bead™ TACE (test arm): patients received DC Bead™ loaded with doxorubicin at a dose of 150 mg in each procedure. The aim of each procedure was be to deliver 2 x 2 ml vials of DC Bead™ (total 4 ml) loaded at 37.5 mg/ml of doxorubicin. It was recommended that chemoembolization should be performed with one vial DC Bead 300-500 µm followed by one vial of 500-700 µm in diameter. No adjustment was made for bilirubin concentration.

Conventional TACE (control arm): patients received intra-arterial injection of an emulsion of doxorubicin in lipiodol followed by proximal embolization with particles. The goal was to deliver the entire dose of 150 mg of doxorubicin together with up to 10 ml of lipiodol.

In both treatment arms, embolization was performed via a unilateral femoral artery approach, and superselective catheterization of the tumour feeding hepatic artery branches. Patients should receive three chemoembolization treatments within 6 months. The tumour response was evaluated based on contrast-enhanced magnetic resonance imaging (MRI). It was reported according to the Response Evaluation Criteria in Solid Tumours (RECIST) criteria (23) and to the modifications of the European Association for the Study of the Liver (EASL). In accordance with the EASL criteria, responses were defined as follows: Complete Response (CR) - complete disappearance of all known viable tumour (assessed via uptake of contrast in the arterial phase of the MRI scan) and no new lesions; Partial Response (PR) - 50% reduction in viable tumour area of all measurable lesions; Stable Disease (SD) - all other cases; Progressive Disease (PD) - 25% increase in size of one or more measurable lesions or the appearance of new lesions. Objective Responses was defined by CR and PR, Disease Control by CR, PR and SD. In the DC Bead™ arm 102 and in the cTACE arm 110 patients were allocated, respectively.

Results of PRECISION V trial: The mean age of the patients was 67.2 years; 185 (87 %) were male. Complete tumour response was achieved in 25 (26.9%) versus 24 (22.2%) in the DC Bead™ versus cTACE arm, respectively. Partial response was achieved in 23 (24.7%) versus 23 (21.3%), and stable disease in 11 (11.8%) versus 9 (8.3%) patients. Therefore, the objective response rate was 51.6% versus 43.5% (p=0.11) and the disease control rate was 63.4 versus 51.8% in the DC Bead™ versus cTACE arm at 6 months, respectively. In patients with more advanced disease and poorer prognosis (67%) due to Child-Pugh B cirrhosis, ECOG 1 performance status, bilobar disease and recurrent disease the objective response rate was significantly better in the DC Bead™ group (P<0.05). The overall time to progression was median 217±7.84 days in the DC Bead™ arm and 196±4.92 days in the cTACE arm. The time to progression of the treated target lesions did not reach the median in the DC Bead™ arm after 270 days whereas the median time in the cTACE arm was 228 days. The rate of doxorubicin related AEs was significantly higher (13% versus 37%; p=0.0001) in the cTACE arm. Cancer related death due to disease progression within 6 months was observed in 1/102 versus 3/110 patients in the DC Bead™ versus cTACE arm, respectively (24).

Discussion: HCC is a highly chemotherapy resistant tumour. However, doxorubicin has shown to have an efficacy when it is given intraarterially. The trend for higher rates in the objective response and disease control rate in all stratified groups, as it was shown in the PRECISION V RCT, offers the assumption that DC Bead™ TACE is superior to cTACE in the treatment of intermediate HCC. This assumption is supported by the experimental studies that could demonstrate a higher and prolonged retention of doxorubicin within the tumour after DC Bead™ TACE. The American Association for the Study of Liver Diseases considered patients with Child-Pugh B cirrhosis and tumour symptoms (ECOG 1) a contraindication for cTACE. In this RCT, patients with Child-Pugh B and ECOG 1 had a significantly high objective response rate after DC Bead™ TACE. Therefore, the treatment of advanced disease is safe and efficacious with DC Bead™ TACE and can be recommended for these patients.

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703.5

Hilar cholangiocarcinoma primarily treated endoscopically

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Learning Objectives
1. To understand the relatives roles of ERCP and PTC in the management of cholangiocarcinoma
2. To understand the limitations of each method

Hilar cholangiocarcinoma still presents both the radiologist and endoscopist with a most difficult challenge regarding adequate drainage. Any interventionalist considering providing stent therapy for a patient with hilar cholangiocarcinoma needs to consider a few basics beforehand. A full understanding of the anatomy of bile duct obstruction is an essential prerequisite to interventional therapy. The mainstay of anatomical assessment now is MRCP supplemented by CT and ultrasound where necessary. Intervention should never be considered without full anatomical assessment. An understanding is needed of the volume of liver, which needs to be drained in order to provide relief of jaundice taking into consideration the likely extension of disease as growth of the cholangiocarcinoma progresses. Normally between 2/3 and 3/4 of the liver volume needs to be drained in order to provide relief of jaundice and continuing reasonable health, although this volume is influenced by the presence of chronic liver disease. Atrophic segments of liver should not be drained and should not be entered with needle, catheter or guide wire. The fear of sepsis in an undrained segment should be prominent in the interventionalist's mind and segments not to be drained should be carefully avoided. The key questions that the

endoscopist has to consider are firstly, can he be confident that he will gain access only to those segments which require drainage and secondly can he be confident that he will be able to insert stents into those segments? After endoscopic sphincterotomy, the use of curved or straight catheters together with a curved or straight hydrophilic guide wire usually allows easy access to intrahepatic ducts. The use of a sphincterotome can occasionally assist placing a guide wire into an appropriate segment. It is important for the endoscopist to place guide wires into all segments that require drainage before the placement of any metal stent. Once all guide wires are in position metal stents can be placed, usually the left duct first, where required, because this is the most difficult stent placement. There has long been an argument amongst endoscopists and radiologists over the need to drain more than one component of the duct system. The endoscopist believes that to drain sufficient liver to allow the jaundice to subside is all that is needed. Endoscopists believe that the increased invasiveness of percutaneous multi-duct drainage was not of sufficient benefit to the patient to support its use. This view was based largely on a now old publication comparing ERCP and PTC for the management of cholangiocarcinoma (1). Fortunately, now there is a further publication that clearly shows the benefit of a percutaneous approach (2). Radiologists should remember that re-intervention is highly likely and make sure that there is good endoscopic access to all stents. So, where is endoscopy preferable? In cholangiocarcinoma, which is confined to the common duct or to the origins of the left and right hepatic ducts, it is easy for the endoscopist to place bilateral metal stents and thereby establish drainage. For more complex cholangiocarcinoma where endoscopic ductal access might fail, a percutaneous transhepatic approach is preferable.

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703.6

Hilar cholangiocarcinoma primarily treated percutaneously

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Learning Objectives

1. To review our experience in biliary endoprosthesis used in patients with hilar cholangiocarcinoma
2. To describe the different techniques used for placement and recanalization of recurrent disease
3. To assess clinical outcome matching it with the different techniques performed

The transhepatic approach for diagnostic visualization of the bile ducts was originally described by Burkhardt and Müller in 1921 with injection of contrast media into the gallbladder with a needle introduced through the liver. This technique was modified in 1937 by Huard *et al.* who injected Lipiodol directly into the bile ducts. After Carter and Leger reports about their experience using a water-soluble contrast media, this technique became more widely used. The method was further improved and popularized by Okuda *et al.* in 1974 using a thin flexible needle of 0.7 mm outer diameter. This fine-needle technique strongly diminished the need of an immediate surgery following the procedure. In 1966, Seldinger reported his experience with transhepatic cholangiography by a right intercostal approach using a sheathed needle, which allowed external drainage of the biliary system following cholangiography. Further developments of this technique were the use of hydrophilic guidewires and catheters, which allowed complete obstructions to be crossed. The main indication for percutaneous transhepatic cholangiography (PTC) is obstructive jaundice primarily diagnosed by ultrasound, CT or MRI. Obstructive and non-obstructive jaundice are well demonstrated by these imaging techniques. Demonstration of very small lesions, partial obstructions and the biliary tree anatomy is beyond their capabilities. In addition, 10 to 20% of patients with obstructing lesions such as tumors, strictures and common duct stones will not have dilated ducts demonstrable by ultrasound or CT. In these cases, cholangiography by percutaneous or endoscopic routes is reliable. For diagnostic purposes, PTC has also partly been replaced by endoscopic retrograde cholangiography (ERC). If ERC fails in patients who are candidates for biliary drainage, especially in hilar obstructions, PTC is still the best method in order to opacify the bile ducts and demonstrate the exact site of an obstruction by a tumor, stones or inflammation. The main indication for percutaneous biliary decompression and drainage is the non-surgical palliation of malignant biliary obstruction. Whenever possible, definitive drainage should be established by internal drainage with an endoprosthesis. Because of the significantly lower mortality rate, the traditional treatment of surgical biliary-enteric anastomosis should be replaced by percutaneous or retrograde endoscopic placement of an endoprosthesis. Further indications are bile leakages after surgery or trauma, which may also be treated with catheter drainage. From October 1997 until December 2008, 647 endoprosthesis were implanted in 519 patients by percutaneous liver puncture under fluoroscopic or US-guidance. The endoprosthesis were implanted mainly in a single procedure technique mostly using right lobe access. Covered stent was rarely used. Self-expandable multi-filament prosthesis was used in the majority of patients. Laser-designed nitinol stents were also used in obstructions due to other tumors than hilar cholangiocarcinoma. Endoprosthesis placement can be done by different approaches depending on the site of the obstruction and on the radiologist's skill to perform the procedure. The insertion of multiple endoprosthesis permits to bypass the obstruction of the biliary tree relieving patient symptoms. Tumor overgrowth is more common as obstructive cause then tumor ingrowth in the re-occlusion of inserted stents. They might be recanalized with percutaneous insertion of other endoprosthesis by several approaches. In our series, biliary duct patency was achieved with a single stent in 91% of the patients. Recanalization was needed in 33% of the patients. The techniques of recanalization used were: A. Co-axial insertion; B. Contra-lateral insertion; C. "T" or "Y" insertions. In 66% of patients, co-axial re-insertion with balloon dilatation was the most frequent technique used. In 23% of patients, we used the lateral insertion through the occluded stent. In the remaining cases (11%), we used other techniques including 'T' or 'Y' re-insertions by homolateral approach. Success was achieved in 86% of the patients submitted to reintervention in the occluded biliary tract, considering a drop of bilirrubin levels as a satisfactory result. The use of biliary endoprosthesis in adults presenting with hilar cholangiocarcinoma with segmental invasion should definitely be treated by percutaneous inserted self-expandable stents. The knowledge of several recanalization techniques may be useful to the interventional radiologist in order to perform a better aid to the patient. Occluded stents should be returned patent or bypassed, thereby maintaining palliation of symptoms, improving life expectancy and quality. Best survival rates are linked to the capability of recanalization techniques.

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Special Session
Lung RF ablation

704.1

Techniques and imaging dilemmas

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Learning Objectives

1. To describe the techniques of RF ablation of the lung
2. To present the imaging problems before, during and after ablation
3. Tips and tricks in challenging cases

Lung RF ablation provides good results with 70 to 90% of complete ablation for lung tumors. In our experience, the rate of local tumor progression at 2 years for the tumors less than 2 cm was 9%, statistically significantly different from 25% for the tumors more than 2 cm (logrank test p=0.057). 51% of the patients were alive without viable lung tumors at 1 year and 35% had no viable lung tumors at 2 years. Overall survival rates were 86, 69, and 52% at 1, 2, and 3 years, respectively. Our rate of incomplete local treatment compares favorably with the rate of incomplete surgical resection reported to be 12% in the largest world report by Pastorino et al.

However, due to the variety of tools used for ablation, there are specificity links to various devices used and they will be detailed, namely differences between straight and expandable devices, and differences between single applicator and multiple applicators systems. Results are highly dependent on the volume of ablation relative to the tumor volume. Indeed, in the 73 tumors with a ratio between the area of ground glass opacity imaged at 24 to 48 hours and the tumor area before treatment of at least 4, the rate of incomplete local treatment was 4%, which is significantly lower (p=0.02) than when this ratio was below 4 with a 19% incomplete local treatment rate. These data clearly emphasis the need for oversizing ablation zone when compared to the tumor. Contact with a large vessel (>3-4 mm) has been reported as a negative predictive factor of complete tumor ablation in lung tumor in the same manner as reported for liver tumor. The so-called heat sink, which is convection cooling of the ablated zone, is probably responsible for this increased failure rate. We will demonstrate technical possibility, good efficacy and poor tolerance of balloon occlusion of the pulmonary artery branch during lung RFA. For applicator placement, technical tricks such as use of a voluntary induced pneumothorax to shield from RF delivery and heating of parietal pleura or mediastinum is a very useful tool that will be explained. Even if it is agreed that CT guidance is the imaging guidance of choice for lung, RF and multiplanar reconstruction are probably mandatory to assess adequate needle positioning, 3D rotational angiography, often more accessible to IR, might be a surrogate for puncture guidance in a close future. Follow up CT images obtained within a few minutes after the end of RF energy delivery shows the lung tumor surrounded by ground glass opacity. This opacity enlarges the diameter of the hyperattenuating area, and this enlargement is even greater on images acquired after 24 and 48 hours, though opacity then decreases in size during follow-up. We have to notice that in our experience of 100 tumors the largest diameter of the ablated zone was still measuring 19 mm at 1 year while the initial tumor diameter was 17 mm. This enhanced the fact that WHO or RECIST criterion cannot be used because the goal of RF ablation is to produce a volume of ablation larger than the initial tumor volume. This ablation volume will then decrease in size very slowly, even if there are some more rapid regressions. Most of the team considers that an ablation volume, which does not increase in size on subsequent imaging, is a complete ablation. This method of evaluation has some drawbacks, namely late discovery of incomplete

treatment. Indeed, in our experience after a minimum of one year follow-up (mean=18 months), we depicted 6 incomplete treatments at 4, 6, 9 and 12 months, respectively, in 1, 2, 2 and 1 patients. PET-CT appears promising to provide early evaluation of treatment response and sensibility and specificity of PET will be discussed as well as pitfalls such as G6PD uptake in mediastinal lymphnodes or at the puncture site. Management complication of RFA means management of pneumothorax, which will occur in 40-60% of the cases. Only 20-40% of pneumothorax will require treatment. The first step must be simple aspiration with a 5 French catheter needle, and chest tube will be placed in case of recurrent pneumothrax, which will occur in 10-20% of cases. Ablation of both lungs in a single session or in two different sessions will be discussed as well as lung tumor ablation in single lung patients. The need and utility of respiratory test for evaluation of lung function will be discussed with regards to the usual good tolerance that made us report no significant changes in lung function and spirometry. Indeed, a month after ablation when compared to pre-ablation spirometry (FEV1=2.2±0.74 liters before treatment and 2.2±0.8 after treatment), we were able to treat patients with FEV1 down to 0.8 liters/second and uneventful follow-up for patient with a FEV1 superior to 1.2 liters.

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704.2

Indication and results of RFA for primary lung cancer

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Learning Objectives

1. To define indications for RF ablation of primary lung cancer
2. To describe follow-up and main complications of lung RFA
3. To present results of RF ablation for primary lung cancer (trials)

Non small cell lung cancer (NSCLC) is one of the most commonly occurring cancer and is the leading cause of cancer-related mortality worldwide. Anatomical surgical resection remains the current standard of care for patients with localised disease and is the best opportunity for long-term survival. Therefore, only few patients (15%) are suitable for surgical resection owing to comorbid medical conditions and advanced stage of the disease. In these conditions, external beam radiation with or without chemotherapy is used. Treatment results are usually suboptimal compared with surgery, produce a modest improvement in survival and induce a substantial toxicity in these fragile patients. In this way, the development of less invasive treatments such as stereotactic radiotherapy, brachytherapy and thermal ablation may be of interest to complement or replace existing therapies. Among the different thermal ablation procedures, radiofrequency ablation (RFA) is the best developed and evaluated. RFA is safe and technically highly successful. Long-term local control rates drop considerably when tumors are larger than 4 cm, although repeat ablations can be performed. The effects of lung RFA on quality of life, in particular dyspnea and pain, are now documented with a low procedural morbidity. There is no association with a loss of pulmonary function after RFA. Pneumothorax is the main complication of this procedure and can be problematic in patients with compromised pulmonary function. Preventive measures include planning electrode route to avoid bullae, chest tube placement. In the management of stage I NSCLC, the evaluation of RFA is in progress, prospective studies are conducted both in Europe and USA on inoperable patients. First results of retrospective studies are positive and encouraging. Trials comparing stererotactic radiotherapy with RFA could be of interest. In more advanced stages (III A for example), after assessment of neo adjuvant chemoradiation, the patients may undergo a surgical resection as a local treatment of the tumor. In these patients, the use of RFA is not evaluated but can be discussed case by case in a multidisciplinary approach. Lastly, RFA may also be used as a treatment for palliation of pain in patients with invasion of the chest wall. Palliation of hemoptysis has been also reported. RFA is an attractive option for patients with lung cancers because the lung is a common site for cancer and has substantial functional reserve.

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704.3

Indication and results of RFA for lung metastasis

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Learning Objectives

1. To present rationale and indications of RF ablation for lung metastases
2. To present image finding and follow-up (CT-MR-PET) and role of adjunctive therapies
3. To present results of RF ablation for lung metastases

Background

Primary lung cancer: lung cancer is the leading cause of cancer related death, responsible of 28% of deaths in patients with cancer. While surgery and particularly lobectomy remain the treatment of choice for localized lung cancers, only 20% of patients with early stage NSCLC are surgical candidates at diagnosis due to limited pulmonary reserve or other comorbidities. 1 and 5 year survival for all stages of lung cancer is 42 and 15%, respectively. The majority of patients with lung cancer are not eligible for surgery and traditionally

they have received chemotherapy and radiation treatments with little effect. Image guided, minimally invasive treatment in this population is extremely important and desirable. Percutaneous image guided radiofrequency (RF) ablation has been applied with encouraging results for local tumor control and overall survival in non-surgical patients with lung cancer. Lung ablation is the most rapidly evolving field of interventional oncology today.

Metastatic pulmonary cancer: autopsies show that 50% of cancer patients have lung metastases. In the surgical literature, isolated pulmonary metastasis (from colon or kidney primaries) can be resected with a 5-year survival rate of 50%. The Pulmonary metastases International Registry (e.g., colon, renal, bladder, sarcoma, melanoma) reported surgical metastatectomy survival rates of 36% at 5 years and 26% at 10 years. Overall Rf ablation is an excellent alternative to surgery, offering local tumor control, improved survival and palliate patients with metastatic lung cancer. The comparison of pneumonectomy, lobectomy and segmentectomy for malignant metastases to the lungs has shown similar oncologic outcomes and fewer complications for parenchymal sparing treatment. This observation has been different in the treatment of metastases when compared to the results seen for the treatment of primary lung tumors. Therefore, parenchymal sparing treatment is preferred in the management of metastases to the lung. RF ablation is an excellent modality for patient with limited number (not more than 4) of metastatic lesions in the lung from any primary.

Indications:

Primary lung cancer: the ideal candidate for RF ablation is a patient with NSCLC stage Ia (tumor up to 3 cm, N0, M0) who is not eligible or refuses surgery. Patients with lung cancer who present with local tumor progression in a previously radiated region or new tumor development after surgical resection of the primary tumor are also good candidates for RF ablation.

Metastatic lung cancer: in general RF ablation is indicated in patients with less than 4 lung metastases in the face of no limited or controlled extrathoracic disease. The ideal candidate is a patient with a central solitary metastasis less than 3 cm in diameter and located in the lung parenchyma more than 1 cm away from a central blood vessel or bronchus and completed surrounded by well aerated lung parenchyma.

Background: RF ablation has been effective in local tumor control in other organs such as the liver and the kidney. It has been particularly effective in preserving the normal parenchyma while locally destroying the tumor. This has been particularly important in the management of renal tumors in patients with poor renal reserve. Several studies showed minimal to no change in creatinine after ablation. The performance of ablation by the radiologist and particularly the interventional radiology was the natural evolution of long-time experience with guided biopsies. CT-guided needle lung aspiration and biopsy has been routine for many years and the performance of lung ablation in a similar setting and by the same physicians that are comfortable performing image guided interventions. The same physicians are also extremely comfortable managing pneumothorax, the most common complication of this treatment. RF ablation of the lung is complicated by pneumothorax as frequently as biopsy and is associated with a relatively low rate (5-10%) of chest tube requiring pneumothorax.

Advantages of percutaneous thermal therapy: percutaneous thermal therapies are minimally invasive and therefore associated with fewer complications, faster recovery and shorter hospital stay when compared to surgery. The minimal invasive nature of the technique and the ability to treat the tumor while sparing normal parenchyma results in preservation of lung function and makes this treatment an option for sicker patients with FEV1 as low as 0.19 L as well as those who have had prior major lung resections or pneumonectomy and those who have residual or recurrent tumor after prior maximum level of radiation therapy. Ablation has also the advantage of being repeatable and can be used to treat local tumor progression (recurrences) after the initial treatment.

Disadvantages of percutaneous thermal therapy: the inability to evaluate the status of local lymph nodes and remove tissue from the ablation zone and the margins remain the most important limitations of percutaneous thermal ablation. The luck of tissue confirmation of necrosis at the end of treatment may be related with residual viable tumor at the treatment cite that can lead to local tumor progression and treatment failure. Pathologic follow-up after RF ablation of the lung was obtained with biopsy of 19/33 patients at 6 months. A study by Belfiore *et al.* demonstrated complete necrosis in 36% (7) {5 of 7 were < 3 cm} and viable tissue in 63% (12) {all tumors > 3 cm}. In another study by Yasui, percutaneous biopsy at 2 months after ablation showed complete necrosis in 60% and residual tumor in 40%. A high incidence of local tumor progression after RF ablation of liver tumors was documented in specimens with identifiable tumor cells positive for proliferation marker Ki67 in a study that we performed by collecting tissue from the RF ablation electrode after treatment. These tissue findings show the limitation of RF ablation and the need to monitor these patients with very close follow-up for early detection of recurrence that in many cases may be retreated.

Candidates for RF ablation of the lung: these are usually the patients that nobody wants to "touch"! -Patient with primary pulmonary malignancy and contraindication to surgery with stage I primary lung cancer patient and a tumor < 3 cm. -Patient with less than 4 pulmonary metastases without other disease. In the case of metastatic lesions with limited or stable extrathoracic disease RF ablation may still be offered in selected patients. - Patient with a recurrence after surgery or in the radiation bed.

Lung cancer staging: stage 1: localized cancer; stage 2: cancer in the lymph nodes at the top of the lung; stage 3: cancer has spread into the chest wall; stage 4: cancer has spread to another part of the body.

Results of RF ablation in the lungs: several studies confirmed that pulmonary function tests were not affected after RF ablation of the lungs. In radiographic follow-up, complete ablation was demonstrated in 69-100% of tumors less than 3 cm. in diameter compared to 23-39%, for tumors larger than 3 cm. In a different series, local tumor progression of 7% was recorded at 7%. This study by deBaere demonstrated an overall survival of 71% and disease free survival of 34%. Several studies of lung ablation have been published reporting 3 year survival between 87 and 95%. In a study by Dupuy, primary lung cancer patients were treated with combination of RF ablation followed by 3D conformal radiotherapy. The study had a mean follow-up of 26.7 months. Cumulative survival rates for stage IA was 92% at 12, 62% at 24 and 46% at 56 months, respectively. For patients with stage IB, survival rates were 73% at 12, 42% at 24 months, and 31% at 60 months, respectively. In a more recent publication by the same group, 153 patients were treated for 183 tumors with 602 RF ablation sessions. In 75/153 patients with stage I non-small cell lung cancer (NSCLC), median overall survival was 29 months and 1, 2, 3, 4, and 5 years overall survival was 78, 57, 36 and 27%, respectively. Patients with stage Ia had an overall survival of 30 months. Tumor size was related to outcomes with tumors <3 cm in size having median time to progression (TTP) of 45 months and 1, 2, 3, 4, and 5 years progression free survival of 83, 64, 57, 47, and 47%, respectively. Larger tumors (>3 cm) had a median time to progression of 12 months and 1, 2, 3, 4 and 5 years progression free survival of 45, 25, 25, 25, and 25%, respectively. In the same study, 57 patients with 82 metastases were treated for relatively small tumors and curative intend. The overall survival was 31 months and 1, 2, and 4 year survival were 70, 54 and 44%, respectively. 18 patients were treated for Stage IV colon cancer metastases to the lung. In this group, median survival was over 25.7 months and 1, 2, 3, and 5 years overall survival was 87, 78, 57, and 57%, respectively. In a recent multicenter prospective, international study by Lencioni *et al.*, 106 patients were treated for 183 lung tumors up to 3.5 cm in largest diameter. These included 33 patients with NSCLC and 73 with lung metastases. The study showed no significant worsening in pulmonary function. Major

complications included pneumothorax (27, <20%) and effusion (4). There were no deaths. Confirmed complete response of at least 1 year by CT criteria was documented in 75/85 (88%). 1 and 2 years cancer specific survival was 92 and 72% for lung cancer, 91 and 68% for colon cancer metastases and 93 and 67% for all other metastases. Overall, 1 and 2 year survival was 70 and 48% for lung cancer, 89 and 66% for metastatic colon cancer and 92 and 64% for all other metastases. The lower overall survival across the board reflects the comorbidities of the enrolled group.

Factors affecting treatment failure: several studies have confirmed that tumor size affects outcomes. Specifically, it has been shown that for tumors less than 3 cm. in largest diameter, time to progression and overall survival are longer when compared to tumors that are over 3 cm. The ability to provide an ablation volume large enough to cover the entire tumor has been associated with a lower local tumor. In the study by Simon *et al*., tumor size was related to outcomes. Tumors <3 cm in size having median time to progression (TTP) of 45 months and 1, 2, 3, 4, and 5 years progression free survival of 83, 64, 57, 47, and 47%, respectively. Larger tumors (>3 cm) had a median time to progression of 12 months and 1, 2, 3, 4 and 5 years progression free survival of 45, 25, 25, 25, and 25%, respectively.

Complications: the following is a list of the complications reported after lung ablation: •Pneumothorax (0-67%); •Hemoptysis (3-5%); •Pleural Effusion (7-50%); •Lung Abscess (7%); •Pneumonia (4-66%); •Death (0-5.5%); •Fever, chest pain, subcutaneous emphysema, broncho-pleural fistula, nerve injury, tumor seeding, stroke are complications that have been reported in extremely small numbers (<1%). The most common complications are related to air leak and are easily managed by the interventional radiologist, many times during the performance of the procedure, by the placement of a small chest tube.

Imaging follow-up: imaging follow-up after ablation is extremely important because it is the only method that can detect local tumor progression or residual tumor as a result of treatment failure. Immediate CT through the ablation area is important and a ground glass surrounding the treated lesion is the first radiological sign that can be associated with good tumor coverage by the ablation zone. Lower HU and air bubbles are frequently seen in the ablation zone. Soft tissue area increase 50-100% compared to pre-RF ablation size are expected. Steinke showed post ablation lesion diameters larger in 100% at 1 week, 95% at 1 month, 76% at 3 months, and 47% at 6 months. These lesions contain necrotic tumor, hemorrhage, consolidated normal lung, fibrosis. CT of the chest and PET CT of the whole body are the most commonly used imaging modalities in the evaluation of the tumor prior and after the ablation. The initial study is important to demonstrate the size and radionuclide uptake by the tumor but also in order to make sure that there is no lymphadenopathy or extrathoracic disease that would make the patient a poor candidate for ablation. Post treatment imaging 4-8 weeks after the ablation is extremely important to determine whether the initial treatment was successful or if there is residual tumor. This first post ablation imaging study is also important as a baseline study. The tumor is significantly larger than the initially treated lesion and it is important to see a gradual decrease in size in future studies. The PET CT usually shows a hypermetabolic rim that decreases in intensity with time. Persistence and irregularity of the activity on PET CT, or enhancement on contrast enhanced CT are consistent with residual or recurrent tumor and should be evaluated with biopsy or/and treated as needed.

Conclusions: percutaneous radiofrequency ablation of small lung tumors in non-surgical patients is feasible with low risk to the patient. Percutaneous ablation of primary lung neoplasm is not an acceptable substitute for surgical resection when operative therapy is indicated and possible. Ablation is an excellent treatment for non-surgical patients. Best results are expected for Stage IA lung cancer, and for tumors <3 cm surrounded by well aerated lung. In patients with metastatic lesions under 3 cm. in diameter, ablation could be offered as a first line treatment, as long as there is close follow-up to detect and treat possible recurrences. In this population, best results could be similar to patients undergoing wedge resections. Ablation techniques are still in evolution and although preliminary results are promising there is a lack of long term outcomes. Well-designed studies correlating clinical, imaging and pathological results of RF ablation are very much needed in order to better understand the mechanism, potential and limitations of this technique. The lack and difficulty in designing and executing randomized controlled trials between surgery, radiation treatments and RF ablation for lung malignancies make it difficult to compare the two treatments. It is however now generally accepted that RF ablation represents an excellent treatment for patients with lung malignancies who cannot undergo surgery. With this in mind, and the continuous combined efforts of physicians and technology to improve this modality, it is likely that the applications of the technique will continue to expand and more patients with cancer will benefit from this treatment.

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Foundation Course Biliary drainage

801.1

Clinical and imaging evaluation of obstructive jaundice

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Learning Objectives

1. To summarize the clinical criteria of gravity of obstructive jaundice
2. To review the indication and results of non-invasive imaging techniques (ultrasound, CT scans, MR studies,) and invasive techniques (endoscopic ultrasound and endoscopic retrograde cholangiopancreatography)
3. To review the main causes of obstructive jaundice and the basics of their practical management

Jaundice is a condition marked by yellow discoloration of the skin, sclerae and mucous membranes as a result of an elevated bilirubin concentration. It is the most visible manifestation of liver and biliary tract disease and has many causes. One is obstruction of the biliary tree leading to the so-called obstructive jaundice. Intraluminal obstruction of the bile ducts can be caused by benign diseases like haemobilia, congenital disorders, parasites, choledocho-lithiasis, inflammatory conditions like primary sclerosing cholangitis or secondary cholangitis due to iatrogenic or post-operative strictures and finally malignant tumors. These tumors can originate from a biliary duct itself or from other extrinsic sites like the pancreas, hilar lymphnodes or the liver parenchyma. Other benign extrinsic compressing conditions are less frequent but still possible, like vascular enlargement due to aneurysms or pseudoaneurysms or after episodes of acute pancreatitis and pseudocyst formation. The diagnostic approach of a jaundiced patient starts with careful patient history, physical examination and screening laboratory tests. Of major importance is medical imaging with help of non-invasive techniques like plain abdominal X-ray, ultrasound (US), computed tomography (CT) and magnetic resonance imaging (MRI) followed by MRCP. The clinical criteria of gravity of obstructive jaundice are level of bilirubin and liver enzymes, presence of pain, acute onset of the symptoms, fever or septic condition, acute abdomen or localized abdominal pain. Depending on the acute condition, the clinician leads the patient to less or more sophisticated imaging examinations: 1) Abdominal US has become an accepted modality for evaluation of jaundice, determining the level and degree of obstruction cause. 2) CT offers more detailed anatomic information revealing inflammatory or tumorous conditions of extra- or intrabiliary origin. 3) MRI provides better delineation of the biliary sorounding tissue and especially of the pancreas, having the possibility of MRCP images. If all the above modalities fail to localize the problem, then more invasive techniques like endoscopic US, ERCP or PTC might provide diagnostic as well as therapeutic help. Endoscopic US can help in the localization of intrapancreatic or papillary tumors and also guide biopsy or therapeutic punctures. ERCP is one of the most frequent applied gastroenterological procedures, helping in diagnostic inspection of the papilla, biopsy, sphincterotomy, lithotripsy and stent placement. Of course, availability of each procedure is nowdays the most important issue. Under most circumstances, if surgery is not indicated, ERCP should be the procedure of choice followed in case of failure by PTC.

801.2

Principle and technique of biliary drainage

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Learning Objectives

1. To review the indications of percutaneous biliary drainage versus endoscopic drainage
2. To summarize the various options for biliary drainage and criteria for selection of the best method
3. To review tips and tricks for biliary drainage and complication prevention

Percutaneous biliary drainage (PTBD) may be performed after failure of endoscopic biliary drainage (e.g., because of duodenal stenosis, failure to cannulate Oddi's sphincter, failure to negotiate a biliary stricture, etc.) or as a primary indicated procedure. Primary indications for a percutaneous approach may include altered anatomy after prior surgery (e.g. roux-Y-anastomosis), (complex) hilar strictures, intrahepatic stone disease, poor condition of the patient, bile duct injury during laparoscopic cholecystectomy or treatment of duodenal leakage. Work-up for PTBD should include adequate pre-procedure imaging, assessment and if necessary correction of coagulation status and administration of antibiotic profylaxis. During the procedure, good intravenous access, proper analgesia and sedation should be available as well as adequate patient monitoring (pulse rate, blood pressure, O_2-saturation). Puncture of the right lobe, left lobe (sub-xyphoid approach) or a combination of these are possible. Puncture should preferably be performed using ultrasound-guidance and a Chiba-needle. Particularly, when treating hilar lesions, ultrasound is indispensable to select the most appropriate lobe and/or segments for drainage. Insertion of guide-wires, catheters and stents should be monitored using fluoroscopy. The use of a sheath facilitates guide-wire exchange and manipulation with catheters. A drainage bag may be attached to the side-port of

the sheath to drain bile during the procedure. Cholangiography is necessary to show the presence of strictures, stones or leakage, but injection of contrast medium should be kept to a minimum during initial drainage as increasing pressure in the biliary system may induce septicaemia. Negotiating strictures can be done using a combination of different angiographic catheters and hydrophilic guide-wires. In some situations, a two-step procedure is preferable over direct stenting of strictures. Biliary stones may be removed using Dormia-baskets, balloon-dilating the papilla of Vater, flushing the bile ducts with saline, sweeping the bile ducts with a balloon or a combination of these techniques. For drainage of the biliary system, externally draining catheters or internally/externally draining catheters may be used. Internally/externally draining catheters should not be used for external drainage for a prolonged period of time as drainage of bowel contents may result in dehydration of the patient. After inserting a metal stent, a drainage tube should be kept in for some days before removal or alternatively the puncture tract may be sealed with the use of gelfoam and there is no need to leave a catheter in place. Complications of PTBD include death (<1%), sepsis, hemorrhage, biliary leakage and dislocation or clogging of catheters.

801.3

Biliary stenting

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Learning Objectives

1. To review the indications of biliary stenting
2. To review the indications of metal stents versus plastic devices
3. To give results and complications as well as basic follow up protocol

1. Indications for biliary stenting: - For palliation of malignant biliary obstruction/stenosis (obstructive jaundice) symptoms in patients who, due to disease extent, age, or associated co-morbid conditions, are not candidates for surgery. Within this principal indication, there is a need to distinguish proximal neoplastic lesions or of the hilium, and distal lesions or of the extra-hepatic biliary tract. Different percutaneous management and the questions such as one or more than one stent, configuration of the multiple stents, transpapilar or suprapapilar location of the stents and their relevance, will be discussed as well. - In benign lesions as a last resort, when recurrence of symptoms occurs following unsuccessful repeated attempts with balloon dilatation, especially in stenosis of bilio-enteric anastomoses - Finally, there will be a brief discussion of the controversial question of whether there is a definite role for covered biliary stents

2. Metal stents versus plastic devices: in our opinion, and in the era of metal stents, there is scarcely any room for plastic devices which, unfortunately, continue to be used frequently for e*ndoscopists after* biliary s*phincterotomy. These days, there is only one possible indication such as its provisional placement for biliary drainage until the* scheduled surgery takes place. But even in this case, the placement of an internal-external catheter for percutaneous drainage can be a better solution.

3. Results, complications and basic follow-up protocol: the outcomes obtained with bare metal stents such as in the palliative treatment of malignant disease are around 50% primary patency at 6 months (range: 43-82%) and the extent of this range depends more on the tumor type, stage, location and overall condition of the patient than on the stent *per se*. The outcomes with covered biliary stents are similar, but the complications differ and lead to controversy. The incidences of tumor overgrowth, sludge incrustation are similar, but tumor ingrowth appears less in the group with covered stents. Nevertheless, the appearance rates of acute cholecystitis (8-12%), pancreatitis (2-4%) perihepatic biloma/hematoma (2-4%) and migration rate and misplacement are of the order of 6-10%; complications which are less frequent with bare stents and which has decreased the initial enthusiasm for this type of stent. There is a need, however, for more long-term data from randomized comparative studies (very difficult in these types of patients). Finally, we must not forget the complications inherent in percutaneous biliary drainage itself (sepsis: 2.5%, hemorrhage: 2.5%, abscess/cholecystitis/ pancreatitis: 1.2%, pleural effusion/pneumothorax: 0.5%, and even death: 1.7%). Follow-up protocol is basically clinical visit, laboratory test, ultrasound every 3 months and CT if dysfunction of the stent is evident. In this case, PTC for de-blocking of the stent with a second co-axial stent is indicated.

801.4

Cholecystostomy

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Learning Objectives

1. To review the indications of cholectysostomy versus surgical ablation
2. To describe the basic technique including tips and tricks
3. To review the clinical and imaging follow up needed

Percutaneous cholecystostomy is a valuable and up to date interventional radiology procedure that has proven benefit in a variety of clinical circumstances. Acute cholecystitis, gallbladder empyema and perforation can be successfully treated in patients at high risk for surgical morbidity and mortality. Critically ill patients with acalculous cholecystitis or sepsis of unknown origin can also benefit from cholecystostomy. Cholecystostomy can also be used to drain the intrahepatic ducts in critically ill patients with common duct occlusion and minimal biliary dilatation. Patient preparation includes coagulation test and possible antibiotics and atropine administration. Previous analgesia and sedation maybe used according to patient condition. Local anesthesia is systematic. US guidance is ideal for performing percutaneous cholecystostomy. US permits accurate selection of the best course for catheter introduction and to define the appropriate entry point into the gallbladder. Transhepatic puncture of the gallbladder provides catheter stability and is preferred to transperitoneal approach. Catheterization of the gallbladder can be done by means of either trocar method or guide-wire exchange technique. Single step approach is better and if necessary a fine needle can be introduced first to confirm the route. Complications from cholecystostomy are rare and can be minimized with appropriate technique. Catheter manipulation or injection should be avoided for at least 24-48 hours. Cholecystogram is mandatory to evaluate cystic duct and common duct patency. Catheter withdrawal is dependent on patient recovery and access route.

Special Session
Thoracic aneurysm and dissection

802.1

Natural history of acute aortic syndrome

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Learning Objectives

1. To describe classification, clinical and imaging features of acute aortic syndrome
2. To discuss the indications for treatment
3. To discuss the outcomes of stent-grafting

Acute aortic syndrome consists of a constellation of lesions that are

loosely related pathologically but share a common feature of abrupt symptom onset and potential catastrophic outcome. This grouping typically includes acute aortic dissection, acute aortic intramural hematoma, symptomatic penetrating atherosclerotic aortic ulcer, and focal aortic tear with contained rupture. In the spirit of bringing attention to the emergent need for accurate prompt diagnosis and therapy, this list is often legitimately expanded to include traumatic aortic transaction and rapidly expanding aortic aneurysm with presumed impending rupture. This classification represents an opportunity to improve the results of historical management approaches by early recognition of the primary nature of the aortic lesion rather than prolonged diagnostic workup of differential considerations related to cardiac (acute coronary insufficiency) or lung (acute pulmonary embolism) pathologies. The medical literature details a 20% positive rate for acute aortic disorders in emergency room evaluations of patients suspected of acute aortic syndrome (excluding acute traumatic injury). The exact diagnoses in these studies consist of a relatively equal distribution of the representative entities that comprise acute aortic syndrome. Roughly 20% of the positive diagnostic imaging studies are associated with acute aortic rupture. Not surprisingly, this group of lesions with evidence of aortic rupture is the category with the worst hospital mortality and accounts for approximately 75% of the overall in-hospital deaths from acute aortic presentations. Indeed, this sub-group of non-traumatic ruptures represents a management opportunity for stent-graft therapy to improve current results over and above the potential for obtaining better outcomes in poly-trauma victims with acute aortic injury. The non-traumatic category of acute aortic syndrome includes patients that are generally older with a greater frequency of accompanying medical conditions, which may negatively impact the morbidity and mortality results of open surgery. The traumatic aortic injury population is often younger and healthier. They are better candidates for open surgical repair; however, their injuries often affect many organ systems. This elevates the relative risks of surgery, including paraplegia. Endografts may play an important future role in the management strategies for all of the entities included in the classification of acute aortic syndrome.

802.2

Acute type B dissection

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Learning Objectives

1. To discuss the current status of endografting in the management of acute type B dissection
2. To discuss the evidence for intervention in uncomplicated acute type B dissection
3. To review the main imaging features that are key in the decision process

No abstract available

802.3

Chronic type B dissection

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Learning Objectives

1. To discuss the current status of endografting in the management of chronic type B dissection
2. To review the main imaging features that are key in the decision process

Introduction: chronic dissection is classified as aortic dissection of more than 14 days duration. The main reason for this distinction is that the risk of life threatening complications is greatest in the first days following dissection. The classification is the same as for acute dissection. Both the DeBakey and Stanford classifications are used, although the Stanford classification is more popular. Most acute type A dissections are treated surgically or die; so chronic type A dissection is unusual. Chronic type B dissection is more common. Patients with acute type B dissection who have uncomplicated disease are at risk of aneurysm formation involving the false lumen at follow-up. If the aortic diameter is greater than 4 cm at presentation in acute dissection, more than 70% of patients develop aneurysms at five years. Persistence of flow in the false lumen appears to increase the risk of late complications and spontaneous thrombosis of the false lumen in chronic dissection is rare. In addition, there are limited data suggesting that if the cross-sectional diameter of the false lumen is greater than 22 mm, the patient is at risk for aneurysm formation. At this time, there is no evidence that patients with uncomplicated type B dissection should be treated to prevent the risk of late aneurysm formation. Therefore, the management paradigm for chronic dissection is regular imaging and the treatment of complications as they occur.

Imaging of chronic dissection: patients with type B dissection are followed up in our institution by annual CT scans. MRI is an alternative modality and has the obvious advantages of MRI compared with CT with respect to ionising radiation. Both modalities are effective for monitoring patients with chronic dissection. The main aims of imaging are the assessment for aneurysm formation. Aneurysm formation may involve the thoracic aorta, the abdominal aorta or the iliac arteries. The diameter criteria for intervention are similar to aneurysmal disease in patients without dissection. Patients may also develop other complications such as visceral ischaemia, although ischaemia is less common in chronic dissection. Patients may also present with rupture. If these patients survive until admission to hospital, imaging is essential to define the anatomy and to direct therapy.

Management of aneurysmal chronic dissection: patients are managed according to their individual anatomy. Treatment of these patients is usually complex and management should be carried out at specialist centres by personnel (interventional radiologists, vascular and cardiothoracic surgeons, vascular anaesthesiologists) with a large experience in the treatment of chronic dissection, and who are able to work together as a team. The main aim of treatment is to exclude the aneurysmal false lumen from the true lumen, so that false lumen flow is abolished and the risk of further FL expansion is prevented. Management may involve conventional open surgery, the insertion of endografts, or hybrid procedures involving visceral artery bypass and endograft insertion. Branched and fenestrated devices also have a role, although they are much more suited to aneurysmal disease in patients without aortic dissection. Patients with primary tears in the upper descending aorta may be treated by closure of the primary tear with an endograft. However, the flap is usually relatively rigid and immobile in chronic dissection. As a result, this manoeuvre is seldom effective at abolishing FL flow because blood is free to pass retrogradely up the rigid FL from natural fenestrations in the upper abdomen. Extending endograft coverage to the upper abdominal true lumen may be effective in some patients with aneurysms limited to the thoracic aorta. If the aneurysm extends to the diaphragm or abdominal aorta, these patients are treated by open surgery or by hybrid procedures. In our institution, hybrid treatment is the main method of treating these patients. With experienced surgeons and interventionalists, and careful patient selection, the mortality and morbidity of hybrid treatment compares favourably with similar patients treated by conventional surgery.

Summary: patients with uncomplicated acute dissection are at risk of late aneurysm formation and should be followed up regularly by CT or MRI. Patients with complicated chronic dissection should be managed in specialist centres by teams of surgeons and interventional radiologists. Treatment is usually complex and often involves a combination of surgery and endovascular techniques.

802.4

Traumatic transsections

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Learning Objectives

1. To discuss the indications for treatment
2. To discuss at which stage of the trauma the patient should undergo stent grafting
3. To discuss the outcomes and drawbacks of stent-grafting

The majority of blunt traumatic ruptures of the thoracic aorta occur at the level of the isthmus when sudden deceleration or thoracic crushing injuries take place. Eighty percent of the patients die at the scene of the accident. Most of the time, aortic disruption is associated with other life threatening injuries, thus making the treatment of the survivors an even more challenging task. In spite of technical advances in aortic surgery, the mortality and morbidity rates remain high. Deaths are mainly attributed to the associated injuries, which may be aggravated by surgical interventions and the circulatory assistance techniques. Post operative paraplegia remains the main neurological complication, ranging between 3 and 20% even in the most experienced trauma centres. In these circumstances, endovascular repair has rapidly emerged as an alternative treatment with promising therapeutic potentials. In spite of attractive aspects of stent-grafting, some technical difficulties have to be overcome. The short proximal neck often seen is considered the main difficulty. The ideal length (at least 15 mm of normal aorta proximal to the lesion) is rarely encountered; moreover, the ostium of the left sub clavian artery (LSCA) is most of the time very close to the site of the injury. In case of intentional coverage of the LSCA, mild discrepancy in systolic blood pressure is observed between both arms on short term post operative course; still, the majority of the patients remain asymptomatic without significant functional deficit or temperature difference between both arms. Nevertheless, we can hypothesize that overstenting of the LSCA may be an important risk factor of paraplegia because of subsequent occlusion of very proximal medullary artery and more importantly occlusion of the higher dorsal medullary artery. Patients with dominant or ectopic left vertebral artery are also to be considered. In our opinion, this would be an indication of carotido-subclavian bypass if LSCA coverage is unavoidable. The tight curvature of the distal aortic arch and the vascular access remain important limitations because of the stiffness and the considerable diameters of the currently available introducers, passing through highly spastic arteries often seen in young patients. In these situations, supra inguinal iliac or infra-renal abdominal aortic accesses would be considered. The main technical improvements, in the future, should relate to the reduction of the size of the devices and to the use of more flexible devices. The stent-grafts with a "proximal sub clavian branch" would also make it possible to avoid the sacrifice of the left sub clavian artery and would allow a more satisfactory proximal sealing. In view of the lack of commercially available stent-grafts with small diameters on the market, the main limitation remains relatively small aortic diameters (<20 mm) in young patients. In fact, excessive over sizing (up to 30%) is well tolerated without any reported rupture in our experience; moreover, it would allow future adaptation of the stent graft to the natural increase of the aortic diameter with aging. In spite of the limitations attributed to monocentric, non randomized nature of the published studies so far, the literature demonstrates that the endovascular treatment of blunt traumatisms of the descending thoracic aorta is a safe and effective therapeutic modality, without increased mid term morbidity and mortality rates. Based on our series of 33 patients with blunt isthmic aortic rupture from 1996, with a mean follow-up of 2.9 years (maximum 12 years), overall survival was 100% and paraplegia rate was 0% in our institute. No conversion to conventional surgery and no endovascular reintervention were required at the level of the aortic injury. Only controlled and randomized studies comparing conventional surgery and endovascular repair would make the confirmation of these results possible; still, they would be difficult to conduct because of the low number of patients treated in each center.

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Special Session Hemoptysis

803.1

Update on imaging

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Learning Objectives
1. To review the results of CTA in hemoptysis including anatomy
2. To discuss when it should be performed prior to embolization
3. To describe the main pathological features on CAT

Haemoptysis and haemoptoe are symptoms of potential life threatening diseases or - if massive - life-threatening by itself. It is one of the most feared respiratory emergencies and therefore a fast, structured diagnostic work-up is mandatory in these patients. Even after diagnosis of the underlying cause, conservative management carries a high risk of mortality. Because of this, interventional or open surgical therapeutic options are necessary in many patients. The first important question is whether we are dealing with a diffuse alveolar haemorrhage or a localised bleeding source. The main differential diagnoses are: - Infections (for example: bronchitis, bronchiectasis, tuberculosis, aspergillosis); - Neoplasm (for example: bronchial carcinoma, carcinoid tumor, lymphoma, etc.); - Cardiovascular diseases (pulmonary embolism, pulmonary hypertension, PAVM in Osler disease); - Trauma (for example: iatrogenic, penetration or non-penetrating trauma); and - Diffuse lung disease (for example: diffuse alveolar haemorrhage, sacrcoidosis). In many diseases that do cause haemoptysis, computed tomography is sufficient to make the diagnosis as a single diagnostic test. This is true for example in bronchiectasis, typical aspergilloma, carcinoid tumours or bronchogenic carcinoma. In some other cases, additional diagnostic tests, including image guided biopsies, are needed to confirm the diagnosis. Typical case vignettes of these underlying diseases causing haemoptysis will be presented during the lecture. If there is a localised bleeding source, we want to know which vascular territory originates the bleeding, because that is going to influence the therapeutic approach. For example, more centrally lesions can be managed by bronchoscopy, more peripheral with percutaneous interventional or open surgical techniques. Vascular territories as potential sources of bleeding are: - Bronchial arteries (90%); - Other thoracic arteries (for example: internal thoracic artery, intercostals arteries); - Pulmonary arteries; and - Bronchial veins. To detect feeder vessels and to perform vessel embolisation, the radiologist should have a thorough knowledge of the thoracic vascular anatomy. Therefore, typical anatomic variants of the thoracic vasculature will be presented. If bleeding is massive (>300 ml/24 h) urgent bronchoscopy is needed. However, in all patients with haemoptysis, chest imaging plays a central part in the diagnostic work up. Chest X-ray is often the initial test and in some typical cases diagnostic, as for example in bronchial carcinoma, lung abscess, pulmonary tuberculosis or pneumonia. However, chest X-ray can be normal and/or nonlocalizing in up to 80% of cases. In addition, it is known that fiberoptic bronchoscopy has a rather low diagnostic accuracy in patients with normal chest X-Ray. Therefore, MD-CT is the diagnostic modality of choice for most patients and is clearly superior in localising and characterising the bleeding source. State of the art CT is diagnostic in the vast majority of cases and exact localisation of the bleeding source is often possible. Of course, contrast-enhanced CT is mandatory to detect feeder vessels. Overall, the diagnostic accuracy of contrast enhanced MD-CT exceeds 80% in modern studies. There is still a debate whether computed tomography and bronchoscopy are competitive or complementary diagnostic tools. However, many researchers are currently suggesting the CT should be performed prior to bronchoscopy in all patients not immediately at risk for asphyxia. In summary, conventional chest X-ray and contrast enhanced thoracic computed tomography are valuable diagnostic tools for diagnosis and treatment planning in patients with haemoptysis.

803.2

Treatment in benign bronchial artery disease

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Learning Objectives
1. To update the results in benign bronchial disease
2. To review the technical challenges according to the underlying disease
3. To discuss the choice of the embolic material (particules, coils, glue, onyx, etc.)

No abstract available

803.3

Results in cancer patients

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Learning Objectives
1. To review the clinical/angiographical presentation according to the type of cancer (SC and NSC, mets, etc.)
2. To discuss the choice of the embolic material (particules, coils, glue, onyx, etc.) in cancer patients
3. To review the results of embolization in cancer patients

Thoracic tumors, especially lung carcinoma, are most often responsible for bloody sputum or small recurrent hemoptysis, but can also be responsible for life-threatening hemoptysis. They are the third cause of hemoptysis leading to endovascular treatment after bronchial dilatation and acute or fibrotic tuberculosis if we except cryptogenic hemoptysis. Mostly, it develops at male patients older

than 50 y, with tobacco addiction, which is also at the origin of the athérosclerosis.

Mechanisms of threatening hemoptysis are multiple: (1) Proliferation of small vessels inside the tumor coming from bronchial arteries. Mostly, angiogenesis remains moderated in untreated primary lung carcinomas. Angiographic appearance of tumors usually shows a neovascularization without nonbronchial systemic artery feeding or systemic to pulmonary shunting. At the opposite, it can be important in hypervascular tumor such as carcinoïd tumor, metastasis from renal carcinoma, thyroid carcinoma, and melanoma. (2) A pulmonary artery false aneurysm or a bronchial artery false aneurysm is developed in a necrotic tumor, especially in large, proximal and irradiated tumors. A recently appeared etiology of tumor necrosis leading to life-threatening hemoptysis is the antiangiogenic treatment of lung tumor. (3) A classical hypertrophy of systemic and bronchial arteries can be due to a compression of pulmonary artery, invasion of the parietal wall, surgery or radiotherapy. (4) Erosion of a great vessel as the aorta, superior vena cava or pulmonary veins is rare.

Management of these patients does not differ from the other patients treated for hemoptysis. In case of tumor suspicion, the information obtained by the multidetector-row CT-angiography (MDCTA) could be improved by using a pre-injection of 40 to 50 ml of contrast media one minute before the usual acquisition of the MDCTA. This kind of MDCTA acquisition equally shows systemic, bronchial and pulmonary arteries, necrosis or cavitations of the tumor and the relation of the tumor with great vessels or chest wall. By showing the mechanism of the hemoptysis, the MDCTA leads to the adequate choice of endovascular therapeutic approach.

Embolic material: the first choice of embolic material is the spherical particles to occlude hypertrophic bronchial arteries. Other materials as coils can be used distally to complete the occlusion of an artery previously treated by spherical particles or definitively when this artery is difficult to catheterize or if its catheterization is dangerous. Coils can be used too to occlude a bronchial or segmental pulmonary artery feeding a false aneurysm. The radial strength developed by coils in an artery weakened by the tumor necrosis can provoke the rupture of this artery. In this situation, the use of Onyx allows filling the lumen of a small false aneurysm without risk of rupture during the endovascular treatment. We never used glue. The use of stent-graft to cover a false aneurysm of a large pulmonary artery or a great vessel must be discussed in such patients.

Results of embolisation for tumor are isolated only in few articles in literature (1-5) without large series. We reviewed a series of 67 patients (55M, 12F; 13-90yo, mean 52) with a chest tumor before the era of MDCTA (1990-1999) and without using of microcatheters. The chest tumor during this period represented 12.3% (67/546) of all patients admitted for hemoptysis in our institute. Fifty-three of sixty-seven patients had a primary chest tumor including 1 carcinoma of esophagus and 51 lung carcinomas (76%). There were 43 non-small cell lung carcinomas, 5 small cell lung carcinoma, and others (4: carcinoïd tumor, one melanoma, one sarcoma, and one bronchiolo-alveolar carcinoma). Fourteen of sixty-seven patients had a lung metastasis. The primary tumors were the kidney (n=4), the ENT (n=3), the colo-anal (n=2), the thyroid (n=2) and others (one choriocarcinoma, one melanoma, one sarcoma). Bronchial artery embolization (BAE) was not performed in 10 patients (10/67). Reasons were: (i) bronchial arteries (BA) feeding the site of hemoptysis were not found (n:6), in two of them the pulmonary artery was involved; (ii) the presence of an anteriorspinal artery (n=2) arising from the intercostal artery of the right broncho-intercostal trunk feeding the site of hemoptysis; (iii) unstable catheter in one patient and a breakdown of the angiography device. All the other patients (n=57) had a BAE (n=56) or an intercostal embolization in a patient with previous thoracic surgery. Anatomically, a systemic to pulmonary shunt was found only in 6 cases. After BAE, the hemoptysis stopped in 72% of cases at a short time and 61.4% for a long time. Complications included 2 transitory ischemic accidents and a transitory acute renal insufficiency. Five (7.4%) patients died during a mean of 98.4 days after the BAE. In a more recent series (2000-2007) in our institute, including 400 consecutive patients, 200 (2000/2004) without workup with MDCTA (G1), and 200 (2004/2007) with MDCTA (G2), the hemoptysis was due to a tumor in 73 patients (18.25%) (G1:33/G2:40) including 8 lung metastasis. These patients was older (mean: 64.5Yo) than all the other patients (mean: 52yo) ($p<0.0001$). Volume of hemoptysis was 100 to 1000 ml (mean G1:390/G2:273; median G1:300/G2:200). A pulmonary involvement was secondarily found in 3 cases (G1:0/G2:3), in two cases with large bronchial arteries. A true dilatation of bronchial arteries was only found in 43/73 patients (59%) (G1:24/G2:19). BAE was successful at the first time in 45/73 (61.6%) (G1:18/G2:27). From the 30/400 (7.5%) who died during the hospitalization, 16 (G1:9/G2:7) had a tumor (53.3%) and represent 22% of patient with a tumor. Comparing to patients without tumor (327), we had only 14 deaths (4.3%); the difference was extremely statistically significant ($p>0.0001$).

Conclusion: intravascular treatment, especially BAE, for hemoptysis in patients with carcinoma, mainly non-small cell lung cancer, is an effective and safe therapeutic modality despite the fact that the vascular changes are often subtle on angiography. However, prognostic remains more serious than for other etiology leading to the same therapeutics.

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803.4

When to target the pulmonary artery

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Learning Objectives

1. To review the main pathologies in which the pulmonary artery may be the bleeder
2. To review the specific clinical and imaging presentation of hemopstysis due to the PA
3. To describe the technique and results in these patients

Introduction: massive haemoptysis, which is perhaps best defined as bleeding into the bronchial tree at a rate that poses a threat to life, is associated with considerable mortality unless treated aggressively. Common aetiologies include bronchiectasis, active tuberculosis (TB) and colonization by aspergillus species of a pre-existing pulmonary cavity resulting from, for example, previous sarcoidosis or post-primary TB. Long-standing pulmonary inflammation present in these conditions results in the development of hypertrophied systemic arteries and haemoptysis is thought usually to arise from small friable vessels within peribronchial inflammatory tissue although a peripheral pulmonary artery pseudoaneurysm may occasionally develop and be the source of massive bleeding. Surgery is rarely

an option as patients frequently have bilateral pulmonary disease with poor respiratory reserve. The embolization of hypertrophied bronchial and non-bronchial systemic arteries, however, which was first reported in 1973, has been shown to significantly improve outcome.

A pulmonary artery source of haemorrhage: haemoptysis secondary to a ruptured pulmonary artery pseudoaneurysm occurs in up to 10% of patients undergoing bronchial angiography for haemoptysis, which is a much higher figure than is generally appreciated. Such pseudoaneurysms are most common in those with chronic pulmonary TB, when they are termed Rasmussen aneurysms, although they do occur in other disease processes. Such aneurysmal disease is important to recognize as embolization is best performed via a pulmonary artery approach although bronchial artery embolization is often also necessary. Such aneurysms are, however, usually small and it is unusual to identify them on CT, although this is becoming more common since the advent of MDCT. Their presence is often first appreciated during bronchial arteriography due to the presence of systemic artery-to-pulmonary artery shunting, which may be so pronounced that there is reversal of blood flow within the pulmonary arteries supplying that entire segment of lung; indeed, pulmonary artery abnormalities in an area of severely disease lung may paradoxically be better seen on systemic rather than pulmonary arteriography because of this pulmonary artery flow reversal. This is an important point to recognize as a Rasmussen pseudoaneurysm demonstrated on CT may be 'invisible' on a subsequent pulmonary arteriogram due to this bronchial artery supply. If pulmonary artery pseudoaneurysmal disease is documented, the pseudoaneurysm should be catheterized and embolized via a pulmonary artery approach; this is often best achieved with metallic coils although other agents including glue may occasionally be helpful. Any abnormal bronchial or non-bronchial systemic artery supplying this area of lung should also be embolized using particles in order to achieve a distal occlusion. Pulmonary artery embolization should also be considered, even in the absence of obvious aneurysmal disease, when haemoptysis continues or recurs after maximal bronchial artery embolization. In such cases, embolization of pulmonary artery branches in the most diseased segment of lung as demonstrated on previous bronchial angiography and/or CT may be helpful. This presentation will concentrate on the imaging by CT and bronchial and pulmonary arteriography of pulmonary artery sources of haemoptysis and their treatment by embolization and will discuss potential complications of treatment and how these are best avoided.

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Special Session
Kidney radiofrequency- and cryoablation

804.1

Technique and results of RFA

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Learning Objectives

1. To describe the techniques of RF ablation of the kidney
2. To present the imaging problems before and during ablation
3. To present results of RF ablation for renal tumours (series and trials)

Partly because of its rising incidence, but mostly because of the availability of modern examination techniques, the detection rate of small renal-cell carcinomas is increasing more and more. Even though tumors exceeding 4 cm in diameter rarely metastasize, all renal lesions that arouse the suspicion of malignancy should be treated. Operative treatment techniques such as radical and partial nephrectomy are increasingly carried out as laparoscopic procedures and are regarded as the gold standard. Modern thermal ablation techniques may be a helpful treatment option for patients who are unfit for a surgical resection or refuse it. Radiofrequency ablation (RFA) is the most frequently applied of these methods. First described by Zlotta and co-workers in1997, RFA is a hyperthermal ablation technique, based on thermal induction by electrical energy. A high frequent alternating current (275-480 kHz) is brought into tissue by an electrical active probe and induces frictional heat due to ionic agitation. The heat extends by thermal conduction and is limited by the cooling effect of blood perfusion of the surrounding tissue. Heat distribution within target tissue is depending on several factors like fluid content, electrical conductivity and blood perfusion and decreases nearly linearly with distance to energy source. The shape of resulting coagulation necrosis is mainly depending on probe configuration, but also of the presence of heat sink effects by cooling vessels (segmental arteries) and collecting system. Modern probes allow ablation of lesions between 2 and 5 cm in diameter. In experimental work, increase of necrosis was achieved by temporary occlusion of the renal artery. A similar effect is obtained by superselective tumor embolization prior to ablation by particles or lipiodol, which is suggested in lesions exceeding 3 cm in size. A further increase in ablation volume requires reposition of the probe. In order to avoid thermal collateral damage in adjacent structures like bowel or liver, an additional injection of carbon dioxide or 5% glucose is suggested in cases of exophytic tumors with broad contact to neighbour organs. In opposition to cryotherapy, thermal effects cannot be imaged directly and requires a thorough monitoring by ultrasound or CT. Under sonographic control, hyperechoic signals due to gas bubbles are seen regularly at the end of coagulation. Unfortunately, they do not correlate to the extent of final necrosis. As coagulated and thus necrotic tissue is not perfused, the use of contrast agent (either US or CT) allows a clear delineation of viable tumor and is recommended to be used before the probe is being removed. Thus, residual tumor can be ablated within the same session. After successful ablation, track ablation avoids bleeding complications and tumor cell seeding successfully. As the procedure is potentially painful, a thorough analgetic regimen is required. In small, exophytic lesions, an analgosedation may be adequate. In more centrally located, larger lesions general anesthesia is recommended. RFA can be performed surgically, laparoscopical and percutaneously. Although there is no evidence for supremacy of one approach in literature, the percutaneous approach is favorable as long as it is technically feasible. While randomized comparative studies against open resection are not yet available, the preliminary results obtained with renal RFA are promising and suggest that RFA may be superior to other thermal ablation techniques. Clinical success rates are over 90% and local relapse is very uncommon. As the renal RFA experience continues to mature, longer-term data addressing the oncologic efficacy of this ablative modality are now available. In a recent publication on 31 patients, the overall recurrence-free survival rate was 90.3% and a 100% metastasis-free and disease specific survival rate at mean follow up period of 60.1 months. Also for the management of patients with T1a renal cortical tumors in a solitary kidney, radiofrequency ablation is an attractive alternative to surgery. Renal function appears to be adequately maintained with promising oncologic outcomes at up to 3 years in a recent study with 21 patients. Furthermore, the impact of RFA on secondary clinical endpoints, such as renal function outcomes, has been addressed in several series. As more renal masses are diagnosed in the elderly or comorbid patients, it is likely that ablative approaches will assume an increasingly central role in management strategies. In this regard, continued studies are necessary, particularly with regard to oncologic outcomes.

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804.2

Technique and results of cryoablation

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Learning Objectives
1. To describe the techniques of cryoablation of the kidney
2. To give a perspective on future technical developments
3. To present results of cryoablation for renal cancer (trials)

Background: cryotherapy achieves tumor ablation with lethal freezing temperatures ranging from -20°C to -40°C. This technique has been successfully used in liver, kidney, lung and bone. However, the former cryo-devices based on liquid nitrogen were using big probes that were much more traumatic and not suitable for a CT or MR-guided approach. The recent development of gas-driven cryoprobes allows their miniaturization (17 gauge), thus their use in CT or MR tunnels. Based on the Thompson-Joule effect, fast decompression of high pressure argon gas achieves extremely low temperature at the tip of the cryoprobe (about -185°C). In opposition, decompression of high pressure helium achieves rewarming up to +30°C at the tip of the probe. Active thawing can be used for repositioning and withdrawing of the probes but also to avoid hyperextension of the ice ball. The ice ball achieves tumor destruction combining two effects: a direct cellular effect with ice crystals formation inducing cell membrane rupture; an indirect vascular effect with obstruction of small vessels by ice crystals causing secondary ischemia. During the first freezing phase, ice crystals are mainly extracellular and cell death is not systematically achieved when temperature ranges from 0°C to -20°C. For this reason, two freezing phases separated by a passive thawing phase are needed; during thawing phase, water diffuses from the extracellular to the intracellular compartment, due to osmotic changes; thus, the second freezing phase produces intracellular ice crystals which disrupt cell membranes. A complete freeze-thaw-freeze cycle lasts about 30 minutes.

Procedure details: renal cryoablation can be considered as a curative alternative treatment for patients who are poor candidates for surgery. The indications are very similar to renal radiofrequency ablation (RFA): single kidney, renal insufficiency, multiple or bilateral tumors, hereditary tumors (such as Von Hippel Lindau disease) and patients suffering from comorbidities are the best indications for renal cryoablation. The intent is curative in a single session for tumors up to 4 cm. Larger tumors can also be treated but the rate of complete ablation in a single session rapidly drops. Pain induced by freezing is low, thus majority of the procedures can be performed under local anaesthesia or conscious sedation. Different cryoprobes are available, producing different sizes and shapes of ice. Multiple electrodes can be activated simultaneously to treat large lesions; in such cases, a gap of 15 to 20 mm between the different cryoprobes has to be respected to achieve optimal tumor covering by the ice ball. Several non adjacent lesions can also be ablated at the same time. Compared to the other thermal ablation techniques, the ice ball created during the cryotherapy can be clearly visualized under CT guidance (hypodensity) or MR guidance (hyposignal on all sequences). At the end of the freezing cycle, multiplanar imaging is mandatory to confirm the complete tumoral coverage by the ice ball. Ideally, the ice ball should extend a few millimeters beyond the tumor margins to avoid recurrence. For renal tumors in central position, cryoablation appears as a major advantage compared to RFA. Indeed, the risk of thermal damage to the pyelic structures is reduced, as the conjunctive layer supporting urothelial cells resists much better to low temperatures than to high temperatures. When the tumor is in contact with vulnerable structures (e.g. bowel, ureter), thermal protection techniques are required. Hydrodissection is a largely accepted protection technique for RFA procedures; however, it is not suitable for cryoablation as the fluid may freeze in contact with the ice ball. Percutaneous CO_2 injection is an excellent thermal protection technique for cryoablation: targeted CO_2 injection using a dedicated set is easily achieved through a 22 gauge needle; CO_2 achieves organs displacement and excellent thermal insulation; a 1 cm gaseous gap is sufficient to achieve thermal insulation; as this gas is highly diffusible, repeated insufflations are needed to maintain this gap. Moreover, insertion of thermocouples in contact with the adjacent vulnerable structure achieves continuous thermal monitoring and increases the safety. Up to 5 thermocouples can be controlled simultaneously by the cryomachine. Based on our experience of about 31 patients and in accordance to the literature data, the results of cryoablation are extremely promising for renal tumors up to 4 cm. Peri- and post procedural pain is low, thus allowing reduction of anaesthesia. Since the miniaturization of gas driven cryoprobes, the risk of haemorrhage has dropped and we did not encounter any significant difference compared to RFA. The visual control of the ice ball is excellent with both CT and MRI, thus allowing precise covering of the tumor. Central renal tumors can be treated with cryoablation with less risk of pyelic thermal injury compared to RFA. The only major complication we encountered was a fatal respiratory distress secondary to a Mendelson syndrome that occurred immediately after cryoablation; however, no renal complication occurred and the direct responsibility of cryoablation is improbable. The use of targeted CO_2 insufflation as dissection and insulation technique achieves excellent thermal protection of adjacent vulnerable organs and also creates a safe access route to tumors in complex location (e.g. anterior tumors). Post-cryoablation imaging is a bit more confusing than post-radiofrequency imaging, particularly in the early phase; indeed, due to the cellular effects of cryoablation, fluid, blood clots and fibrosis are found in the treatment zone; however, resorption of the ablated tissues is faster than with RFA. One major drawback of cryoablation is its significantly higher cost.

Conclusion: cryoablation of renal tumors is a very promising technique for patients who are poor candidates for surgery. The excellent visual control of the ice ball and the low risk of thermal damage to the pyelic structures are the two major advantages compared to other thermal ablation techniques. Moreover, combination of cryoablation with thermal protection techniques - particularly targeted CO_2 insufflation - gives new opportunities to treat safely tumors in challenging locations.

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804.3

How to avoid complications: how to treat them

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Learning Objectives

1. To discuss common complications and their incidence
2. Role of ancillary techniques in avoiding complications
3. Management of complications

The success-rate of percutaneous RFA of renal masses is approximately 90%, although there are papers reporting success-rates of 100%. Repeat session for residual tumor is required in 10% of the cases and is likely to be higher in lesions larger than 4 cm in diameter. In centrally located lesions, major vessels act as a heat sink during the procedure, explaining poorer results with RFA. Even in smaller lesions, tissue charring increases the electrical impedance and interferes with the effectivity of the procedure. Therefore, the best indication for RFA is peripheral lesions of 3 cm in diameter. Yet, repeated cycles and overlapping ablation are feasible to tackle larger lesions to improve the success rate of central located lesions. The problem of 'skipping' areas, i.e., persistence of viable intralesional viable tumor cells immediately after the ablation has been reported in three smaller series of peroperative RFA. The incidence of such skipping areas ranges between 50 and 100%. It is not clear, however, whether these cells will ultimately survive and cause local tumor recurrence. According to a meta-analysis performed in our institution, and including papers with an experience of at least 35 cases of RFA of renal masses (total number of patients 488), the initial success-rate is 87.5 and the final success-rate (i.e., after a repeat procedure) is 95.6% (comparable figures for cryoablation are 90.5 and 96.9%, respectively). Complications of RFA of renal masses are usually related to probe placement or to the thermal energy. Complication rates widely ranging from 7 to 63% have been reported, including indeed all minor and major complications. According to the above mentioned meta-analysis, the complication rate of RFA is 15.4%, including 10.7% of grade I complications and 4.7% of grade II-V lesions (classification according to Dindo et al. Ann Surg 2004). Comparable figures for cryoablation are 11.8, 4.3 and 7.5%, respectively. Post-RF ablation syndrome (i.e., low-grade fever and flulike symptoms) is described in approximately one-third of patients but is self-limiting within 10 days after the procedure. Hemorrhage and perirenal hematoma are usually managed conservatively; rarely, embolization or transfusion with packed cells is required. RFA of central tumors is prone to a higher risk of bleeding complications. It seems that perirenal hemorrhage is more likely to occur after a lesion biopsy immediately prior to the ablation procedure. Ablation of the needle course on withdrawal of the probe has been suggested to decrease the risk of postprocedural hemorrhage. Furthermore, this action would be helpful to avoid needle tract seeding. Hematuria is usually transient. If gross hematuria causes clots that persist in obstructing the collecting system, ureteral stent or bladder catheter placement may be necessary. Urinoma due to pelvicalyceal or ureteral injury requires percutaneous drainage and/or ureteral stents. Leakage from the pelvicalyceal system seems to occur slightly more after RFA compared to cryablation. Incidental thermal ablation of the ureter (lesions at the medial aspect of the lower pole) must be avoided by careful probe placement, hydrodissection or an indwelling ureteral stent. Fistula (urinary-cutaneous, nephrocolonic, nephroduodenal fistula) have been reported, usually resulting from direct thermal damage. Again, such complications must be avoided by careful probe placement, by increasing the distance between the tumor and the surrounding susceptible structures (hydrodissection, injection of air, injection of carbondioxide, balloon distraction). (Proximal) ureteral strictures are reported and are treated with nephrostomy and/or ureteral stent placement. Abscess formation should be treated appropriately by percutaneous drainage. Pneumothorax has been reported. Transpleural approach should be avoided. Post-op (aspiration) pneumonia (1 fatal case has been reported) must be treated appropriately. Transient probe site pain, flank wall weakness or laxity, paresthesia in the distribution of the genitofemoral nerve (often described as most frequent minor complication), transient neuropathic pain require conservative management; narcotic pain medication is rarely indicated. Thermal lesions (skin burn, liver burn, colonic perforation) have been reported. To prevent thermal injury to adjacent structures, hydrodissection, CO_2-dissection and balloon distraction can be used. Transient elevation of the serum creatinine level has been reported. Pseudotumoral inflammatory track mass has been reported. Tumor seeding along the electrode track has been reported, i.e., a skin metastasis, managed by local excision.

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Foundation Course
Nephrostomy and ureteric stents

901.1

Clinical and imaging evaluation of obstructive uropathy

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Learning Objectives
1. Etiology and clinical presentation of obstructive uropathy
2. When and which imaging is required
3. Which are the indications for emergency/elective interventions

No abstract available

901.2

Basic technique of nephrostomy and ureteric stenting

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Learning Objectives
1. To describe how to access the pelvicalyceal system using fluoroscopic and/or ultrasound guidance
2. To decide whether a nephrostomy or antegrade stent is indicated in specific clinical scenarios
3. To teach how to cross an ureteral occlusion and place a percutaneous catheter or ureteric stent

Please refer to abstract no. 2105.5.

901.3

How to access non-dilated kidney

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Learning Objectives
1. Indications / clinical scenarios for percutaneous access of the non dilated kidney
2. Tips and technical tricks
3. What to do if nothing works

Most nephrostomies are performed in obstructed dilated kidney. In these cases, the distended calices present a well-recognizable target that is easy to puncture. Occasionally, percutaneous nephrostomy of non-dilated kidney is necessary (urinary fistulas or non-dilated urinary obstruction). Entry into a non-dilated or minimally dilated pelvicaliceal system remains problematic, and multiple punctures may be required, increasing the chance of complications. The success rate ranges from 80 to 96% in the literature. Several techniques can be used to puncture a posterior calyx. In our experience, the use of ultrasound must be attempted firstly for guiding the initial puncture with an 18G needle even if the calyces are poorly seen; if necessary, intravenous administration of a diuretic agent (20-40 mg of furosemide) can be helpful by inducing transient dilatation of the pelvicaliceal system. Indeed, the control of the needle tract is better under ultrasound than under fluoroscopic-guidance and calices are frequently seen on ultrasound imaging carefully performed. Then, guidewire manipulation and nephrostomy catheter placement are performed under fluoroscopic-guidance. In case of failure, the first alternative is the administration of 50 ml of intravenous contrast agent to depict the calices on fluoroscopic imaging. Then a 22G needle is used either to puncture the calices directly or the renal pelvis under fluoroscopic-guidance. In case of calices puncture, a 0.018-inch guidewire is advanced through the 22G needle into the renal pelvis and ideally in the ureter. In case of renal pelvis puncture, the 22G needle is used to improve the visualization and distend the pelvicaliceal system with contrast agent alone or contrast agent plus air (double contrast pyelogram). Distention facilitates the definitive puncture of the calices with an 18G needle under fluoroscopic-guidance. The second alternative is to perform the procedure with an 18G needle under CT-guidance. It has the advantage of obtaining detailed images of the kidney region and thus the procedure can be performed even in patients with obesity, ectopic kidney or retrorenal colon. The retrograde technique has now fallen out of favor and to our knowledge, the use of magnetic resonance for this purpose has only been studied in animal models.

901.4

Management of complications

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Learning Objectives
1. Tips and tricks to avoid complications
2. How to manage early complications
3. How to manage late complications

This section of the foundation course deals with the management of complications of nephrostomy and ureteric stent insertion. During the session, I will discuss some details of technique to help minimise complications. The session will cover early complications of nephrostomy such as, haemorrhage, pelvic puncture/ruptured pc system, sepsis and adjacent organ damage including colonic transgression and pneumothorax. Late complications include displaced nephrostomy. I also aim to cover stent complications including retained threads, the forgotton stent and difficult stent retrieval. The session will include some videos demonstrating management of these complications.

Special Session
Native fistula management

902.1

When and how to dilate

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Learning Objectives

1. To describe the indications, techniques and various types of balloon and stents in native fistula PTA
2. To describe the clinical symptoms of most common stenosis of AV fistula (artery, vein, anastomosis, etc.)
3. To describe the follow-up and main complicationsof native fistula PTA

Stenosis due to intimal hyperplasia is by far the most frequent complication of hemodialysis access and leads to thrombosis. Dilatation (PTA) is the first choice of treatment in the majority of cases: It is an outpatient procedure with minimal invasiveness and the success rates are over 90%. Stenosis predominates at the venous anastomosis of grafts, in the anastomotic area of forearm native fistulas and in the venous outflow far from the anastomosis of upper arm fistulas.

Stenosis detection and indications for treatment: stenosis must be treated when it results in insufficient dialysis or clinical impairment or if it threatens access patency (stenosis over 50 or 70% is considered significant). Clinical impairment includes insufficient inflow with vacuum phenomenon during dialysis, difficulties in cannulation, venous hyperpressure, arm edema, increased bleeding after needle removal, distal ischemia, aneurysms, pain and skin necrosis. Clinical examination should remain the key detection method, even though it is operator-dependent and time-consuming. To determine when a stenosis must be corrected solely for the prevention of thrombosis remains to be determined for both fistulae and grafts. Among the numerous methods described for stenosis screening, routine measurements of access blood flow and of Doppler ultrasound were used. It has been shown that screening with either those two methods may have no benefit to patients with grafts; and that in arteriovenous fistulas, access blood flow screening may prevent access thrombosis, but may not reduce the risk of access loss or extent of resource use. Anyway, there is still much controversy in this area.

Technique: there is a consensus in the literature concerning the technique of dilatation. The access is gained from the outflow vein or the graft in the vast majority of cases to maintain the minimal invasiveness of the procedure. However, arterial puncture or an arterial route for dilatation of forearm fistulas may be used in selected cases, namely in arterial or anastomotic lesions. Dilatation is painful locally. Local anesthesia should be performed when stenosis are just under the skin. Otherwise, neuroleptanalgesia may be necessary. High-pressure balloons are used to abolish the waist of the stenosis. In resistant stenosis, ultrahigh pressure balloons should be used. Cutting balloon is a quite expensive device that should be reserved to treat the rare cases of stenosis resistant to ultrahigh pressure balloons. Their theoretical benefits include reduced vessel wall barotrauma and a reduction of elastic recoil. The diameter of the balloon should equal to or 1 mm greater than the diameter of the immediately upstream or downstream normal vessel, taking the smaller one first in cases of discrepancy. But some under-dilatation is desired in special cases, like stenosis in arteries, in veins near the elbow anastomosis and in cases where dilatation could lead to a secondary high flow or steal phenomenon. For a venous anastomosis of a 6 mm graft, balloons from 6 to 8 mm are used and the outcome might be better after over-dilatation to 8 mm. Stents should be reserved for rupture control or elimination of aneurysm. Once they are used, stents must not obviate further surgery and must protect the ease of making new anastomoses.

Results:

• **AV fistulas, grafts and central venous stenosis**: long-term results in forearm native fistulae are significantly better than for grafts (1-year primary patency rates from 44 to 51% for forearm fistulae and 17 to 40% for grafts) whereas stenosis treatment in upper arm fistulae gives intermediate results. The results after simple dilatation in central vein stenosis are the poorest (23 to 29% primary patency rates at 6 months); elastic recoil in 65% of all cases plays an important role in the poor result. The relative poor primary rates can be overcome by repeated interventions. For example, in forearm fistulae to reintervene every 18 months after the initial dilatation may achieve secondary patient rates of 85% at 1 year, 82% at 2 years and 80% at 3 years. During the same period, the rates for upper-arm fistulae may reach 82% at 1 year and 69% at 2 years, but with more frequent reinterventions (11 vs 18 months). For grafts, the secondary patient rates are usually similar to those found for upper-arm fistulas.

• **Cephalic arch stenosis**: in upper arm fistulas, stenosis in the cephalic arch occur quite often; there is a significant difference in the prevalence of cephalic arch stenosis between brachiocephalic and radiocephalic fistulas (39 vs 2%). The success rate of PTA of cephalic arch stenosis has been reported to be 76% in contrast to more than 90% in the forearm stenosis. Rupture rate was nearly 15% as opposed to 8% in forearm PTAs.

• **Immature fistula**: many arteriovenous fistulas can fail to mature adequately after creation; fistula dysfunction is assessed clinically on the basis of insufficient development after 1 month, difficulties in cannulation or impossibility of achieving 300 ml/min dialysis flow rate without recirculation. An underlying stenosis is diagnosed in 100% of cases. Half of them are located in the anastomotic area. The initial success rate of dilatation was shown to be 97%. Primary and secondary patency rates at 1 year were 39 and 79%, respectively.

• **Arterial stenosis** (less than 10% of stenosis in forearm AV fistulas) may lead to insufficient flow for dialysis treatment or to ischaemia. Dilatation of the underlying lesions is most efficient. In a cohort of 33 patients with a total of 35 accesses where arterial stenosis dilatation was attempted, it was reported PTA success in all but one patient. Re-stenosis occurred but redilatation was performed. Primary and secondary patencies were 63 and 90% at 6 months and 40 and 75% at 24 months.

Complications: complications are rare. Morbidity rates range from 2 to 15%, including severe allergy to iodine, infection, thrombosis and dilatation-induced ruptures. Loss of vascular access following uncontrolled vessel rupture is rare due to the availability of stents. An overall 30-day mortality rate of 2% has been reported and it seems normal in a population with such comorbidities. Procedure-related deaths are extremely rare.

New therapies: new therapies have been developed to reduce the formation and/or recurrence of neointimal hyperplasia. These include special cutting balloons, atherectomy devices, drug-eluting stents, laser, external radiotherapy and endovascular brachytherapy, far-infrared therapy and cryotherapy. Cryotherapy with the cryoballoon (cryoplasty) was reported as a useful therapy for patients with intractable stenosis at or near the venous anastomosis of arteriovenous grafts.

Radiology vs surgery approach: the radiology approach has several advantages over surgery: imaging of the whole fistula from the artery to the superior vena cava, which minimizes the risk of overlooking associated lesions (reported in 4 to 32%); better preservation of the patient's venous capital; less invasiveness; immediate availability for dialysis; Advantages specially marked are cases of long or multiple inflow and outflow stenosis either in the forearm or the upper arm, because in such cases the only durable surgical solution is either the sacrifice of all the vein upstream from the most central stenosis or placement of a bridge graft. There is one situation in which radiology is not superior to surgery, and that is in isolated stenosis located within 10 cm of the wrist in Brescia-cimino fistulas, if the feeding artery above the anastomosis is patent.

902.2

Management of central vein stenosis

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Learning Objectives

1. To describe the indications, techniques and stent for central vein treatment
2. To describe the follow-up and main complications of central vein treatment
3. To discuss, with clinical cases, tips and tricks in central vein treatment

The central venous vasculature, in particular the upper venous system, may be obstructed by benign or malignant lesions. Malignant central venous obstructions are mainly due to bronchiogenic carcinoma, mediastinal metastasis, pleural mesothelioma or lymphoma. The large group of benign diseases includes the prominent group of vascular access patients often presenting with symptoms aggravated by iatrogenic causes, in particular by the increasing use of permanent central venous catheters and implantable cardiac rhythm management devices. In addition, central venous obstruction may occur after radiation-therapy. Other benign reasons are nowadays rather uncommon. Thus, one of the most common causes for treating benign central venous obstruction is hemodialysis related. The incidence of hemodialysis related central venous obstruction resulting in angioplasty is described to be more than 10-fold higher compared to, for example, pace-maker induced stenosis. Adequate venous outflow is important for proper functioning of hemodialysis access in end-stage-renal-diseases patients and is considered the Achilles´ heel of vascular access. In spite of all improvements in dialysis techniques, the overall patency prognosis for the vascular access is still mediocre. At most, 15% of vascular accesses remain permanently functional. Stenosis of the upper central veins can lead to central venous hypertension, which may be the cause of shunt malfunction or even access loss. Such complications occur in 11-50% of hemodialysis patients. The most significant clinical symptom of central venous stenosis is swelling of the access arm. The superficial veins may become prominent due to collateral flow, and pain and paresthesia may result. Central venous stenoses have to be treated, when they are severe and disabling such as in impairing upper extremity swelling, wearisome pain or if they lead to inadequate haemodialysis. Percutaneous intervention by PTA with or without stent deployment has been advocated to prolong vascular access patencies for more than two decades. It is now an undisputed fact, that angioplasty should be applied as the primary treatment modality in central veins. Stent deployment is necessary in primary PTA failures such as elastic recoil or insufficient PTA. An appropriate endoprosthesis for central veins should be flexible enough to be used in curved and tortuous vessels. To evade stent dislocation and proximal embolization, a self-expanding stent should be preferred because venous stenosis may undergo progressive luminal enlargement after stent placement. Vanishing of collateral veins is a good indicator of successful angioplasty after sufficient reconstruction of the venous lumina. With respect to a conservative attitude, stent placement should be considered in cases of early (3 to 6 months) reobstruction. It is still in debate whether primary stenting generally decreases the likelihood of recurrence in central venous obstructions, but it may prolong patency intervals and allow for easy repetitive interventions. Nevertheless, routine placement of a stent for central stenoses to prevent restenosis is not generally recommended in view of the published results after primary or secondary stenting compared to primary PTA. Restenosis seems to be a steadily progressing process, without apparent regression and is frequently observed. It is more likely to occur after thrombosis has occurred for the first time. The interventionalist must be prepared for sometimes multiple angioplastic re-interventions after stent placement. For that, early regular follow-up and treatment of complications are compulsory to sustain the functionality of the dialysis access over a prolonged period.

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902.3

Saving the immature fistula

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Learning Objectives

1. To illustrate the background and patho-mechanisms of insufficient maturation
2. To discuss the indications, techniques and devices for immature

fistula treatment
3. To describe follow-up and main complications of treatment of immature fistulas

Autogenous fistulas are the primary shunts created for chronic hemodialysis patients in most European hemodialysis centers. Although autogenous fistulas have longer life spans (total functional time) than prosthetic graft fistulas, up to 30% of autogenous fistulas do not mature to facilitate effective hemodialysis. Endovascular interventions are an established and effective treatment of failing mature autogenous fistulas, but the usefulness of endovascular therapy on nonmaturing fistulas is not so well known. The prospective registry of our hospital covering all endovascular interventions on hemodialysis fistulas revealed that more than one-third of all primary interventions on native fistulas (72/201) during a twelve-year period were performed because of maturing problems (4). While Turmel-Rodrigues et al. found an underlying anatomic reason for maturing all their 69 patients in fistulography, Clark et al. found hemodynamically significant stenoses only in 89 of 101 patients. In our study, an obvious underlying lesion was not found only in two out of 75 fistulas at angiography. In all trials, multiple lesions have been commonly encountered.

Technique of endovascular intervention: in our center, the fistula is usually allowed to mature until three months, but in case of totally silent fistula (no thrill) angiography is performed earlier. If an underlying lesion responsible for nonmaturing is identified, recanalization and balloon angioplasty is attempted. Fistulography from brachial artery provides the best overview of both the arterial and vein status and facilitates superb evaluation of the entire hemodynamic conditions of the antebrachium, including the arteries distal to the anastomosis, as well as it reliably identifies the principal outflow veins. For the endovascular treatments, a 12 cm long, 5 or 6 Fr introducer sheath is inserted with the aid of digital road mapping control, and 5000 units of heparin was administrated intra-arterially. In cases of local infection, severe elbow deformity, highly located brachial artery bifurcation, and on antecubital fistulas the intervention is done by right femoral artery access through a 90 cm long introducer sheath, usually reaching the axillary artery level. The stenosed or occluded segments are traversed with a hydrophilic guide wire, and balloon angioplasty is performed using high-pressure balloons up to 25 atmosphere pressures. Intravenous boluses of Fentanyl (0.05 mg, up to a total dose of 0.15 mg) are given if the patient complained of pain during balloon dilatation. Nitroglycerin boluses of 0.25 mg were given intra-arterially in cases of spasm into the radial artery. Balloon inflation of 2-4 minutes' duration are routinely used and in cases of flow limiting dissections and/or elastic recoil, or vessel rupture up to 15 minutes' inflations are performed. Vessel wall thrombus is macerated with a PTA balloon and/or aspirated through the introducer sheath or an end-hole catheter. The indication for stent placement is inadequate PTA results (residual stenosis exceeding 50% and/or a flow-limiting dissection). After the endovascular intervention, the introducer sheath is immediately removed and the puncture site is manually compressed for 15-20 minutes, after which a compressive band was placed and left on for 6 hours. After the intervention, the fistula is allowed to mature up another four weeks before attempting hemodialysis. The main lesion responsible for the maturing problem is most often located at the anastomosis segment, while in matured fistulas most lesions are located in other vein segments. Inflow arterial lesions are identified in 4-7%.

Results of endovascular salvage of nonmaturing fistulas: we performed a prospective trial during a twelve-year period and angiography revealed anatomical lesion at 75 (72 radiocephalic and 3 brachiocephalic) fistulas with maturing problems (4). Endovascular therapy through antegrade arterial access was attempted on 72 fistulas. A series of 45 consecutive patients with endovascular salvage of failing mature fistulas was used as a control group. We obtained technical success of 88% and clinical success of 87% for the nonmaturing fistulas. Including the secondary interventions, the rate of complications was 6%. In addition to our trial, one prospective observational trial and five retrospective have been published about the results gained by active policy of fistulography and endovascular salvage on nonmaturing autogenous fistulas. Also, most others have gained encouraging success of 84-98%. In our trial, Kaplan-Meier analysis revealed the primary clinical patency rates were 43, 36, and 23% and the secondary patency rates 76, 68, and 57% at 6, 12 and 36 months, respectively. A small inflow artery (<3 mm in diameter) predicted poorer primary patency (28 versus 48% at one year, P=0.01). The secondary patency of nonmaturing fistulas was worse than that of mature fistulas (P=0.02); 57 versus 79% at three years, correspondingly. The mean total functional time achieved by the endovascular interventions was 1.5 times longer in the control group of mature fistulas in comparison with the nonmaturing fistulas group (59 versus 41 months). While a diagram in the report of Nassar et al. demonstrates excellent primary patency (about 62% at one year), most others have obtained worse results; Turmel-Rodrigues et al. gained primary and secondary patency of 39 and 79% at one year, and Clark et al. (6) 34 and 75%, respectively. No other study has reached the impressive primary patency rate of 68% at one year reported by Beathard et al. Some investigators report accessory collateral veins as a cause of maturing problem with subsequent embolotherapy in a proportion of fistulas while we, as well as Turmel-Rodriques and Shin, never embolized or ligated possible competing outflow branches. The rationale for embolotherapy is controversial, especially in case of a small principal outflow vein because these side branches may to be valuable as a puncture segment later, in case that the original puncture segment is eventually lost in spite of all salvage efforts. To summarize, fistulography should be done on all native fistulas with maturation problems and in vast majority an underlying lesion for matutation problem can be identified and treated successfully by endovascular intervention. Although the gained functional time of these fistulas is shorter than on failing mature fistulas, more than half of nonmaturing fistulas are functional after three years. Secondary patency rate of 80% at three years obtained for an initially successful intervention shows that repeated endovascular therapy is worth doing also for nonmaturing autogenous hemodialysis fistulas, however.

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902.4

Hand ischemia

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Learning Objectives

1. To discuss the possible mechanisms of hand ischemia
2. To describe the imaging work-up of suspected hand ischemia
3. To describe, with clinical cases, the techniques of treatment and the results

Dialysis access-induced ischemia is a serious complication that may lead to major amputation when not treated in time. Although compensatory increase in blood flow to the whole limb develops after fistula creation, because of the low resistance circuit, an absolute reduction in flow beyond the arteriovenous anastomosis may result. Symptomatic ischemic syndrome will develop if residual flow to the hand is insufficient to maintain the basic metabolic needs of tissues. This explains why an excessively high flow fistula can cause ischemia despite normal peripheral arteries and why even a relatively low flow fistula can cause ischemia if collaterals are unable to compensate for arteries that are damaged by arteriosclerosis or diabetes. Unfortunately, the occurrence of steal syndrome before the construction of an arteriovenous access is unpredictable. A 1-4 scale of classification for access-induced ischemia can be used (grade 1=pale/blue and/or cold hand with no pain, grade 2=pain during exercise and/or dialysis, grade 3=ischemic pain at rest, grade 4=ulceration, necrosis and gangrene). For grades 1 and 2, conservative treatment is possible most of the time. For grades 3 and 4, interventional treatment is indicated. It can be estimated from published series that the risk of symptomatic ischemia is below 2% in forearm fistulas but reaches 26% in elbow accesses. However, due to the increasing age and proportions of diabetics in incident dialysis patients, this is a growing problem. Unfortunately, the diagnosis of hand ischemia is often overlooked and delayed by dialysis nurses and nephrologists who monitor or treat the fistula and not the hand, and who are tired of constant complaints from many patients. All those responsible for the treatment of dialysis patients should bear in mind that any chronic pain or delayed cutaneous healing of the hand ipsilateral to a dialysis fistula is due to the fistula, as long as the responsibility of the fistula has not been ruled out by complementary examinations. Steal syndrome is likely to disappear if the access is ligated, but creation of a new arteriovenous access on another extremity also carries a significant risk of recurring peripheral ischemia. Correction of steal syndrome must therefore be attempted, the aim being both to preserve the access and to improve distal arterial supply to the hand. This is especially true when nephrologists are aware that, for social or economic reasons, a permanent catheter would lead to the rapid death of the patient from infectious complications. Ethical issues can be raised: what is worse? A patient with finger amputations and residual pain with a working fistula or cured steal syndrome in a dead patient? Clinical diagnosis is easy at the stage of skin ulceration. In the pain stages, non-invasive testing with measurement of digital pressure, calculation of the digit-to-brachial index (DBI) and transcutaneous oxygen determination are important steps. These tests help to distinguish steal syndrome from other conditions such as carpal tunnel syndrome, calciphylaxis (local acute formation of calcium concretions), destructive arthropathy and algodystrophy. Ischemic monomelic neuropathy (IMN) is a devastating complication occurring early after construction of elbow fistulas in diabetic patients. It is due to damage to the vasa nervorum. The result is rapid and often non-reversible severe sensorimotric dysfunction of the ulnar, median and radial nerves with no tissue loss and with indices that are normal or above critical values. Ultrasound examination of all the arteries of the entire limb with vascular access flow-rate measurement helps in the decision-making process. In experienced hands, US examination can provide the diagnosis of significant arterial stenoses and indicates the direction of the flow in the artery distal to the anastomosis. Despite the value of US examinations, invasive angiography is mandatory to define the treatment strategy. Angiography includes opacification of the whole arterial tree from the ostium of the subclavian artery to the fingers. Iodixanol (Visipaque®) is the best iodinated contrast medium for this indication because it does not cause any pain, and this helps the patient not to move the hand during angiography. The site of catheterization for diagnosis angiography depends on the clinical presentation. Retrograde cannulation of the arterialized vein or graft can be considered in elbow fistulas, and a 4F catheter can be pushed through the anastomosis into the proximal brachial artery up to the subclavian level. In forearm fistulas, retrograde catheterization of the feeding artery can be extremely difficult when there is a sharp angle at the anastomosis where it can cause spasm or occlusion of the radial artery. Direct retrograde cannulation of the elbow artery is often a better approach. It must be kept in mind that in 15 to 20% of patients, the radial artery (less frequently the ulnar artery and rarely the interosseous artery) has a high origin from the axillary or brachial artery and that the artery cannulated at the elbow level can be either the radial artery or the common trunk to the ulnar and interosseous arteries. A femoral approach with selective catheterization of the subclavian artery has to be considered when no pulse is felt at the elbow level. In all cases, it is of paramount importance to be sure that all collaterals originating from the axillary artery are filled in order to be sure to dye all arteries involved in the distal arterial supply. There are 7 points to be analyzed and recorded when performing angiography for hand ischemia: -search for arterial stenoses, occlusions or emboli; -kinetics of opacification of arteries; -kinetics of opacification of collaterals; -search for additional arteriovenous communications or stumps of former fistulas; -palmar arches; -opacification of digital arteries, with runs under compression of the fistula; and -venous outflow. Any significant arterial stenosis located upstream from the anastomosis should be searched for and treated since this can improve or cure the patient in many cases. Dilatation of a stenosis on the brachial artery distal to the anastomosis is indicated if antegrade flow is preserved, but contra-indicated in cases of retrograde flow. At the forearm level, dilatation of a stenosis on the proximal radial artery feeding the fistula will have no or little effect on distal ischemia since the resulting increased flow will run into the fistula. In contrast, dilatation of a stenosis on the ulnar artery, whenever technically feasible, automatically increases flow to the hand and can cure some patients. Similarly, chronic occlusions can sometimes be recanalized and fresh clots (iatrogenic embolism complicating a recent declotting procedure of an elbow fistula) can be aspirated. The kinetics of opacification of the artery distal to the anastomosis is of special importance. If the flow is reversed, ligation of the distal artery may be an easy and effective treatment. In cases of antegrade flow in the distal artery, such ligation is contra-indicated unless a concomitant distal arterial bypass is performed. However, it must be remembered that the majority of radiocephalic fistulas show retrograde flow in the distal radial artery and that a very small minority exert symptomatic steal. The kinetics of flow in collaterals help to explain how arteries distal to the anastomosis are fed and which artery can be ligated to decrease steal or dilate to improve distal flow. Many patients with an elbow fistula have undergone previous attempts at creation of a more distal fistula. It is not rare to see evidence of a residual arteriovenous fistula. Such residual fistulas can be embolized or surgically ligated. Similarly, a residual stump at

the anastomotic site of a former fistula can remain patent and be a "nest" for local clots that may then migrate into the arterial outflow. The quality of palmar arches helps to grade the steal exerted by a radiocephalic fistula on the ulnar flow and conversely to predict if the excessive flow of a radiocephalic fistula might be treated by ligation of the proximal radial artery. Spontaneous opacification of the digital arteries up to the finger pad is only seen in mild ischemic syndromes. If spontaneous opacification of digital arteries is not obtained, runs under compression or transient occlusion of the fistula should be performed. If arteries become clearly opacified under fistula compression, healing after treatment of the cause of the steal is likely. When no arteries are visible, necrosis is predictable. In contrast, spontaneous hypervascularisation of a finger tip indicates an inflammatory response and rules out the responsibility of insufficient arterial inflow in the genesis of pain or tissue loss. Confirmed distal arterial hypoperfusion syndrome is an absolute contraindication to dilatation of any kind of stenosis located on the arterialized vein. The resulting increase in fistula flow would mean increased steal on the arterial supply to the hand. Similarly, it is difficult to predict steal syndrome after overgenerous dilatation of a stenosis in any kind of arteriovenous access. A poor ulnar artery is probably a good indicator of the risk of subsequent development of distal ischemia. In some rare cases, mild ischemic symptoms can be explained by chronic abnormal venous reflux to the hand as a result of stenosis or occlusion of the main outflow vein. Magnetic Resonance Angiography with gadolinium injection is not a reasonable technique because of the risk of nephrogenic systemic fibrosis in these patients, although no case has been reported to date with the most stable gadolinium-based agent (Gadoteric acid, Dotarem®). Computed Tomography Angiography is a diagnosis method deleterious to the venous reserve of the patient since cannulation of a "large healthy vein" is necessary for contrast injection. Overall, concomitant dilatation of diagnosed arterial stenoses is not possible to date using these two invasive imaging modalities. Surgical techniques aim either to reduce fistula flow or to increase distal perfusion. Again, the most effective method is fistula ligation, which solves the ischemia problem immediately but can jeopardize the patient's life if the only alternative is the placement of a permanent catheter prone to fatal infection. In cases of high flow fistulas, flow reduction techniques include banding and RUDI (Revision Using Distal Inflow). Banding aims at creating a narrow vessel segment within the access, close to the anastomosis. Unfortunately, banding is frequently either too tight, resulting in access thrombosis, or too loose and ineffective. RUDI techniques include ligation of the proximal radial artery and techniques leading to replacement of the brachial artery by the radial inflow artery. The radial artery can be cut distally and transposed to the elbow level, or a graft can be interposed between the radial artery and the elbow vein. Development of stenoses at the new anastomosis sites will occur with both techniques. In low or normal flow elbow fistulas, DRIL (Distal Revascularisation Interval Ligation) is the most popular technique. A graft is interposed between the proximal brachial artery and the distal brachial artery in order to improve flow to forearm arteries. Concomitantly, the distal brachial artery is ligated as close as possible to the fistula in order to prevent steal by retrograde flow to the fistula. In forearm fistulas, single distal radial artery ligation (DRAL) is performed as close as possible to the anastomosis, with no distal bypass. Surgical series of DRIL and DRAL have reported immediately favourable results. The most recently described technique is called PAI (Proximalization of Arterial Inflow). The initial elbow anastomosis is ligated and a graft is interposed between the axillary artery and the elbow vein. The optimistic results of the only series reported to date have to be confirmed. In conclusion, hand ischemia related to the presence of an ipsilateral arteriovenous access for dialysis is an increasing and potentially dramatic problem. Diagnosis, imaging and treatment are often difficult and require a multidisciplinary approach. The radiologist has the easiest role, providing full arterial mapping of the limb and dilating significant stenoses. However, even experienced surgeons are unable to read all the details and subtleties of angiography by themselves: a detailed and convincing angiography report is absolutely necessary since effective treatment rarely results from incorrect reasoning. Telephone calls help to avoid misunderstandings. The worst and most dramatic cases are the consequence of elbow fistulas. This is a serious reason to encourage the creation of fistulas in the forearm, even in cases of suboptimal arteries or veins at pre-operative mapping.

Special Session
Anaesthesia simple to complex

903.1

Basics of pain management for IR procedures

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Learning Objectives

1. To describe the use of morphine (indication, risks, intravenous, etc.) including PCA
2. To describe the nervous bloc (technique, indications, etc.)
3. To describe the use of MEOPA for conscious sedation

The mechanism of pain induced by IR procedures is mainly nociceptive (Bone, visceral, inflammatory). Pain varies greatly according to the procedures: **Moderate pain:** Liver tumor embolisation, UFE embolisation, coeliac plexus block, cementoplasty, lung R.F., gastrostomy. **Intense pain:** Radio frequency ablation, bone RF, biliary drainage, dialysis fistula, digestive stenting.

A pre- interventional visit, 48 h before procedure (unless emergency), is essential to determine the choice of analgesia (sedation or general anaesthesia) according to pain intensity and physical patient status (chronic obstructive pulmonary disease, obesity, chronic renal failure, coronary artery disease or psychological disorder). Information is given to the patient and consent is obtained. Premedication is prescribed: (Hydroxyzine: 1 mg/kg, application of Emla® cream on the site of puncture).

Sedation combines PCA opioids (Morphine: bolus 3 mg, interval: 3 min or Oxycodone: bolus 1.5 mg interval: 3 min), midazolam: titration: 0.03 mg/Kg), inhalation of mixed equimolecular oxygen/nitrous oxide). Low doses of ketamine (0.2 mg/Kg) I.V. have antihyperalgesic effects in association with opioids. The patient is monitored by NIBP, EKG, oxymetry, adequate training personnel with no other responsibilities in IR room maintains verbal contact with the patient. Patient controlled administration of propofol is border to general anaesthesia. Bispectral index monitoring may increase safety if frontal brain activity is preserved above 85/100. However, an anaesthesiologist may be ready for rescue in case hemodynamic or ventilation failure. Hypnosis has been shown to be effective in reducing pain and anxiety during IR procedures but needs a psychologist sitting next the patient and addition of sedative drugs.

Loco-regional anaesthesia (Troncular, plexic) may be used for upper or lower limbs interventions (RF, cementoplasty, dialysis fistula), using ropivacaïne 0.2 or 0.75% (max dose: 150 mg) but must be performed by an anaesthesiologist as epidural analgesia for pelvic procedures.

General anaesthesia is required in case of important pain, no possibility of prone position in conscious patient, unstable status patient (hemodynamic, respiratory, metabolic) and high risk of vital function decompensation (lung R.F, vascular endoprothesis).

In post interventional period after sedation or general anaesthesia, the patient is transferred in recovery room. Antalgia is multimodal: acetaminophen: 1000 mg x 4; nefopam: 120 mg /24 h, NSAIDs, ketoprofen 100 mg x 3 (except usual contra-indications: renal or cardiac impairment, risk of gastric bleeding). Opioids are

administered with PCA device (morphine or oxycodone). In case of chronic opioid administration before intervention, a continuous rate of infusion is prescribed, associated with opioid PCA. Switch to oral route is made as soon as possible.

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903.2

When do we need GA

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Learning Objectives
1. To describe the various types of GA (intubation, curare, etc.)
2. To describe the advantages and drawbacks of GA (mortality, morbidity, etc.)
3. To discuss the IR procedures that require GA

General anaesthesia minimizes patient's discomfort while undergoing painful and/or prolonged invasive procedures. In addition, the presence of an anaesthesiologist increases patient's safety, since this physician is specifically trained to deal with most vital threats (blood loss, hemodynamic variations, respiratory failure) potentially related to the procedure itself or inherent to patient's co-morbidities. Patient's comfort and safety are two excellent reasons to request the help of an anaesthesiologist when interventional radiology (IR) procedures are considered. On the other hand, anaesthetic management per se not only prolongs and complicates the procedure but also drastically increases its cost. Anaesthesia can only be administered in specific locations where the technical environment (usually defined by law) is adequate. The decision to perform IR procedure with or without general anaesthesia relies on a combined evaluation of feasibility and tolerance of a specific procedure in a given patient (1). The tolerance relates usually to the duration, position, and painful character of intervention. Laser and radiofrequency procedure for example are often painful. The availability of anaesthetic staff, usually a physician and a nurse, and equipment may also sometimes represent a limiting factor at some institutions. Intravenous sedation and analgesia decrease the level of consciousness but also depress the respiratory drive and the reflexes protecting airways from aspiration. These two side effects of anaesthetic agents usually require oro-tracheal intubation for both mechanical ventilation and airway protection. It is sometimes acceptable to use sedation without oro-tracheal intubation when it is not necessary to achieve a deep level of sedation and when the risk of aspiration pneumonia is low (i.e., short, elective procedures) (2). However, in such situations, the patient may be reactive to noxious stimuli and remains at risk of hypoventilation and aspiration. The risks intrinsically associated with anaesthesia (anaphylaxis, complications of airway management) are very low, but always deserve to be considered in terms of benefit/risk ratio for each individual patient. Anaphylactic reactions during anaesthesia are most often associated with the use of muscle relaxants and antibiotics. Muscle relaxants are used to facilitate intubation and antibiotics are commonly administered for prophylaxis of wound infection. Some IR procedures cannot be performed without general anaesthesia because they are prolonged and painful, or require that the patient remains strictly motionless. In situations of life-threatening emergencies (post-partum haemorrhage, multiple trauma with pelvic fractures) requiring IR, the presence of an anaesthesiologist is mandatory for the management of vital functions, even if the procedure is performed under local anaesthesia. Sometimes, the choice of using general anaesthesia relies on the preferences of the radiologist and/or the patient himself. When there is a need for anaesthesia, the most appropriate technique will be selected during anaesthetic consultation, after medical examination of the patient and complete information regarding the benefits and risks of both IR and anaesthetic procedures.

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903.3

Complex interventions should be done with anaesthesiologic care only - PRO

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Radiology , University Clinics Vienna , Vienna, Austria.

Learning Objectives
1. To discuss how IR can handle complex interventions without the need of an anaesthesiologist

No abstract available

903.4

Complex interventions should be done with anaesthesiologic care only - CON

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Learning Objectives
1. To review the limitations of carrying out complex interventions with IR monitored conscious sedation
2. To review why GA is the best way to achieve successful and safe complex interventions

Introduction: the total number of diagnostic and therapeutic invasive interventions in medicine has increased considerably in the past decades due to technical developments, especially in the field of imaging, in a huge variety of medical specialty fields. These interventions usually require some form of analgesia, mostly by local anaesthesia techniques but nevertheless may be painful to undergo and are definitely not pleasant for many patients. This latter condition frequently causes the patient to show signs of unrest during the procedure, thus decreasing the likelihood of optimal interventional conditions. This in turn leads to loss of costly intervention time and frequently untimely abortion of the diagnostic or therapeutic procedure. Unfortunately, anaesthesiologists or anaesthesia departments will not be able to fill in the request for more sedation service: there is a shortage of anaesthetists in many countries in Europe, which, unfortunately will last for many years to come. Fortunately, new drugs have been developed to provide sedation and/or analgesia, which are easy to handle but which are not devoid of potentially life threatening side effects.

Procedural sedation and/or analgesia (PSA): safe techniques are required to meet the demand for high quality and safe sedation for patients undergoing invasive procedures. The knowledge and skill competencies that are required are the traditional domain of anaesthesiology but may successfully be taught to other doctors, non-anaesthesiologists and even to dedicated nurses or other

health professionals. These PSA techniques require the procedure of screening of patients, identifying the impact of the invasive procedure, personal observation and instrumental monitoring of the patient during sedation, adequate recovery conditions. The most important prerogative, however, is: training of the PSA practioner in sedation and cardiorespiratory monitoring techniques. These procedures, when performed by non-anaesthesiology health professionals must be limited to ASA I and ASA II patients; for ASA III and IV the input of an anaesthesiologist or of an anaesthesia department is needed.

Radiology: in clinical image sciences, PSA is mainly applied for image-guided interventions. There appears to be a suboptimal usage of these PSA techniques by radiologists, mostly caused by unfamiliarity with the safe use procedures of PSA techniques. PSA techniques may contribute to patient safety and both doctor and patient satisfaction for a number of radiological interventions such as peripheral vascular interventions, diagnostic functions and biopsies, nefrostomies, percutaneous gastro/jejunostomies, ERCP procedures and application of central venous lines. Some radiology procedures such as MRI for children or for intensive care patients are less suitable for PSA by non-anaesthesiologists only, due to technical limitations and/or the medical condition of the patient. These require the special expertise of an anaesthesiologist.

Modification of practice? many experts are fully convinced that PSA can be applied safely by non-anaesthesiology practitioners for selected patients when certain and strict safety conditions have been met. Our first experiences with physician assistants or anaesthesia assistants who received additional training in screening techniques, sedation techniques and pain relief techniques providing sedation for gastroenterology, IVF procedures and bronchoscopies in more than 700 patients in our hospital are very promising and need to be worked out and evaluated further. Anaesthesiology should take responsibilities in PSA procedures, but need not provide PSA for all patients in person.

Honorary Lecture
Andreas Gruentzig Lecture

1102.1

Interventional oncology

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During the past few years, the use of image-guided interventions in cancer treatment has experienced unparalleled growth. Several innovative techniques and devices for direct tumour ablation and trans-arterial therapy have been introduced. Sophisticated imaging methods improving tumour targeting and treatment monitoring have been devised. A number of trials have been successfully completed in different clinical settings. Interventional oncology procedures are increasingly used as an alternate or complementary treatment for a variety of solid cancers under the common denominator of effective local tumor control without the morbidity of open surgery or the toxicity of chemotherapy and radiation. A central conviction underpinning the research strategy is that the core approaches to cancer treatment, namely systemic drug administration and surgery, will be supplemented by minimally-invasive treatments for locally-dominant disease to increase response, achieve better side-effect profile, reduce cost and potentially improve survival. An integrated, multidisciplinary approach is instrumental for interventional oncology to be accepted by referring physicians, governing bodies, and patients as another defined arena similar and coequal to radiation oncology, surgical oncology, and medical oncology in the field of cancer clinical care. Such an approach will eventually enable interventional oncology to have a pivotal role in the therapeutic management of cancer.

Foundation Course
Abdominal and pelvic abscess drainage

1401.1

Clinical and imaging evaluation of abdominal abscesses

V. Válek;
Dept. of Radiology , University Hopital Brno, Masaryk University , Brno, Czech Republic.

Learning Objectives

1. To review clinical symptoms and signs of abdominal abscesses
2. To review imaging features of abdominal abscesses
3. To discuss the indications and relative contraindications of abdominal abscesses

With the new antimicrobial agents and advances in diagnostic imaging and imaging-guided percutaneous procedures has been significantly improved management of pyogenic liver abscess. The advantages of the percutaneous approach include a marked decrease in the invasiveness and cost of abscess drainage. The classic triad of fever, upper right quadrant pain or fullness, and jaundice is rarely seen nowadays. Possible image-based exclusionary criteria for drainage included abscess size of less than 3 cm in diameter, fluid attenuation of more than 40 HU, absence of contrast material-enhanced margins, absence of trapped air in a fluid collection, absence of free intraperitoneal air, and presence of air without fluid in the abscess cavity. The most important is size of less than 3 cm. Possible clinical exclusionary criteria included normal white blood cell count, normal temperature, normal blood pressure, absence of peritoneal signs, lack of relevant medical history and do-not-resuscitate code status. Indications for percutaneous approach to abdominal abscess drainage are clinical sign of inflammation and fluid collection (abscess) large then 3 cm. Contraindications are today only relative. Percutaneous needle aspiration or catheter drainage guided by CT of sonography, therefore, has become the therapy of choice for abdominal abscess.

1401.2

Basic technique of abdominal and pelvic abscess drainage

O. Akhan;
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Learning Objectives

1. To review main characteristics of "Seldinger and Trochar techniques"
2. To teach some tips and tricks on how imaging modalities are employed during abdominal and pelvic catheterization
3. To review transgluteal, transrectal and transvaginal approaches besides transabdominal for pelvic catheterization

Percutaneous drainage has already gained a wide acceptance in the patients with abdominal and pelvic abscesses as it is a safe and effective treatment of choice. Percutaneous drainage is performed under either US or CT guidance. If the initial puncture is carried out under US guidance the next steps of the procedure are completed under fluoroscopy guidance. This approach gives a chance to us to complete the procedure safer as all the necessary manipulations for the final catheter placement are easily carried out under fluoroscopy guidance. Catheterization is performed by one of two basic techniques, either Seldinger technique or Trocar technique. As a general rule, Trocar technique is employed for the large and superficially located abscesses while Seldinger technique is preferred for small and deeply located abscesses. It is very easy to carry the procedure in patients with pelvic abscess if it is located in the proximity of anterior abdominal wall. However, it is sometimes a difficult challenge to perform catheterization in patients with deeply located pelvic abscesses because of the surrounding structures such as bony

pelvis, urinary bladder, intestinal loops, iliac vessels and gynaecologic organs, which preclude safe access. The transgluteal approach can provide an important alternative to drain these groups of abscesses. The ideal puncture for transgluteal access is defined to be as close to sacrum as possible at the level of the sacrospinous ligament. Deeply located pelvis abscesses are also drained by either transvaginal or transrectal approaches when indicated. The procedure can be carried out under either US or US-flouroscopic guidance.

1401.3

Challenging access

D.E. Malone;
St. Vincent's University Hospital , Dublin, Ireland.

Learning Objectives

1. To review how to prepare for difficult drainages
2. To describe image guidance methods for challenging accesses
3. To review techniques for drainage in specific challenging cases

Once you know how to image abscesses and understand the basic techniques for their drainage, you will be consulted about abscesses in many abdominal and pelvic locations. This presentation focuses on getting a satisfactory clinical result with the lowest possible risk of complications and medico-legal consequences in difficult cases. Challenging access is not as safe as basic abscess drainage. Do not be daunted by this. The techniques are generally the same, only the planning and access routes are different. Before doing the procedure, talk to the referring clinicians, the patient and if necessary their family. Evaluate the insights, concerns and expectations of the patient and explain the benefits, alternatives and risks of the procedure. Ensure you are planning from recent imaging. Correct any coagulation defects and ensure antibiotic cover is optimal. Pay careful attention to the adequacy of sedation and do not hesitate to seek general anaesthesia if you consider it warranted. Be sure any surgical options that may be needed if things go wrong are in place and have been explained to the patient. Then, relax and do the procedure as planned. These procedures usually work well and proper planning will negate predictable complications. Imaging guidance using ultrasound, fluoroscopy and CT will be discussed. Procedures will be considered by anatomic drainage route. The presentation will cover difficulties in pelvic abscess drainage by transvaginal, transrectal and transgluteal routes; access to high intrahepatic and subphrenic abscesses; retroperitoneal drainage; narrow window and angled drainage using US and CT; drainage of infected pancreatic phlegmon in severe acute pancreatitis; gas-containing abscesses; splenic abscess drainage; transhepatic drainage of lesser sac abscesses; drainage of 'inacessible' interloop abscesses and management of inadvertent enteric transgression. The equipment typically used by the speaker in each case will briefly be described. References will be provided where available.

1401.4

Patient management after drainage

H. van Overhagen;
Dept. of Radiology , Haga Hospital , The Hague, Netherlands.

Learning Objectives

1. To review the importance of clinical evaluation and daily drainage of the patients
2. To review the importance of imaging follow-up of the patients
3. To teach when the catheters should be taken out

There is little statistical evidence supporting this subject. Most is based on retrospective studies and our clinical experience. Once the abscess drain is placed, it should be secured. Drain output should be checked immediately. When there is no drain production, the location of the drain should be reassessed. Aspirated material should be sent for gram stain and culture to allow adequate antibiotic therapy. After-care is important in PAD. It should be clear who is responsible for daily management. A national survey showed that in the UK, the clinical team generally takes over daily management. Nevertheless, an occasional visit to the patient on the ward and contact with the doctors and nurses on the ward is advised. Most authors recommend to flush the drain 2-4 times daily with small amounts (5-10 ml) of saline in order to maintain patency. Saline irrigation of the abscess is usually not performed. There are a few encouraging reports in the literature regarding the instillation of urokinase or tissue-type plasminogen activator in abscesses with viscous content. The two most important factors during follow-up are the clinical condition of the patient and the drain production. If the patient does not improve clinically and there is no other reason to explain this, the drain function should be assessed. In those cases the drain produces normally, reimaging of the patient should be performed to determine whether the drainage is incomplete or if there are more (new) abscesses. In those cases when the drain shows a constant high production, a fistula should be suspected. The presence of such a fistula can be demonstrated fluoroscopically with a fistulogram. Common causes of drain dysfunction are locked connectors and drain kinking, which should be ruled out by the intervention radiologist who has best knowledge of the materials that have been used. Drain occlusion due to large clots can be assessed by flushing the drain with saline. Another cause of drain dysfunction is drain dislodgement. The position of the drain can be checked with ultrasound, which can be facilitated by injecting a small amount of air through the catheter under direct view, or with CT, which can be facilitated by the injection of diluted (1:20) contrast material through the catheter. When the patient has improved clinically, the drain can be removed. However, removal should take place after complete evacuation of the abscess has been demonstrated on ultrasound or (preferentially) CT.

Special Session
Complex stent grafts (branched and fenestrated)

1402.1

The aortic arch

M.D. Dake;
Falk Cardiovascular Research Center, Stanford University School of Medicine, Stanford, CA, United States

Learning Objectives

1. To review the indications and imaging work-up for treatment
2. To discuss the techniques and results of hybrid treatment
3. To discuss the current status of branched technology for aortic arch disease

The aortic arch with its great vessel branches presents a perplexing challenge for endograft management. The technical strategies to consider are necessarily intertwined with an individual patient's clinical situation, including the specific anatomical and physiological factors associated with any number of diseases affecting the thoracic aorta. Depending on the particular characteristics of any arch lesion under consideration, a variety of less invasive alternatives to open surgery may be options. All of the potential solutions are designed to address a range of inadequate proximal necks that are unsuitable for TEVAR. The pathologic processes may include a spectrum of branch vessel involvement that may affect a single branch (usually the left subclavian artery origin), encompass two branch origins (left subclavian and left carotid arteries) or extensively include all arch branches. Some endovascular techniques and devices are created to target limited arch involvement with procedures that do not commonly require elaborate approaches customized to the patient's anatomy. As more comprehensive solutions are required to deal with complete debranching, especially by endografts

exclusively, the devices, often with integrated or modular branch attachments, become more dependent upon custom-tailoring to the individual arch configuration. This focus relies on meticulous measurements in the planning stage and precise orientation during device placement. Some of the possibilities for management of complex aortic arch anatomy include: fenestrated grafts, "chimney" technique with parallel branch grafts, elephant trunk surgical procedure in conjunction with endograft, hybrid surgical procedures with a variety of operative arch debranching grafts combined with aortic endograft, single or multiple branched endografts, and in situ endograft fenestration with peripheral branch stent-graft extension. Examples of these challenging procedures will be presented.

1402.2

Thoraco abdominal branched stent graft

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Surgery, University Medical Center Groningen, Groningen, Netherlands.

Learning Objectives

1. To review the indications and imaging work-up for treatment
2. To discuss the techniques and results of hybrid treatment
3. To discuss the techniques and results of branched devices

Introduction: thoracoabdominal aortic aneurysms (TAAA) involve both the thoracic and abdominal aorta and are relatively uncommon. If left untreated, these patients are at risk of aneurysm rupture and death. Postoperative complications are often severe and include myocardial infarction and ischaemia, respiratory insufficiency with prolonged ventilation, and acute renal failure. Thirty-day mortality and one-year survival in a large American population based study were reported to be 20 and 69%, respectively. In addition, there is an inherent risk for paraplegia depending on the extent of the aneurysm and its repair. Due to the major impact on the patient, open surgery is only justified in those patients who are in reasonably healthy condition and present with larger aneurysms. Results with open surgery opened the way to explore alternative treatment options. Besides endovascular treatment with branched grafts, which is slowly becoming more available, a hybrid solution has been proposed. Nevertheless, a proportion of patients are still refused treatment because of advanced age or co-morbidity.

Indications and Imaging work-up for treatment: indications for endovascular treatment with branched grafts should not differ from open repair with regard to size of the aneurysm, simply because the endovascular repair also presents with the risks of a complex technical procedure, and because mid- and longer term results are still lacking. Pre-operative imaging work-up should be optimal and therefore performed with multislice computed tomography with the use of post-processing software (e.g., Terarecon, 3-Mensio, Osirix) to evaluate the complete aorta and specifically the exact position and orientation of all vital side branches. Maximum intensity projection in different planes and 3-D rendering should help define the choice between branches and/or fenestrations, and the selection of additional multiple tubular and bifurcated grafts to complete the procedure. Engineers and other technicians can help draw a graft plan, but the approval of the graft design and the appreciation of the different technical difficulties related to the implantation remain the full responsibility of the team performing the procedure. No graft plan is complete without a scenario that takes all potential complications into account. Finally, it is important to realize the need of ancillary products such as multiple guiding sheaths and bridging stent-grafts.

Techniques and results of hybrid treatment: the hybrid treatment aims at avoiding thoracophrenolaparotmy, and cross-clamping of the aorta in TAAA, by debranching the visceral vessels surgically. This surgical debranching can be achieved through a laparotomy only and without clamping of the aorta itself, and creates landing zones for a subsequent endovascular repair. The procedure reduces the visceral and renal ischemia time and can be performed under hemodynamically stable conditions, which diminish the risk of paraplegia. Often, the surgical bypass can be started at the level of the distal part of the abdominal aorta, but sometimes a bypass starting from one iliac vessel may be needed (i.e., if the aneurysm extends to the level of the aortic bifurcation. This combined solution can be carried out in one stage, but the endovascular procedure can also be performed at a later stage. Results have been described to be promising, especially with regard to a reduced risk of paraplegia. However, caution should be exerted as no comparative studies have been carried out up-to-date. Indeed, the technique has been used in higher risk patients and sometimes in the acute situation, but mortality and morbidity remain high, especially in acute patients. Longer term results are awaited because the patients are at risk of both endovascular (endoleak, migration) and open (occlusion of bypass, anastomotic problems, late fistulae) complications.

Techniques and results of branched devices: all fenestrated/branched grafts for TAAA have to be individually customized to the patients' unique anatomy, and fitted with fenestrations or directional branches for the visceral side branches of the aorta (celiac trunk, superior mesenteric artery, both renal arteries) Fenestrations are best chosen when the distance between the graft and the ostium of the target vessel is short (e.g., when the main graft lies against the wall of the aorta). Branches are chosen when a larger gap needs to be bridged. The branches do provide a better seal and fixation for the bridging stent-graft. Narrowing down the main graft at the level of the visceral vessels allows for space for the branches. Branches also need less critical positioning with regard to the target vessel. Branches, however, do require a cranial approach to catheterize the branches and target vessels. Our favorite approach for that purpose is the left axillary artery through a small cut down. In view of the length of the procedure and the multiple accesses, general anesthesia is preferred. Systolic blood pressure should remain high and spinal fluid drainage indicated to reduce the risk of paraplegia. We prefer to drain roughly 10 ml/hour for 2-3 days, rather than measuring the pressure. The minimal invasive approach allows for hemodynamically stable conditions during the procedure thus reducing both systemic complications and the risk of paraplegia. The largest reported series so far includes a cohort of 73 patients as published in 2007 and operated on in The Cleveland Clinic Foundation, Cleveland, Ohio, USA. In that series, there were 28 type I, II, or III and 45 type IV TAAAs. Technical success was achieved in 93% of patients (68/73). Thirty-day mortality was 5.5% (4/73). Major perioperative complications occurred in 11 (14%) patients and included paraplegia (2.7%, 2/73), new onset of dialysis (1.4%, 1/73), prolonged ventilator support (6.8%, 5/73), myocardial infarction (5.5%, 4/73), and minor hemorrhagic stroke (1.4%; 1/72). Mean length of stay was 8.6 days. Our personal series includes 34 patients, of which 23 (68%) were refused open surgery. Type of the aneurysm was as follows: TAAA I, n=10; TAAA II, n=6; TAAA III, n=13; and TAAA IV, n=5. The devices used were all individually tailored custom-made Zenith stent-grafts (Cook Medical Inc, Brisbane, Australia). In the majority of cases, balloon expandable stents (Advanta, Atrium Medical Corporation, Hudson, NH, USA, or Jomed Covered Stent Graft, Jomed International AB, Helsingborg, Sweden) were used to bridge the branches of the stent-graft to the target vessels. Additional support to prevent kinking was usually achieved with self expandable stents (Zilver Stent, Cook Medical Inc, Bloomington, IN, USA, or Smart Stent, Cordis, Miami, FL, USA). Technical success was achieved in 31 (91%) patients. Three (8.8%) patients died within 30 days. Complications were seen in 13 (43%) patients including three cardiac complications [STEMI (n=2), atrial fibrillation (n=1)], two respiratory complications, and one urinary tract infection. One patient required dialysis, and one patient had a glomerular filtration rate decrease of more than 30%. Two retroperitoneal hematomas were managed with transfusion and conservative measurements. Symptoms of paraparesis/paraplegia were seen in five (16.7%) patients, but they all resolved with systolic

blood pressure raise and continued spinal fluid drainage. Mean operation time was 286±78 min (range 135-480); median blood loss was 570 ml (range 100-5500). Mean contrast used was 277±92 ml (range 80-480) and mean fluoroscopy time was 74±29 min (range 15-140). Half of the patients required admission to the intensive care unit after the procedure. Median stay in intensive care unit was one day (range 0-28). Median hospital stay was 8 days (range 3-50).

Conclusion: in view of the major impact of open surgery, alternative minimal invasive techniques will continue to progress. In the near future, more patients with TAAA will be treated by endovascular means. Open repair will continue to play a role, mainly in relatively healthy or younger patients (e.g., Marfan), but the hybrid solution will probably be reserved to some specific cases only. Finally, with more options available, a smaller proportion of patients will be denied treatment.

1402.3

Abdominal fenestrated stent graft

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Learning Objectives

1. To review the indications and imaging work-up for treatment
2. To review the technique of implantation
3. To review the results and complications
4. To discuss cases not suitable for fenestrated devices

Fenestrated grafts for AAA: fenestrated endovascular grafts are being increasingly used to treat short-necked and juxta-renal abdominal aortic aneurysms. Several centres have reported their early/intermediate term results with these devices which are encouraging[1-6]. Registry data are necessary to determine if such results can be reproduced in the wider clinical setting. Randomised trial data are lacking to directly compare fenestrated EVAR (f-EVAR) with either open surgery for juxta-renal aneurysms or standard endografts for short-necked aneurysms. Although comparative data and more generalized data are awaited, it is fair to say that f-EVAR has now become an established part of the armamentarium for treating abdominal aortic aneurysms. Fenestrated endografting introduces some different thinking to the process of evaluation, planning, treatment and surveillance after EVAR. The iliac access must not only allow graft introduction but also allow repositioning of the graft so that the fenestrations align with their target vessels. There should not be excessive atheroma at the level of the position of maximal device and catheter manipulation as this increases the risk of potentially fatal micro-embolisation. The anatomy at the level of the visceral arteries must be examined. Sometimes, the vessels arise too close together to allow for separate fenestrations and this particularly applies to the right renal artery and SMA, which may arise as very close neighbours. The point of the first branch of the target vessels must be evaluated to ensure that there is a sufficient landing zone for the branch stents, particularly if these will be covered stents. Stenotic disease at the visceral artery ostia can make catheterisation more difficult and may require different techniques for safe access to these vessels. Excessive aortic angulation at the visceral artery level makes the process of planning and deploying a fenestrated endograft much more difficult and this should be viewed as a contraindication to f-EVAR. Graft planning demands a high quality CT dataset and a dedicated workstation for image manipulation and measurement. The optimal solution is one that offers a stable position for the proximal endograft without making the graft unnecessarily complex. We aim to place the sealing stent of the endograft entirely within healthy aorta and to keep the graft as simple as is possible. A simple graft is not always possible but it should be remembered that the more fenestrations in the device, then the more complicated is the deployment. Standard devices may contain from one to four fenestrations. A single scallop for a renal artery is the simplest graft whereas the more complicated grafts will contain fenestrations for both renals and the SMA and a scallop for the celiac trunk. Graft planning may either be performed by the endovascular unit or sent to a dedicated company-run planning centre. If a unit chooses to use the services of a dedicated planning centre, then it is still important for them to understand the planning concepts involved as this is relevant to all other aspects of this technology. Deployment of fenestrated endografts is again more complicated than standard endografts. The imaging must be of high quality and reliable. Ideally, this would be performed in a dedicated hybrid theatre with fixed imaging and optimal radiation protection. Many devices are implanted in operating theatres with mobile image intensifiers and these must have a rotating anode and preferably active cooling and be used with a carbon fibre table. If using a mobile system, then it is mandatory that a backup system is available as overheating of the tube is well documented during difficult fenestrated EVAR. The operators must be familiar with the sequence of radio-opaque markers on the devices and must position the device at the correct height and orientation before release. The body of the graft may be twisted as the fenestrations are rotated into alignment if the graft is rotated to different amounts at its proximal and distal attachments to the delivery system. If this occurs, then it can still be corrected before the graft is completely released from the delivery system. A thorough understanding of the marker system and the delivery system is necessary to ensure that the correct attempts are made to untwist the device should this occur. The process of catheterization of the target vessels is normally straightforward if the graft has been planned and deployed accurately. Our aim is to position sheaths and stents in the target vessels before final graft release and it is necessary to obtain a stable position of the guidewire in the distal circulation of the target vessel to allow this. Several tricks have been employed to facilitate this and these will be discussed. The choice of catheter depends on the position of the fenestration from the top of the graft and the angle of the target vessel. Sometimes, it is necessary to use reverse curved catheters that are formed either inside or outside the fenestration. Life may become more simple with the future development of robotic systems and accompanying sheaths and catheters. The choice of branch stent is important and options include covered and uncovered stents and open or closed cell designs. The experience at the Cleveland clinic favours the use of covered stents in most settings[7]. Our own preference has been to only use covered stents when there is a minimal sealing zone below the target vessel. It is important to ensure that there is good overlap of the modular body connection of fenestrated grafts as this is a deliberately weak connection at which there may be some movement with the risk of late separation and aneurysm repressurisation. Surveillance after f-EVAR encompasses the usual interest in endoleak, sac expansion and migration. Additional note must be made of the evolution of the visceral artery stents as there is a risk of stenosis, occlusion, stent fracture and stent dislocation. Fortunately, the evolution of fenestrated grafts has been good and these complications are relatively rare.

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Special Session
BTK in diabetics

1403.1

Factors and time line of healing of the diabetic foot

S. Morbach;
Diabetologie , Marienkrankenhaus GmbH , Soest, Germany.

Learning Objectives
1. To review the factors and timeline within the healing process of the diabetic foot
2. To review the epidemiology of diabetic foot ulcer
3. To discuss how to talk to diabetologists

No abstract available

1403.2

Update on results of PTA

K. Katsanos;
University Hospital of Patras , Patras, Greece.

Learning Objectives
1. To review the indications and techniques for PTA below the knee in diabetics
2. To review the results of angioplasty in diabetics
3. To review complex cases where angioplasty can still be performed (foot, ankle, distal peroneal, etc.)

CLI represents one of the most challenging and cost-consuming cardiovascular health care problems in the world. It refers to limb-threatening peripheral atherosclerotic ischemia and is typically characterized by multilevel, multivessel infrainguinal and tibial arterial occlusive disease, primarily afflicting patients with diabetes and end-stage renal disease (1,2,3). It is estimated that almost 1% of all people older than 50 years of age present with symptoms of CLI, accounting for 1.5 million patients in Europe and approximately 2 million patients in the United States (1,3). Diabetes mellitus is well known to multiply the risk of CLI by a factor of four, and diabetic patients with CLI are as much as 10 times more vulnerable to amputation than normoglycemic patients. Almost half of all amputees have diabetes (1,2,3). Without prompt revascularization, CLI entails a high risk of major amputation. Wolfe et al. classically described the poor prognosis of CLI in more than 6000 patients (4). If left untreated, CLI caused major amputation in 73% of patients with rest pain and in 95% of patients with tissue loss at 1 year. On the contrary, revascularization achieved a 75% 1-year limb salvage rate. Overall survival was poor, and cumulative probabilities were around 50% after 3 years (4). In the interest of prevention of limb loss, patients with CLI are candidates for revascularization attempts by surgical or percutaneous methods. Although infrainguinal bypass surgery remains the cornerstone of CLI treatment, the majority of the patients are ineligible because of diffuse infrapopliteal arterial occlusions, absence of suitable vein grafts, and multiple underlying comorbidities (6,8,9). Compared to surgery, angioplasty is a minimally invasive procedure with a clear benefit of reduced complications and periprocedural adverse events, especially in the frail patient cohort of elderly octogenarians (5,8). In addition, it may be repeated as necessary, and more than 1 vessel to the foot may be recanalized. Technologic advancements and additions to the "endovascular toolbox" have increased their versatility and applicability in the highly morbid and fragile population of patients with CLI, with consistently favorable clinical results. The primary goal of infrapopliteal angioplasty is to restore at least 1 straight line of blood flow to the distal foot. The secondary objective is to preserve the patency of the treated lesion for as long as possible to avoid recurrence of CLI symptoms. In the majority of the cases, infrapopliteal angioplasty may be combined with more proximal femoropopliteal endovascular procedures (6,10,11). Occasionally, it may be applied in tight distal anastomotic lesions of bypass grafts to avoid early graft failure and thrombosis. It is now clear that patency outcomes after superficial femoral artery (SFA) procedures are negatively affected by compromised and poor tibial runoff (12). Reported complication rates range from 3 to 11% and include puncture site hematomas, vessel perforation, dissection, and distal embolism or thrombosis, which may be successfully managed endovascularly. The reported 30-day mortality rate of infrapopliteal angioplasty is <1.7% (8). Scientific evidence regarding safety and overall clinical effectiveness of infrapopliteal angioplasty supports its application as a first-line treatment option for infrapopliteal obstructive arterial disease in the setting of CLI (7,8,10,11,13,14). The FIRE (Foundation for Interventional Radiology in Europe) registry organized by the Cardiovascular Interventional Radiology Society of Europe enrolled 396 patients with 409 critically ischemic limbs. An 83% cumulative limb salvage rate and a 91% cumulative survival rate were achieved after a mean follow-up period of almost 6 months (15). Univariate analysis within the FIRE registry showed that cardiac disease, carotid disease, and renal insufficiency were unfavorably associated with both mortality and limb salvage (15). A random effects meta-regression analysis of 18 studies published between 1984 and 1997 and including 1280 patients treated with infrapopliteal balloon angioplasty reported overall limb salvage rates of 79% at 1 year and 74% after 2 years (16). A more recent meta-analysis of 30 studies published between 1990 and 2006 reported 3-year limb salvage and patient survival probabilities of 82.4 and 68.4%, respectively (17). For comparison, the 5-year limb salvage rates using autogenous veins for infrapopliteal bypass range from 73 to 81% (18,19,20,21). Theoretically, endovascular alternatives may also relate to reduced healthcare costs as a result of the decreasing number of amputations being performed. The patients' quality of life may also be dramatically improved if we prevent or even lessen the extent of amputation. Schillinger et al. have documented that increased serum C-reactive protein levels before and after the intervention and a suboptimal angioplasty result are the primary factors adversely affecting restenosis, while poor runoff showed a weaker association with increased vascular restenosis at 6 months (24). The authors also reported that a suboptimal angioplasty outcome with >30% residual stenosis of the dilated infrapopliteal lesion occurred in almost 50% of the treated patients (22). Below-the-knee disease is characterized predominantly by long occlusive lesions. Morphological angiographic analysis performed by Graziani et al. has shown that two-thirds of all infrapopliteal lesions are occlusions (26). More importantly, 50% of all lesions are occlusions >10 cm long (26). Therefore, it is imperative that long balloons and devices dedicated for the special features of infrapopliteal disease are developed and used. The rate of short-term angiographic restenosis of the infrapopliteal arteries is high and remains a major concern. Reportedly, reocclusion may occur in up to 50% of the cases at 1 year, frequently resulting in CLI relapse and requiring repeat revascularization procedures (9,23,24).

Although stenting of the tibial arteries is usually reserved as a bailout procedure in case of flow-limiting dissection, residual stenosis >30%, or elastic recoil, experience with the application of stents in the infrapopliteal territory is rapidly growing (9). Motivated by the initial enthusiastic results of sirolimus-eluting stents in the coronary arteries, researchers have applied them in the infrapopliteal arteries to forestall restenosis and prolong amputation- and reintervention-free survival of CLI patients. Recently published data from controlled trials of sirolimus-eluting stents show favorable clinical results at 6 and 12 months, with significantly higher angiographic patency and less repeat procedures due to clinical recurrence compared to bare metal stents (9,23,24,25). To conclude, minimally invasive infrapopliteal angioplasty procedures are becoming the new gold standard of below-the-knee arterial disease, especially in patients suffering from CLI. To date, infrapopliteal sirolimus-eluting stents have shown significant promise in inhibiting restenosis and thereby reducing repeat revascularization procedures.

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1403.3

Update on results of stents

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Learning Objectives

1. To review the indications, techniques and results of bare and DES stent types in the SFA
2. To review the indications, techniques and results of bare and DES stent types BTK
3. To review cost effectiveness of stenting in this setting

BTK update stents: over the last years, endovascular approach

has become a well accepted method for the treatment of CLI (critical limb ischemia) due to infra inguinal disease, and has also demonstrated advantages versus bypass surgery in patients with CLI. The introduction of dedicated techniques and devices has shown that percutaneous arterial revascularization by means of percutaneous transluminal angioplasty (PTA) was feasible and safe and yielded satisfactory clinical results in infrapopliteal lesions. However, the role of stenting lesions below the knee in CLI patients is still debated and a limited number of studies available yet. Trials have been established, with the use of bare metal stents, passive coated stents (PCS), balloon absorbable stents, ballon expandable drug eluting stents (DES) and self expanding nitinol stents. Major interest in these studies was given to the angiographic and numeric data, such as, restenosis rate, late lumen loss due to intimal hyperplasia and long term patency. The implantation of bare metal coronary stents demonstrated a certain value in addition to infrapopliteal angioplasty in case of critical limb ischemia; however, restenosis rates ranged between 50 and 60%, limb salvage rates were found to be more than 90% after 1 year. Tepe *et al.* investigated the feasibility of self-expanding nitinol stents for treatment of infragenicular arteries following unsuccessful balloon angioplasty and found their use in tibioperoneal and popliteal arteries as a safe and feasible option for the treatment of unsuccessful PTA. The stent system is based on a low profile nitinol device. The results showed an accumulative patency rate of 82% at 6 months, and a 6 months limb salvage rate regarding major amputation of 100%. Peregrin *et al.* reported about the clinical investigation of self expandible stents in infrapopliteal arteries after unsuccessful angioplasty, and concluded that stent placement restored the flow in the artery immediately after unsuccessful PTA. Regarding drug eluting stents, major studies have been provided by Siablis *et al.* and Scheinert D. Siablis *et al.* reported the 1-year angiographic and clinical outcome from a prospective single center study investigating the infrapopliteal application of sirolimus-eluting versus bare metal stents in patients with critical limb ischemia (CLI) who underwent below-the-knee endovascular revascularization. The application of sirolimus-eluting stents reduced the restenosis rate in the infrapopliteal arteries and the rate of repeat endovascular procedures the first year after treatment. Restenosis rate was significantly lower after 6 months in case of drug eluting stents. After 1 year, sirolimus-eluting stents were associated with increased patency as well as lower in stent restenosis. In a pilot study, Rand *et al.* demonstrated first results for the use of passive coated stents (carbon stent design), with 6 months results that showed positive effects regarding the restenosis rate for Stents versus PTA. New developments such as bioabsorbable stents have already been tested for peripheral application. The AMS Insight study, a prospective randomized multicenter study, however, did not show efficacy in long-term patency over standard PTA in infrapopliteal vessels and the authors suggested stent design modifications to overcome its limitations. Regarding the infragenicualr use of stents, main concerns are raised on the risks of restenosis and thrombosis. Furthermore, the leading question that remains is, if stents in an infrapopliteal approach might have an effect on the clinical outcome of patients and if such stents might reduce the amputation rate in these patients. To overcome the limitations of their pilot study, and to focus the study questions into a more clinically driven approach, the Inperia 2 study was designed as a multicenter, prospective randomized study emphasizing the effect of stents vs PTA for clinical outcomes and amputation rates on a 9 months observation period. Results showed a significant effect of stents vs PTA within the first 3 months with improved clinical outcome, higher ABI indices as well as positive impacts on minimum lumen diameter and restenosis rate. After 9 months, however, clinical results were rather similar again for PTA and the Stent patient groups. Major work has recently been finished by Biondi Zoccai *et al.*, by presenting a metaanalysis of studies regarding the infrainguinal use of stents. The authors present a systematic review; build upon 16 primary studies representing more than 640 patients. The metaanalysis provides important insights on early and mid-term outcomes following infra-genicular stenting for BTK disease. Specifically, the authors found that bail-out stenting with either balloon-expandable or self-expandable stents was associated with satisfactory angiographic results, patency and clinical outcomes up to a median of 12 months of follow-up. Sub-analyses were also performed focusing more precisely on device type, and comparing balloon- versus self-expandable devices and bare-metal versus drug-eluting stents. Such interaction analyses showed that balloon- and self-expandable stents performed similarly at early and mid-term in the included studies, avoiding joint segments or pedal vessels. In addition, the available data suggest the superiority of sirolimus-eluting stents in comparison to bare-metal or paclitaxel-eluting stents. The authors emphasized, that such favorable clinical results were obtained in the hands of experienced operators, often employing antegrade access and continuing dual antiplatelet therapy for variable periods (from 3 months to long-term). In conclusion, all current BTK studies have some limitations such as relatively small numbers of patients, high dropout rates, decreased statistical power, and cannot be defined as Level 1 evidence at the moment. Moreover, in none of this studies 2 year follow up results are available.

Summary: below the knee (BTK) peripheral artery disease is characterized by patients with critical limb ischemia (CLI). In many cases, a multi level type of peripheral artery disease involving the infrapopliteal arteries is present. The endovascular approach is made even more complex by the fact that BTK disease usually ends up being very diffuse with a high prevalence of long total occlusions. The use of bare balloon expandable stents had been proven to lead to superior results compared to plain old balloon angioplasty (POBA) alone in short lesions. Similar studies have also shown an advantage in using small diameter self expanding stents, or drug eluting stents. However, dedicated stents for BTK applications have only become available recently and data regarding the use of stents in the infrapopliteal arteries is still limited.

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1403.4

Long infrapopliteal occlusions

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Learning Objectives

1. To describe the technique of subintimal PTA for the recannalisation of long tibial occlusions
2. To describe the concept of temporary bypass
3. To discuss the results

Over one million people in the United Kingdom have diabetes mellitus, of whom around 7-10% will, at some point, develop a foot ulcer. This becomes even more significant with the increasing age of the population as the prevalence of diabetes increases. Diabetic patients are particularly prone to peripheral neuropathy and peripheral atherosclerotic disease, which results in some patients getting foot ulceration and gangrene. Foot ulceration and gangrene are important causes of morbidity in diabetic patients and therefore it is important that measures are taken that would eventually lead to healing of the ulcers or gangrene. As occlusive atherosclerotic disease of the tibial arteries is particularly common in diabetic patients, and infra popliteal revascularisation is often required. This has traditionally been accomplished by percutaneous transluminal angioplasty (PTA) or a surgical bypass, with moderately good results. More recently, subintimal angioplasty has been practiced as an alternative minimally invasive treatment to recanalise long arterial occlusions with promising patentcy rates even in small vessels of the lower leg. Treatment of diabetic vascular disease is challenging and requires an aggressive multi disciplinary approach with co-operation between diabetologists, interventional radiologists, vascular and plastic surgeons. Non invasive vascular imaging is normally the first line investigation in patients with peripheral vascular disease. Whilst in non diabetic patients, the ABPI (ankle brachial pressure index) is reduced in the presence of peripheral vascular disease, and in diabetic patients it can be falsely high due to calcified and non compliant peripheral vasculature, and is therefore unreliable. Duplex scanning is a fast, cost effective and non invasive way of imaging diseased arteries in the periphery but it is operator dependant. The tibial arteries can sometimes be difficult to image, especially in the presence of calcification, oedema, ulceration and bandaging of the legs. Despite these limitations, it proves an extremely useful investigation and usually sufficient to base a decision, on the mode of intervention for revascularisation, either by surgery or angioplasty. MRI has boosted the non invasive imaging potential of patients with peripheral vascular disease. Excellent pictures can be produced in the majority of patients with proximal arteries particularly well demonstrated. Accurate demonstration of tibial vessels requires a cooperative patient and a radiologist geared up to providing a good study. Patients who are incapable of keeping still and who are suffering from claustrophobia may be unsuitable. CT angiography has an application and as multi slice and fast scanners are becoming more available, it is assuming greater importance, particularly in the tibial arteries. Femoral angiography and, in particular, DSA (digital subtraction angiography) has been regarded as the gold standard for demonstrating the arterial tree up to the foot vessels. This would usually precede an invasive intervention for treating tibial arteries. The aim of endovascular treatment of tibial arteries is to at least achieve a straight line flow down to one of the foot vessels. Patients with critical limb ischemia, in particular diabetic patients, tend to have distal vessel disease, which may be affecting all the run off vessels. Long occlusions are a common occurrence. After antegrade femoral puncture, DSA will reveal the extent of disease in the below knee arteries. Whilst the conventional PTA is available to treat simple stenosis or short occlusions in the tibial vessels, subintimal angioplasty is capable of treating a large number of cases because of the ability of the technique to treat long tibial occlusions, multiple vessels and reconstitution of the trifurcation. Subintimal angioplasty has been shown to make a substantial impact on the treatment of critical limb ischaemia mainly due to the fact that long superficial femoral artery and tibial occlusions can be tackled with this technique, quite often at the same sitting. The technique involves traversing the occlusion through the subintimal space, this making use of the disease free dissection space that becomes available as a conduit for blood flow. The technique utilises a deliberate but controlled arterial dissection to cross an arterial occlusion. The subintimal space is the path of least resistance, therefore, relatively easy to cross using a loop in a hydrophilic guide wire. The wire most commonly used has a 1.5 mm J tip (Terumo Japan), which helps to form a loop in these small vessels. The wire is “half stiff” and is 0.035 diameter and 180 cm long. The leading edge of the J wire, in the form of the loop, is followed by a 5 French 3 x 20 mm balloon catheter. The reason for using the short length of the balloon is to overcome the level of resistance encountered during crossing of long occlusions. It is important to keep the length of the loop short in order to avoid the possibility of a perforation. This is achieved by progressive advancement of the loop, followed by the balloon catheter and then withdrawal of part of the wire in order to reduce the length of the loop. As one approaches the level of the end of the occlusion, the loop must be significantly short (1-2 cm in length) and with some twisting action re-entry is usually achieved without a great deal of effort. Having crossed the lesion, the entire length of the occlusion is dilated using the same balloon catheter. The inflations are short (5 seconds) in order to achieve recanalisation in the shortest periods of time. Subintimal angioplasty allows the recanalisation of the trifurcation. Therefore, if more than one vessels is available distally, the aim is to try and achieve recanalisation into whatever

vessels are available. This has the advantage of not only increasing the total perfusion of the foot, but helping with the patency of any proximally angioplastied segments, as the overall flow will be faster through multiple recanalised vessels. Subintimal angioplasty in infrapopliteal artery occlusions was first reported in 1994. There have been a number of publications since, all of them reporting excellent outcomes in terms of limb salvage. Primary success rates of 80-90% are achieved depending on experience and limb salvage rates of around 88% have been reported consistently.

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Special Session
Liver imaging and tumour response assessment

1404.1

Imaging key points to tailor your ablation (size, location, neighbouring vessels)

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Learning Objectives

1. To introduce the concepts of tumour size, number, location, hepatic volumetry and neighbouring vessels and how they modify treatment strategy
2. To present what imaging techniques are preferably used to obtain this information
3. To discuss the different techniques actually available to guide ablation (advantages, limitations, perspectives)

No abstract available

1404.2

Response criteria: which is the best?

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Learning Objectives

1. To present the different systems used to assess tumour response (WHO, RECIST, EASL)
2. To present in detail the different imaging criteria available to assess tumour response including MR diffusion of the liver
3. To present suggestions to adopt one or another system and to propagate it in order to reduce variability

Tumor response in oncology is usually measured according to the World Health Organization (WHO) criteria (1) or the Response Evaluation Criteria In Solid Tumors (RECIST) guidelines (2). WHO and RECIST define standard measurement methods for converting radiology image observations into a quantitative and statistically tractable framework for measuring the response of tumor size to therapy. Both methods offer simple approaches to determining anatomic size and lesion changes during treatment as an indicator of response. Target lesions are measured using either the bilinear product approach (WHO) or single linear summation (RECIST). The WHO criteria and RECIST have been designed primarily for evaluation of cytotoxic agents inducing cell death, even in the absence of major necrotic phenomena. They do not address measures of antitumor activity other than tumor shrinkage. Hence, assessments based solely on changes in tumor size or morphology can be misleading when applied to other anticancer drugs, such as molecular targeted therapies, or other therapeutic interventions, such as percutaneous ablation or transarterial chemoembolization. In fact, recent studies have found a poor correlation between the extent of tumor necrosis induced by new agents such as sorafenib or by interventional procedures and conventional methods of response assessment (3). In 2000, a panel of experts on hepatocellular carcinoma (HCC) convened by European Association for the Study of the Liver (EASL) recommended that the response criteria be amended to take into account tumor necrosis induced by treatment (4). That panel considered the estimation of the reduction in viable tumor area using contrast-enhanced radiological imaging to be the optimal method to assess treatment response of HCC. Viable tumor was defined as uptake of contrast agent in the arterial phase of dynamic computed tomography (CT) or magnetic resonance imaging (MRI). In 2006, a group of experts convened by the American Association

for the Study of Liver Diseases (AASLD) developed a set of guidelines that aimed at providing a framework for the design of clinical trials in HCC has adapted the concept of viable tumor endorsed by the EASL and has proposed formal amendments to RECIST criteria for the determination of tumor response in HCC (3). A representative of the Office of Oncology Drug Products, Center of Drug Evaluation and Research, FDA, was a member of the panel and provided advice on potential endpoints for oncology drug approvals. These amendments are referred to as "AASLD-JNCI amendments" to RECIST. The AASLD-JNCI document has introduced the following amendments to RECIST in the determination of tumor response for target lesions: complete response: the disappearance of any intratumoral arterial enhancement in all target lesions; partial response: at least a 30% decrease in the sum of diameters of viable (contrast enhancement in the arterial phase) target lesions, taking as reference the baseline sum of the diameters of target lesions; progressive disease: an increase of at least 20% in the sum of the diameters of viable (enhancing) target lesions, taking as reference the smallest sum of the diameters of viable (enhancing) target lesions recorded since the treatment started; stable disease: any cases that do not qualify for either partial response or progressive disease. Concerning new lesions, the AASLD-JNCI amendments to RECIST state that: (a) a newly detected hepatic nodule will be classified as HCC (and therefore will be declared as evidence of progression) when its longest diameter is at least 10 mm and the nodule shows the typical vascular pattern of HCC on dynamic imaging, that is, hypervascularization in the arterial phase with washout in the portal venous or late venous phase; (b) lesions larger than 10 mm that do not show a typical vascular pattern can be diagnosed as HCC by evidence of at least 1-cm interval growth in subsequent scans; and (c) an individual radiological event will be adjudicated in retrospect as progression at the time it was first detected by imaging techniques, even if strict criteria were fulfilled only on subsequent radiological testing. In this presentation, the changes introduced by the AASLD-JNCI paper in HCC response assessment will be illustrated and a guideline for proper application of the amended criteria will be provided. The concepts endorsed by the AASLD-JNCI document have already been shown to provide a better assessment of response in the setting of clinical trials (5). However, the amended criteria are not intended to play a role in the daily clinical decision making process, except if determined appropriate by the treating physician.

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1404.3

The role of perfusion/diffusion imaging (CT/MR)

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Learning Objectives

1. To learn capabilities of MR diffusion for liver (diagnostic and follow-up)
2. To learn about perfusion imaging of liver tumours (CT and MR)
3. To learn the results of these techniques (versus nuclear medicine)

Objective response assessment is important to follow the treatment effect of anticancer drug or non chirurgical local ablative technique. Antitumor response based on decrease in tumor size was generally recommended. It was accepted that a decrease in tumor size was correlated with treatment effect. Standardized measurement with imaging methods according to the World Health Organisation (WHO) criteria and more recently according to the Response Evaluation Criteria in Solid Tumors (RECIST) has been considered to be the primary endpoint for trials. In the last few years, the development of new anticancer drug with targeted molecular showed clinically survival advantages with only marginal tumor response with the RECIST criteria. Concerning radio-frequency ablation, the size of the lesion due to the tumor necrosis, ischemia and cytotoxicity should be larger than that of the pretreatment tumor during the first months after thermotherapy. Furthermore, the current use of new imaging techniques with high spatial and temporal resolution (multidetector computed tomography or MRI with fast imaging technique) allowing dynamic contrast enhanced studies demonstrated that reduction of tumor size does not always represent tumor response and the proposition that a decrease in tumor size corresponds to an improvement in the prognosis is not true for all cases. Also, the RECIST necessitates to be modified. Other important imaging innovation is the possibility to perform diffusion-weighted MRI (DWI) of the liver. For tumour response assessment, DWI derives its image contrast from differences in the motion of water molecules between viable tumor and cellular necrosis.

Perfusion imaging: dynamic contrast-enhanced cross-sectional imaging is frequently used for the assessment of radio-frequency ablation of hypervascular liver tumor. Necrotic area shows no enhancement in completely ablated lesions. A circumferential homogenous rim at the periphery of the treated tumor corresponding to congestion or granulation tissue (without viable tumor) may be a normal finding and a source of diagnostic difficulties. This finding typically resolves within 1-4 months. In contrast, incomplete ablation or local recurrence appears as nodular enhancement during the arterial phase with washout during the venous phase at the periphery of ablated area. Transarterial therapy with conventional chemoembolization, with drug-eluting microsphere or with yttrium-90 microsphere has been shown to decrease tumor size, but despite favourable clinical outcome, many responses do not qualify as complete according to the RECIST. Size alone may not be a reliable criterion for assessing the response with these therapies because necrosis, edema, and hemorrhage may cause an initial increase in the size of the tumor. Perfusion analysis showed significant changes after transarterial therapy and can be used to assess response of targeted tumors. The new development of molecular therapies in liver tumor with antiangiogenic therapies targeted against tyrosine kinase receptors need also specific assessment of the perfusion that seem parallel to the clinical outcome.

Diffusion imaging: the apparent diffusion coefficient (ADC) calculated in diffusion-weighted MRI is a biomarker of tumor response to therapy. The ADC is a measure of the mobility of the water in tissue. The high cellularity in viable tumor with intact cell membrane restricts the diffusion of water molecules resulting in low ADC. On the contrary, cellular necrosis and cellular membrane destruction allowing water molecule to diffuse freely results in

high ADC. Diffusion imaging was used to assess tumor response to transarterial therapy. This presentation will discuss the current challenges and future goals of these new functional techniques for the liver imaging and tumour response assessment.

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1404.4

PET and PET-CT after treatment

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Learning Objectives

1. To learn about basics of PET and PET CT for liver tumours
2. To learn about indications and results
3. To learn about limitations and current guidelines

With introduction of percutaneous ablation techniques like radiofrequency ablation (RFA), local therapy of hepatic malignancies became a viable alternative to surgery. RFA is widely used for the treatment of hepatocellular carcinoma and metastatic liver cancer. Short and mid-term results are encouraging, but there is a relevant number of residual and recurrent tumors. Unlike in open surgery, there is no specimen for pathology. Thus, ablative treatment success is strongly dependent on imaging to ensure complete tumor destruction. Waiting until residual or recurrent tumor growth becomes manifest is not an acceptable option and much effort has been spent on the identification of the optimal imaging technique for post-interventional identification of vital tumor tissue. Contrast enhanced (ce) computed tomography (CT), magnetic resonance imaging (MRI), 18-FDG-Positron emission tomography (PET) and PET/CT are currently used for this purpose. A meta-analysis on the diagnostic sensitivity for detecting colo-rectal liver metastases PET performed best. On a per patient basis, the sensitivity estimates for spiral CT, 1.5T MRI, and PET were 64.7, 75.8, and 94.6%, respectively [1]. Moreover, several studies indicated that PET/CT is superior to the standard staging with ce-CT alone or PET alone, resulting in a rapid replacement of PET by PET/CT. Consequently, this technique appears to be a good candidate for optimizing post-interventional lesion detection. In post-interventional CT and MRI, which both utilize morphology and perfusion as surrogates for assessing vital tumor, there are several problems limiting early lesion detection. One of these problems is a typical rim-like increase of contrast enhancement. PET uses metabolic information for detecting vital tumor, providing a different access to lesion detection. The low radiation dose non-contrast CT component of PET/CT provides the data needed for attenuation correction for PET. It also provides structural information that is used to assign a localized increased metabolic activity to anatomical structures. An additional ce-CT not only provides a more exact spatial localization of a metabolic active lesion in the body, but also improves specificity and sensitivity for lesion detection. Thus, PET/CT is a more accurate test than either of its individual components. In post-interventional imaging after hepatic RFA, the overall procedure based sensitivity for detection of residual tumor has been reported to be about 65% for PET and PET/CT, but only 44% for CT alone [2]. When comparing PET, PET/CT and MRI sensitivities for post-interventional tumor, detection were 76% for PET alone, 83% for PET/CT and 75% for MRI, respectively [3]. A positive PET after RFA provides a positive predictive value of 80% for the detection of local tumor recurrence. PET/CT has also been reported to detect RFA treatment failure as well as local relapse earlier than ce-CT [4]. These results have raised high expectations, but there are some relevant limitations of this technique. Currently available PET systems provide a spatial resolution of only 4-6 mm. Moreover, the liver moves because of respiratory motion. Therefore, small areas of residual tumor will not be detected by PET. There is data reporting a dramatic drop in sensitivity of PET for detecting lesions of less than 1 cm. In addition FDG is an unspecific tracer. Consequently, post-interventional tissue regeneration as a cause of increased glucose metabolism limits PET and PET/CT in the early post-interventional phase. In these patients, a homogeneous tracer distribution surrounding the area of necrosis is often seen after thermal ablation. This is a relevant drawback, as early detection of residual tumor is of particular importance. The development of tissue regeneration takes several days and immediate post-interventional PET imaging may therefore overcome this limitation. The presence of PET negative tumors presents another limitation, where no additional diagnostic use is obtained when compared with CT alone. Obesity and neo-adjuvant chemotherapy are also known to negatively affect the accuracy of PET for detecting colorectal liver metastases. PET/CT is currently under investigation for post-interventional imaging. It is not yet considered a routine procedure after local tumor ablation, but it is recommended in well selected patients. Considering the promising early results as well as the ongoing technical advances, PET/CT will play a major role in post-interventional tumor imaging.

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Foundation Course
Gastrojejunostomy

1501.1

Indications: gastrostomy versus gastrojejunostomy

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Learning Objectives

1. To discover common indications for gastrostomy and gastrojejunostomy
2. To learn when to perform a gastrojejunostomy versus gastrostomy
3. To discover when it is not appropriate to perform a gastrostomy

Enteral feeding of gastrostomy and gastrojejunostomy is indicated if feeding is required for more than thirty days. Up to this point, nasogastric feeding is sufficient. Parenteral feeding is indicated for short gut syndrome or if there is an inactive gut. Indications for enteral feeding include: the unconscious patient, such as, a patient with a head injury or a patient who is ventilated, and is likely to be ventilated for a long period of time; patients with swallowing disorders, such as patients with CVA, multiple sclerosis or motor neuron disease; patients with upper GI obstruction such as oral pharyngeal and laryngeal cancers, often require prolonged enteral feeding, and patients also with increasing nutritional requirements, due to disease entities such as cystic fibrosis and extensive burns also require enteral feeding. These are predominately the types of patients for whom enteral access is required. Contraindications to gastrotomy include: previous gastrectomy, colonic interposition between the stomach and the anterior abdominal wall, gastric varices, prolonged ileus and importantly imminent death. Indications for gastrojejunostomy as opposed to gastrostomy include: patients who have a hiatus hernia, previous episodes of aspiration, reflux or patients with gastric atony.

1501.2

Basic technique for gastrostomy and button

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Learning Objectives

1. To become familiar with the technique of tube gastrostomy insertion
2. To become familiar with button gastrostomy insertion
3. To become familiar with radiologic peg insertion

The placement of gastrostomy and gastrojejunostomy tubes for the provision of nutrition is a well established technique. The traditional surgical method has been superseded over the last two decades with endoscopic (PEG), and more recently percutaneous radiological gastrostomy (PRG) placement. The advantages of these latter two methods are the lower associated morbidity and mortality rates. In addition, PRG placement may be possible in some patients who fail PEG placement e.g., head and neck/oesophageal tumours. The indications/contraindications and basic technique of gastrostomy/button placement will be described. Recent catheter and procedural modifications, including the use of routine gastropexy and the placement of PEG type tubes, will be detailed. Potential associated complications will also be described.

1501.3

Basic technique for gastrojejunostomy

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Learning Objectives

1. To learn how to perform gastrojejunostomy
2. To learn when to perform gastrojejunostomy
3. To discover methods by which gastrojejunal tubes are fed

Gastrojejunostomy tube placement entails the placement of a feeding tube through the stomach and duodenum, with the tip terminating in the jejunum. This method combines the simplicity of gastric access with the benefits of direct small-bowel tube feedings. The main indication for a percutaneous gastrojejunostomy is a previous history of reflux or aspiration. All patients undergoing de novo placement of gastrojejunostomy tubes should fast for several hours prior to the procedure, ideally overnight. Percutaneous enteral access procedures can be performed safely and comfortably with local anesthesia, with conscious sedation reserved only for uncooperative patients. Fluoroscopic visualization, gastric puncture and tract dilatation are greatly facilitated by gaseous distention of the stomach, typically performed through a nasogastric tube. In the rare patient in whom nasogastric access cannot be achieved, gastric distention may be performed through a needle introduced into the stomach under image guidance. Previous ultrasonographic examination may be helpful in localizing the superior epigastric artery and avoiding transhepatic access. A barium enema one day prior to the procedure minimizes the risk for colonic puncture. After percutaneous gastropexy, which involves the placement of a threaded metal or nylon fastener into the stomach through a needle, in order to appose the anterior gastric wall to the anterior abdominal wall, the entry needle should be pointed towards the pylorus to facilitate passage of a guidewire and consequently of the feeding tube towards the pyloric canal. After placement of a Kumpe catheter over a 0.035-inch “J” wire, which is exchanged for an hydrophilic guidewire, both are used for negotiating the pyloric canal and duodenum, placing them beyond the ligament of Treitz. Over a 0.035-inch superstiff guidewire, the track is dilated and a peel-away sheath is loaded over the guidewire down towards the pylorus. When the catheter is placed, contrast is injected to confirm the jejunal location ant the peel-away is removed. Although no universal guidelines exist with respect to the timing of the first feeding through new gastrojejunostomy tubes, feedings can safely begin 4 hours after tube placement. Tube sites should be cheeked on a daily basis for leakage or signs of infection and the suture from the gastropexy anchors should be removed 10-21 days after initial tube placement. A totally different feeding regimen is used for jejunal as opposed to gastric tubes. Bolus feeding cannot be used for jejunal tubes as severe diarrhea will ensue. A slower drip feeding is used for jejunal tubes.

1501.4

Patient follow-up and management of complications

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Learning Objectives

1. To discover what types of complications can occur
2. To learn how to deal with complications
3. To learn how to prevent complications

There is little statistical evidence supporting this subject. Prospective studies are rare, most relies on retrospective studies. Commonly encountered complications, measures of prevention (P) and treatment (T).

Bleeding: P: Correct coagulopathy or thrombocypenia. Ultrasound

should be used to rule out interposition of the liver and spleen. T: Correct hemostasis. Endoscopy may reveal bleeding cause. With bleeding at the entry site of the stomach, a Foley catheter can be considered for tamponade. At other sites consider embolization.
Infection: P: A reduction of infection has been shown with prophylactic antibiotics for PEGs. Cantwell demonstrated significantly less infections in patients with head and neck cancer undergoing gastrostomy and gastrojejunostomy after receiving prophylatic antibiotics. T: Local or systemic antibiotics. Keep the skin as dry and less irritated as possible. T-fasteners should be cut. Catheter migration or occlusion should be ruled out.
Peritonitis: P: Prevention is of uppermost importance to prevent intraperitoneal leakage of gastric content. Patients should fast for 12-24 hours prior to the procedure. Ascites is considered a contraindication. Thornton showed that T-fasteners can reduce the chance of catheter misplacement and thus intraperitoneal leakage in patients undergoing PRG. Check the position of the catheter fluoroscopically at the end of the procedure with contrast. The catheter should only be used for feeding once the patient does not experience significant abdominal pain.
Catheter blockage: P: Gastrojejunostomy tubes are more likely to occlude than gastrostomy tubes. Thus, instruct to administer medicine as a fluid and avoid grinded tablets. Some recommend large bore catheters. However, these may be difficult to insert through the pylorus and may cause gastric outlet obstruction.
Catheter dislocation: Consider when the patient is nauseous, vomits or complains of pain. Check the position of the catheter fluoroscopically. P: Take care to angle the initial puncture towards the pylorus to avoid recoil of the catheter back into the stomach. T: In cases of gastric recoil, conversion to a transpyloric position is usually possible under fluoroscopic guidance. With recurrent recoil, consider placement of a new catheter with a proper angle.
Pain: P: Adequate analgesia will reduce the pain, and provide a more smooth procedure. T: Pain immediately after the procedure should be treated with analgetics. Consider cutting T-fasteners. At a later stage, rule out catheter dislodgement with bowel obstruction, especially with balloon catheters. Also, rule out leakage of gastric content.

Special Session
AAA

1502.1

Update on results

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Learning Objectives
1. To review current results of EVAR in fit patients
2. To review current results of EVAR in unfit patients

It has been 19 years since the first patient was treated with an endograft for the treatment of an abdominal aortic aneurysm. During this period of time, multiple devices have been developed by several manufacturers and utilized nationally and internationally in clinical practice. Some of the devices have had little or no success and therefore have been abandoned. On the other hand, several devices continue to be widely used in clinical practice. There have been, and continue to be, a variety of types of clinical trials performed, including those directed at obtaining device approval in various countries, as well as other randomized trials designed at looking at the safety and efficacy of endovascular aneurysm repair (EVAR) as a direct alternative to open surgical repair. Some clinical trials are designed to determine safety and efficacy for clinical applications, and other trials are designed to assist physicians at making judgments in choosing between alternative methods of therapy. Trials of late generation endografts have shown extremely high success rates of 98-99%, with extremely low morbidity. While initial clinical trials were associated with significant rates of conversion from endovascular aortic repair to open surgical repair, the most recent trials have been able to accomplish treatment of a large number of patients with little or no incidents of conversion from endovascular aortic repair to open surgical repair. This is the result of much improved technology, and successful improvement in operator skill and clinical experience in implanting these endografts devices. The trials associated with the development of contemporary endovascular repair devices will be discussed, as well as pivotal trials such as DREAM, EVAR I and EVAR II, for the treatment of abdominal aortic aneurysms (AAA). These trials have successfully compared open surgical repair to the less invasive endovascular therapy; however, frequently they suffer from many technology trials in that the EVAR technology has continued to advance during the course of these trials. Many patients can currently be treated percutaneously, using “pre-close” techniques, and it is reasonable to question whether the results of these trials represent a “snap shot” in time that is not necessarily significant today. The impact of these trials on clinical practice will be identified. Additionally, this discussion will review what remains unknown about EVAR, some of which could be resolved by future clinical trials. Finally, a brief state-of-the-art device development will be included with an eye on new directions necessary to be explored for aneurysm therapy. In the United States, EVAR has greatly exceeded the use of open surgical repair for elective abdominal aortic aneurysm therapy. During this process, it has been noted that many patients are being treated who do not meet the inclusion and exclusion criteria used for inclusion in various trials as described above. Treating patients with demanding anatomy, complex proximal necks, challenging tortuosity, etc. is known to affect outcome; however, relatively little clinical data has been developed in these “non-ideal” patients. The benefits of EVAR will be summarized in the context of these data.

1502.2

Device deficiencies in EVAR

P.R. Taylor;
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Learning Objectives
1. To review current devices
2. To discuss device specific results
3. To highlight device specific complications and suggest device modifications to improve success

Device deficiencies have bedevilled endovascular infrarenal aneurysm repair since the pioneers started publishing their results in 1991. The early designs of Parodi and Palmaz only used a proximal stent. The necessity for a distal stent quickly became apparent. However, aortic tube stents were prone to distal endoleak and bifurcated devices, which used the common iliac arteries as a distal landing zone were much more resistant to distal endoleak. These early devices were either modular or a single piece. The Ancure device was a single piece which had iliac limbs that were not supported by any stent and could therefore twist on deployment resulting in limb ischaemia. The Mintec device originally was manufactured with a seam, which came undone. The sutures securing the stent to each other and the fabric were unreliable allowing the stent to change its position relative to the fabric. The apices of the rings often perforated the fabric resulting in endoleaks. The fabric was very thin and not resistant to perforation. The early stents had inadequate surface characteristics and could be phagocytosed by monocytes resulting in fracture. The Mintec device was taken over by Boston Scientific and became the Vanguard I, but even in its third incarnation this device was quickly superseded by its competitors. The second generation of devices included the Talent (Medtronic), the Zenith (Cook), the AneuRx (Medtronic) and the

Excluder (Gore). All of the early incarnations were made without any form of anti-migration device such as hooks, barbs or anchors. In addition, the Excluder was made from PTFE, which was permeable allowing the sac to increase in size due to ultra-filtration of plasma, without the identification of a radiologically detectable endoleak. Eventually, the problem with the PTFE fabric was solved by incorporating a non-permeable PTFE layer within the wall. Small barbs were also added to the proximal part of the device to prevent migration. The rapid deployment is a "once only" event, and no adjustment can be made to the device once it is deployed. Some authorities have circumvented this by a slow pull release proximal to the optimal landing point so that the device can be moved distally before full deployment. However, there is a risk of arterial wall damage from the barbs if this is performed too vigorously. The AneuRx device was fully supported throughout the length of both the body and limbs. It therefore had column strength and was resistant to narrowing. However, the limbs had to be half the diameter of the body and therefore many aneurysms were not suitable for this device. There were no anti-migratory designs incorporated into the device and in Europe distal migration ultimately led to its demise as other more secure devices became available. The Talent device was designed originally without any anti-migration aids. Diameters of both the body and limbs were also limited and there was no suprarenal fixation. This first generation device was superseded by a new generation, which had suprarenal fixation and a much wider range of diameters of both the body and limbs. The Talent lacked any form of anti-migratory device. The devices currently available in the UK include the Zenith (Cook), the Talent and (very recently) the Endurant (Medtronic) the Excluder (Gore), the Anaconda (Vascutek), the Aorfix (Lombard) and the Powerlink and Endofit (Le Maitre). Three devices accounted for the majority of grafts inserted in the EVAR trials and these were the Zenith, the Talent and the Excluder. The Zenith has undergone many revisions during its evolution. It remains the most complicated device to deploy because of the two safety wires securing the proximal and distal parts of the body to the delivery system, together with a top cap that captures the bare proximal stent to the delivery system. The proximal bare stent with numerous barbs secures suprarenal fixation and is resistant to migration. The rationale behind suprarenal fixation is that it secures the device in the aorta most resistant to dilatation. Possible complications such as deterioration in renal function are rare. However, the potential problems relating to endovascular stenting of stenosed renal arteries remains a concern, although in the vast majority of cases a device stent crossing the orifice of the renal artery can be moved by using a balloon expandable stent to open the renal orifice. The Zenith has had some recent adverse publicity concerning the release of the top cap, which keeps the device bound to the delivery system ensuring accurate deployment. In circumstances where there is extreme tortuosity of the native arteries, the safety wire controlling the proximal stent may be affected by rotation of the device before deployment in a very tortuous aorta. Recapture of the top cap may be very difficult in very tortuous necks where the bare proximal stent may lie across the lumen of the aorta. The most common complication relating to the Zenith device in our experience is occlusion of the iliac limb in tortuous iliac arteries. The circular rings of the limbs are separated by unsupported fabric. In order to make the device more compliant, the distance between the stents has been increased so allowing significant stenoses to occur between the stents in very tortuous vessels so leading to subsequent thrombosis. This problem can be treated intraoperatively by firstly removing stiff wires before the final angiogram to identify any stenosis, secondly, treating any stenosis with either balloon expandable or self-expanding stents, and thirdly, making sure that the distal stent of the iliac limb lies apposed to the arterial wall. Self-expanding stents should be used to align the distal stent with the adjacent distal iliac lumen to prevent iliac occlusion. Anaconda has a recapture mechanism to allow the device to be moved to an optimal position before final deployment. However, this requires the whole device to be moved away from the previous position, so making subsequent positioning more difficult. The single double ring proximal stent is secured by bars preventing migration but has a tendency to straighten with time becoming horizontal. This may cause distortion of the aorta at this level. It also has long effective barbs to prevent distal migration. The body is not supported throughout its length with a stent and at present only limited lengths and diameters of the limbs are available. The stents of limbs are made of rings which do not support the limb longitudinally and therefore they are prone to buckle. The limbs can therefore dislocate proximally into the aneurysm sac with time. The Aorfix device was designed to conform to tortuous aortic necks. It also has an important proximal stent to secure the device with anti-migratory barbs. The device uses rods to hold it in place before final deployment. The stent has poor radio-density, which can lead to difficulties in identifying the position of the stent that is recommended to be deployed with the limbs AP and not lateral. The limbs also have stents made of rings and so column strength may be less than other devices. The current length of the body is quite limited. Le Maitre market the Endofit as an aortouniiliac device designed to treat ruptured aneurysms, but this is not yet widely available in Europe. They also have the Powerlink. This is a unibody device, which does not have stents supporting the iliac limbs that are therefore prone to twisting and occlusion. This device originally had limited aortic and iliac limb diameters, although larger diameters with appropriate cuffs are now available. It was found that migration was an issue as the device has no anti-migratory features. Subsequently, the manufacturers suggest that the device is parked on the iliac bifurcation, and proximal and distal cuffs are then used to reach the optimal landing zones, which makes the device much more stable and reduces the necessity of secondary interventions. The perfect device must have a stent resistant to fracture and the stent must be present throughout both the body and the limbs of the device, but also be flexible enough to allow the device to accommodate arterial tortuosity. The stent must also have sufficient column strength to prevent collapse and migration of the device. Several lengths of body should be available as longer bodies are less prone to migration than short ones. A wide range of diameters of both the body and iliac limbs are essential with appropriate cuffs to extend the device both proximally and distally if required. Suprarenal fixation has no level I evidence to support its use but has become very popular for several reasons. It allows fixation to that part of the aorta least likely to dilate; it effectively lengthens the proximal landing zone; it does not seem to affect renal function in the medium term. The fabric should be strong, resistant to both fluid transudation and perforation by the stent. It should be manufactured around the stent rather than attached to it by sutures, and it should allow in-growth of cells to allow an endothelial surface to be established. The device should have a low profile for percutaneous delivery and have secure modular connections. The device should be trackable, pushable and resistant to kinking. It should also be able to cope with changes in the anatomy of the arteries following exclusion of the aneurysm and subsequent shrinkage of the sac. The perfect device should exclude the aneurysm from the circulation for the lifetime of the patient, while allowing normal blood flow to the distal vascular beds. It should have a permanent fixation with no possibility of migration and an easy and accurate deployment. It should be able to cope with difficult anatomy by having a wide range of sizes in both length and diameter to accommodate all patients. It should be readily identifiable by both fluoroscopy and magnetic resonance imaging. Finally, it should be affordable. It can therefore be easily deduced what future modifications should be made to the three most popular devices. The Cook Zenith requires much better fully stented iliac limbs to prevent thrombosis secondary to narrowing of the unsupported fabric in tortuous iliacs. The Gore Excluder requires some method of recapture to allow a change in its position before final deployment. The Medtronic Talent has metamorphosed into

the Endurant by acquiring suprarenal fixation, anti-migratory hooks/barbs/anchors and a capture mechanism to the delivery system allowing accurate deployment. Finally, all devices need to accommodate important side branches such as the internal iliac, the renals and the superior mesenteric and coeliac arteries.

1502.3

New insights on imaging follow-up

K. Hausegger;
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Learning Objectives

1. To discuss the advantages and disadvantages of current imaging strategy after EVAR
2. To review results of ultrasound vs. CT
3. To review place of MRI in follow-up

Due to the lack of data about long-term durability and the potential risk of stent-graft related complications, life-time surveillance after endovascular repair of abdominal aortic aneurysms (EAVR) is still warranted. However, there is still no consensus about the most efficacious technique and the best timing of follow-up. CT, colour coded ultrasound and MRI have been well validated as follow-up techniques after EVAR. The value of physiologic monitoring (i.e., sac pressure measurement) and the value of serum markers have been studied in limited series of patients and are not used in clinical routine.

CT and CT angiography: CT is the most widely used follow-up technique after EVAR. State-of-the art multislice CT reliably displays the maximum diameter of the aneurysm and shows EL with high level of confidence. A typical comprehensive CT-protocol is tri-phasic, comprising a non-enhanced scan, an early arterial phase and a delayed scan 50 seconds after KM application. However, at least two recent studies have shown that the CT-protocol can be reduced to at least a bi-phasic scan, by eliminating the arterial phase or unenhanced phase. Recently, it has been shown that with the new dual energy technique a single late phase scan with calculation of a virtual non-enhanced scan may be equivalent to a conventional multiphasic protocol by reducing the radiation dose in the range of 60% if compared to a triphasic protocol. Nevertheless, the main disadvantage of CT remains radiation exposure, the need of potentionally nephrotoxic contrast medium and the fact that in routine protocols no flow dynamics can be shown.

Ultrasound: ultrasound (US) is a potentionally attractive alternative to CT since it is not radiation and no nephrotoxic contrast medium is needed. Several studies have encouraging results especially if contrast enhanced US is performed. US may show flow dynamics and may allow a further sub-classification into hypo- and hyperdynamic endoleaks (ELs). However, there is a large diversity of the results in the literature, which reflects the well-known fact of the strong operator dependence of US. Furthermore, obesity and bowl gas may interfere with the examination.

MR-imaging and MR-angiography: MRI avoids radiation; however, with the recently recognized problem of nephrogenic systemic fibrosis (NSF), the possibility of application of MR contrast medium is limited in a similar degree as it is the case for ionated X-ray contrast medium. The metallic skeleton of the stent-graft and eventually applied metallic markers may cause artefacts to different degrees. Stent-grafts with a high content of ferromagnetic material cause strong artefacts; therefore, MR-follow-up studies in patients with these types of stent-grafts are useless. On the other hand, if the skeleton of the stent-graft consists of Nitinol, only minor artefacts are produced in MRI and MRI can show even small ELs more clearly than multiphasic CT. If a dedicated acquisition protocol is applied also, dynamic studies can be performed.

Intraarterial angiography: intraarterial angiography is not a routine examination in the follow-up of patients after EVAR. However, in unclear cases in patients with increasing sac diameter and not clearly demonstrated EL or EL of unclear origin, intraarterial angiography is the method of choice for further evaluation, with the possibility of an intervention during the same procedure.

Plain abdominal films: the plain abdominal film shows the skeleton to the stent-graft in good detail. It also can be seen if there is some dislodgement or distortion of the stent-graft. Since both these findings are correlated with an increased risk of stent-graft failure, plain abdominal films are an integrated part of FU-protocols in many institutions. However, with modern multislice CT, excellent display of the metallic structures is possible and all information shown by plain abdominal films can be seen on CT reconstructions. In addition, plain abdominal films never can be the sole FU-modality, since the sac is not shown.

Alternative methods: physiological monitoring in form of sac pressure measurements seem to an attractive non-invasive method. The technique of placing a sensor into the sac and the wireless transmission of pressure data has been evaluated in some clinical studies and showed some promising results. However, this technique is still far from clinical routine. And even if the technical aspects have been solved, it is obvious that a sensor can measure the intrasac pressure only in one distinct location. There are profound reasons to assume that there is no even pressure distribution thoughout the whole aneurysma sac, and therefore it is not clear yet what significance one focal pressure measurement has. Currently, there are no valid data that show the distinctive serum markers like measurement of the D-dimere level or the metalloproteinase may play a role in routine follow-up of patients after EVAR.

Conclusion: there is clear evidence that ELs influence the outcome after EVAR. Type I and III ELs are significant risk factors for rupture after EVAR whereas most type II Els are benign. A wide variety of FU-examinations can be performed and ELs may be shown in great detail. FU-examinations must give clear information about the type of EL if present, and the integrity and position of the stent. The choice of imaging modalities depends on the preference of the different centers. Although multiphasic CT still is the most commonly applied FU-method, several centers favour contrast enhanced US combined with plain abdominal films. MR as a single imaging method seems to be problematic since it does not show the metallic components of the stent-graft in detail. Typical FU-intervals are 3, 6 and 12 months in the first year after EVAR and yearly intervals thereafter in case of uneventful course.

1502.4

Management of ruptured aneurysms

M. Thompson;
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Learning Objectives

1. To review the indications, techniques and results of EVAR for ruptured aneurysms
2. To highlight problems of EVAR for ruptured aneurysms and discuss solutions

No abstract available

Special Session
Your idea: how to succeed with new device creation

1503.1

Intellectual property overview

S. Haley;
Gill Jennings & Every LLP (GJE) , London, United Kingdom.

Learning Objectives

1. To provide an overview of the intellectual property process (how to obtain patient protection)
2. To explain how to best protect your intellectual property and avoid making costly mistakes (discuss confidentiality, publishing issues, etc.)
3. To understand how to develop an intellectual property strategy (understand claim structure, how patent reviewers think, the costs of filing,etc.)

The Intellectual Property process has developed over the years into a large and complicated system. Its evolution has resulted in the creation of a number of different types of intellectual property. In addition, because of its evolution at different paces and in different ways in each of the major industrial markets, the application procedures that form part of the process vary considerably from country to country. All of this has resulted in a system which can, for the novice, seem very daunting and complicated. However, inventors and development companies should not be discouraged from taking advantage of the benefits of the process just because of the apparent complexity of it. It is possible to understand some of the underlying principles that form the foundation of the process and to use that understanding to develop a strategy for the protection of intellectual property. Furthermore, by understanding some of the underlying principles it is possible to develop a strategy that maximises the advantages of the intellectual property process whilst avoiding some of the pitfalls that are also present in it. This talk attempts to outline some of the basic principles of the intellectual property process as applied to the main types of intellectual property. It will provide an outline of some of the basic requirements for the major jurisdictions for seeking intellectual property protection. It will then go onto emphasise some of the simple mistakes that can be made, and which can also be avoided, when following that process. The intellectual property process has been developed to provide a number of main categories of intellectual property protection. These include patents, trademarks, registered and unregistered design right, copyright and confidential information/trade secrets. The process with the most pitfalls is that of patent protection. Accordingly, my talk will focus on some of the key stages in the patent application process, will outline some of the fundamental principles underlying the patent system, and will hopefully highlight some of the key pitfalls present in the system. The patent application process requires, in pretty much every jurisdiction, for the inventor and/or owner of an invention to actually file an application at each individual national patent office of interest. It is important for the patent applicant to ensure that disclosure of their invention to third parties is kept under tight control until the application documentation has been submitted, as inadvertent early disclosure of the invention can destroy the validity of any application that is submitted after such disclosure. It is also important for the applicants to ensure that their filing provides a sufficiently high level of detail to justify the granting of a patent. On the other hand, it is important for the applicant not to limit their application to the extent that third parties can avoid infringing their rights in future, effectively making any granted patent worthless. On this basis, it is important for an applicant for a patent to understand the basic structure of a patent application, in terms of provision of a detailed description, with broader legal definitions (commonly known as claims) attached thereto. Once an application has been filed, it is also sensible for an applicant to have a basic understanding of the key stages that such an application goes through before individual patent offices, and so these stages can be handled appropriately. A first significant stage is that of search, where the patent office looks for publications which pre-date the application and which may affect the ability of the applicant to obtain a granted patent. A further stage is substantive examination, where a patent office examiner looks in detail at the results of the search and also the content of the claims to ensure that the content of the claims is distinguished from the detail of earlier publications to the extent that a patent can be granted. Some patent offices handle these two stages at the same time, others separate them out. In just about every jurisdiction at some stage during the application process there will be an early publication of the application, making the full details of the application available to the public and an applicant should be aware of this and appreciate the consequences in terms of retaining confidential information related both to the technology and perhaps also business strategy. Following on from substantive examination, there are usually certain grant formalities that need to be completed, as well as renewal fees payable to maintain a patent once granted, and it is sensible for an inventor or developing company to ensure that the cost of these components of the application process are factored into longer term planning, particularly if sought in a significant number of jurisdictions.

1503.2

Regulatory overview

I. Tariah;
Bristish Standards Institution, Reston, VA, United States.

Learning Objectives

1. To understand the regulatory process and how the CE mark protects the medical community and patients
2. To summarise the pre-clinical and clinical steps necessary to obtain regulatory approval of a device
3. To understand the reporting and data collection process needed to maintain regulatory approval

All medical devices placed on the market and put into service in the EU must demonstrate compliance with the appropriate directive: 90/385/EEC - Active Implantable Medical devices (AIMD); 93/42/EEC - Medical Devices (MDD); 98/79/EEC - In Vitro Diagnostics Directive (IVD) (sub category of the MDD) and 2007/47/EEC (from March 2010) - Amendments to AIMD and MDD. The directives that have been transposed into National laws of individual member countries of the EU are the set of legal requirements and instruments of the law with which manufacturers of non-compliant products may be prosecuted. An important first step in the regulatory process is the ***selection of a Notified Body (NB) preferably based on expertise, and experience of the device type***. The NB is responsible for the assessment of the Quality Management System (QMS) of the legal manufacturer and review of products' technical documentations - technical files for medium to lower risk devices and design dossiers for higher risk devices. An ***'open' relationship between the manufacturer and NB is critical*** to ensure there is a common understanding of the regulatory requirements and hence ***an agreed regulatory path*** that should result in a timely and successful approval. In preparing a QMS and product technical documentation, the manufacturer is expected to preferably follow applicable European harmonized standards (where available) or internationally recognized standards. Other EU regulatory documents that should be helpful in providing guidance are the so called MEDEV documents (provided by the EU Commission) and NB-MED Recommendations (consensus interpretations of the directive provided by notified bodies). Whereas the directives are legal requirements, harmonized standards and guidance documents are not legally binding but are considered

"acknowledged state of the art." The foundation of a European Medical Device approval is the QMS, which has to demonstrate compliance with the relevant requirements of the Directive (depends on chosen conformity assessment route). As such, preparation for this assessment, addressing any identified non-conformities following the assessment with an acceptable Corrective Action Plan (CAPA) in a timely manner is important for a timely approval. Equally important is an agreed certification scope that defines the activities, products or services covered by the QMS assessment. Additionally, device approval in the EU, which rides on the back of the QMS, is governed by a risk based classification and the requirement is for all processes and characterizations to demonstrate compliance with applicable sections of the ***"Essential Requirements"*** of the appropriate directive. Consequently, agreement of the device classification by both manufacturer and NB early in the process is important. Thereafter, objective evidence that should include items such as (list is not exhaustive): material biocompatibility, toxicity, package integrity testing, shelf life claims, process validations, product validations and verifications, risk management, historical performance (if appropriate), pertinent review of the literature, clinical data (including human clinical investigation - if deemed necessary); post market surveillance data (if available), Labeling and Instructions For Use (IFU); to demonstrate compliance with the essential requirements by the manufacturer applying acknowledged state of the art should enable the NB utilizing ***appropriate expertise*** determine that the device is ***"safe and would perform as intended"***, issue appropriate CE certification and hence allow the legal manufacturer apply the CE Mark.

References

1. 90/385/EEC - Active Implantable Devices Directive.
2. 94/42/EEC - Medical Devices Directive.
3. 98/79/EEC - In Vitro Diagonstics Directive.
4. 2007/47/EEC - Amendments to AIMD and MDD.
5. ISO 13485:2003 - Quality Management Standard for Manufacturers of Medical Devices.

1503.3

Various ways to get your concept to the market

S. Hvozda;
Hatch Medical, L.L.C. , Atlanta, GA, United States.

Learning Objectives

1. To understand the options that exist for physician inventors to bring their technology to the market
2. To understand how to decide which option is best for the physician and how to develop a plan to advance your technology
3. To understand what the medical device industry looks for when licensing or acquiring a technology and how you can best prepare to meet their needs

The evolutionary success of interventional medicine is largely indebted to the lineage of physician inventors in this specialty. There seems to be no shortage of revised methods to enhance a clinical outcome or a unique new widget that may revolutionalize a classic procedure. While it is apparent that being an interventional physician is more than a full time job, it is astonishing as to how many invest immeasurable hours and considerable expense to bring their concept to market. Yet, for a myriad of reasons, only a handful of physician inventors ever truly realize this goal. The inventor recognizes they have an extraordinary device that reduces procedural costs and provides both improved patient care and clinical outcomes. But for some mysterious reason, the roadblocks they face seem insurmountable. The euphoria of "eureka" wears off quickly with the realization of significant investment in both time and money to initiate a medical device development program. Add the invariable risks and the competitive driven "need for speed" and the notion of pending success often diminishes. Physician inventors are left wondering how to turn their ideas into reality.

An honest self-assessment: as an inventor, it is critical to understand the myriad of options that are available for physicians to bring their unique technology to market. However, an initial step that may frequently be over-looked is the necessity to honestly self-diagnose individual circumstances and limits of burden. This accurate appraisal of personal resources and commitment are critical to ensure the development process is successful.

Ask the tough questions: how much time is the inventor actually willing or able to invest? How much capital is he willing or able to invest? How much business expertise does the inventor realistically lend to this effort? What is the ultimate motive for embarking on this quest?

Throughout this period of self-examination, it needs to be abundantly clear that there is a direct relationship between the amount of time and money an inventor is willing to invest, and the ultimate financial returns and degree of control one can expect.

What are the inventor's options? the development pathway from concept to commercialized medical product is a multistage process that is surprisingly uniform and consistent for physician inventors. The basic steps are: idea conception, protection of the intellectual property, iterative prototype production, experimentation, sourcing capital, licensing or partnership, manufacturing and commercialization. While physicians are often the source of new ideas, the real work arguably begins after conception. In all but very rare cases, the inventor cannot do it alone. Device development requires experts in intellectual property, executive management, engineering, regulatory affairs, and operations. It is important to remember that an idea has no value unless it is implemented. The inventor choosing this path has many options including self-funding the entire process, forming a small company with venture or angel funding, working with an incubator, or partnering with an existing company, among others.

Option: medical device industry partner - one of the simplest and most straightforward options for a physician inventor is to partner with an experienced medical device company. The inventor can limit financial risk while industry enjoys new additions to their organic development pipeline. It is worthy to understand what the medical device industry looks for when licensing or acquiring a technology and how to best prepare to meet their needs. Generally speaking, most industry decisions revolve around four key areas - market potential, organizational focus, resource allocation and risk tolerance. While most large companies seek new technology platforms that participate in excess of a $500 million market opportunity, there are others that enjoy smaller market, niche products that can fill a gap in a company's product offering. An inventor should be mind-full that regardless of a company's size, all have finite resources. Each company must prioritize its list of projects and allocate resources based upon the earning potential of each project. Historically, industry has licensed early stage ideas from physicians and invested their internal resources to commercialize these technologies. This model had been successful for both the inventor and industry alike. However, with the increased number of physician inventors combined with limited industry resources, it is critical to stand out. Today, greater opportunities exist for inventors who take the extra step of filing intellectual property and proving device feasibility. Companies are much more likely to license or acquire externally developed technologies that will greatly reduced their investment risk and are often willing to pay a premium for this benefit. Do not limit industry discussions to a handful of top tiered companies. Cast the contact net far and wide. Often, many smaller organizations are searching for segment specific, differentiated devices to help launch them into a particular competitive field.

Option: incubator firms - medical device incubators are designed to accelerate the successful development of technologies through an array of business support resources and services. By rigorously assessing ideas, incubators are revolutionizing the way medical device technology is developed. Incubators search for promising technology ideas in

their earliest stages, develop them into groundbreaking products, and lead them to market via varying forms. There are several types of incubator firms that vary from geographical focus to specialty focus. Differences also lie in their selection of market size participation and their preferred choice of exit strategy. Once the development cycle is complete, some prefer to license or sell the assets while others find value in forming a separate company around the technology. Regardless of type, incubators can be the ideal solution for inventors with early-stage development needs that lack the required core competencies. Incubators provide inventors with a "one-stop shop" development opportunity with a common goal of dramatically increasing the over-all value of the invention. They provide hands-on management expertise, development experience and the channel experience to take your concept through to commercialization. They will effectively evaluate the invention market potential, consider patents for the technology, and develop an appropriate exit strategy. Experienced incubators will be able to quickly determine whether an idea is viable and whether an investment around that idea will generate a return. Incubator engineering resources have the ability to solve early development problems. Their regulatory affairs resources will conduct early testing and due-diligence that provide insight as to the appropriate regulatory pathway. Their legal team ensures the appropriate intellectual property and contractual coverage is in place. All the while, the executive group provides a strategic vision through vast experience to see the product to commercialization. Depending upon incubator selection, physician inventors have the option to either immediately license the rights to their invention or share in an equity position, the latter of which yields better returns. The inventor decides the level of their involvement and will typically be compensated accordingly. Physician inventors who wish to enter an incubation program must provide a convincing argument that their concept is worthy of the time and investment needed to reach commercialization. Acceptance criteria will vary, but in general, only those with patentable ideas and a significant market potential are accepted.

Option: venture capital firms - venture capital (VC) is a type of private equity funding typically provided to early-stage technologies in the interest of generating a return through an exit event such as an IPO or sale of the company. VC investments are generally made as cash in exchange for equity in the invested technology. Venture capital is most attractive for inventors that have limited experience and are perhaps unable to raise capital in the public markets or secure institutional funding. VCs have the resources and experience to create long-term value for inventors and can be an ideal option if the concept lends itself to become a complete technology platform around which a new company can be formed. VCs tend to have seasoned executive management teams that often possess relationships with some of the industry's leading practitioners that can ultimately add substantial value. In exchange for the high risk that venture capitalists assume, they usually obtain significant control over company decisions and a majority of the company's ownership. As additional rounds of funding become necessary, the inventor's equity is correspondingly diluted. To obtain VC interest and commitment, a great deal of upfront work is required to get their attention. These are seasoned business people that have little time to spend with inventors who do not have their business plan fully vetted and their IP secure. The scale of VC investment depends on the nature of the transaction and will vary widely based on several factors, such as the size of the target market, strong intellectual property, unique technology with clear benefit, compelling business plan and a clear path to market.

Option: angel funding - angels are high net worth private investors who are typically CEOs or senior executives of successful entrepreneurial ventures. They have the capital, time, experience, skills and passion to work with inventors to build new companies. Unlike venture capitalists, angels typically invest their own personal funds. Angel funding often fills the gap in start-up financing between "friends and family" who provide seed funding and venture capital. Angel investments bear extremely high risks and are usually subject to dilution from future investment rounds and, as such, require a substantial return on investment. Similar to the VC model, angel investors seek investments that have the potential to return multiples of their original investment within a predefined period of time and through a defined exit strategy, such as plans for an initial public offering or an acquisition. In addition to providing capital, angel investors can often provide valuable management advice and important contacts. Angel groups that are focused in the medical device arena can be infinitely more knowledgeable of the clinical advantages of a physician's invention. This becomes increasingly attractive when trying to entice an angel group to buy-into an inventor's technology. Similar to VC expectations, the angel requires a detailed business plan clearly outlining everything from technology benefits to exit strategy. If the ultimate goal is to form a company around a concept, then angel funding may be a compelling option.

Option: tech transfer - for those inventors that work at a teaching institution or a large hospital, the technology transfer center (TTC) within their facility may be a viable option, and perhaps the only option. The TTC will provide faculty inventors with an array of resources from IP funding, filing and prosecution to assistance with prototype development. The technology transfer objective is to license or sell the innovative, leading edge technologies discovered during the course of academic research. The TTC serves as a bridge between the physician inventor and industry and plays a vital role in negotiating license agreements. In exchange for this service, inventors are entitled to a percentage of revenues generated back to the institution. An inventor's financial risk is greatly minimized when partnering with the TTC but the revenue reward often less attractive.

Option: self-funded development - should the inventor possess inherent business acumen, there is a viable option to enhance the overall value of the invention by embarking on some early stage initiatives. Conducting a web search on the concept could identify any potential similar concepts. Attempt to quantify the global market opportunity reviewing industry annual reports, related press releases and company websites. Review patent office websites to gain a better understanding of the intellectual property landscape. Allocate time to attend a regional medical device manufacturing conferences. This can be an ideal forum to search out viable manufacturing partners specific to conceptual design. Contact the local government body to gain regulatory pathway clarity. While this option is fraught with risk and will involve notable expense, if executed properly, it will invariably be much increase the concept value and as a result, gain interest from potential investors or acquirers. In summary, the physician inventor must always make an honest assessment of their situation and ideal exit strategy. Once there is a clear understanding of limitations, the path for success will become much more apparent. Be mindful that the further the inventor can take the development process, the more receptive the audience and the more healthy the return on investment. Remember to document and date any/all ideas and take action now.

1503.4

How to fail: a case review

J.A. Reekers;
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Learning Objectives

1. To describe the author's personal history from the idea to the product
2. To describe how the author approached industry and how s/he protected her/himself
3. To summarise the reasons why this experience was a failure

No abstract available

1503.5

How to succeed: a case review

S. Trerotola;
Interventional Radiology , University of Pennsylvania Medical Center , Philadelphia, PA, United States.

Learning Objectives

1. To describe the author's personal history from the idea to the product
2. To describe how the author approached industry and how s/he protected her/himself
3. To summarise the reasons why this experience was a success

Most, if not all IR physicians have something of an inventor in them. By our very nature, we invent all the time. We come up with new ways to treat old and new diseases, sometimes using tools we have available to us, and occasionally developing new ones. Succeeding in developing a new device is no secret, yet all too often innovators make the very same mistakes they are taught to avoid in presentations such as this one. With the benefit of nearly 20 years of hindsight, it is relatively easy to see what went wrong and what went right in developing the Arrow-Trerotola Percutaneous Thrombolytic device (PTD), yet at the time it was not at all clear. It is my hope that this brief presentation will allow innovators to learn from the PTD story, and apply that knowledge to their own invention development. It is very true that necessity is the mother of invention, and we had plenty of necessity in hemodialysis graft declotting in 1990. Using Urokinase, procedure times were long and bleeding complications common. Declots were reviled and avoided by attending physicians I worked with then as a fellow. I felt that if we could expedite the process of thrombectomy, the rest of the procedure would be straightforward and above all beneficial to the patient. Little did I know then just how big a part of our practice dialysis access management was to become. At Johns Hopkins we did a lot of biliary work, and thus had a large number of stone removal devices on hand. We also had the Simpson Atherectomy motor drive available, and importantly Hopkins had a small device lab, something I consider essential to making one's ideas a reality. With access to the device lab as well as in vitro testing materials, I was able to create multiple prototypes and find what worked (very few designs) and what did not (many designs). Once I had a viable prototype I was able to test it on real clot and prove that it worked. This was, in retrospect, one of the most critical pieces of the success story: when we took the device to industry, we had a functional prototype that we knew worked, as opposed to an idea on paper without proof of concept. The next steps were straightforward enough; I was given good advice about documenting my invention and reporting it to Johns Hopkins Technology Transfer. This advice is critical and is always a key message in invention "how-to" presentations: you have to protect yourself. There is far more to the story as I soon learned when I presented the data at the next SIR meeting before the international patent applications were filed; a potentially costly error borne out of naïveté and enthusiasm to share my ideas, thinking they were protected. Thus, anyone making a report of invention must keep it very quiet until the patent attorneys tell them it is safe to proceed. In a similar vein, it is essential to have nondisclosure agreements in place when discussing your invention with potential industry partners; and we did so religiously. While the attorneys worked on the patent application, I was busy in the lab, trying to test every possible aspect of the device I could think of. That work led to publications describing the effect on endothelium, pulmonary emboli, particle size, efficacy in animal models, effects on valves and potential uses in DVT (1-8). It is my firm belief that the evidence basis created by this preclinical work and ultimately the randomized trial that led to the device's FDA approval are important reasons the device remains so popular today: it is a big part of the success story. Just as a functional prototype is appealing to a corporate partner, so is background work supporting the proposed clinical uses. Once given the green light to proceed, we met with three potential corporate partners. The first two large corporations declined to work with this for very different reasons: one did not have core competence in motor drives and declined; the other felt there was "no future for rotational mechanical thrombectomy devices" and also declined. Our interaction with Arrow came by sheer luck: a researcher working with Arrow and Johns Hopkins on another project learned of the device and convinced the Arrow president to take a good look at the device. Arrow had the perfect combination of expertise: they were leaders in catheters and had another device in development (which ultimately never made it to market) that used a motor drive. This expertise, coupled with the good reviews from our mutual acquaintance led to a successful licensing of the product. As mentioned so often, luck is often a big part of success, and it was the case with the PTD as well that we were lucky to come across Arrow. After licensing, we continued the preclinical work outlined above as the device wound its way through the approval process. At this point, another key element of our success occurred: Anne Roberts was spending a sabbatical year at the FDA and her extensive knowledge of dialysis access interventions and declotting (Anne was from UCSD, the clear leaders in dialysis access thrombolysis at the time) helped to foster an understanding on the part of FDA personnel of the importance of mechanical thrombectomy to the future of endovascular interventions. Further, Anne's efforts helped secure permission to have pulse-spray thrombolysis with urokinase as the predicate (comparison) treatment in the clinical trial. This fortuitous change allowed us to offer our patients two percutaneous approaches in the trial, as opposed to a percutaneous and a surgical one as the two prior trial designs (Amplatz device and AngioJet) had and which allowed much faster subject recruitment compared to those trials. Again, luck was on the side of the PTD. Once the clinical trial was complete and the device's efficacy and safety proven, we were not content to rest on our laurels, rather continued exploring as many properties of the device as we could. This resulted in physical refinements improving durability, with key input from several very talented engineers at Arrow; our research resulted in approvals for treating the arterial plug with the device (the only device with such approval) as well as eventual approval for fistula thrombectomy. The published work done at this time, added to the extensive preclinical work, now forms a continuous chain of evidence equaled by no other device. This took hard work and a firm belief in the device as well as the support and patience of family, partners and my colleagues at Arrow. In my opinion, it is one of the main reasons for the longevity of the PTD and something of which I am extremely proud. Incidentally, this is the "99% perspiration" so often referred to in presentations such as this. The story of the PTD is far from finished. As we move toward more mechanical thrombectomy in DVT treatment, the published animal DVT work (5-7), small human clinical trial in DVT, and studies by other authors describing off-label use of the device in DVT (9) should help clear a way for the device in that area: presently off-label yet very well studied compared to some other devices in widespread use for this purpose. The core traits of the device - simplicity and efficacy - remain. In summary, the success and longevity of the PTD are no different than other successful inventions: a clear-cut need, a decent idea, a lot of hard work, and even more luck. The mistakes made in the process were few and probably avoidable; however no process is ever perfect. Anyone with a good idea can learn from this story and hopefully make theirs the next success story.

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Special Session
Key imaging points to follow your patients

1504.1

MR after UFE

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Learning Objectives
1. To learn potential complications and classical evolution
2. To learn the different techniques to follow-up including perfusion MR
3. To learn the key imaging findings (measurements, complications) and the propositions to react

No abstract available

1504.2

Post EVAR

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Learning Objectives
1. To learn classification of endoleaks and potential complications post EVAR
2. To review the different techniques to follow-up after stent-grafting
3. To learn the key imaging findings (measurements, complications, endoleaks) and the propositions to react

Open surgery is not actually the only technique for abdominal aortic aneurysms; endovascular aortic aneurysm repair (EVAR) is becoming a viable alternative for many situations. Unlike open repair, it requires imaging surveillance. For the patient, it is crucial to detect complications that can occur even after successful procedure. The most serious complication is obviously expansion and rupture. Endoleaks, not infrequent complications, are important to detect and to characterize during imaging controls by the radiologist; some need only surveillance but some of them indicate invasive treatment. Endoleak is defined as a blood flow inside the aneurysm sac, they are classified into five categories based on the source of blood flow: **I: attachment-site leak (proximal or distal). II: collateral-vessel leak (lombar, inferior mesenteric). III: graft failure (hole, disconnection or junctional leak). IV: graft-wall porosity.** Endotension is an expansion of the aneurysm without a real endoleak and is classically named type V. The cause of this endotension is unclear; it may include endoleaks occult to imaging techniques, ultrafiltration of blood or a thrombus in the sac with an ineffective barrier to pressure transmission. Techniques for surveillance imaging are: plain radiography considered as a standard by some authors to evaluate integrity and kinks has to be reevaluated because of the improvements in MDCT (resolution and visualization tools). The high spatial resolution allows thin transverse sections as well as multiplanar reformations and 3D volumes, and so measurements generated by MDCT are highly accurate for size and volume of the aneurysms. Moreover, CT angiography is able to depict endoleaks with a higher sensitivity than conventional angiography. Because endoleaks have various flow rate, at least two acquisitions (arterial and venous phase) are mandatory. Some authors emphasized the superiority of plain acquisition to determine calcifications. To reduce radiation dose, frequently this plain phase is acquired only for the first post-EVAR control (30 days). Other imaging techniques as MRI, CO2 -DSA, contrast-enhanced ultrasonography and nuclear medicine that are promising but under estimation will be discussed during the lecture. Some recent studies emphasized their potential superiority for detection of endoleaks, but they have to be associated to one other examination (at least unenhanced CT) for reproducible measurements. Management of endoleaks is frequently determined by small changes in the eneurysm size, issues of reproducibility and accuracy of aneurysm measurement have come to the forefront. To avoid imprecision or interobserver variability, it is necessary to measure diameters in a plane perpendicular to the center line of the vessel (with multiplanar reformation or semi-automated software). However, some authors suggested that the volume measurement is the most reproducible, but is more time consuming. The key-words for measurements on CT are definitely precision and comparison (if reformation is used to establish the center line of the vessel it has to be performed in a similar plane). Endoleak treatment: type I is immediately repaired; type II is more controversial, up to 40% of those endoleaks will spontaneously thrombose, some authors believe that follow-up is sufficient except if the aneurysm is growing, others believe it always has to be treated (two routes are possible, intraarterial navigation and, apparently the most efficient, translumbar embolization) ; type III, perhaps the most dangerous has to be treated by a stent-graft extension; type IV are uncommon with actual grafts and are self-limited; type V are difficult to confirm, and so all the available technique have to be used to exclude endoleaks (Contrast-enhanced US, MRI), when it is confirmed the classical outcome is open surgical conversion.

Take home messages: -Imaging post EVAR is mandatory for the lifetime. -CT (MDCT) is the technique of choice for this imaging surveillance despite other techniques could be useful, for patients with renal impairment, post-embolization (coils artifacts) or confirmation of endotension. -Measurements have a major role for decision-making during the follow-up, comparison and reproducibility are crucial (semi-automated software could help). -Plain X-ray is optional if the CT reformations are not doubtful. -Calcifications are best seen with plain CT, so it is reasonable to perform it for the first control (1 month). -Bi-phasic (arterial and venous phases) CT angiography is necessary to detect endoleaks. -Arteriography is reserved for pre-treatment characterization of endoleaks.

Musts for imaging surveillance post-EVAR: 1) MDCT is actually the first choice for many centers, MRI can be useful for detection of endoleaks but measurements are less precise. 2) Measurements and identification of changes in form or dimension. 3) Detection and if possible characterization of endoleaks. 4) Detection of mechanical

changes in the stent-graft (migration, kinking, fracture). 5) Permeability of limbs. 6) Incidental findings in those CT post-contrast examinations of abdomen and pelvis.

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1504.3

HCC ablation and TACE

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Learning Objectives

1. To learn potential complications and classical evolution
2. To learn the different techniques to follow-up
3. To learn the key imaging findings (measurements, complications) and the propositions to react

No abstract available

1504.4

Renal tumour ablation: key imaging points

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Learning Objectives

1. To learn potential complications and classical evolution
2. To learn the different techniques to follow-up
3. To learn the key imaging findings (measurements, complications)

and the propositions to react

Fundamentally, most minimally invasive interventional oncology involves non-extirpative techniques. Traditional surgical resection allowed the specimen to be sent intact to histopathology for verification of its histological nature and margins. Many embolic and ablative techniques are now achieving, or aiming to achieve, similarly effective oncological outcomes but the tumour remains in situ. The onus therefore falls on the IR not only to carry out these image-guided interventions but to also ensure that the ablation is complete.

Pre-assessment: on referral it is essential that these patients are seen in an outpatient setting at least one week prior to the procedure. In undertaking the primary interventional treatment for a patient's renal tumour, the IR should be able to confirm with the patient that the procedure is being undertaken and planned with the intention of cure similar to any other planned surgical intervention. Recent imaging must be up-to-date and ideally performed within the last six weeks. The proportion of benign renal masses rises as the target tumour size diminishes. Approximately 20% of sub-3 cm tumours are benign in nature at resection. Careful attention should be paid to the possibility of complex/hyperdense cysts or fat-poor AMLs. All tumours should be biopsied either at the time of the ablative procedure or if an ablative procedure will prove onerous on the patient, prior to it. It is essential that every effort is made to confirm the malignant nature of a tumour and its grade. The renal masses that treat most readily - given current technology - are pedunculated and of less than 4 cm in diameter. Over time, the IR should seek to educate referrers that it is better to consider ablation at this size rather than wait until some are over 5 cm in diameter before referring for image-guided ablation (IGA). This previous management concept was predicated around the morbidity of traditional resectional techniques in older patients. IGA is considerably better tolerated than even laparoscopic procedures and can therefore be appropriately deployed at an earlier stage for smaller volume disease. At pre-assessment, the patient's co-morbidities should be reviewed. The operator should also take this opportunity to assess the patient's amenability to prone-oblique positioning (which will often be required for around 2 hours) and to plan an optimal path and positioning for probe placement. The author believes it is advisable to carry out these procedures with formal anaesthetic assistance with a view to general anaesthesia or well-managed intravenous sedoanalgesia. Ideally, therefore, the patient should be seen by the IR and the anaesthetist at this visit.

Peri-procedural: a combination of CT and US-guidance remains the most available method of probe placement. Considerable attention to detail is required in achieving optimal RF or cryoprobe positioning, if sound oncological outcomes are to be achieved. Significant 'over-treatment' remains the objective if crescentic marginal treatment failures are to be avoided. Retroperitoneal 'hydrodissection' (using 3% contrast-doped 5% Dextrose) is, therefore, commonly used in order to safely displace adjacent gut and viscera so that the tumour margins can be treated adequately. A useful mantra in tumour ablation is 'treat the margins..... and the central tumour will look after itself'.

Post procedural: meticulous and critical imaging follow-up is essential to good oncological outcomes. Contrast-enhancement remains the most useful surrogate marker of tumour ablation for the present. Many of these cases will have been referred due to limited renal function. Careful attention should be paid to eGFR and creatinine in deciding CT or MR follow-up with regard to the risks of both CIN (contrast-induced nephropathy) and NSF (nephrogenic systemic fibrosis). The author has increasingly found subtraction MR a useful follow-up technique. An adequate late arterial phase acquisition (high flow rate 3.5-5 ml/sec with sound timing usually at about 40 seconds) is the most critical with regards to the detection of any residual enhancing disease. This assumes the pre-treatment tumour demonstrated enhancement in this phase. Be aware that many papillary tumours (10-20% of all) demonstrate little or no enhancement. In these cases, signs of collateral injury in the retroperitoneum or adjacent cortex need to be sought to confirm adequate treatment. With careful technique, any subtotal treatments can usually be confirmed and re-booked for treatment completion. Evolving standards suggest that any individual practitioner should now be incurring subtotal treatments in 5% at most. Again, be aware that late recurrent disease has been noted in some 3% of cases as late as 2 years after the procedure. Most centres, therefore, advise at least 6 monthly imaging to two years and annually to 5 years. Careful pre-, peri- and post-procedural imaging are essential to a sound practice in image-guided ablation. This applies particularly to renal tumour ablation where IGA is the definitive treatment of the patients' renal cancer.

Special Session
Trauma

2101.1

Logistics and algorithm of trauma patients

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Learning Objectives

1. To review how to optimize the logistics upon patient admission
2. To review the results of CTA in trauma and its place in patient triage and management
3. To present one or two different algorithm in trauma patients

Trauma is a major source of morbidity and mortality, especially in people below the age of 50 years. For the evaluation of trauma patients CT scanning has gained wide acceptance and provides detailed information on location and severity of injuries. However, CT scanning is frequently time consuming due to logistical (location of CT scanner elsewhere in the hospital) and technical issues. An innovative and unique infrastructural change has been made in the AMC in which the CT scanner is transported to the patient instead of the patient to the CT scanner. We developed a new shockroom resuscitation setting that includes a moveable, multislice computed tomography (CT) scanner capable of scanning patients during the initial trauma resuscitation phase without (multiple) patient transfers that previously were necessary. This enables us to perform a complete diagnostic trauma workup, without leaving the shockroom. As a consequence, early shockroom CT scanning provides an all-inclusive multifocal diagnostic modality that can detect (potentially life-threatening) injuries in a very early stage, so that immediate therapy can be directed based on these findings. Data of 100 consecutive trauma patients were collected prospectively (2005 cohort) and compared with 100 consecutive trauma patients seen in our previous trauma resuscitation setting (2003 cohort). For all patients, time management was evaluated using video registration and complemented with electronic imaging times. Patients with and without CT scanning were compared with the effect of CT scanning on complete workup time, defined as time from admission to the trauma room to time of completion of diagnostic workup. Patient demographics, including appliance of CT imaging, were similar. Complete diagnostic workup for patients who underwent CT imaging took an average of 79 minutes (standard deviation ± 29 minutes) in the 2005 cohort and 105 minutes (standard deviation ± 48 minutes) in the 2003 cohort. Complete diagnostic workup without CT imaging took 56 minutes and 53 minutes for the 2005 and 2003 cohorts, respectively. There was no difference found for nonscanned patients, whereas there was a significant difference between 2005 and 2003 for scanned patients ($p<0.01$). So, our new trauma workflow concept with a sliding CT scanner was significantly faster for completing the initial diagnostic workup, especially when CT imaging was required. After the initial study phase, we wanted to assess the effect of the new trauma workflow concept on the initial diagnostic workup times in the trauma room in a prospective, randomized trial, the REACT study (Randomized Early Assessment CT).

Methods/design: the REACT-trial is a prospective, randomized trial, comparing two Dutch level-1 trauma centers, respectively, the Free University Medical Center (VUmc) and Academic Medical Center, with the only difference being the location of the CT scanner (respectively, in the Radiology Department and in the shockroom). All trauma patients who are transported to the AMC or VUmc shockroom according to the current prehospital triage system are included. Patients younger than 16 years of age and patients who die during transport are excluded. Randomization will be performed prehospitally. Study parameters are the number of days outside the hospital during the first year following the trauma (primary outcome), general health at 6 and 12 months post trauma, mortality and morbidity, and various time intervals during initial evaluation. In addition, a cost-effectiveness analysis of this shockroom concept will be performed. Regarding primary outcome, it is estimated that the common standard deviation of days spent outside of the hospital during the first year following trauma is a total of 12 days. To detect an overall difference of 2 days within the first year between the two strategies, 562 patients per group are needed (alpha 0.95 and beta 0.80). The REACT-trial will provide evidence on the effects of a strategy involving early shockroom CT scanning compared with a standard diagnostic imaging strategy in trauma patients on both patient outcome and operations research. Inclusion of patients was successfully ended in November 2008. The results are expected in November 2009. The development of the algorithm of severe trauma patients is now focused on direct total body 64 slice contrast enhanced CT scanning as a first measure before treatment in the unstable patient group.

2101.2

Pelvic trauma

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Learning Objectives
1. Discuss CT findings in Pelvic trauma
2. Results of embolizations
3. Complications

Embolization is an accepted alternative to surgery for patients with active bleeding related to pelvic trauma. The role of CT has significantly evolved to become an important tool in the treatment decision algorithm. In hemodynamically stable patients, contrast enhanced CT (CECT) is the preferred method of investigation. Compared to angiography (gold standard), Pereira *et al.* found a sensitivity of 90%, specificity of 98.6% and accuracy of 98.3% using scans that were helically acquired by using 10 mm intervals with a pitch of 1.0:1 to 1.5:1. They suggested its use as a method for screening polytrauma patients with pelvic fractures to accurately identify patients who would benefit from emergent angiographic embolization. With improving technology resulting in faster image acquisition and higher resolution images, CECT is even more impressive and may even surpass conventional angiography in sensitivity. It is not generally recommended that hemodynamically unstable patients undergo computed tomography (CT) scan. However, most patients with trauma suffer multi-organ injuries including brain trauma with reduce level of consciousness. A whole body CT is therefore very helpful to evaluate the extent of injuries and the best treatment approach. In fact, if a patient can tolerate CT, all other diagnostic investigations (DPL/US/laparoscopy/angiography) may not be necessary. CTA can demonstrate pelvic fractures and associated hematoma. Hematoma is the most frequent sign associated with pelvic vascular damage. The active contrast extravasation can be seen and needs to be treated in timely manner and aggressively. In case the extravasation is not seen, the progression of the hematoma in consecutive CTs is an important finding. The topographic location of extravasation and hematoma could give some indications of the vessel involved. Vessel discontinuity, pseudoaneurysm and stenosis/spasms are other secondary signs of arterial damage. Embolization is effective in controlling the arterial hemorrhage associated to pelvic trauma. The success rate ranges between 80 and 95%. The success of embolization depends on the patient hemodynamic status, delay between the trauma and the embolization, experience of both trauma and IR teams, number of vessels involved and the extent of injuries to other organs. The above elements will affect as well the mortality rate that remains high after trauma. In a recent paper, the presence of sacroiliac joint disruption, female gender, and duration of hypotension reliably predict patients who would benefit from arterial embolization. This predictive model can help early identification of patients who would benefit from pelvic angiography. Complications related to embolization of pelvic vessels are less than 10%. Beside the well-known complications related to catheter angiography, several embolization-specific complications can occur. Embolization, by definition, reduces blood flow to the affected organ. Therefore, target and non-target organ ischemia and necrosis are recognized complications of trauma embolization. However, unintentional reflux of embolization material from the internal iliac into the femoral artery can cause inadvertent ischemia in the leg. Sciatic palsy with associated foot drop and sacral plexus palsy has been reported. Bladder ischemic lesions have also been reported. Embolization of the superior gluteal artery may result in sacral and buttock ischemia leading to skin break down. Sexual dysfunction after pelvic trauma seems not to be a complication of bilateral internal iliac artery embolization, but more likely a result of nerve injury secondary to the fracture or pelvic trauma.

2101.3

Solid organs

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Learning Objectives
1. To review the indications and results of embolization in splenic trauma
2. To review the indications and results of embolization in liver trauma
3. To review the indications and results of embolization in trauma of the kidney

Embolization has an important role in the management of patients with hepatic, splenic, and renal trauma. The Interventional Radiologist (IR) rarely has a primary role in the overall management of these patients, but may have a central role in stabilization and initial treatment. The IR should have a thorough understanding of the management priorities of these patients, the principles of management of injuries to these organs (1). Moreover, the IR must possess a broad range of skills and excellent judgment in the technical aspects of transcatheter embolization. No two trauma patients are alike, and no two trauma embolizations are the same. The two most common etiologies of traumatic hepatic vascular bleeding are blunt and penetrating injury (2). In many tertiary care centers, iatrogenic injuries (from biopsies or trans-hepatic procedures) comprise a large portion of penetrating trauma. There are three potential sources of hepatic bleeding: arterial, portal venous, and hepatic venous. Bleeding may be subcapsular, intraperitoneal, or into the biliary tract. When accompanied by diaphragmatic injury, hemothorax may be present. The mechanism of injury may help determine the likely sources of bleeding, but CT remains a useful modality in the stable patient (2). Often, conservative management with correction of coagulopathy is successful (3). However, when bleeding continues or results in hemodynamic instability, further intervention is warranted. Arterial embolization of liver injuries should begin with directed visceral angiography. Variant arterial anatomy of the liver is

common. The dual perfusion of the liver by the hepatic arteries and the portal vein allows some leeway during arterial embolization. A key principle of hepatic embolization is the rich intra-hepatic arterial collaterals. Proximal embolization alone may be insufficient in central hepatic arterial injuries; crossing the injury to gain embolic distal and proximal control is almost always desirable. In situations where the distal artery can be opacified, but not catheterized, a liquid embolic such as cyanoacrylate glue can achieve distal control. Permanent embolic agents are preferred. These patients often manifest injury to the other set of tubes in the liver, the biliary ducts (4). Splenic embolization for trauma is most often employed in patients with high-grade blunt injuries (5-7). Spontaneous rupture can also occur in patients with acutely enlarged spleens due to viral infection of hematologic malignancy. The principles of embolization are control of bleeding with preservation of splenic pulp (and therefore function). Within the spleen the arteries are end-arteries, but proximal to the splenic hilum there is rich collateral supply through short gastric arteries, the pancreatic tail, and the epiploic artery. The splenic arterial supply has less variability than the liver, and usually a celiac artery angiogram will demonstrate the relevant splenic vascular anatomy. Extravasation from the spleen can be embolized selectively, followed by occlusion of the distal splenic hilum proximal to the collaterals named above. Fractured spleens without extravasation at angiography can be managed with distal main splenic artery occlusion alone. The embolic agents of choice are coils or plugs in order to maintain collateral perfusion (6). Injury can occur to native or transplanted kidneys. Blunt injury is the most common mechanism for the former, while penetrating (biopsy) injuries are more frequent in transplanted kidneys. Bleeding can be subcapsular, within Gerota's fascia or the retroperitoneum, or into the renal collecting system (8). The management of most blunt renal injuries is conservative, particularly in the absence of evidence of active bleeding (9). Embolization for patients with continued blood loss should begin with a diagnostic aortogram to identify and localize accessory renal arteries. Selective embolization is then performed. Pseudo aneurysms and arteriovenous fistulas are commonly seen following iatrogenic (biopsy or nephrostomy) injuries. The renal parenchymal arteries do not have meaningful collateral supply in the absence of pre-existing renal artery stenosis. Superselective embolization will preserve renal parenchyma, but more proximal embolization will be sufficient when an expedient procedure is necessary. In patients with transplant kidneys, every attempt should be made to minimize the loss of renal parenchyma. However, in life-threatening situations in which there are multiple foci of extravasation from numerous locations, rapid and complete embolization of the main renal artery may be desirable. In trauma embolization, a little too much is often preferable to not enough. A high level of suspicion for multiple organ injuries is necessary in the patient undergoing embolization for trauma. After control of the extravasation, there is usually an immediate and noticeable decrease in infusion and/or vasopressor requirements, and evidence of stabilization of blood pressure and heart rate. If there is no change, and particularly if vigorous resuscitation is still required after control of bleeding in the target organ, other vascular injuries should be sought ("exploratory angiography").

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2101.4

Peripheral vascular trauma

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Learning Objectives

1. To review the most frequent peripheral arterial network involved and types of possible lesions
2. To review the results of embolization using target vessel occlusion
3. To review the technique and results using small/medium-sized stent-grafts

Peripheral vascular injury is part of mankind since the development of primitive weapons and the treatment is described by ancient Egyptians. The treatment of vascular injuries was advanced by the experience from major conflicts. The spectrum of major peripheral vascular injury from the Vietnam vascular registry was 34.2% upper extremity and 56.8% lower extremity. Data from more recent conflicts have the following distribution of injury 39% upper extremity, 51% lower extremity, 7% neck and 3% pelvis (3). Data from a civilian database demonstrate 25.8% upper extremity and 74.2% lower extremity (4). In the civilian database (4), vessels involved in descending order in upper extremity are brachial artery, radial artery, ulnar artery and circumflex humeral artery and in the lower extremity tibio and peronal arteries, popliteal arteries, the superficial femoral artery, profunda femoris and the dorsal pedis artery. In a recent military database from Afghanistan and Iraq (3), in descending order, in upper limbs are axillary artery, branchial artery, radial artery, ulnar artery and in the lower limb are superficial femoral artery, popliteal artery, deep femoral artery and tibial artery. This difference is due to the different mechanisms of injury. The injury range is between vessel spasm and intimal flap to complete transsection and AV fistula. Embolization is just a smarter method of vessel ligation done from the remote site when direct vessel ligation necessitates additional surgical exposure. Large vessel ligation is a common method of bleeding control in extremities and part of the practice in World War II, however, with an amputation rate of 49% (5). Interventional techniques favour limb salvage; thus, embolization only done in smaller vessels for AV fistula and pseudoaneurysms (3) (7) with good results. When doing embolization, keep in mind acute traumatic coagulopathy (6) with the selection of embolization material. The high amputation rate of World War II was reduced with vessel reconstruction during the Korean and later Vietnam conflict with a 16% amputation rate more recently (3). Stent grafts could obviously be used for vessel reconstruction however relatively limited the experience with stent grafts. Don du Toit (7) from South Africa reports a 100% success in placement of covered stent grafts in carotid and subclavian arteries with AV fistula as well as Fox et al. (3) for pseudo aneurysms for axillary and brachial artery. Long term patency, however, is unknown as the material of choice for vascular reconstruction is autologous vein graft as the use of prosthetic graft material to treat arterial trauma remains controversial (3). Data from

covered stents for peripheral vascular disease could may be the extrapolated and demonstrate 65% patency after one year (8) and secondary patency of 79% at 4 years (9). The advantages of covered stent grafts in wound contamination, associated nerve injury as well as orthopedic injury allows is obvious with good results reported by White (10) in a study of 62 patients with a freedom of bypass in 74% of iliac and 100% of the femoral and subclavian injuries (10). The treatment principle is to customize a vascular repair plan based on the wounds, the physiological condition and response to resuscitation as well as the equipment and the personnel available (1).

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Special Session
Challenges in PAD

2102.1

Techniques and results on subclavian stenosis/occlusion

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Learning Objectives

1. To review the clinical indications and technique for subclavian artery occlusive disease
2. To review the results of subclavian artery PTA and stent treatment
3. To review the results of bypass/transposition for stenosis/occlusion

The subclavian artery together with the innominate artery and the common carotid artery are collectively called aortic arch arteries, or brachiocephalic arteries. Symptomatic disease of these arteries occurs less frequently than in the carotid bifurcations, affects relatively younger patients [mean age 49 to 69 years]. The most common cause is atherosclerosis. Takayasu's arteritis is the next common cause although much less frequent. This patient population frequently suffers from severe comorbid conditions: 50% have coronary artery disease; 27% suffer from peripheral vascular disease; 29% have carotid and vertebral artery lesions. Because of their comorbidity, these patients have a high surgical risk, which explains the relatively high rates of morbidity and mortality associated with surgical reconstructions. The clinical presentation of the brachiocephalic artery occlusive disease depends on the location of the lesion, the arteries involved, and the presence of collateral circulation. Subclavian arteries lesions involve 4.3% of a total of 1961 operations performed at the University of California, San Francisco for occlusive lesions of the aortic branches, including the carotid bifurcations over 20 years. The left subclavian artery is more frequently affected by atherosclerotic disease than the other aortic arch arteries. Innominate artery lesions are less common than subclavian artery lesions. These lesions represent 1.7% in the same series. Patients with isolated subclavian artery lesions are often asymptomatic because a rich collateral circulation is developed. If they are symptomatic, they present with upper limb ischemia i.e., muscle fatigue, arm claudication, rest pain, or finger necrosis from embolization, ischemia of the posterior circulation i.e., visual disturbances, vertigo, ataxia, syncope, dysphasia, dysarthria, sensory deficits of the face, and motor and sensory deficits of the extremities. Patients with a prior left internal mammary to coronary artery bypass graft (LIMA graft) present with angina if a subclavian artery occlusive lesion develops. Similarly, patients with axillo-femoral bypass, will present with leg claudication or limb ischemia. Treatment is advocated only in symptomatic patients. Surgical options include carotid-subclavian bypass using synthetic grafts or saphenous vein, and transposition of the subclavian artery up to the common carotid artery. Both techniques have low mortality and stroke rates of 0-1.4% and 0.5-5%, respectively. Patency rates are very good with 5-year and 10-year patency of 92-95 and 83-95%, respectively. The interventional treatment is the preferred method in most centers. The technical success is excellent: 90-100% for stenoses, 25-95% for occlusions. The procedures can be accomplished without perioperative mortality, while the stroke rate is 0.9-1.4%, significantly better than open surgery, which justifies the enthusiastic use of these methods. Short-term patency rates are excellent: 2-year patency of 91-92% have been reported. Long-term patency rates are inferior to surgery, although no randomized studies have been published. In a recent comparison between stent treatment and carotid-subclavian bypass using synthetic conduits (CSBG), the primary patency rates at 1, 3, and 5 years were 100, 98, and 96% for the CSBG group versus 93, 78, and 70% for the stent group, respectively ($p<0.0001$). Freedom from symptom recurrence was also statistically superior in the bypass group versus the stent group ($p<0.0001$). There was no difference in the survival rates between the two groups. The lesions of the innominate arteries may be asymptomatic. Symptoms include: a) neurologic symptoms from the anterior circulation [right amaurosis fugax, right hemispheric transient ischemic attacks, stroke], vertebrobasilar symptoms or both; b) right arm ischemia [hand claudication, finger embolization] ; c) in patients with axillo-femoral bypass graft a lesion of the innominate artery may cause leg claudication or crtitical ischemia. The surgical treatment of the innominate artery lesions includes extraanatomic bypass and direct reconstruction. Extraanatomic bypasses have lower perioperative morbidity and mortality, but also have lower patency rates. Direct reconstruction includes aortic origin bypass grafting and endarterectomy. In experienced hands, these techniques give excellent results: freedom from stroke was 87-88.8% at 5 years and 80-81% at 10 years. Primary graft patency was 94-98.4% at 5 years and 88-96.3% at 10 years. The major problem with the surgical method is the relatively high perioperative stroke and mortality rates of 5.4-8%. Treatment with balloon angioplasty or stent placement is the preferred method. Excellent technical and clinical success rates of 96-100% are reported, with stroke rates of 1.1% and no mortality. Patency rates like those of the subclavian artery interventional treatment are very good: primary and secondary patency rates of 93 and 98%, respectively, are reported. In summary, treatment of the lesions of the subclavian and innominate arteries is advocated only in symptomatic patients. Although long-term patency rates are inferior to surgery, the interventional treatment is the first choice because it has minimal mortality and morbidity

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2102.2

Chronic mesenteric ischemia technique and results

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Learning Objectives

1. To review the anatomy and pathophysiology of chronic mesenteric ischemia
2. To describe the imaging and treatment strategy for chronic mesenteric ischemia
3. To review the results and complications of the interventional treatment of chronic mesenteric ischemia

CMI is infrequent and usually concerns old patients. CT is now the key of its difficult diagnosis. The goal is to make an early diagnosis before a worse prognosis, when malabsorption related complications or acute mesenteric ischemia occurs. PTA is today the first line treatment.

1 Anatomy and physiopathology: the celiac artery (CA), superior mesenteric artery (SMA) and inferior mesenteric artery (IMA) usually originate from the abdominal aorta as separate vessels. In rare instances, CA and SMA may have a single common origin off the aorta. The CA supplies the foregut; SMA supplies the jejunum, ileon, and the right half of the colon; IMA territory goes from transverse colon to the rectum. There are numerous anatomic variants and collateral pathways: among them, the most important are duodeno-pancreatic anastomosis between CA and SMA, and Riolan anastomosis between SMA and IMA. Others branches from abdominal aorta and pelvis arteries may participate to the GI tract perfusion in case of obstruction of the 3 main mesenteric arteries. It is generally considered that narrowing or occlusion of at least 2 of the 3 main vessels is required before symptoms of CMI occur. But some patients with up to 3 vessels involved may be asymptomatic, whereas others with a single lesion have pain. The blood pressure, the anatomic variants, the quality of collateral pathways, the site of the lesion (distal or proximal from anastomosis), the tempo of progression of lesions and the extension of atherosclerosis to the distal visceral vessels (as in patients with diabetes or end-stage renal disease) are the principal factors of occurrence of CMI. Atheroma is the principal cause of CMI, concerning in the majority of cases the ostia and/or the proximal segments of the visceral arteries. There is usually evidence of some risk factors and vascular diseases elsewhere, with often quite severe aortic involvement. But CMI may be caused by non atheromatous lesions such as Takayasu's arteritis, fibromuscular dysplasia, aortic or SMA alone dissections, radiation induced arteritis. Patients with vasculitides and inflammatory diseases are younger than atheromatous, and severe narrowing diseases may occur before an efficient collateral network has time to develop.

2 Diagnosis: post prandial abdominal pain, weight loss and food avoidance are the classical symptoms of CMI; diarrhea, gastroduodenite unesponsive to medications, gastroparesis, vomiting and post prandial heaviness are also possible. These non specific symptoms of an infrequent pathology (but of which prevalence increases with age) usually develop insidiously, and the diagnosis is often delayed. Gastric and duodenal ulcers, primary and secondary malignancies, aneurysmal diseases and median arcuate ligament syndrome are differential diagnosis, which can mimic the clinical presentation. Medical history, evidence of atherosclerotic risk factors and diseases elsewhere in quite old patients suggest CMI diagnosis possible. The goal is to make it before the symptoms become too debilitating, and before the onset of acute mesenteric ischemia, of which the prognosis is much worse. Catheter based angiography was the classical CMI diagnosis test; today, it must be reserved for the setting of endovascular treatment. If there is clinical suspicion of CMI, non invasive imaging have be performed first. Because occlusive visceral artery lesions are non specific, imaging studies of the abdomen contribute also to rule out other causes. Duplex US is often used to image abdomen and pelvis and to screen proximal arterial stenosis or occlusion. A fasting state peak systolic velocity greater than 275 cm/s seems highly specific for significant SMA stenosis, although an end diastolic velocity greater than 45 cm/s may be more accurate (1). However, duplex US is operator-but also patient-dependant. MDCT is for us the key test, imaging the entire abdominal cavity and so contributing to rule out differential diagnosis, and moreover showing the small bowel walls, whose normal appearance in CMI rules out an acute event. Accuracy of CT angiography in the evaluation of mesenteric arteries approach 95 to 100% (2). CT gives a clear depiction of vessel wall calcification, which if extensive makes quantification difficult. Radiation and use of iodine contrast agents, in often poor renal function patients, are its main drawbacks. MRA is another interesting CMI diagnostic modality. Morphologic abdominal MR and MR cholangiography may complete the differential diagnosis investigation. As arterial lesions are very often proximal, sensibility and specificity of 3D contrast MRA is 95 to 100%. (2). The IMA and the periphery of the other splanchnic vessels are currently better assessed with CTA than with MRA (3). A functional approach of mesenteric arterial flow is advocated using MRA or duplex US (comparing velocities and resistive index between the fasting state and the post prandial state). These functional tests may hold promise for the future in helping to diagnose the physio-pathologic significance of arterial obstruction. At least endoscopy has often been performed to exclude stomach or duodenum pathologies. In summary: CMI diagnosis is often difficult to establish. Non invasive imaging techniques are useful screening tests, avoiding if normal invasive angiography. But the positive predictive value of obstructive arterial lesions is limited, and as no accurate routinely functional test is available, the diagnosis of CMI is still based on a careful medical history and exclusion of other causes. Then the indication of catheter based angiography is discussed, with if possible endovascular revascularisation.

3 Endovascular treatment (ET)

3.1 Indications

3.1.1 GI artery revascularisation: - Revascularisation is indicated in case of association of CMI clinical symptoms and involvement of at least two vessels - Mesenteric revascularisation should be performed on patients with asymptomatic arterial disease who are undergoing reconstruction of their abdominal aorta (consensus among vascular specialists based on the surgical litterature), and probably also before GI tract, urological and cardio-thoracic surgeries. - In other cases, mesenteric revascularisation in asymptomatic patients still remains controversial.

3.1.2 ET vs surgery: to our knowledge, there is no randomised study prospectively comparing the two options. Even if long term patency after surgery is probably higher, a significatively lower mortality and morbidity (especially post operative cardiopulmonary and abdominal morbidity) favors, for most of the authors, ET as the first treatment option. - Extrinsic compression does not respond to PTA.

Symptoms related to the median arcuate ligament syndrome are most likely neurogenic, and CA ostial breathing constraint will likely lead to stent fracture and vessel occlusion (and even symptoms may be more severe after stenting). - Cost/benefit ratio of ET have to be seriously discussed if severe atheromatous disease, at risk for cruoric, atheromatous or cholesterol embolisation. - Initial ET may provide a good bridge therapy, so that surgery can be performed later when the nutritional status is better and surgical risks minimized. In summary: when the risks of catheterization stay limited (cholesterol embolisation +++). ET is now considered for most of the authors as the first choice to treat the obstructive lesions causing CMI, occurring usually in quite old patients.

3.2 Technique: technique of PTA ± stent for CMI is quite similar to that for renal artery interventions. Femoral approach is often possible; in cases of infra renal aortic occlusion or of severe caudal angulation of the visceral vessels frequently observed when severe weight loss, a brachial approach may be necessary: the profile of the system used has then to be minimal.

High quality angiography equipment is mandatory, as selective catheterisation, PTA and angiography are ideally performed in lateral projection to best profile the origin of CA and SMA. A 60° right anterior oblique projection is required to delineate the IMA origin. To treat CA and SMA, a long sheath is more advisable. Some authors use guiding catheters, which permit per procedural aortographic controls. We routinely use a double femoral approach, in order to get an independent pigtail aortic catheter to opacify and accurately determine the adequate stent position before dropping. The choice between mono rail and coaxial platforms depends on operator's preference. There is no prospective randomised study to compare stent versus balloon PTA alone. In our experience, stent is necessary for most of the procedure, but instead of direct stenting, we prefer a previous balloon pre dilatation in order to open the lumen, making easier the stent crossing, and stabilizing the "dropping zone" to avoid any "jump". With femoral approach, one must beware of "whip effect" when guide-wire retrieval after stenting. To treat ostial stenosis, most of the authors prefer balloon expandable stents; self expandable stents are useful to treat long troncular lesions. When indication of invasive angiography and treatment has been acted, translesionnal pressure gradients as decision criterion are controversial. If more than one vessel has to be treated, we first dilate stenosis before attempting to recanalize occlusion, and if possible we treat first SMA. Patient stays fasting during 12 h post procedure, but with IV hydratation. Per procedure and sometimes immediate post procedure decoagulation is usual (we inject in situ a bolus of 1500 to 3000 heparin units at the beginning of the procedure, and then IV for 2 days). Antiplatelet agents should begin before procedure; a 4 to 6 week double medication (aspirin + clopidogrel) is recommended.

3.3 Results: (2.4): 80 to 95% technical success rates are reported. Perioperative mortality is difficult to know because all of the series are relatively small. Up to 15-20 % complication rates are reported : - aspecific adverse events, not so rare in these polyvascular patients (puncture site, catheterisation, post procedure renal failure); - or complications related to the procedure: dissection (which could be successfully managed by stenting), embolisation, occlusion (which may be treated by thrombo-aspiration and /or fibrinolysis), reperfusion syndrome (in very severe and long standing CMI), as manifested by abdominal pain, mucosal edemas, and ascites, which treatment is still controversial. Restenosis rates appear to be similar to renal PTA: 15-26% at 1 year, retreatable by repeat intervention, with primary assisted patency rates upper than 95%. More symptomatic recurrences are described with CA PTA. Meta analysis shows high clinical benefits ranges: 72-84% with a mean follow up of 16-52 months (2); 92% after reintervention (25.9 % recurrences) with a 21.2 months mean follow up (1-73) (4). Once recurrence symptoms develop, restenosis must be researched, and if documented redilatation can safely be performed. To our knowledge, there is not any recommendation concerning the imaging detection of the restenosis. We perform a 6 months follow up angio CT; Duplex US is also possible. MRA is unable to accurately assess for endostent recurrent stenoses.

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2102.3

Takayasu disease: special challenges

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Learning Objectives

1. To review the epidemiology and manifestations of Takayasu's disease
2. To review the diagnostic and treatment strategies for Takayasu arteritis in different vascular territories
3. To review the results and complications of the interventional treatment in patients with Takayasu's arteritis

Takayasu arteritis (TA) is a chronic inflammatory and obliterative disease of medium and large arteries with a possible autoimmune origin.[1] It is found mostly in female patients. It has a predilection for the aorta and its major branches. Sometimes, it involves coronary and pulmonary arteries and the aortic root and valve leaflets, which may cause aortic regurgitation. Although it is more commonly seen in the Asian and Latin American countries, the disease has a worldwide distribution.[2-4] Diagnosis is based on symptoms, physical and laboratory findings, and imaging, because tissue diagnosis is rarely feasible. Although the clinical presentation ranges from asymptomatic to catastrophic with stroke, diagnosis is usually made at the stage of late occlusive phase with symptoms and signs of major arterial stenosis and end-organ ischemia (vascular bruit, cerebral ischemia, myocardial ischemia, mesenteric angina, renovascular hypertension and claudication).[4] The early symptoms of TA may be mainly systemic, such as fever, night sweat, general weakness, weight loss, arthralgia, and myalgia. Therefore, it is usually difficult to make a diagnosis at this stage of early systemic phase. The basic pathologic features of TA are transmural inflammation and fibrosis in the great vessels. Imaging of the whole aorta and its major branches and pulmonary arteries are necessary to diagnose and evaluate the extent of the disease. Long stenotic lesions occur in most patients, whereas irregularity of the vessel wall and aneurysmal dilatation is also present. Traditionally, conventional angiography has been used as a gold standard in facilitating a diagnosis.[5, 6] However, conventional angiography underestimates the true extent of the disease because mural changes cannot be evaluated with conventional angiography. [7] The diagnosis of TA in its early systemic phase is often missed because of a non-specific clinical presentation or because of no luminal changes of involved vessels. With the recent advances in CT and MR technology, CT and MR angiography not only allow generalized survey of the aorta and its major branches for areas of stenosis but also effectively demonstrate thickening and inflammation of the involved arterial wall, which may be the earliest manifestation of the disease, occurring before stenosis and

dilatation.[8-10] They show a high accuracy comparable to conventional angiography in the diagnosis of the disease.[7] The knowledge about patterns of aortic wall involvement is important not only in understanding the disease process and making the accurate diagnosis, but also in planning imaging studies and treatments. The real distribution of disease involvement, skipped lesions and coexistence of active and inactive lesions in a patient can be demonstrated with spiral CT angiography.[9] The disease activity has been reported as a risk factor for failure of surgical or interventional procedures.[4] For bypass surgery, areas of the arterial tree not affected by disease are preferred anastomotic sites. During the active stage of disease, PTA is not recommended because chances of recurrence are reported to be very high in the cases with active disease.[11] However, it is not easy to determine the disease activity. The clinical criteria for disease activity are: 1) systemic symptoms such as fever or vascular pain, 2) an elevated erythrocyte sedimentation rate (ESR) higher than 20 mm/hr, 3) progressive disease of vascular ischemia or inflammation, and 4) changes in follow-up angiography. New onset or worsening of two or more features of aforementioned criteria indicates active disease.[4] However, it is reported that ESR is elevated in 72% of patients during active disease and ESR is normal in only 56% of patients with disease remission. Arterial biopsy specimens obtained during arterial bypass procedures in patients with clinically inactive disease showed various features of vasculitis.[4] Activity of the disease can be predicted based on the intensity of contrast enhancement and thickness of the involved vessel wall on imaging studies.[12] On spiral CT angiography, the mural changes suggestive of active disease are prominent enhancement of thickened aortic wall (> 3 mm) and low attenuation ring due to intimal thickening. MR angiography avoids the risks of arterial puncture, iodinated contrast load, and radiation exposure. Ultrasound can be helpful in detecting thickened carotid arterial wall and in differentiating TA from atherosclerotic disease based on minimal plaque content, concentric and long segmental involvement, and location of lesion.[13] Recently, the use of 18-fluorodeoxyglucose (18F-FDG) PET, either alone or in combination with contrast-enhanced CTA or MRA, has emerged as a useful tool for the early diagnosis and follow-up and assessment of disease activity of TA.[14,15] TA remains a therapeutic challenge. Corticosteroids are used in the active phase of TA. In spite of corticosteroids treatments, progression of vascular lesions is observed frequently. Unfortunately, relapse is common when prednisone is tapered to dosages of 15 mg/day or less.[16] Other immunosuppressive agents including methotrexate, mycophenolate mofetil, azathioprine, and infliximab have shown promise.[15] For patients who require revascularization intervention, both surgical and endovascular procedures can be performed that are safe, with low morbidity and mortality. The indications for vascular intervention are: 1) clinically significant ischemic symptoms such as renovascular hypertension or extremity ischemia limiting activities of daily living, 2) clinical features of cerebro-vascular ischemia or critical stenosis of at least three cerebral vessels, 3) clinically inactive disease state, and 4) angiographically demonstrable stenosis > 50% of diameter and a focal stenotic lesion rather than a diffuse long-segment lesion.[17] The best long-term outcomes are achieved with conventional bypass grafts.[18-20] However, progressive inflammatory nature of disease has precluded a widespread use of reconstructive surgery. Endovascular procedures can be a cost effective and safe method for relief of stenotic lesions in patients with TA .[21-23] The procedure of balloon dilatation of aortoarteritic lesions is different from that of atherosclerosis. Guide wire may pass through stenotic lesion easily due to minimal involvement of intima in this disease. Technical problems may occur in crossing the stenotic or occluded lesion with balloon catheter during renal or subclavian angioplasty, attributed to the highly fibrotic nature of the lesion.[22, 24] Higher balloon inflation pressure was required to dilate the lesions.[22] Extreme caution should be paid during the balloon dilatation, because it usually causes severe pain and may cause complication such as arterial dissection or rupture. The initial technical success rate has been reported to be high between the range of 80 and 90%).[21-25] However, when compared with atherosclerosis, we can easily expect higher rates of residual stenosis in TA. Although initial technical results are promising, restenosis still remains a major concern. The reported incidence of restenosis is variable from 19 to 78%.[18,19,22,23,26] Percutaneous transluminal angioplasty provides good results for short lesions. Residual stenosis of more than 20% and residual pressure gradient of more than 10 mmHg appear to increase the risk of restenosis.[24] Kerr et al. reported that restenosis developed within 3.5 to 13.6 months.[4] However, one may try redilatation of the restenotic lesion, which may be again responsive. Persistent inflammation and endothelial dysfunction may put patients with TA at risk for premature atherosclerosis. Delayed hemodynamic and angiographic improvement may occur after angioplasty in patients with TA .[6] The proposed mechanism of delayed response is either due to slow retraction of the ruptured fibrous bands or relief of superimposed spasm or regression of transmural inflammation. Intravascular stent can be used in case of residual stenosis or dissection after balloon angioplasty.[25,27] However, in contrast to the results in treating atherosclerosis, the use of conventional stents may not yield long-term vessel patency in TA, especially in active stage. The immunosuppressive therapy prior to endovascular treatment may reduce restenosis after intervention procedures.[27] Recently, successful revascularization with a drug-eluting stent was reported for proximal coronary disease in patients with TA.[28]

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Special Session
SFA

2103.1

Management of acute femoro-popliteal thrombosis

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Learning Objectives
1. To review the clinical presentation and indications for treatment of acute FP thrombosis
2. To review the technique and outcomes of thrombolysis
3. To review the techniques and outcomes of mechanical thrombectomy

Acute peripheral arterial occlusion is responsible for a wide variety of complications culminating in limb loss or death. The incidence of acute limb ischemia is still unsettled but it is assessed at 14/100.000 people and accounts for 10-16% of the vascular workload. Different causes of acute occlusions of the peripheral arteries have been described: thrombosis of a native artery with atherosclerotic stenoses, thrombosis of an arterial bypass graft, embolism from the heart, aneurysm, atherosclerotic plaque, thrombosed aneurysm especially in the popliteal area. Generally speaking, acute arterial occlusion is mainly provoked by embolism and thrombosis whose differentiation is difficult and clinically impossible in 10-15% of cases. The severity of acute peripheral arterial occlusion depends primarily on location and extent of luminal obstruction by a new thrombus or embolus and the capability of the existing collateral bed to let the blood flow around the obstruction. Three different stages of the disease are clinically classified: I-Viable, II-Threatened and III-Irreversible. The sudden onset of hypoperfusion of the leg leads rapidly to systematic acid-base and electrolyte disorders that impair cardiopulmonary function. Successful revascularization may induce a severe injury, causing further neuromuscular damage within the extremity. Thrombolysis agents have been clinically employed since 1955. At the beginning of the 1970s, thrombolytic agents were administered by intravenous route; streptokinase and urokinase are effective in restoring the patency of acute occluded arteries in about 75% of cases. The high risk of bleeding complications of systemic infusion has increased the catheter-direct thrombolytic therapy. The thrombolytic therapy can be used in case of acute thrombosis of a patent by-pass graft or native artery, acute arterial embolus not accessible to embolectomy, acute thrombosis of a popliteal artery aneurysm resulting in severe ischemia, acute thromboembolic occlusion when surgery involves a high degree of mortality risk. A series of absolute, relative and minor contraindications to thrombolysis are: active bleeding diathesis (absolute), acute gatroduodenal ulcers (absolute), recent gastrointestinal bleeding within previous 10 days (absolute), history of stroke (absolute), neurosurgery or intracranial trauma within 3 months (absolute), uncontrolled hypertension (relative), intracranial neoplasm (relative), intracerebral vascular malformations (relative), renal or hepatic insufficiency (minor), antiplatelet therapy (relative). Patients with an acute, severe, irreversible limb ischemia and no evidence of collateral circulation are not candidates for thrombolysis. Indeed in these cases, the rapid restoration of the blood flow increases the risk of the rare (<1%) but serious reperfusion syndrome. Intra-arterial thrombolysis is based on the original technique described by Mc Namara and Fisher in 1985. In patients with femoral and iliac occlusion the favourite access site is the controlateral femoral artery. Access through the ipsilateral femoral is preferred for thrombi in the superficial femoral artery, popliteal artery or tibial arteries. By using the ipsilateral limb access, potential catheter-related complications in the intact limb are avoided. If no femoral artery can be used, a low brachial approach may be considered. The thrombolytic agent can be infused through a catheter with the tip at the level of the proximal part of the thrombus (regional infusion) or with the catheter advanced within the thrombus (local). Several studies have documented that forceful infusion of the thrombolytic agent into the entire length of the thrombus accelerates thrombolysis. A successful passage of the guidewire through the thrombus predicts >95% likelihood of successful lysis, whereas inability to pass the thrombus reduces the chance of success. Successful outcome is more frequent in prosthetic graft (78%) and native arterial occlusion (72%) than in vein graft thromboses (53%). An efficacious procedure is based on the aggressive initial lacing of the entire length of the thrombus with a high dose bolus of lytic agent, followed by a continuous low-dose infusion. Another technique is based on the use of a pulse-spray infusion of forceful periodic injection of thrombolytic agent into the thrombus in order to fragment it and increase the surface area available for the action of the lytic agent. Different types of plasminogen activators have been used such as streptokinase, urokinase, tissue-type plasminogen activators (rt-PA), recombinant

glycosylated pro-urokinase and recombinant staphylokinase. Nowadays, in most centers urokinase is preferred because it achieved a higher initial clinical success rate with a lower incidence of bleeding complications. Several studies have also demonstrated the validity of rt-PA (Alteplase) especially in case of fresh thrombus. It permits a more aggressive treatment, but an accurate analysis of the clinical history of the patient is mandatory to avoid intracranial hemorrhagic complications. Rt-Pa seems to induce a more rapid thrombolysis than urokinase but statistically there is no difference either in the number of patients achieving complete lysis at 24h or in the clinical outcomes at 30 days. A non randomized retrospective analysis compared the efficacy and safety of local infusion of streptokinase, urokinase and rt-PA and reported a complete thrombolysis in 60, 91 and 95%, respectively. The incidence of major haemorrhage was 28, 12 and 6%, respectively. Death rate was 4, 2 and 0%, respectively. Moreover a 2% of intracranial haemorrhage was described when using streptokinase and rt-PA. However, cost-analysis studies comparing rt-Pa and urokinase are not available for the present. New thrombolytic agents with a superior fibrin-specificity are currently subject to an extensive investigation with the main target to decrease the bleeding complication rate of intra-arterial thrombolysis. The percutaneous treatment of acute thrombosis can be associated with some technical complications related to intra-arterial catheter insertion including pericatheter thrombosis (3%). To minimize the risk of pericatheter thrombosis, it is necessary to maintain a therapeutic anticoagulation and to avoid any unnecessary prolongation of the infusion. Other complications are represented by distal embolization of thrombus fragments during treatment, causing a sudden onset of pain or loss of distal pulse. This can occur with an incidence of 5%. Most of such emboli are resolved prolonging the lytic therapy. Compartment syndrome, a complication secondary to a rapid reperfusion of the limb occurs in 2% of patients. It is clinically manifested with pain, tenseness over the anterior muscle compartment and progressive loss of muscle and nerve function. Fasciotomy successfully relieves the high compartment pressures. Death is a rare complication (<1%) and is often secondary to intracranial, intraperitoneal haemorrhage or reperfusion syndrome. Surgical revascularization is indicated in case of profoundly ischemic limb. Embolectomy should be performed in case of acute ischemia, with loss of sensitivity, discolouration of the skin, decreased skin temperature and moderate rigor of the muscles. When ischemia becomes irreversible, blotchy cyanotic discolouration is observed, the calf muscle has a firm consistency and there is anaesthesia and paralysis of the extremity. Primary amputation represents the treatment of choice. Embolectomy can be performed via arteriotomy of the femoral artery using Fogarty catheters. Multiple passages of the catheter are recommended to avoid any residual embolic material being left. An angiogram should be performed at the end of the procedure because residual stuff has been found in 25-40% of cases. Percutaneous thrombolysis can be considered an appropriate and valid therapeutic option especially in case of acute condition. Surgical procedure should be selected only in case of acute severe ischemia or profoundly ischemic limb. However, an accurate evaluation of the patient's clinical conditions is fundamental to correctly select the lytic agent and consequently to reduce the incidence of bleeding complications.

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2103.2

Update on SFA stenting

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Learning Objectives

1. To review the types of bare stents for use in the SFA
2. To review the up-to-date data on bare SFA stents including the fracture issue
3. To review the evidence for covered stents in this area

Bare metal stents: the most challenging lesions for femoral-popliteal intervention are the higher-grade **T**rans**A**tlantic Inter**S**ocietal **C**onsensus group (TASC) lesions (type B to type D), which include long segment stenosis and occlusions. Stents in these cases appear to be promising to convert early balloon angioplasty (PTA) failure into success. Experience with first generations of vascular stents (i.e., Wallstent, Palmaz, Strecker) in the femoropoliteal segment has been disappointing in most series due to intimal hyperplasia in the stent or at stent edges resulting in early occlusion (1). These first generation stents have largely been replaced by new generations of nitinol stents allowing for better wall apposition, improved radial strength and more precise placement due to minimal dynamic shortening. A growing body of clinical experience with these new stents in the femoropopliteal arteries shows encouraging mid-term results, with 3-year primary patency rates up to 76% for SFA lesions (2). A recent single center randomized study compared primary implantation of nitinol stents (Absolute, ABBOTT) to PTA in the SFA in a limited patient population. At 6 months, the angiographic restenosis rate was 24% in the stent group and 43% in the PTA group. At 1 year, restenosis as detected by duplex ultrasound was 37% in the stent and 63% in the PTA group demonstrating a clear benefit for SFA stenting (3). Another European multicenter trial (FAST trial) randomizing patients to PTA versus Luminexx (BARD) stent placement however did not find a significant difference in patency or target lesion revascularization (TLR) at 12 months, although longer occlusion fared better with stenting (4). Difference in stent design and flexibility might have played an important role in the diverging outcome of those two trials. However, the initial promising results are confounded by a variety of possible complications such as stent maldeployment, stent occlusion and stent fracture. Reports of nitinol stent fractures, first noticed in the SFA in the SIROCCO phase I study (18.1% of stents, Smart, CORDIS) (5) were associated with placement of multiple overlapping stents in long lesions. Scheinert further showed that the stent fracture rate with various designs can be as high as 37% and is highly correlated with stent occlusion (four- to sixfold higher in the fracture group) (6). To explicate the role of multiple stent deployment, a nonrandomized multicenter trial assessed the utilization of single up to 15 cm long stents in the SFA; the results demonstrated a 12 months 72.2% primary patency rate, but the stent fracture rate remained high at 8.1% (DURABILITY I, Scheinert, TCT 2008). These fractures rarely occur with coil stent designs, suggesting that they are more compatible with the biomechanical forces present in the SFA. Recently, a metanalysis of the current literature confirmed the cumulative incidence of stent fractures ranging from 6 to 100 per 1000 person-months. Stent fractures occur more frequently in the distal superficial femoral artery and are common when multiple stents are deployed and overlap. Stent fractures are progressive over time, associated with a higher risk of in-stent restenosis and re-occlusion (7). Thus, these fractures are not inconsequential. Well-designed trials

including randomization, multicenter design with independent core lab evaluation are now underway to better define the use of self-expandable nitinol stents in the treatment of infrainguinal occlusive disease and providing level 1 evidence for treatment algorithms. The RESILIENT trial randomizing patients with femoropoliteal disease and lesion length < 150 mm to PTA or LifeStent (BARD) implantation is the first to report preliminary 12 month data. A surprising difference in freedom from target lesion revascularization (TLR) (2 years) [42% (PTA); 78% (Stent)] was found; the stent fracture was 3.8% at 18 months (Katzen, ISET 2009). The LifeStent to date is the only bare metal stent with FDA indication for femoropoliteal implantation in the US. A different study design is followed by the DURABILITY II trial (Protégé Everflex stent, EV3), a single-arm trial design with a point estimate for PTA restenosis in the SFA. The nitinol stent would have to show superior 12-month patency rate compared to a historical PTA point estimate. Furthermore, the trials' hypothesis again is placement of a single long nitinol stent (up to 200 mm) may translate into a reduced incidence in stent fractures and, therefore, a reduced 12-month TLR rate. Despite continued uncertainty of the role of stents in the infrainguinal segment the initial recommendation of TASC to reserve stent placement for PTA failure might have to be revisited in light of improved stent technology. Better understanding of biomechanical forces exerted on the SFA, salvage of stent failure and cost benefit evaluations, however, need to be considered when using a permanently implantable device in the femoropoliteal segment.

Covered stents: covered stents in the femoropopliteal segment have the potential advantage of decreased cellular in-growth, decreased intimal hyperplasia, and are in structure closest to surgical grafts. The initial experience however utilizing an expandable nitinol stent covered with woven polyester, Cragg EndoPro System, demonstrated substantial complication rates and limited patency (8). The early stent designs have progressed to more durable and biocompatible devices. To date, the Viabahn (GORE) endograft, a expanded polytetrafluoroethylene (ePTFE) with an external nitinol stent is the only endograft with FDA approval for use in the SFA. Recently, the Hemobahn multicenter randomized registry, comparing PTA to the previous Viabahn design was published despite early termination demonstrating initial higher technical success and patency benefit at 12 months for the endograft (9). Various other reports to some extend part of the above mentioned registry, reported mixed results with the device. Lammer in a mixed patient population including treatment of iliac and femoropopliteal arteries mostly TASC A or B lesions, reported acute thrombosis rate of 4% and reocclusion rates at one year of 20%. The primary patency rate was 90% at 6 months and 79% at 12 months, respectively (10). Deutschmann on the other hand published disappointing results with primary patency rates at 3 and 6 months of 61 and 49%. Twenty-two percent of patients had early reocclusions at less than 1 month and an additional 49% of all grafts were occluded at 7 months. Significant intimal hyperplasia was seen at the leading and trailing edges of the stent and the highest reocclusion rate in stents over 10 cm in length. Saxon, also part of the initial study reported 2 year patency in the Viabahn group to be significantly better compared to the PTA group (87 versus 25%) (11). At 4 years, primary patency of 55% and secondary patency of 79% was maintained without evidence of stent fractures. Clearly, devices of 5 mm had an inferior patency of below 40% at 1 year indicating the need for a suitable sized artery (12). The similarity of endografts to synthtetic surgically bypass grafts lend itself to the comparison of the two techniques. Indeed, Kedora recently published a single center randomized trial enrolling 86 claudicators into Viabahn endograft placement or surgical femoro-popliteal bypass graft placement with Dacron or ePTFE grafts (13). The primary patency at 1 year was identical at 74% demonstrating equality of surgical and endovascular techniques at 1 year in a head to head comparison. The VIBRANT multicenter randomized trial comparing the Viabahn stent graft to nitinol bare metal stents is enrolling patient with long segment lesions (TASC C, D) looking for a longterm patency comparison at 3 years. Data from this trial will be helpful to determine the role of stent grafts in this patient population.

Drug eluting stents: recent literature on sirolimus or paclitaxel drug-coated stents in the coronary arteries has shown excellent outcomes with low rates of target lesion revascularization at long-term follow-up. There has been one published trial in the SFA (5). In the initial phase of this randomized trial (SIROCCO I) comparing sirolimus-eluting vs. bare stents (Smart, CORDIS), 6 month angiographic follow-up demonstrated a statistically improved mean vessel diameter in the sirolimus group but no decreased restenosis rate. In the extension phase of the same trial (SIROCCO II), 57 additional patients with SFA lesions were randomized to treatment with sirolimus-slow-eluting vs. bare SMART stents. Although there was a trend for inhibition of intimal hyperplasia in the sirolimus group, there were no statistically significant differences among the endpoints between the bare and drug-eluting stent groups (14). A recent multicenter randomized trial compares PTA to a drug eluting stent (Zilver, paclitaxel coating, COOK). Preliminary data at 6 months demonstrated a significant benefit for the drug-eluting arm in terms of freedom from TLR at 6 months (90 versus 50%). The stent fracture rate compared to the SIROCCO trials was very low at 1% (Dake M, TCT 2008). Another nonrandomized study using the everolimus drug eluting Dynalink stent system (ABBOTT) is underway to look primarily at 12 months instent restenosis.

Biodegradable stents: another wave of stent designs driven by the quest of eliminating intimal hyperplasia, instent restenosis and stent occlusion are the development of semipermanent absorbable devices. The demand seems to be stronger for the coronary circulation and for below the knee intervention. Investigation of these stents in the femoro-popliteal circulation has been scant. Indeed, only one trial in 45 patients has been published. A bioabsorbable knitted poly-L-lactic acid (PLLA) stent (Igaki-Tamai stent) was used for the treatment of SFA occlusive disease. Results were impressive with no restenosis at 6 months and an assisted primary patency rate of 91% at 9 months (15). Future studies are expected and the role of these stents is eagerly awaited since the lack of a persistent proinflammatory implantable device seems of long-term benefit.

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2103.3

Drug eluting stents and balloons

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Learning Objectives
1. To describe the types of DES and drug-eluting balloons for use in the SFA
2. To review the outcomes of DES and drug-eluting balloons in the SFA
3. To review future developments

Introduction: the high restenosis rate is still the major limitation of peripheral arterial interventions. Within the last years, drug eluting stents have gained wide acceptance in the coronary arteries; however, these devices are not currently available for arteries outside the coronary vasculature. This article summarizes the special role of the superficial femoral artery in restenosis, with efforts being made to reduce the restenosis rate in this artery, focusing on drug eluting stents and drug eluting balloons.

Drug eluting stents: stent coating modifies the stent surface characteristics and is intended to either improve biophysical performance or limit restenosis. DES has several components, which are all very important: - Stent coating for drug release. - Stent geometry for drug release. - Choice of the active component as drug for prevention of restenosis. If one of the above factors fails, the DES might not be clinically effective. Most DES achieves drug release via a polymer matrix. However, one drug-eluting stent system under investigation by Cook (Bloomington, IN) employs direct drug binding to the stent surface. The first trial investigating the use of DES in peripheral arteries was the Sirocco trial. In this trial, uncoated SMART stents (Cordis) were compared to sirolimus coated stents. Unfortunately, the DES in Sirocco did not show superior results to the uncoated stents. The quick release as well as the coating material was discussed as possible reasons for the lack of efficacy of the additional local drug release. Currently, there are there are two more DES SFA trials. Both trials completed randomization; nevertheless, because of uncompleted follow-up, no conclusive data are available. The biggest ever trial in the SFA is the Zilver PTX drug eluting stent trial with the enrolment of more than 1000 patients. The investigations with the Zilver PTX stent are carried out both in the US and in Europe. Compared to the Sirocco trial, several important differences have to be pointed out: different stent, different drug, and different kind of drug release. The first data of the European registry showed that the Zilver PTX stent was safe. In addition, the risk of restenosis was especially reduced in longer lesions, in-stent restenosis and diabetic patients. The third DES trial based on the local delivery of drugs from the nitinol stent platform is the STRIDES trial (Abbott vascular) based on the Absolute stent coated with everolimus. A total of 102 patients have been enrolled in this trial, which was done for safety reasons and no control arm.

DEB - another option for local drug delivery: systemic therapy proved to be ineffective for most drugs or the doses required would be too high. The best outcome was achieved with local drug delivery from stents as a permanent platform for sustained release. Shortly after initiation of the coronary in-stent restenosis study, the first patients were also enrolled in two additional trials addressing de novo stenosis and occlusion as well as restenosis in the superficial femoral or popliteal arteries. Both trials randomly compared paclitaxel-coated and uncoated balloon catheters using late lumen loss 6 months after treatment as the primary end point, which was determined by blinded independent core labs, and both trials included a 2-year follow-up. The *Thunder* trial contained a third treatment arm with paclitaxel in the contrast medium used to visualize the treated artery. Selected data and results of the *Thunder* trial are presented in table 2. Briefly, 6 months after the intervention patients treated with the paclitaxel-coated balloons displayed far less late lumen loss than patients of the control group (no local drug delivery) or patients treated with paclitaxel dissolved in the contrast medium ($p<0.001$); fewer patients of the coated-balloon group required target lesion revascularization. The latter difference was maintained over the full observation period. The second study (*Femoral Paclitaxel*) confirmed the results of the *Thunder* trial; however, late lumen loss in the control group was less and therefore the difference to the group treated with the coated balloon smaller. Nevertheless, the advantage of the coated balloon group in respect of fewer target lesion revascularizations was also maintained until the end of the observation period.

Conclusion: the current treatment modalities in the infrainguinal arteries are limited due to the high restenosis rates. Therefore, new approaches such as the use of drug eluting stents and drug eluting balloons are needed. Unlike in the coronary arteries, data regarding the superiority of drug eluting stents in mid- and long term follow-up are lacking. Clinical trials are ongoing. Drug eluting balloons have shown to significantly reduce the restenosis rate and the need for repeat revascularization. This benefit was sustained at two year follow-up. Based on the promise of drug eluting technologies and the significant limitations of endovascular therapy especially in the SFA, most of the SFA interventions will be performed with additional drug delivery in the near future.

2103.4

Special tools for SFA recanalization

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Learning Objectives
1. To describe the different tools currently available for difficult SFA recanalizations
2. To review the outcomes of these devices

Chronic total occlusions (CTOs) are a significant portion of the peripheral vascular disease lesions encountered by endovascular specialists. The ability to successfully cross long total occlusions and re-enter the true lumen is directly related to acute procedural success and patency. With the new TASC recommendations, this has to become even more relevance. Standard guidewire recanalization has been the technique of choice for most long, obstructive and occlusive lesions. In fact, technical success for crossing long (>10 cm) superficial femoral artery (SFA) occlusions ranges from 50 to 90%, depending on lesion length, calcification, operator experience, and runoff vessel status. Permanent advances in wire technology and adjunctive devices have increased the interventional

armamentarium for this challenging disease subset. Most often and as a first attempt, the guide wire technique should be used as a first-line step to cross the occlusion. The Bolia technique (intentional subintimal recanalization)/Pier-technique (Percutaneous Intentional Extraluminal Recanalization) is widespread to treat occlusive SFA disease. This technique is usually carried out by using a hydrophilic guide wire (i.e., Terumo 0.035 inch, Japan). Once the proximal tip of the wire enters the occlusion, it may naturally form a small loop at its tip to pass the entire diseased segment. The highest degree of success is reported in lesions that reconstitute above the adductor canal, where the vessel is relatively large. If the occlusion does not collateralize until the popliteal artery or even lower, re-entry becomes more challenging either by PIER technique or in case of failure by using dedicated re-entry devices. An alternative to this technique is the application of V-18 .018-inch Control Wire (Boston Scientific Corporation, Natick, MA), or less often other 0.014-inch stiff, but steerable coronary wires used in a straight configuration as a drill activated by rotating the torque device, which is packed with a V-18 wire. However, this manoeuvre might fail also, either to pass the lesion or to re-enter the patent distal artery. A dangerous, sometime effective solution resulting in technical success is the use of the Terumo wires' reverse end, the so-called bad end. In case of unsuccessful entry into the occluded vascular segment, the technique of so called blunt microdissection might lead to success. The Frontrunner catheter (Cordis Corporation, a Johnson & Johnson Company, Miami, FL) is a blunt microdissection device that takes advantage of the elastic properties of adventitia versus inelastic properties of fibrocalcific plaque to create fracture planes. This technique may be advantageous in penetrating hard fibrous caps of the SFA occlusions. The device separates atherosclerotic plaque in various tissue planes, creating a passage through the CTO. Finally, laser might be also used by some physicians to recanalize CTOs. However, these devices are also no guaranty for gaining access and re-entry to the patent distal artery. If the methods as described above fail to enter the true lumen, by the way these attempts are also time consuming, re-entry devices intended to access the patent vascular segment without extending the subintimal passage/dissection down into the P 1 segment, will help to complete the procedure with a high technical success rate. The lecture describes technical tips and tricks for successful recanalization of the SFA with special regard how using which wires and re-entry catheters to achieve procedural success, if the regular treatment algorithm by using wires only fails. Latest devices for handling peripheral CTO will be demonstrated.

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Special Session
How to promote IR to patients and referring physicians

2104.1

UFE

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Learning Objectives

1. To learn how to enhance patient awareness using the media (press, internet, etc.)
2. To learn which key messages to convey to the GP about UFE
3. To learn which key messages to convey to the OBGYN about UFE

The range of treatment options for symptomatic fibroids has increased considerably within the last two decades. They include uterine sparing surgery such as laparoscopic myomectomy, hysteroscopic resection, ablative therapies such as MR guided focused ultrasound (MRgFUS) and UFE as well as various laparoscopically-assisted and traditional forms of hysterectomy. However, information about non-surgical alternatives such as UFE is still not available to most women in Europe. Although the safety and efficacy of UFE is well proven and documented in depth in the current literature, most gynecologists either do not inform patients about UFE at all, or give inaccurate and misleading information. This is a basic problem that interventional radiologists (IR) face for many of the interventions they offer. Against this background, it is imperative that we take a more proactive role to ensure that our potential patients have access to information about UFE as well as increasing awareness of this treatment option among gynecologists and the general public. Traditionally, IR has used in-house education of physicians to obtain referrals for their procedures. Although excellent cooperation with the gynecology department is an essential pre-requisite to offering UFE, it does not in my experience lead to increased awareness among patients and office-based gynecologists and therefore to higher numbers of referrals. These groups need to be targeted directly through information events organised by IR and their cooperating gynaecological departments, which cover the spectrum of treatment options offered for patients with fibroids at the hospital. IR also need to position themselves as clinical partners with longstanding expertise in minimal-invasive image guided techniques, something which is not known to many physicians in practice. Information events can easily be put on with a minimum of resources and may be supported by clinic management as a good opportunity to promote the clinic in the local community. Do not forget to target general practitioners. They are often the trusted partners of women with symptomatic fibroids and have a deep understanding of quality of life issues. Lastly - consider putting on an information event for women and opinion leaders from women's organisations. An advanced integrated communication approach will include the *internet and e-mail*, *patient information leaflets* and *media activities* as important marketing tools. These tools may seem daunting and time consuming initially, but they are fascinating and I believe they are the way forward for interventional radiologists in the 21st century.

Why set up a website? a website offers a unique opportunity to reach patients with information about UFE directly. There is no loss of information through a third party, it saves time since patients can get information about the procedure and answers to some of their questions, it offers the possibility to present an image of your department and staff, it allows the patient to get in direct contact with you. The array of information that can be offered includes: **Background information on the procedure:** History, safety and

efficacy, comparison to other alternatives. Patients can download consensus papers for example to show their health care providers and referring physicians that UFE has been proven safe and effective. **The procedure in depth**: "Doc, what will happen to me during treatment?" **Question and answers:** The most frequently asked questions can be answered. **Images and movies**: As interventional radiology procedures are not "bloody", we can easily explain what we do via images and film clips without causing anxiety to the patient. **How to get in contact:** Be sure to allow patients to contact you via phone, fax or even e-mail. This can be time consuming but is essential. There is no such thing as an "easy referral" in UFE. Friendly, approachable office staff who can take calls and sort out which further steps need to be taken by the patient and whether additional direct contact is necessary can take some of the pressure off you. Reserve time for patient consultation. **Tip:** If the idea of an creating an internet site seems difficult, start with the minimum - perhaps one page presenting your department with links to other sites containing more detailed information. The media studies of a local further education college might be able to help you put one together free as a student project.

Patient information leaflets: this is a simple way to offer comprehensive written information to women. Leaflets may be sent by email or by post on request and give the patient the **opportunity to discuss the facts about UFE with their gynecologists**. It also allows you to give **precise instructions** about which kind of diagnostic and laboratory tests should be performed prior to UAE and **which additional information is needed prior to hospital admission**. This will save you time and compensate for the time expended on some of the extra activities described in this chapter. A patient information leaflet from CIRSE is available for download on the website www.uterinefibroids.eu.

Media work: media work is a challenging but also low cost and very effective communication tool. It not about "selling" the procedure UFE, it is about educating the public and building confidence in interventional radiologists. The majority of IR practice in a hospital, which is embedded in local community. Targeting patients from distant cities via national media may be worthwhile for large tertiary care or university hospitals ("the big names") but it is a strategy that is not appropriate for most IR, in any case most patients prefer to be treated nearer home. That is why it is essential to define your goals before approaching the media. You need to know, *who* you want to reach, *what* kind of information you want to give and identify what kind of press echo you expect. Media reports are a good way of drawing attention to and increasing traffic on your website. The press/media is generally looking for personal stories. They need to be short but attractive to their audience. Therefore "big science" or "high tech" is generally not the key ingredient to deliver your message. Uterine fibroids are not a life threatening disease such as cancer but an underestimated health problem with a tremendous impact on a woman´s quality of life. That is the area to make a point. You are offering a non-surgical minimal-invasive treatment, which is highly effective and safe. Ideally, a patient story will transport the information you want to deliver. If you already treat patients by UFE, one of your former patients may be willing explain how she experienced the procedure and the benefits to her personally, while you cover background and technical aspects. It is best not to criticise gynecologists for not informing patients about the UFE, since they are the primary care givers and also your best friend in difficult cases. It is a good strategy to have one of your cooperating gynecologists make a positive statement.

Patient groups and forums: patient organisations and "self-help groups" are an established element of the health care system in many countries. A further development of this is the patient internet forum. They provide an easy way for women to get in contact with other fibroid sufferers and give each other psychological and emotional support. This can be useful as it may take a few months before the benefits of the treatment are felt by the patient. The moderator of a good forum will censure any attempts by members to give each other medical advice or influence choices, but will encourage women to research their options and to take a proactive role in their own health care, for example, by actively seeking out a gynaecologist who will give them a referral to your department. Please find some two examples, one U.S. and one German forum below. If there is no patient forum in your language to which you can refer patients, you might encourage one of your patients to start one. Many of the women choosing UFE today are highly educated, professional women who will have the necessary skills to start and moderate a forum.

http://de.groups.yahoo.com/group/myome/http://health.groups.yahoo.com/group/uterinefibroids/

2104.2

Vertebroplasty

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Learning Objectives

1. To learn how to enhance patient awareness using the media (press, internet, etc.)
2. To learn which key messages to convey to the GP about vertebroplasty
3. To learn which key messages to convey to orthopedist-rhumato-oncologists about vertebroplasty

Percutaneous vertebroplasty is a therapeutic, image guided procedure that involves injection of radio-opaque cement into a painful, partially collapsed vertebral body to internally splint it, in an effort to relieve pain and provide stability. This is procedure is one of the most successful procedures of the last two decades. The success of this technique has attracted all other specialties to perform vertebroplasty or a similar procedure. Before promoting the technique, the operators should be fully trained and master the technique, the indications, and the management of the complications. After this step, the promotion can begin. The best providers are rheumatologists, internists, endocrinologists, and GPs for osteoporosis. For tumor cases, oncologists, radiotherapists, pain management specialists are the principle providers. Once you have determined in your hospital and environment the best spokesperson, you can begin to contact them. The first contact could be a short lecture. However, successful cases are the best advertisement for the procedure. One qualified operator should participate regularly to multidisciplinary meeting for oncology, pain management, and osteoporosis. In our experience, this was the best approach to promote the technique. Another approach that is not only local promotion is the website dedicated to vertebroplasty. Ideally, this should be in two parts one for patients and one for physicians. The first procedures are surely very important and the best advertisement for your technique. However, for a long term success you should be able to follow-up your patient and be able to respond quickly in case of new fractures and new cases. A department with more than 3 week's delays is not optimal. Once the minimally invasive centre is recognized for its good work with excellent patient care and follow-up, the success is systematic and the risk is the too fast increase of the patient flow and increases of the delay. Finally it is simple to never begin something you cannot finish! Percutaneous verterboplasty is a relatively new technique for treatment of vertebral compression fractures of diverse aetiologies. It is one of the most satisfactory techniques developed in the last decade, which results in excellent and rapid pain control. The technique has now gained widespread acceptance and is considered a standard of care for osteoporotic fractures and tumour cases. With the number of published cases increasing in literature, the indications, technique and complications are well described. Even though it is easy to perform with minimal complications, this percutaneous technique should be mastered and the inclusion and exclusion criteria respected for excellent results.

2104.3

PAD interventions

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Learning Objectives

1. To learn the major role of modern diagnostic imaging as a key factor in selecting and directing the patient to the IR suite
2. To learn which key messages to convey to the GP about PVD in IR
3. To learn which key messages to convey to the cardiologist-internist about PVD

In the future, the practice model of the "angiographer" or "special procedurist", comprising a practitioner exclusively focused on the performance of image-guided interventions and image interpretation without any component of office-based clinical medicine, will cease to exist. In the U.S., most revascularization procedures are done by endovascular means first, with open surgical procedures reserved for those who fail endovascular attempts. Pending results of multicenter randomized clinical trials in carotid, renal, and lower extremity circulations, the number of interventional revascularization procedures done annually in the U.S. could rival coronary interventional procedure volume, or roughly 1 million cases annually (1 procedure for every 300 people). PAD is one of the "legs of the stool" of interventional radiology, a critical elective interventional service that is essential for every interventional radiologist (IR) to offer. Other interventional specialties are very interested in serving this demand, including vascular surgeons (who now call themselves, "vascular and endovascular surgeons") and interventional cardiologists (now, "cardiovascular specialists"). Interventional radiologists should note their unique training in interventional procedures, and should refer to themselves (and all interventional practitioners) generically in this context as "vascular specialists". It is inevitable that IRs will experience competition from vascular surgeons or interventional cardiologists for PAD patients. If not experienced that yet, when it happens IRs will be at a disadvantage *if they are currently performing percutaneous revascularization procedures for them based on their order or request.* That is because they are serving as the gatekeeper or middleman for those referrals, and can turn them off at will. The most important initiative IRs can undertake now to remain relevant and competitive in the future is to stop this practice immediately (note however that it is essential to be prepared in terms of a clinical office and hospital service to handle the referrals appropriately). Interventional radiologists are cognitive as well as procedural doctors and should be *consulted* or have patients *referred* for evaluation and management, not for procedures. Better still, IRs should inform referring doctors *right now* that they are happy to consult on their patients and treat them, but that it is confusing for patients to be referred to multiple vascular specialists and request that they consult the IR if they want their patient to be considered for percutaneous revascularization first. When speaking with referring doctors, IRs should let them know that they should pick one vascular specialist for their patients, and that the model of sending everyone to the vascular surgeon is anachronistic and impractical for all involved, especially the patient. The time to implement this is *before* competition arises. With regard to imaging, vascular CT and MR have replaced a substantial amount of diagnostic angiograph, and rightly so. If IRs can get their radiology colleagues to notify them or the referring doctor when a positive case is seen, they may generate some referrals by direct contact especially if you have established a relationship previously with them. More importantly, they must offer comprehensive in-office vascular diagnosis, including vascular noninvasive vascular testing. Many referring doctors send patients to vascular surgeons for these tests, and without an office vascular testing machine able to perform segmental limb pressures, pulse volume recordings, and Doppler waveform analysis at a minimum, it will not be possible to compete for these referrals if other local specialists offer them.

2104.4

Oncology

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Learning Objectives

1. To learn the major role of modern diagnostic imaging as a key factor in selecting and directing the patient to the IR suite
2. To learn which key messages to convey to the GP about interventional oncology in IR
3. To learn which key messages to convey to the medical, surgical oncologist and radiotherapist about interventional oncology

During the past four years, the use of image-guided interventions in cancer treatment has experienced unparalleled growth. Several innovative techniques and devices for direct tumour ablation and trans-arterial therapy have been introduced. Sophisticated imaging methods improving tumour targeting and treatment monitoring have been devised. A number of trials have been successfully completed in different clinical settings. Interventional oncology procedures are increasingly used as an alternate or complementary treatment for a variety of solid cancers under the common denominator of effective local tumor control without the morbidity of open surgery or the toxicity of chemotherapy and radiation. Much has still to be done, however. A comprehensive, multi-pronged approach to the discipline of interventional oncology with a robust portfolio of clinical, basic, and translational research is required to achieve significant discovery and clinical implementation of novel and effective therapeutic approaches to benefit patients with cancer (1). A central conviction underpinning the research strategy is that the core approaches to cancer treatment, namely systemic drug administration and surgery, can and will be supplemented by minimally-invasive treatments for locally-dominant disease to increase response, achieve better side-effect profile, reduce cost and potentially improve survival. An integrated, multidisciplinary approach is instrumental for interventional oncology to be accepted by referring physicians, governing bodies, and patients as another defined arena similar and coequal to radiation oncology, surgical oncology, and medical oncology in the field of cancer clinical care. Such an approach will eventually enable interventional oncology to have a pivotal role in the therapeutic management of cancer. The incorporation of interventional radiology procedures into clinical practice has always resulted in an important change in patient care. Many procedures initially developed as "therapeutic alternatives" have now become first choice treatments (2). Interventional radiology societies should take a leadership position in organizing a basic and clinical research agenda for interventional oncology and in implementing a structured educational program to meet the needs of interventionists who wish to acquire knowledge and skills in this emerging field. The CIRSE is highly committed to interventional oncology. CIRSE actively supports clinical trials and research development and carries out registries and studies in collaboration with other professional societies or on its own. The CIRSE Foundation is a permanent source of funds in order to provide training programmes to doctors and other medical staff in the field of minimally invasive, image guided procedures. The CIRSE Foundation has also recently started a very successful continuing educational programme with a focus on oncology, including a number of local courses of the European School of Interventional Radiology and the first European Conference on Interventional Oncology, held in spring 2008. Interventional oncology will become the fourth pillar of cancer care, along with medical oncology, surgical oncology, and radiation oncology. However, the more oncologic interventions will be recognized, the more they will become a subject of turf issues. As other specialties continue to move toward minimally invasive approaches, a very competitive environment has already formed. Total patient care with direct referral will be the key to the long-term

survival of oncologic interventions inside interventional radiology and within the house of radiology (2).

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Special Session
Palliative treatment for oncology patients

2105.1

SVC syndrome

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Learning Objectives

1. To present rationale and indications for SVC and IVC PTA/Stenting in oncology
2. To describe the techniques for SVC and IVC PTA/Stenting
3. To describe the results and the management of complications

No abstract available

2105.2

Intractable ascites

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Learning Objectives

1. To present rationale and indications for minimally invasive treatment of ascites (including peritoneal ports)
2. To describe the techniques of ascites management and complications
3. To discuss follow-up and maintenance of percutaneous peritoneal ports

Intractable ascites in the oncology patient causes distressing symptoms because of abdominal tension, the weight of the ascites, breathlessness from splinting of the diaphragm and other well recognised symptoms such as gastro-oesophageal reflux. Ascites is usually the consequence of peritoneal involvement with malignant disease but may also arise as a complication of portal hypertension in patients with incidental liver cirrhosis or in patients with portal vein thrombosis as a consequence of disease or therapy. Traditionally, malignant ascites has been managed by intermittent paracentesis, which may have to be practised as frequently as once each week in order to keep symptoms under control. This is distressing for the patient because of the need for repeated peritoneal puncture and can be complicated by sepsis, loculation of the ascites leading to inability to drain completely as well as by technical complications, such as inadvertent puncture of intra-abdominal or pelvic organs. The LeVeen peritoneo-venous shunt, which is a well recognised method managing intractable ascites in patients with cirrhosis, has been used on occasion in patients with malignant ascites with some benefit. Life expectancy of the patient with malignant ascites is short and therefore the risk of dissemination of malignant disease by venous shunting is not considered to be too a severe complication to make the procedure contraindicated. Contraindications do exist however, particularly the inability of the patient to deal with a large volume of intravascular fluid i.e., renal failure or heart failure. Medical therapy with salt and water restriction with diuretics can be partially effective but rarely give complete control of ascites and result in significant complications such as postural hypotension and prerenal failure. The Pleurex indwelling drainage catheter is a new implantable device with a tunnelled subcutaneous component that can be used intermittently to drain ascitic fluid. The multisidehole silicon catheter can be placed under a mild intravenous sedation and local anaesthesia in the right upper quadrant so that the catheter itself lies within the peritoneal space usually along the right paracolic gutter. The tunnelled component reduces the risk of port site infection and a valve system on the catheter connector allows connection to a vacuum drainage bottle and minimises this inadvertent re-instillation of ascitic fluid into the peritoneal cavity. Transjugular intrahepatic portosystemic shunting (TIPS) can be used for the management of ascites in patients with cirrhosis of the liver but at the cost of increased risk of hepatic encephalopathy. In a patient with malignant disease, TIPS can be partially effective particularly if there is an element of portal hypertension involved in a genesis the ascites. There are a variety of case reports on the use of an indwelling catheter attached to a subcutaneous port that allows safe, relatively atraumatic drainage of ascites while reducing the risk of infection. Inevitably, the risk of any long-term catheter drainage system is that of stoma site or intraperitoneal infection and the maintenance management of catheters mustdiligently pay attention to reduce this risk by absolute care and attention to aseptic technique. Catheter migration from the dependent position within the peritoneum can occur and may require resiting of the catheter. Further development of the systems is clearly required and long-term studies will be necessary to determine their place in the management of the patient with malignant ascites.

2105.3

Biliary stenting

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Learning Objectives

1. To describe the indications, techniques and complications for biliary stenting
2. To discuss uni- vs. bi-lobar biliary drainage/stenting
3. To discuss bare vs. graft-stents for biliary drainage / Future perspectives in stent design
4. Management of the obstructed stent

Self-expanding biliary metallic stent placement is for more than 20 years an established method of palliative treatment of inoperable biliary malignant strictures [1]. Metallic stents have replaced the conventional plastic ones since they have shown higher patency and lower complication rate providing a better quality of life to the oncologic patient [2]. Nevertheless, jaundice may reoccur and most of the times it is due to tumor ingrowth and/or overgrowth and less frequently due to sludge, food debris or stones. In these cases, reintervention for new stent placement is usually needed [1,3]. In the effort to prevent tumor ingrowth and to avoid reintervention, covered metallic stents have been developed using diverse covering materials [4-9]. The ePTFE/FEP covered stents placement has been shown to be safe, feasible and effective in biliary drainage and with low complication rates [10,11]. In this abstract, we will describe the indications, techniques and complications for biliary drainage and stenting. We will discuss uni- vs. bi-lobar biliary drainage/stenting, as well as bare vs. covered graft-stents for biliary drainage and future perspectives in stent design. Finally, we will describe the management of the obstructed stents. Percutaneous Transhepatic Biliary Drainage (PTBD) is a percutaneous therapeutic procedure, which leads to the drainage of the obstructed bile duct system. Doctors request a PTBD

to aid in the treatment of jaundice if no other option is preferable. The underlying disease of jaundice might be a malignancy of the bile ducts itself, of the pancreas head or of adjacent organs or structures, like lymphnodes, the gallbladder or the stomach. Percutaneous Transhepatic Cholangiography (PTC) is the basic procedure for opacification of dilated biliary tree. PTC is performed under sterile conditions, with the patient in supine position. After percutaneous local anesthesia, we puncture the liver with a fine 21-22G Chiba needle, under fluoroscopic guidance. We usually enter the liver in the right middle axillary line between the 9th and 11th intercostal space targeting the xiphoid, keeping the needle on a horizontal level until we reach the level of the right lateral spine margin. If we prefer to puncture the left biliary duct system, we then puncture the anterior abdominal wall just under the xiphoid, aiming posterior and right lateral. After opacification of the obstructed biliary system, decision must be made about the site of puncture for introduction of the drainage catheter. There are two major techniques for introduction of a biliary catheter: A. the fine 22 G needle technique and B. the 18 G needle technique. Advantage of the fine needle technique is that even multiple needle passages may not cause complications, so the procedure can be considered as safer as using the 18 G needle. However, the fine needle technique might be difficult in more inexperienced hands. For common bile duct (CBD) lesions, right-sided approach is preferred, except in cases of ascites or colon interposition. Right side route provides a more straight way for wire and catheter and keeps operator's hands away from X-ray beam. For hilar lesions, the puncture site should be decided after studying tumor location, extent and liver lobe infiltration or atrophy. In case of opacification of multiple obstructed bile ducts, the operator should try to drain as many opacified ducts as possible in order to avoid bacterial contamination and post procedural cholangitis. The drainage of the bile ducts is performed with a small plastic multiple-hole pigtail catheter. The catheter is placed internally across the narrowed duct, having an external end connected to a drainage bag. The catheter is secured to the skin with sutures. Self-locking catheters are preferred in order to minimize the dislocation risk. The percutaneous catheter is pushed through the stenosed/obstructed CBD, so that bile is draining through the catheter towards the bowel loops. The drainage procedure can be extended with the placement of a permanent metallic stent, which keeps the stenosed biliary duct patent, without need for a catheter. Metallic biliary stents have been proved as the best palliative treatment of non-resectable malignant obstructive jaundice, allowing longer patency rates than plastic endoprostheses [12-16]. The technique is safe, with low complication rate and procedure related mortality between 0.8 and 3.4% [14]. The most feared complications are bleeding and sepsis. Other complications are less frequent, but you may encounter mild post procedural pain for which analgesia will be given, and infection, so patients should get antibiotics. Procedure related complications like stent misplacement or migration can be corrected by placement of a second stent. The technical success of the procedure depends on the experience of the interventional radiologist performing the drainage. It can be as high as nearly 100%. Clinical efficacy is usually lower but still over 90%. It has been shown that single lobe drainage is sufficient for bilirubin decrease and jaundice control. Single lobe stenting, no matter which lobe is drained, is then recommended in order to reduce patient discomfort and complication rate. Still controversial remains the timing between initial drainage and metallic stent placement, as well as the question of balloon dilatation before stent insertion. There is some evidence that if the initial transhepatic drainage is completed without causing any severe complications, especially bleeding in form of haemobilia, primary metallic stenting can follow as a single-step procedure. The majority of intrabiliary bleedings is caused by hemorrhage of venous origin, and so that most of them tamponade maximal two weeks after placement of an 8 Fr biliary catheter. Besides tract tamponade, safety catheters allow: a) flushing in order to prevent clot formation, b) re-intervention access and c) trans-catheter control cholangiography. So, we may assume that if initial procedure is completed without complications, primary stenting is justified and if bleeding or perhaps severe complications occur, a safety catheter should be left in place. One might perform pre- or post-stenting balloon dilatation. Pre-stenting stricture dilatation has several advantages. It allows better initial stent expansion, which leads to wide free bile flow towards the bowel, decreasing the risk of post-interventional cholangitis and sepsis and inducing more rapid bilirubin reduction. If all this occurs, then catheter retrieval may be undertaken even the next day allowing minimalization of hospitalization time and costs, if of course the patient's condition has improved. Nevertheless, pre-stenting dilatation might be also combined with several disadvantages, such as induction of new or worsening of existing cholangitis or septicemia, due to dilatation provoked local traumatism, tumor bleeding and haemobilia, parenchymal damage during balloon extraction and finally, moderate to severe pain. Post-stenting dilatation may be used if initial stent expansion is not adequate, so it would be possible that placement of even a thin 5 Fr catheter would occlude the small stent lumen. Already in 1991, Adam et al. suggested that self-expandable stents can be placed in patients with a better prognosis as one-step procedure, so that total hospitalization time is decreased [16]. This is achieved by placement of a thin 4-5 Fr diagnostic angiography catheter through the expanded stent, which can be used the next or a few days later as an access for cholangiographic control. This catheter can be retrieved immediately after we are sure the stent is fully expanded and that no other major complications like arterial bleeding, sepsis or stent malfunction are present. So, the keys for shortening the total intervention time seem to be: 1. careful initial transhepatic drainage, in order to allow primary metallic stenting, in the absence of haemobilia. 2. single lobe drainage and stenting in order to reduce patient discomfort and complication rate. 3. immediate optimal stent expansion, so that free bile drainage is guaranteed and the possibility of cholangitis decreases. 4. placement of a thin catheter (4-5 Fr) after stent placement, which can be retrieved even on the next post-procedural day. The whole procedure may last 1-2 hours, depending on the grade of difficulty and the cooperation of the patient. Deep sedation and analgesia might be needed for that purpose. In general, patients are kept in the hospital until they recover. Post procedural, the blood pressure and pulse must be monitored, the haematocrit must be controlled and the catheter site must be checked frequently. Patients can eat and drink normally, or as instructed by the doctors. They must be careful not to dislodge the catheter. Stent patency depends on the cause and the site of the stenosis. It can reach 6-12 months or more, depending on several parameters. Most problems are caused by tumor ingrowth and/or overgrowth and in fewer cases due to bile sludge incrustation, food debris or stones, which may lead to jaundice reoccurrence. In those cases, new percutaneous intervention is required, in order to negotiate the obstructed stent and try to achieve patency. This can be done either with balloon dilation of the obstructed stent and new stent placement or we can try to clean the stent if we think that occlusion is caused by debris. A semi-inflated balloon can be manipulated up and downwards inside the stent until there is no resistance. If cholangiography reveals that the lumen is still narrow, biopsy should be performed in order to prove if tumor ingrowth is the reason for stent dysfunction, so that a new stent must be placed. In the effort to prevent tumor ingrowth and to avoid reintervention covered metallic stents have been developed, using diverse covering materials [4-9]. The newer developed ePTFE/FEP covered stents (Viabil, Gore, USA) have been clinically used over the last years and have been shown to be safe, feasible and effective in biliary drainage and with low complication rates [10,11]. More recent studies with covered stents have shown quit promising results [17,18]. In these studies, Viabil covered stents due to their ePTFE/FEP coverage and their specific conformation have shown to be safe and effective in the palliation of malignant biliary disease and efficient in

preventing from tumor ingrowth. Comparison studies with covered versus uncovered stents are under publication, showing quit promising results in favour of the covered biliary stents [19]. Regarding tumour overgrowth, Viabil stents seem to have a disadvantage in comparison with uncovered stents which can be intrahepatically extended. Mesh stents have been shown to be effective in preventing tumor overgrowth. This characteristic is absent from the Viabil stents, where due to the nitinol skeleton the endoprosthesis does not shorten after deployment and tumor overgrowth may not always be prevented if stent is expanding only 1-2 cm above the tumor proximal site. Future thoughts should be made about construction of a new covered stent design with proximal and distal bare stent extension [20].

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2105.4

GI stenting

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Learning Objectives

1. Rationale for treatment. Techniques and devices for GI stenting
2. To describe complications and how to deal with them
3. Results of GI stenting in oncology
4. Follow-up and management of the obstructed GI stent

The use of autoexpandable metallic stents for the treatment of gastric or colonic strictures is a direct application of their well established usefulness in treating obstruction within the biliary tree, tracheobronchial tree, vascular system, and esophagus. In the esophagus, stent placement has been used efficiently in the treatment of malignant dysphagia, being nowadays a commonly used procedure. Technical success approaches 100%, and the dysphagia degree improves from 83 to 100%. Unlike treatment in the esophagus, the treatment of gastroduodenal and colorectal obstructions with metallic stents is, to our knowledge, not yet well established. As in the esophagus, metallic stents used in the stomach, duodenum, and colon are not intended to be curative but useful as a nonsurgical palliation of the symptoms of obstruction. They have been used both in benignant and malignant obstructions; however, indications for use in benignant strictures are yet not well defined. Currently available metallic devices are not yet ideal in design and need further technical improvement. However, they already offer advantages over conventional plastic stents and they are becoming standard for esophageal stenting. Unlike plastic tubes or catheters, flexible metallic stents have a high ratio of deployed (expanded) diameter to introduction diameter. That is, they have a relatively small-caliber introduction system that allows safe and atraumatic placement via the mouth or anus; yet when deployed, they expand to a diameter large enough to relieve the obstruction. Some of these devices will even pass through the working channel of a therapeutic endoscope, but they always need to be used under fluoroscopy control. Despite technologic refinements in the stents and their delivery systems, improvements related to the adaptability of the stent to the treated organ should be made. A better adjustment in length, shape and diameter would be desirable (personalized-anatomical stents) as long as research in new material. Several models of biodegradable reabsorbable stents are nowadays in different stages of development. Self-expandable metallic stents are being increasingly used to palliate malignant stenoses of the

gastrointestinal tract. These prostheses have made it possible to reestablish luminal continuity in patients with malignant obstruction of esophagus, gastric outlet, small bowel, or colon who are at high risk of immediate surgical intervention. In some cases, these stents are used as an intermediate step before a surgical intervention, solving the obstruction and allowing the patient to improve his clinical status, which will result in a safer and less complex surgery (bridging to surgery). When surgery is not indicated, stenting solves the obstruction and improves the quality of life for the neoplasic patient, avoiding unnecessary palliative surgery that only compromises more his life (palliative use). This last application have meant a great advance in Oncology for the management of obstructive pathology, allowing radiotherapic or quimiotherapic treatments for the cancer, without resorting to an unneeded surgery, and often reaching an complete remission of the pathology ("curative" use). Placement of GI stents has shown to have high technical and clinical success rates, typically over 90%, with acceptable complication rates and good outcome and although an increasing number of studies related to self-expandable metal stents, data regarding their long-term efficacy, side effect profile and true cost efficacy are being published, we lack structured randomized trials versus other treatment modalities, in a search for real evidence. Increased familiarity with the available devices, knowledge of the absolute and relative indications and mastering of the techniques will be necessary before a widespread acceptance can be achieved. Evidence-based medicine and innovations in stent design also promise an increase in the use of these techniques in the future.

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2105.5

Nephrostomy

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Learning Objectives

1. To present indications and techniques of nephrostomy in oncology
2. Follow-up and post-procedure care of nephrostomy
3. When ureteral stenting is indicated and when it is not

Malignant ureteric obstruction resulting in uremia is quickly a terminal event if untreated, not only because of tubular atrophy and renal insufficiency but also because of increased risk of infection and pyonephrosis as well as renal pevis or forniceal rupture. Since its initial description in 1955[1], percutaneous nephrostomy has been affirmed as a well-established method in the treatment of

supravesical urinary obstruction. Technology progression in imaging and tools as well as cumulative experience expanded the applications to ureteral stent insertion, percutaneous lithotripsy and fistulae management. Indications for percutaneous nephrostomy include: 1. urinary tract obstruction, 2. pyonephrosis or infected hydronephrosis, 3.Urinary fistulae or leakage, 4. Access for ureteral stent placement. While in most of the cases the indications are unequivocal, in a recent survey [2] there was an indication bias between urologists and oncologists on the treatment of asymptomatic oncology patients with good or poor prognosis, with the oncologists being more likely to recommend nephrostomy and JJ stenting. Moreover, the role of urinary tract decompression in patients with advanced malignancy and poor prognostic factors (i.e., presence of metastases; previous established malignancy; low serum albumin) remains controversial, as it does not seem to affect overall survival[3-5]. Improvement of obstruction-related symptoms and availability of further treatment still remain commonly proposed reasons for decompression. Contraindications to percutaneous nephrostomy are mainly uncorrectable severe coagulopathy and terminal illness. Pre-operative patient preparation should include correction of electrolytic or metabolic imbalance such as hyperkaliemia (>7 mEq/L) or metabolic acidosis, coagulation and platelet count. It is recommended[7] that the patients have INR 80000/dL. Although the value of antibiotic prophylaxis has not been demonstrated in randomized clinical trials, most authors recommend it prior to percutaneous nephrostomy. A 1 g cefazolin or ceftriaxone IV is adequate for most of the cases. However, in high-risk patients, the antibiotic prophylaxis should be altered accordingly and should be last for 5-7 days. Special attention should be paid to those who are at risk of endocarditis. Familiarity with renal anatomy and imaging modalities is mandatory for selection of the safest route to the renal excretory system. The optimal access to the kidney should avoid the branches of the renal artery. The Brodel's line corresponds to a non-vascular area at the border of the region of the ventral and the posterior branches of the renal artery. Access from this area reduces the risk of arterial puncture. The choice of the initial access has to be made with regards to the severity, the length and the level of the obstruction. The lower pole calyces are less vascular and easier to puncture from a subcostal point. Aiming for an upper pole calyx usually can be from an intercostal point, thus, increasing the risk of inadvertent intercostal vessel puncture or/and potential postoperative pain due to the proximity of the nephrostomy catheter to the ribs. However, dealing with a tight and long obstruction is usually easier for a superior calyx access due to better manipulation capabilities, especially if a ureteral stent is to be placed. Intercostal acess should be made with special attention to the pleura, as it reaches down the 12th rib. Intercostal and paravertebral muscles can pose more difficulties on catheter insertion and they should be avoided if possible. In general, at least 10 cm distance from the midline provides an excellent rule in keeping with the above and having the shortest possible route at the same time. In principal, the least punctures of the renal capsule the better. Ultrasound with fluoroscopic guidance is currently the best option, although in some institutions CT is preferred for the initial access. The tip of the papilla of a posterior calyx represents the ideal puncture site. Continuous inspection of the needle under ultrasound is essential to avoid more central advance and vascular or pelvic puncture. As it relates to the skills of the operator, SCVIR guidelines suggest that the interventional radiologist should perform 10-15 percutaneous nephrostomies a year to maintain a sufficient level of familiarity with the procedure. Having punctured the dilated calyx, removal of the inner stylet of the 22G needle will result in free urine flow. Otherwise, a tiny retraction of the 22G needle with simultaneous subtle aspiration should yield some urine. In any other case, correction of the needle is needed. Once in the correct position, special attention must be given not to move the needle henceforth and contrast medium should be injected, preferably through a short connecting tube, to opacify the collecting system. Then, under fluoroscopy, a 0.18" mandril wire is advanced to the renal pelvis or the proximal ureter, followed by a coaxial set of 5F catheter (Accustick, Boston Scientific or Neff, Cook). The outer catheter of the coaxial set stays in place. Next, a stiff wire is placed either in the renal pelvis or, preferably, in the proximal ureter. After repeat dilations, if needed, the nephrostomy catheter is inserted and secured in place. Usually an 8F self-locking pigtail catheter is adequate while, in case of thick purulent content or in the presence of debris a 10F or even 12F catheter may be necessary. Minor complications occur in 6.8-23% [7] and include minor hematuria, pain, urine extravasation, catheter dislodgement during the first month and inability to remove the catheter because of encrustation or crystallization around it. Minor hematuria usually does not require specific treatment, apart from exchange for a larger-bore catheter to tamponade the access route. Clot presence immediately after the tube placement does not necessarily need catheter flushing, as urokinase in freshly produced urine dissolves the clot. However, it is advisory to inject 5-10 ml of normal saline every 6-8 hours just to check the catheter patency by means of easy injection and aspiration of the renal pelvic content. Major complications of percutaneous nephrostomy include hemorrhage, sepsis and puncture of adjacent organs. The mortality rate is 0.046-0.3% [8]. Severe bleeding that requires intervention and/or transfusion occurs in 1-3% of patients undergoing percutaneous nephrostomy. When it cannot be controlled by tamponade with a large-bore tube, angiographic evaluation for renal A-V fistula, pseudoaneurysm or vessel laceration is needed. Embolization is usually effective and surgery is rarely necessary.[8] Septic shock, requiring intensive care, occurs in 1-3% but a 7-9% presence may be anticipated in case of pyonephrosis. Manipulations, therefore (i.e., dilatations, catheter exchanges, frequent flushing), should be kept to a minimum. Puncture of adjacent organs include pneumothorax (0.1-0.2%) or retrorenal colon puncture (0.2%). Its probability increases with improper guidance (e.g., fluoroscopy only). Once the nephrostomy is done, the next step is to negotiate with the cause of the obstruction. Antegrade placement of a ureteral stent is higly possible (88-96%)[9], even when a retrograde attempt is not successful. Contrast injection through the nephrostomy access will reveal the level of the obstruction. Next, probing of the obstructed segment of the ureter is done with an angiographic or a biliary manipulation catheter and a soft-tip or a hydrophilic guidewire. If crossing the lesion is not possible at the time of nephrostomy, a nephrostomy catheter is left on external drainage and the procedure is repeated 5-7 days later. When the obstruction is crossed, a stiff wire is coiled into the urinary bladder and a safety wire is placed into the proximal ureter. Usually an 8F JJ stent is inserted over the stiff guidewire. The length of the stent is measured by bending a guidewire when its tip is a few cm into the bladder, pull it out and bend it again when its tip is in the renal pelvis. A safety nephrostomy catheter is usually left in place for a next-day nephrostogram. Good contrast flow in the stent is followed by removal of the nephrostomy catheter over a guidewire. This is to keep an access while check for bleeding from the nephrostomy skin entry and re-insert a nephrostomy catheter if necessary. In case of hemorrhagic cystitis or a non-functional bladder (neurogenic; infiltrated), insertion of a JJ stent is not indicated and nephrostomy is usually adequate for urine diversion. Conservative and surgical management of urinary tract fistula can fail up to 35% of patients[10]. In case of lower urinary tract fistula as vesicovaginal, vesicorectal, uretrovaginal, ureteroenteric, ureterovaginal or ureterocutaneous, diversion by means of nephrostomy is usually sufficient. A nephroureteral catheter could be placed instead, again with the nephrostomy output in free drainage. This applies especially in cases of coexistence of a fistula and ureteric obstruction either of neoplastic or post-irradiation origin. In case of refractory or large urinary fistula, usually associated with neoplasm, permanent occlusion of the ureter may be used with the aid of coils, tissue adhesives or fulguration[11]. Covered stents have been used in cases of persistent ureteric fistulae

despite a long time (8 weeks to several months) in free nephrostomy drainage[12]. In case of infected urine or pyonephrosis, insertion of a JJ stent is not advisory until proper antibiotic treatment is given and clearance of the urine is inspected. Postoperative care should include frequent vital signs monitoring (e.g., half-hourly for the first 2 hours, then hourly for the next 2 hours, then every 2 hours for the next 4 hours), nephrostomy output charting, pain relief even with narcotics, antibiotic coverage if urine infection is suspected. If a JJ stent has been inserted, the safety nephrostomy catheter is clamped 6-8 hours postoperatively to assess the patency of the stent. Some patients, most likely in the setting of bilateral hydronephrosis, experience postobstructive marked polyuria that can lead to wasting of sodium, potassium, phosphate and the divalent cations. Management include electrolytes replacement when appropriate. Usually postoperative diuresis is self-limited and lasts for more or less a week[13]. JJ stents need follow-up and replacement if occlusion is suspected. A useful tool is ultrasonographic assessment monthly or bimonthly with measurement of a certain parameter (e.g., diameter of a calyceal infundibulum). Replacement of the stent can usually be done retrograde; if this fails, the stent can be removed by starting over with a new nephrostomy and use of special tools (gooseneck snare).

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Special Session
Upper and lower GI bleeding

2201.1

CTA in acute GI bleeding

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Learning Objectives

1. To review the technique and results of CTA in upper GI bleeding
2. To review the technique and results of CTA in lower GI bleeding
3. To demonstrate main findings and their significance for the "embolizator"

Despite advances in diagnosis and therapy, acute GI bleeding remains an emergency situation with high mortality rates, ranging from 3.6 to 19%. The annual incidence for GI bleeding ranges between 20 and 150 cases per 100,000 persons, with a higher incidence for upper GI hemorrhage. Fast detection and localisation of the bleeding site allowing an early hemostatic procedure is the key point to reduce the mortality rate, which can be as high as 40% if patients are hemodynamically unstable or require transfusion of more than four units of packed red blood cells per day. Currently, the primary diagnostic procedure in case of upper GI bleeding is endoscopy, with identification of the bleeding source in approximately 90% of cases and successful treatment in 85% of these cases, whereas lower GI tract bleeding patients undergo colonoscopy, conventional angiography or 99m Tc-red blood cell scintigraphy. These procedures have some limitations: in unprepared endoscopy, the bleeding site may be obscured by clots or feces. Conventional angiography is an invasive technique carrying a risk of complications; finally, scintigraphy is a time-consuming method with a limited ability to identify bleeding sites.

MDCT has several advantages over other more conventional radiological techniques in the initial imaging of patients presenting with acute GI hemorrhage: - The simplicity, non-invasive nature and widely availability of the technique compared with conventional angiography make CT angiography possible in situations where conventional angiography is not available. - In the absence of oral contrast medium, MDCT is very sensitive to detect extravased intravenous contrast medium within the bowel lumen, even for bleeding rates as low as 0.3 ml/min, which is below the reported threshold for selective catheter angiography (0.5 ml/min). - Movement artefact from respiration and peristaltis is a common problem in the interpretation of conventional angiography and may be responsible for false-positive IADSA. False negatives may also occur with IADSA if the appropriate vascular territory is not selected: this is abolished with rapid acquisition times and the use of multiplanar images to remove overlying bowel loops and all vascular territories can be imaged simultaneously during the contrast bolus. High-quality thin-section data with post-processing can lead to accurate localization of the anatomical site of bleeding, as well as depicting the specific bleeding vessel, leading to rapid targeted embolization without the need for preliminary time-consuming angiography of all territories. -

Assessment of the abnormality causing hemorrhage may be helpful in planning the patient's subsequent management. Even if an active bleeding site is not determined, a pathological lesion may be identified and the cause of intermittent bleeding may be established.

Technical considerations and protocol design considerations: - The techniques described in the literature vary widely. - MDCT scan should be performed without prior oral administration of water or contrast material: Active CM extravasation into the bowel might be obscured by orally given contrast material and intraluminal water might lead to a dilution of extravasated contrast agent causing falsely negative MDCT results. However, the ability to distend the lumen of the GI tract with a low-density oral agent may help better identify the site of contrast extravasation into the bowel. When bowel loops are collapsed, musosal enhancement can be mistaken for active bleeding. - False-positive CTA might occur from calcifications, suture material after previous bowel surgery or from hyperdense material in the bowel lumen (foreign bodies, oral drugs, hemostatic clips, retained CM in diverticula): Misinterpretation of these hyperdensities may be avoided by an additional unenhanced MDCT phase, resulting in a higher radiation exposure. However, the usefulness of unenhanced CT prior to CM injection remains controversial. - Additional portal or delayed venous phase might improve the accuracy in detection and localisation of bleeding sites from tumorous origin and may help in detecting venous GI bleeding. The most important arterial phase MDCT scan is routinely obtained after administration of highly concentrated (350-400 mg%I) CM injected, via a power injector, at a rate of 4-6 ML/sec and followed by a saline chaser. The scan delay is determined either by using a bolus tracking with a ROI in the abdominal aorta (predefined 150 HU enhancement threshold level) or empirically at 25 seconds. However, an additional delay of 5 to 25 seconds (depending on scanning time) from the 150-HU bolus-trigger threshold to the commencement of scanning allows obtaining CT angiographic data during the late capillary phase of bowel enhancement, which offers several advantages. The scanning acquisition ranges from the hepatic dome to the inferior pubic ramus using the following parameters:

4 detector row: slice thickness 2.5 mm, pitch 1.5, tube voltage 120 kV, acquisition time 20-25 sec, reconstruction at 2 mm intervals

16-40 detector row: slice thickness 1-2 mm, pitch 1.5, tube voltage 120 kV, acquisition time 10-18 sec, reconstruction at 0.8-1.2 mm intervals

64 detector row: slice thickness 0.75-0.9 mm, pitch 0.9, tube voltage 120 kV, acquisition time 6-8 sec, reconstruction at 0.5-1 mm intervals. Axial CT images and MPR reconstructions (coronal) are the most useful clues for diagnosis.

Several studies had demonstrated the usefulness of bi- or triphasic MDCT-angio in the detection and localization of upper or lower GI bleeding.

Active CM extravasation was demonstrated in between 43 and 81% of patients, successful localization of the bleeding site is reported in 79-100% of cases and the mean arterial phase attenuation of extravasated blood ranges from 73 to 245 HU, depending on the iodine concentration of the used CM (270 versus 350 mg%). Best results are obtained when using a large amount of CM and a biphasic protocol with a late (capillary) arterial phase and an additional portal phase.

A variety of configurations of extravasated material have been described, including linear, jet-like, swirled, pooled, and ellipsoid. Extravasation can appear as a rounded collection or a linear area inside the bowel lumen or may fill the entire bowel lumen, resulting in a hyperattenuating loop. It is important to be able to differentiate active contrast extravasation (attenuation values ranging from 90 to 274 HU) from clotted blood (attenuation values ranging from 28 to 82 HU). Several other criteria for active GI bleeding, such as spontaneous hyperdensity of peribowel fat, contrast enhancement of the bowel wall, thickening of the bowel wall, polyp, tumor or vascular dilation were also defined but these signs are relatively non-specific for active hemorrhage. A meta-analysis of 5 published series (4-64 MDCT scanner) including 94 patients reported a good correlation between MDCT and surgery or prepared colonoscopy in 85-90% of cases and false negative CTA in 12-15%. Compared with IADSA, a good correlation was observed in 72% with a 6% false positive and 10% false negative for MDCT. Limitations to the use of MDCT-angio include patients with renal failure, hyperthyreosis or allergies to CM. It can be impossible to determine the source of bleeding if hemorrhage ceases intermittently, but this limitation also applies to angiography and endoscopy. Another limitation is that MDCT is a purely diagnostic modality without therapeutic capabilities.

Conclusions: in patients with acute GI bleeding, in whom upper or lower endoscopy failed to identify the site of bleeding or was not feasible, MDCT-angio CT should be considered as the initial radiological investigation. It is a very simple technique that can be employed widely in all centers regardless of local access to nuclear medicine and catheter angiography. MDCT-angio still requires active bleeding at the time of imaging, but may be repeated in case of first negative examination. A positive MDCT-angio can select appropriate patients for rapid targeted embolization. The visualization of active extravasation of IV contrast in the GI tract requires careful attention to technique, including thin collimation, rapid IV contrast administration and appropriate scan timing. The addition of multiplanar reconstructions (MPR) and 3D imaging may be beneficial in identifying the exact source of the bleeding.

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2201.2

Technique and results of upper GI embolization

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Learning Objectives
1. To review the technique of embolization in upper GI bleeding
2. To review the results of embolization in upper GI bleeding
3. To review the technique and results of blind embolization in upper GI bleeding

Indications: most types of arterial hemorrhage in the GI-tract can be treated with embolization. The most common indication in the upper GI-tract for embolization is hemorrhage from duodenal or gastric ulcers, which is refractory to endoscopic treatment or which recurs after multiple endoscopic treatments. Other, less frequently occurring indications include bleeding false aneurysms caused by pancreatitis, bleeding into the bowel lumen from true visceral aneurysms, or iatrogenic bleeds, e.g., post-operative bowel hemorrhage or hemorrhage after endoscopic sfincterotomy. In case of suspicion of an aorto-enteric fistula, embolization is no option and CT should be used to rule out this condition. Bleeds from inflammatory bowel disease, bowel tumors and angiodysplasias are usually not very well suited for embolization, although in special circumstances embolization may be useful. Variceal bleeds may also lead to massive hematemesis, but these will not be further discussed in this special focus session.

Technique: angiography and embolization can nearly always be performed from a common femoral artery approach using a 5 Fr. sheath. Diagnostic series should at least include selective series of the celiac axis and the superior mesenteric artery, preferably also supplemented by selective series of all major side-branches. Long series should be obtained to see subtle contrast extravasation and it may be helpful to immobilize the bowel by administrating glucagon or buscopan. When endoscopy is done immediately prior to angiography, it may also be helpful to ask the endoscopist to place a hemostatic clip at the site of the hemorrhage, to serve as a road map during angiography. However, it should be noted that such clips tend to migrate. Generally speaking, active hemorrhage can be found at angiography when: 1) there are clinical signs of ongoing hemorrhage (decrease in blood pressure, tachycardia, etc.), 2) blood loss equals at least 0.5 ml. per minute (which off course cannot be measured accurately, 3) transfusion requirements equal at least 3 units of red blood cells per 24 hours or 4) when active hemorrhage is seen at endoscopy. When extravasation is not seen, provocation by injecting a fibrinolytic agent or repeated forceful hand-injections may be helpful. When contrast extravasation is observed, embolization should preferably be performed using coils. Coils can be placed very accurately and are associated with a low risk for inducing bowel ischemia. In exceptional cases (e.g. coagulation disorders), the use of other materials may be required. Materials used by different authors include gelfoam, particles (PVA) or glue. As a general rule, embolization should be performed as selective as possible, but in the upper GI-tract this is not always crucial. Superselective embolization requires the use of co-axial microcatheters and micro-coils (0.014 Inch). In many cases, the use of micro-catheters is not necessary and 4 or 5 Fr. catheters combined with 0.035 Inch coils will suffice. When embolizing in the upper GI-tract (particularly in the territory of the gastroduodenal or splenic artery), care should be taken to embolize the vessel proximal as well as distal to the bleeding point, as the flow in the vessel may reverse after closing it from only one side and bleeding may continue. In addition, after embolizing an upper GI-tract bleed from a celiac axis approach, it is also important to exclude ongoing hemorrhage from branches of the superior mesenteric artery. As a result of the rich collateral vascular supply to the stomach and duodenum recurrent hemorrhage - even after embolization using proper technique - may be seen in up to 30% of cases. In case of recurrent hemorrhage, repeat embolization can usually be performed safely. The risk of inducing ischemia during embolization of the upper GI-tract is low and the whole gastroduodenal artery can be embolized without any adverse effect if necessary. In case of recurrent massive bleeding and repeated negative endoscopies and/or angiograms, empirical embolization of a suspected vessel may be performed. This usually involves the gastroduodenal artery.

Results and complications: for embolization of upper GI-tract hemorrhage, prolonged clinical success is obtained in 50-80% of patients. Recurrent hemorrhage is seen in up to 30% of patients, part of whom can be treated by repeat embolization. For embolization of false aneurysm due to pancreatitis or true visceral aneurysms, success rates up to 90% are reported. However, in patients with pancreatitis, hemorrhage often eventually recurs as the underlying inflammatory disease process is left untreated with embolization. Complications of angiography and embolization include systemic effects such as contrast induced nefropathy and allergic reactions to contrast media, puncture site related complications such as groin hematoma, thrombosis or dissection, and embolization procedure related complications such as bowel ischemia. All major and minor complications combined occur in no more than 10% of patients in most recent series. In older series, bowel ischemia has been reported in up to 15% of patients, but in all recent major series this figure is close to 5%.

2201.3

Technique and results of lower GI embolization

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Learning Objectives
1. To review the technique of embolization in lower GI bleeding
2. To discuss the potential cause for negative angio and the management of these patients
3. To review the main complications and their prevention

Introduction: lower gastrointestinal haemorrhage is that which occurs from any portion of the GI tract below the duodeno-jejunal flexure and may be *acute* or *chronic*, the latter being defined as recurrent low-grade blood loss causing iron deficiency anaemia, which may be transfusion dependent. In this *chronic* group, bleeding may be 'overt' but, in a significant proportion of patients, blood may not be visible and will only be detected in stool by chemical analysis - so-called 'occult' bleeding. Whilst the cause of upper GI haemorrhage is identified by routine investigations, in particular by endoscopy, in more than 90% of cases, this is not true for lower GI haemorrhage where the source of bleeding is often much more difficult to define. 'Push' and capsule endoscopy have undoubtedly helped in the investigation of *chronic* bleeding from the small bowel

but are less useful in the context of *acute* active haemorrhage. The same is true of a colonic source of *acute* bleeding when a large amount of blood in the gut lumen will often prevent diagnostic colonoscopy. Contrast enhanced multidetector CT has, however, had a major impact on the management of patients with *acute*, and to a lesser but still important extent *chronic*, lower GI haemorrhage such that all individuals who have alluded diagnosis by other means (in particular endoscopy) should undergo this investigation before proceeding to angiography. The timing of CT in a patient with acute lower GI haemorrhage is important as the aim is to demonstrate active contrast medium extravasation into the gut lumen; there should, therefore, be clinical signs of active bleeding at the time of this study. If active contrast medium extravasation is seen, the patient can be transferred immediately to the angiographic suite for embolization although occasionally it will be more appropriate to send an individual to endoscopy if the source of haemorrhage is at a site easily accessible to endoscopic therapy. In the absence of contrast medium extravasation or other secondary signs of a source of bleeding such as a visceral artery pseudoaneurysm on CT, it is unlikely that immediate angiography will identify the cause of haemorrhage.

Angiographic and embolization technique: the prior identification of the site of active contrast medium extravasation on MDCT undoubtedly, helps during subsequent angiography but a meticulous technique is still essential in order to achieve a diagnostic study and includes the liberal use of anti-peristaltic agents; the injection of sufficient contrast medium in order to opacify completely the vessel being studied; and methods to overcome the problems of patient respiration. The visceral artery supplying the area of abnormality as demonstrated on CT should be studied first and active contrast medium extravasation will often be identified. Superselective catheterization of the vasa recta from which contrast medium extravasation is occurring should then be performed with a co-axial catheter where embolization is best undertaken with microcoils. If this is achieved, the likelihood of a successful outcome is high. A sufficiently distal catheterization is not always possible, however, and in such instances embolization may need to be performed with a combination of particles and coils from a more proximal position than is ideal; the results of such a technique are still good but are less impressive and the risk of complications, including bowel necrosis, greater. This presentation will concentrate upon the angiographic and embolization techniques that are required in order to achieve a successful outcome in this difficult group of patients. Results of treatment and possible complications will also be discussed.

2201.4

What to do if the angio is negative?

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Learning Objectives

1. To review why Angiography should rarely be negative
2. To review alternative contrast agents and challenge techniques
3. To review what to do if no bleeding point is found

Protocols and algorithms properly formulated and agreed by the multidisciplinary team that looks after patients with acute gastrointestinal bleeding should ensure that only patients who are going to benefit from invasive procedures receive them. It is important to remember that 90% of patients will stop bleeding spontaneously but that 50% of these will have a second bleed with a recurring theme. Any algorithm where angiography is a first line investigation for any patient with GI bleeding will ensure negative angiograms in the majority of investigations. Only those whose bleeding is life threatening or who have intermittent large bleeds that show no signs of ceasing require investigation and treatment. Angiography must be carried out when the patient is actively bleeding if the exact site of blood loss is to be found and embolised. Where the patient shows sign of shock, angiography is indicated as first line investigation. Where shock is not present but the patient appears to have been actively bleeding, contrast enhanced MDCT should precede angiography. If negative for contrast extravasation, angiography is not indicated. Provided such rules are adhered to, angiography will rarely be negative for lower GI bleeding. If it is, then this can only be accounted for by time interval. For upper GI bleeding, the situation is different. If endoscopy has been carried out at least twice and any identified bleeding points clipped, then extravasation at angiography, though ideal, is not absolutely necessary. If despite all this, angiography using contrast is negative, then CO2 angiography might help determine the bleeding site. If CT has already given a clue as to the site of bleeding, super selective angiography will also improve detection. The use of vasodilators, heparin and lytic agents can also be considered but carries added risk and should only be considered in exceptional circumstances. Gastric ulcer bleeding is one scenario where angiography is often negative despite algorithms. Even where clips have been placed on the edge of the ulcer, it can often be difficult on two dimensional angiography to locate the artery in the ulcer crater exactly. In addition, there is such an extensive collateral supply that if bleeding is recurrent and life threatening the only alternative is to use an agent like glue to take out as much of the supply as possible. Duodenal ulceration can likewise sometimes be associated with negative angiography. Here, clips are vital if the correct artery is to be embolised. Post operative bleeding or bleeding as a result of inflammatory conditions like pancreatitis must have contrast enhanced MDCT prior to angiography and this requires very careful scrutiny for a possible site of bleeding - sometimes aneurysms can be very small indeed. The finding if vascular abnormalities without any extravasation is rare, occurring in only 5-10% of angiograms. Small angiodysplasias can be embolised but extensive ones with no evidence of extravasation, bowel tumours and Meckles Diverticula should be referred for surgery unless actively bleeding. In conclusion: good protocols should ensure that negative angiography is rare in acute bleeding. Angiography is of little value if contrast enhanced MDCT is negative in acute or chronic GI bleeding.

Special Session
Controversies in vascular intervention

2202.1

Protection in carotid stenting: always

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Learning Objectives

1. To evaluate the available evidence in favour of cerebral protection
2. To apprecaite the limitations in the world literature
3. To distinguish between clinical outcomes and surrogate markers of neurological injusry when evaluating the current evidence-base for cerebral protection

Rationale for cerebral protection: vascular stents are most often employed to widen a narrowed artery in order to improve perfusion to the end organ. Carotid stenting (CAS) is unique in that it is performed in order to prevent embolisation of atheromatous debris and/or thrombus from a friable plaque that has already embolised or is perceived to be at high risk of embolising to the brain and causing stroke. In order to successfully place a carotid stent, one has to negotiate a friable lesion and interact with it in a number of ways (ballooning, stent crossing and deployment), each of which can liberate plaque and cause stroke. Cerebral protection devices were developed in order to limit or control the amount of debris that reaches the brain. "You don't need a randomised trial of parachutes".

Evidence for cerebral protection: there is a host of experimental

and clinical data in the world literature. These can roughly be divided into randomised trials (at the top of the hierarchy of reliable evidence) and all other "trials", into studies based on clinical outcomes and those using surrogate markers of clinical outcome (largely procedural transcranial Doppler [TCD] and DWI of brain).

Clinical studies: focusing on studies with clinical outcomes, it is clear that the literature is saturated with registry data and large case series employing historical controls that are subject to bias and therefore regularly challenged. Regardless, this level III-IV data suggests benefit for cerebral protection (1). Registries employing concurrent controls do not appear to demonstrate any benefit for cerebral protection (2) but these registries are notable in that they include large numbers of cases from very experienced units in whom the event rates are exceedingly low for both protected and unprotected cases. There are some data comparing protected versus unprotected CAS within randomised trials comparing CAS with carotid endarterectomy (3, 4). These data are easily dismissed as such trials were not powered to address the utility of cerebral protection. Unfortunately, there are no randomised trials comparing protected and unprotected CAS that utilise clinical outcome measures. It should be noted, however, that the event rate is generally so low for CAS that around 2,000 patients would be needed in order to be adequately powered to show a difference between protected and unprotected CAS. There is thus only soft evidence of a benefit from cerebral protection but in the words of Carl Sagan: "Absence of evidence is not evidence of absence".

Macroemboli: in terms of capture of macroemboli, Level III evidence demonstrates that every available device on the market is capable of capturing emboli that are large enough to cause series occlusion of the ipsilateral middle cerebral artery and potentially risk major stroke (5).

Microemboli: there is a wealth of studies focusing on the impact of cerebral protection devices on microembolic load. Scrutiny of the available level I evidence demonstrates that filters may be associated with more new white lesions on DWI and more microembolic signals on TCD i.e., that filters effect a "controlled embolisation" (6, 7). This does not appear to translate into stroke and the clinical impact of these microemboli is not known. There is less robust evidence demonstrating that distal balloon occlusion and proximal occlusion devices will significantly reduce microembolic load compared to unprotected CAS. Flow reversal may eliminate the microembolic burden and this system needs to be further evaluated. It would appear that the impact on the microembolic burden of the procedure is device-specific (5).

Evidence against cerebral protection: there is no convincing clinical evidence that use of cerebral protection devices is associated with harm, accepting that use of each device will be associated with a specific learning curve. Experimental studies highlight the potential for damage to the distal internal carotid artery with distal protection devices but this has not been shown to translate into stroke risk (8).

Plaque vulnerability: there are conflicting data in the world literature about the utility of current methods of in-vivo plaque analysis. Some workers suggest that plaques with low Grey Scale Median values (GSM) are at high risk for CAS i.e., they are more likely to embolise, but other workers refute this claim (9, 10). Certainly, in my clinical practice, it is not possible to predict which patients have particularly friable or vulnerable plaque and I am regularly taken by surprise when a large macroembolus is retrieved from the filter at the end of the procedure.

Summary: vulnerable plaque is unpredictable. Protection devices are not associated with clinical harm. As one cannot choose which patients to protect there are two choices: to protect all patients or protect none. Ethically you can only chose to protect none if: (a) use of cerebral protection is associated with convincing evidence of harm and (b) the risk of atheroembolisation to the brain during unprotected CAS is non-existent. "Cerebral protection is intuitive . Only a hooligan would perform carotid stenting without protecting the brain." (11).

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2202.2

Protection in carotid stenting: never

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Learning Objective

To understand the advantages and limits of protecting devices

A little historical overview may help understand why we say "Protection in carotid stenting: never". Around fifteen years ago, in the early 1990s when we started the stenting procedure in the carotids, we were very focussed on the potential problems and complications of the approach. Being neuroradiologists, we had a profound knowledge of the clinical implications of adverse events and of the technicalities of extra and intracranial catheterization. To justify the endovascular approach, we had to start with the very difficult cases, those rejected by experienced surgeons. We were then a little surprised to find out that not only the procedure was technically very feasible, but also with a very low complication rate (around 3-5%). And this was in very difficult cases. It was then natural to widen the indications to simpler and more frequent cases. In view of the very good results (almost), nobody felt the need for a "protecting device". Especially because of all complications, only a minimal percentage was due to embolic problems during the procedure. Most were secondary to later events (intra-stent thrombosis, hyper perfusion syndrome, lowering of pressure and heart rate, and so on).

There were long discussions on the possibility of using a temporary balloon, but the advantages of this approach were disagreed upon. A "primary stenting" was considered a very good limiting factor against emboli. But device companies saw a growing business and very soon came with unneeded "helps". At least at the beginning, many patients suffered an avoidable complication because of the use of a "protection". This was unjustifiable. Over time, the devices have improved but their complication rate is still significant, its benefit still being unproven. The most successful marketing idea was to call them "protecting devices". Who would not use a "protection"? But if you called them "temporary carotid occlusion devices", or something similar, may be people would consider them differently. Unfortunately, most complications occurred in early times with these devices have gone unpublished. And in no trial, the "protecting effect" has been proved. It is not enough to show they have a limited complication rate, it must be proven they are useful. Many recent papers and trials have shown the limited, if at all, efficacy of these devices. The actual devices really seem to be a "protection" for the physician, for possible medico-legal issues. It is a protection from inexperience and insufficient training, not from emboli. The "real protection" of the patient comes from a number of other more important factors. First of all, it is important to understand the correct indications (which means to treat real stenosis in really symptomatic patients). Too many times we see asymptomatic patients being stented for very low grade stenosis. Then, it is of key importance a correct training of the operators (which means both technical and cultural issues, with the ability to face intracranial complications) and an immaculate operating field (no blood in the syringes, in the catheters, on the sheets, etc.). In conclusion, we are not against a "protection". Who would be if it were really so? We are still waiting for the real good one. How should a "real protection" be? It should have a very low complication rate (<0.1%) and absolutely no learning curve. In every procedure, one more element of complexity is one more possible source of complication. The best protection is, therefore, a rapid and simple procedure.

2202.3

Stable aneurysm with type II endoleak: embolization always

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Learning Objective

To determine if there is evidence to justify an active policy of embolisation for type II endoleaks in stable aneurysms

The author neither practices nor believes the title of this article! It is nonetheless my responsibility to consider the matter and seek evidence in support of the statement. I shall start by looking at some recent papers, which can potentially be used to justify an aggressive policy of indiscriminate embolisation. Schlosser et al.[1] took on the significant challenge of trawling through Medline, Embase and the Cochrane library database up to March 2008 and found 110 suitable articles from a starting number of 2794. There were 270 patients recorded to have had ruptured AAA after EVAR with a mean time to rupture of 24±18 months. The commonest cause of rupture recorded was endoleak, which was described in 160/235. The type of endoleak was determined in most cases based on the findings at CT after rupture or at open surgery. In 56/160 patients with endoleak as the recorded cause of rupture, this was based on the findings at the last follow up before rupture. We know from the manuscript that at least 6 of these were type 2 endoleaks without sac enlargement. We do not know if others were type 2 endoleaks with either sac enlargement or shrinkage. The rupture was fatal in 119/231 patients for whom outcome data were available. Of these 160 patients for whom the main cause of rupture was endoleak, 23 were recorded as being due to type 2 endoleak. The rupture risk after EVAR is quoted to be between 0.5 and 1.2% per patient per year, which is a worryingly large number. So, based on the Schlosser paper, we could state that type 2 endoleak is responsible for 8.5% of ruptures after EVAR and that this carries approximately 50% mortality risk. Jones et al.[2] published an analysis of 873 patients treated with EVAR at a single centre over a 12-year period. The surveillance imaging protocol involved a triple phase CT scan with unenhanced, arterial phase and delayed images performed in the first month after EVAR at 6 months, 12 months and then annually. The incidence of type 2 endoleak was 18.8% (164/873) and this is likely to be accurate given the use of triple phase CT although there is an interesting comment that "any discrepancy in image interpretation was adjudicated by an independent surgeon blinded to the study". The evolution of these early type 2 endoleaks is well documented and 79.9% resolved completely and permanently within 6 months. 33 patients had a persistent type 2 endoleak and 18 (54.5%) of these developed sac enlargement. 16 patients underwent interventions (20 catheter-based and 1 open) and 9/16 had successful treatment. There were four cases of sac rupture associated with type 2 endoleak and two of these were not associated with sac growth. Two ruptured within sixth months of the EVAR. One patient ruptured after a failed attempt at embolisation of type 2 endoleak. A potential conclusion from this paper would be to argue that type 2 endoleak is an important cause of sac growth and a potential cause of rupture, which may occur both early and without sac growth. This would potentially lead to a policy of treating all type 2 endoleaks even if the sac is stable. The EUROSTAR database was reviewed[3] to study the outcome of type 2 endoleak and 9% of 3595 patients were found to have isolated type 2 endoleak. Aneurysm growth was significantly more common in the group with type 2 endoleak although there was no significant difference in the rupture rate between those patients with and without isolated type 2 endoleaks. This report does not create a strong argument for intervention but it did lead the authors to conclude that type 2 endoleak "may not be harmless". I think it is reasonable to conclude that type 2 endoleak may be the explanation of some cases of sac rupture after EVAR. A policy of always embolising stable aneurysms with type 2 endoleak requires a risk/benefit analysis to justify this. One would need to show that the risks and costs of surveillance and the risks and costs of the interventions in a substantial group of patients after EVAR were justified to prevent rupture in a very small number of patients. The embolisations will often not be effective and the vast majority of endoleaks would have thrombosed spontaneously. Although there is some evidence that type 2 endoleak is a risk factor for rupture, I have not found evidence to support the statement that we should always embolise type 2 endoleaks with stable aneurysms. I have been selective in the papers I have cited and not been critical of these. At the annual meeting, I shall analyse these in a little more depth and shall incorporate any new information, should it become available.

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2202.4

Stable aneurysm with type II endoleak: embolization never

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Learning Objectives
1. When to treat a type II endoleak after EVAR
2. Risk of Type II endoleak
3. Literature data of endoleaks after EVAR

Endovascular repair of abdominal aortic aneurysms (EVAR) is being performed increasingly more often and has yielded favorable results. Defined as arterial perfusion outside the stent graft lumen and within the aneurysmal sac, endoleaks are divided into four commonly recognized types (types I-IV). Type II endoleaks arise as a result of retrograde flow from aortic arterial branches, excluded by the stent graft, for example, lumbar, inferior mesenteric, and less commonly internal iliac, sacral, gonadal, or accessory renal arteries. Type II endoleaks occur at a rate of 5-25% after endovascular repair of abdominal aortic aneurysms (AAA). The mode and time point of treating endoleaks remain controversial. These most frequently encountered endoleaks can be categorized as early or primary [diagnosed on initial follow-up computed tomographic angiography (CTA) 1-30 days following EVAR] and late or delayed [diagnosed after 30 days with a history of negative computed tomographic (CT) scan in the past]. Persistent endoleaks are defined as those lasting longer than 6 months. Gelfand et al. reviewed 2,617 patients reported in 10 trials published within last 5 years and showed that the reported incidence of type II endoleak ranges 6-17% upon discharge or 30 days post-EVAR but decreases to 1-8% at 6-month follow-up. Type II endoleak may cause pressurization of the excluded aneurysmal sac and thus influence the rate of sac shrinkage. There were no aneurysmal ruptures related to type II endoleak in the studies reviewed, supporting the concept that type II endoleaks may be managed more conservatively than type I endoleaks. We conclude that type II endoleaks may be followed carefully up to 12 months, expecting that up to 58% will disappear spontaneously. If AAA sac enlargement occurs after 6 months in the presence of a type II endoleak, intra-arterial feeding vessel occlusion or translumbar aneurysmal sac thrombosis should be considered. Persistent or late-developing type II endoleaks, without sac enlargement, may be followed closely with CT or ultrasound surveillance. Definitive elective treatment is indicated if type II endoleaks persist for >12 months. Indications for early intervention include a symptomatic or pulsatile AAA sac, sac enlargement of >5 mm, or an aneurysmal sac pressure >20% of systolic pressure. No incidence of aneurysmal sac rupture in association with type II endoleaks in these 10 trials, there are five cases reported of isolated type II endoleak and rupture. The analysis of Harris et al.15 of the European Collaboration on Stent Graft Techniques for Aortic Aneurysm Repair (EUROSTAR) data registry found nine (2.1%) AAA ruptures in 421 patients who had type II endoleaks at a mean follow-up of 14.7 months; however, the actual cause of rupture in eight of these patients was considered to be a concurrent type I endoleak. Early intervention for type II endoleaks may avoid the risk for aneurysm enlargement and rupture and the need for other diagnostic evaluations, which may not be as accurate as necessary. An aggressive approach has been suggested by Baum et al. on the basis of their experience.14 If a patient has a persistent type II endoleak at 6-month follow-up, regardless of the size of the aneurysm, a translumbar intervention is suggested. These interventions have been performed with very low complication rates, in their experience, but it is still unclear whether they are really necessary. Steinmetz et al. in their experience with 486 patients who received treatment with a variety of endovascular devices, the risk for rupture was 0%. Patients underwent only intervention to treat persistent (6 months) type II endoleak that was associated with aneurysm diameter increase 5 mm or greater. Thirty-five patients had persistent type II endoleaks, but only 5 of them (1% of all EVAR patients) also had an enlarging aneurysm. Treatment was successful in all 5 patients. In our extensive experience, there have been no ruptures associated with type II endoleaks. This experience has led their team to adopt a more conservative approach to the management of type II endoleaks, which can be followed up long term with minimal associated morbidity and mortality. Our results at Henri Mondor Hospital confirm the literature. We reviewed all 986 patients treated by EVAR between 1996 and 2008 that presented a type II endoleak at least once on a CT-scan control. The number of patients with an endoleak was 147 (15%). The number of patients with a type II endoleak was 98 (10%). The spontaneous evolution (table 1) of the aneurysmal sac was: - 50% of growth, 29% of shrinking and 21 stable. We treated only patient with enlargement sac 47 cases (49%). Spontaneous occlusion of the type II endoleak occurs in 26% during follow-up (mean delay of 13 months). No rupture occurred in any patient treated and in patients with stable or shrinking aneurysm. For us, the conservative approach with selective intervention only in case of aneurysmal sac enlargement is safe and cost-effective. There is no data in the literature proving the interest of treating stable aneurysms.

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2202.5

Long SFA lesion: always stenting?

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No abstract available

2202.6

Long SFA lesion: never stenting?

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Learning Objectives
1. To learn the association of long term patency of PTA/stent placement and lenght of SFA occlusion
2. To learn the usefulness of prolonged balloon dilatation to improve primary success of fremoropopliteal PTA
3. To understand that the use of stents in long SFA occlusions is very limited and inincludes only bail out situations

Balloon angioplasty: the basic technique of endovascular revascularization of SFA

A recent meta-analysis indicates that stent placement in the femoropopliteal occlusive disease does not increase the patency rate when compared with angioplasty alone at 1 year (1). This is especially true in case of long lesions. Lesion length has been observed by many authors to be an important determinant for long-term patency; short lesions (< 2 and 2-5 cm) tend to fare better than lesions greater than 10 cm. Results from STAR registry demonstrated that lesions more than 10 cm in length have a 2.8-fold relative risk of occlusion compared to those lesions less than 10 cm. Residual stenosis, because of immediate elastic recoil or due to flow-limiting dissection is a major problem after balloon angioplasty. Especially at long diseased segments that are poor targets for stent placement, prolonged balloon inflation up to 10-15 minutes is useful since it effectively improves angiographic result although it seems not to improve long-term patency.

Disappointing patency of femoropopliteal stents: in the femoropopliteal region, highly variable 1-year primary patency rates between 22 and 81% with various stents have been reported. In three randomised studies, although the primary success rate of stent placement was higher than that after balloon angioplasty alone, the long-term patency was not improved by using stents (11-13). The authors of the largest randomized multicenter comparison of femoropopliteal PTA and balloon expanded stent placement with 154 treated limbs summarised that the beneficial effect of stents is to rescue PTA failures. Currently, there is a tendency towards self-expanding nitinol stents in the femoropopliteal artery. In one study, three year primary patency rate of 76% was obtained after primary stenting of relatively short, less than 6 cm long lesions. However, midterm restenosis after long-segment femoropopliteal stenting remains a problem. In recent single-center observational study in which long segments (median length 16 cm) were covered by nitinol stent after initial failure of PTA, the primary patency was only 54% at one year. Especially, poor result (22% one year patency) was obtained in diabetics. Stent in the femoropopliteal artery are exposed to unique long term stress in the form of repeated compression, flexion and torsion and it is probably the reason why recent studies have revealed stent fractures in up to 50% of nitinol stents 1 year after placement and in 19% of Wallstents a mean of 43 months after placement. The fractures seem to be associated with poorer patency and they are more common in longer stents. The clinical experience of stent-grafts in atherosclerotic femoral artery disease is still very limited. In earlier studies, a high incidence of complications, perivascular inflammatory reactions and early thrombosis were major problems. Restenosis at the uncovered ends of the prosthesis seems to be a particular problem. The short and mid-term term results of Dacron-covered stent-graft have been disappointing with up 17% reocclusion during the first 24 hours and only 23% primary patency at 12 months.

Conclusions: there is very limited scientific data available about the usefulness, other than PTA and stent placement, in the femoropopliteal artery. There is wide consensus that balloon angioplasty is still the basic technique in this vascular segment and other techniques are mainly indicated when it fails. Residual diameter stenosis greater than 30% is usually considered an indication for stent placement. A meta-analysis suggested that primary stenting might be better in case of total occlusions, especially if the patient is suffering of CLI. However, in extensive atherosclerotic disease with very long diseased segments, the long term patency of stents is also poor and prolonged balloon inflation is an alternative to obtain hemodynamically acceptable primary result.

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Special Session
Cardiac imaging

2203.1

Cardiac anatomy

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Learning Objectives

1. To learn about cardiac anatomical basis and major imaging planes
2. To present the bull's-eye scheme for myocardial ischemia
3. To review the anatomy of the coronary arteries as visualised with CTA

Knowledge and familiarity with cardiac anatomy is a prerequisite for understanding both cardiac physiology and pathological changes in both congenital and adult heart diseases. Depiction of cardiac anatomy on imaging studies until relatively recently has involved plain X-rays, cardiac catheterizations and ultrasonography, the latter two being almost exclusively practiced by cardiologists. Indications of cardiac imaging on sequential CT or early MR scanners remained relatively limited in everyday clinical practice, mainly due to the low temporal resolution of these modalities and/or the unacceptable long scanning times. With the advent, however, of modern multislice CT and the evolution of cardiac MR imaging, a still evolving wide spectrum of new clinical indications arises. Traditional training in radiology during residency often does not yield familiarization with different structures in specific intrinsic organ-related tomographic planes (long-axis, short-axis, 4-chamber etc), which are mainly used by cardiologists. Cardiologists, on the other hand, are not generally familiar with tomographic imaging and the variety of post-processing techniques (MPR, MIP, SSD, Volume rendering etc.), already widely used in everyday radiology. Successful patient management requires additional familiarization with different modalities used by both specialties, as well as establishment of a common ground of communication. A radiologist involved in cardiac imaging should be familiar with normal cardiac size, shape, position, situs in relation to viscera and lungs, cardiac chamber position and specific anatomic components of the embryologically right and left atria and ventricles, major vessels, atrioventricular and ventriculoarterial connections, as well as their respective valve anatomy, and finally anatomy and course of coronary vessels, variations in their origin and supplied vascular bed (left or right dominance). He should be able to recognize the major landmarks and anatomic elements on a variety of imaging planes or projections of conventional cardiac angiography, US, CT and MR images. Regarding cardiac size, its relationship to the thoracic cage varies with age: radiographically, the normal cardiothoracic ratio is 50% or less in adults and children (60% or less for newborns). The cardiac size is proportional to the body size and correlates better with body surface area and weight than with height. In well-conditioned athletes, with physiologic cardiac hypertrophy, heart weights may approach or slightly exceed the upper limits of normal. The heart is a four chambered organ with two atria and two ventricles. It has right and left chambers (anterior and posterior in the thoracic cage). It is positioned centrally in the thorax with a double oblique angulation of its long axis, coursing from its base on the upper posterior right to its apex on the lower anterior, with the ventricles in a more inferior position than the atria. This angulation may vary among individuals from nearly vertical to almost horizontal in more obese persons. This normal position with the cardiac apex situated in the lower anterior left hemithorax is described as levocardia; the term dextrocardia refers to the cardiac apex being on the right, while the rare mesocardia consists of a centrally positioned heart with the both base and apex along the midline with the former more cranial and the latter more caudal (such as in the hearts of mammalian quadripeds). The position of the apex is independent from the situs of the heart, lungs and viscera. The situs of viscera and lungs does not depend on the position of the cardiac apex (levo-, meso-, or dextrocardia). It always correlates with the position of the morphological right or left atrium. There are five categories according to the position of the morphologically right or left atrium: 1. Situs solitus (right atrium on the right). 2. Situs inversus or mirror image (right atrium on the left). 3. Right isomerism (asplenia, bilateral right atria and morphological right main bronchi). 4. Left isomerism (polysplenia, bilateral left atria and morphological left main bronchi). 5. Situs ambiguous (inability of atrial characterization). Regarding the external topography of the heart, the atrioventricular groove defines the plane of the base of the heart (4 cardiac valves) and defines the short-axis plane of the heart, containing the right coronary artery and left circumflex artery in the right and left atrioventricular grooves, respectively. The left anterior coronary artery courses along the anterior interventricular groove, while the posterior descending coronary artery courses along the inferior interventricular groove. As a general rule, morphological right chambers are more coarsely trabeculated and morphological left chambers more smooth in their interior surfaces. The morphological right atrium is a right posterolateral chamber. Its posterior aspect receives the two caval veins and has a vein-like appearance, in keeping with its embryologic origin from the venous sinus (sinus venosus), while the coronary sinus enters the right atrium anteriorly (Thebesian valve) in front of the inferior vena cava ostium (Eustachian valve). It has a wide-based pyramidal-shaped appendage, contains the limbs of the septum secundum (oval fossa limbs) and has free-wall and septal components. A prominent C-shaped ridge of muscle forms the terminal crest (or crista terminalis), which separates the two regions and forms one of the tracts for internodal conduction. The right atrium is characterized by the presence of numerous pectinate muscles, which arise from the terminal crest and travel as parallel ridges along the anterior aspect of the free wall. The interatrial septum when viewed from the right has an interatrial component and an atrioventricular component (RA-LV). The interatrial portion is relatively small and contains the oval fossa, which consists of a horseshoe-shaped muscular rim (limb), containing a pathway of internodal conduction, and a central thin fibrous membrane (valve of the oval fossa). The morphological left atrium receives the pulmonary veins, has a narrow-based fingerlike appendage and contains the remnants of the septum primum, while it does not have a crista terminalis or pectinate muscles but rather demonstrates a smooth internal surface. The atrioventricular valves always accompany their reciprocal ventricles. The tricuspid valve has three cusps, three papillary muscles with a septal cusp and papillary muscle, and is separated from the pulmonary valve by a muscular infundibulum. It may, however, have a conal, rather than septal, papillary muscle. The mitral valve has two cusps and two papillary muscles with absence of septal attachments and has a fibrous continuity with the aortic valve. In congenital heart disorders, there may be a single common atrioventricular valve. The ventricles consist of three well developed parts: the inflow tract, the body and the outflow tract, which is of conotruncal origin. In congenital heart disorders, hypoplastic ventricles may consist of one or two of the above parts, or a single ventricle may be present. The morphological right ventricle has coarse trabeculations. The most prominent of the septomarginal trabeculae is termed the moderator band, which contains part of the electrical conduction system and is one of the most important right ventricular landmarks on imaging studies. The right ventricle has a muscular infundibulum, three papillary muscles (usually anterior, posterior and septal), and a tricuspid valve, with its diaphragmatic cusp closer to the apex. The morphological left ventricle has a cylindrical shape and smooth interior surface with small and thin trabeculae mainly at the apex, two papillary muscles (anterior and posterior), a bicuspid mitral valve with fibrous continuity between it and the aortic valve. The semilunar valves connect the ventricles to the great arteries. They consist of an annulus, cusps, and commissures without tensor apparatus (tendinous cords and

papillary muscles). Behind each cusp, there is an outpouching of the great artery, known as a sinus of Valsalva that imparts a tribulbous, or cloverleaf, shape to the arterial root. The junction between the sinus portion of a great artery and its distal tubular portion forms a prominent ridge, the sinotubular junction. From the right and left aortic sinuses, adjacent to the pulmonary artery and proximal to this junction arise the right and left coronary arteries, respectively, while the third sinus is termed the non-coronary sinus. The right coronary artery vascular territory typically includes the infundibulum and the RV free wall, while variations range from ending in the right atrioventricular groove up to the left atrioventricular groove, or rarely even up to the LAD territory. Usually, the posterior descending artery originates from the right coronary artery and supplies the inferoseptal part of the left ventricle; in a small proportion of individuals, the inferior wall has double arterial supply from both right coronary and left circumflex coronary arteries, while rarely the posterior descending artery originates solely from the left circumflex artery. The left anterior and left circumflex arteries arise from the short main stem of the left coronary artery. The left anterior descending artery courses in the anterior interventricular groove, terminating at the cardiac apex, while the left circumflex artery courses in the left atrioventricular groove. This lecture will focus on depiction of cardiac anatomy on different imaging modalities, familiarization with different imaging planes, specific anatomical characteristics of cardiac chambers as well as anatomical variants, which may mimic or cause pathology.

2203.2

MR of myocardial ischemia and viability

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Learning Objectives

1. To review the various degrees of coronary ischemia and the interest of depicting ischemic myocardium
2. To learn the results and techniques of MRI for detection of myocardial ischemia
3. To learn about the results and techniques of MRI in estimating myocardial viability

Normal myocardial contraction is dependent on an adequate coronary flow and oxygen delivery. The presence of stress-induced myocardial ischemia is diagnostic of coronary artery disease. Traditional stress tests have been based on ECG, nuclear medicine and ultrasound techniques. Cardiac MR is a powerful and novel technique able to diagnose myocardial ischemia with high sensitivity and specificity. This can be achieved with adenosine or dobutamine-stress. Adenosine-stress MR is able to assess cardiac perfusion reserve. First-pass imaging after the injection of gadolinium chelates (0.1 mmol/kg) is performed at rest and during stress (infusion of adenosine for 3 minutes at a dose of 140 µg/kg/min). Significant coronary artery disease is diagnosed by the presence of hypoperfusion at stress not present at rest. Dobutamine-stress is based on the response of the myocardium to increased doses of this drug (5/10/20/30/40 µg/kg/min). The presence of declining systolic myocardial thickening and new wall motion abnormalities with increasing doses is diagnostic of significant disease. Viable myocardium is defined by the presence of living myocytes, irrespective of their contractile function. The goal of assessing viability is to identify patients with ischemic left ventricular dysfunction that may improve their function after coronary revascularization. Several imaging techniques can be used for the assessment of myocardial viability. Nuclear medicine techniques such as sestamibi- and thallium-SPECT have been extensively used. FDG-PET is a more recent technique with greater diagnostic accuracy than the former. Low-dose dobutamine stress echocardiography (DSE) has greater specificity but lower sensitivity than thallium-SPECT. CT can detect areas of delayed enhancement, but the need for an additional acquisition with greater radiation exposure, use of iodinated contrast, and smaller contrast resolution between infarcted and non-infarcted myocardium are important drawbacks. MR is now one of the most important imaging tools in viability imaging. Myocardial wall thickness greater than 5 mm in areas of chronic transmural myocardial infarction (MI) was initially proposed as a marker of viability. However, there are segments with a thickness smaller than 5 mm that improve function after revascularization and others with a thickness greater than 5 mm that do not. Delayed-enhancement MR (DE-MR) is performed 10 to 15 minutes after the administration of 0.1-0.2 mmol/kg of gadolinium chelates with an inversion-recovery gradient echo sequence. The normal myocardium has uniform low signal and abnormal areas appear enhanced. Ischemic DE is starts in the subendocardial layer and can progress to involve the entire thickness of the wall and it has a vascular distribution pattern. It is a very robust technique as it is the only imaging technique that can quantify the transmural extent of infarction (TEI). DE-MR predicts functional improvement after reperfusion and the likelihood of improvement is inversely related with the TEI. Low-dose dobutamine-stress MR (5 µg/kg/min) also has an excellent sensitivity and specificity in the detection of viable myocardium, greater than DSE. Viable myocardium is identified by the presence of improved function with low-dose dobutamine compared with rest. In conclusion, MR is a very useful technique as it provides important information regarding cardiac function, myocardial perfusion and myocardial viability.

2203.3

Coronary CTA

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Learning Objectives

1. To know when to apply a coronary CTA examination
2. To know how to perform a proper coronary CTA scan
3. To properly interpret the CTA images
4. To further direct the diagnostic workup of the patient

Over the last decade multi-detector-row computed tomography (MDCT) has continued its rapid technological development and has been established as a non-invasive imaging method of the heart. With introduction of 64- or even 320-slice scanners and increasing gantry rotation times down to 280 ms both spatial and temporal resolution have improved allowing for detailed analysis of the rapidly moving coronary arteries (1-4). With the introduction of dual-source CT-scanning (DSCT) and flash CT temporal resolution has improved even further down to 75-83 msec (5).

When performing cardiac CT, proper patient selection and patient preparation are key-issues in order to achieve satisfying results. Sinus rhythm is desirable and contraindications for iodine contrast media like renal insufficiency and hyperthyroidism need to be respected. Administration of oral or i.v. Beta-blockers has to be considered in patients with heart rates above 80 bpm and knowledge of contra-indications and potential side-effects is crucial. ECG-synchronization is essential in cardiac MDCT and retrospective ECG gating has been established for state of the art contrast-enhanced scanning. However, pitfalls in ECG-lead placement and strategies for better ECG signal acquisition always need to be considered. Even in DSCT-scanning the use of a beta-blocker may be beneficial as not only the heart rate but also the heart beat variability are decreased, both leading to improved image quality (6).

For data acquisition several parameters like the detector collimation, the (heart rate dependent) pitch or different means of radiation dose reduction can be modified. Radiation dose reduction in cardiac CT-scanning may be achieved following different strategies. Depending

on the patient's body weight or body-mass index the tube current can be adapted (7). Some vendors implement tools for attenuation based dose adaptation with the corresponding tube current value being chosen based on the attenuation of the scanogram. For non-enhanced scans a dose reduction of up to 31.1% could be achieved (8). Second ECG-dependent tube current modulation offers the possibility for considerable patient dose reduction (9). Sinus rhythm is mandatory for this technique and depending on the patient' s heart rate the radiation exposure can be reduced by 28% to 48%. With newer generations of CT-scanners also the pitch can be adapted to the patient's heart rate with higher pitch values for higher heart rates (5). With increasing patient dose the idea of prospective ECG-triggering in CTA has been reintroduced (10-13). With wide detectors and short rotations times this approach appears to offer a comparable image quality with a potential dose reduction of up to 83% resulting in 2.8 mSv per examination (11). With Flash CT the patient dose may re even less (5). In comparison to phantom measurements calculation programs for estimation of radiation exposure proved to be useful and reliable (14).

Applying retrospective ECG gating a continuous spiral CT scan with simultaneous ECG tracing results in a 4D dataset; after completion of the scan, image reconstruction with respect to the stored ECG signal is performed. As the anatomic structures of the heart are continuously imaged over the whole cardiac cycle, a substantially reduced pitch factor (table feed/total collimation) is mandatory. In return however, images at every phase of the cardiac cycle can be reconstructed from the acquired 4D dataset.

Of course, optimum vessel lumen attenuation is a major prerequisite for optimum image quality and diagnostic value of cardiac MDCT, in order to detect atherosclerotic changes and coronary artery stenoses. An intravascular attenuation of 350-400 HU is recommended for coronary CTA (15). Injection parameters for optimum bolus geometry in cardiac CT-angiography (CTA) include an iodine flow rate from 1.2 to 2 g/s. With decreasing scan time precise bolus timing has become even more crucial. The choice between different iodine concentrations, contrast volumes, several injection phases and flow rates has to be made and the injection protocol may also be weight-adapted (16). The use of a saline chaser is recommended.

After completion of the scan features like different convolution kernels, multi-phase image reconstruction, (automated) detection of motion-artefact-free cardiac phases and different tools for image post-processing including (curved) multiplanar reformations, maximum-intensity projections and volume rendering techniques are available. The introduced automated detection of motion-artefact-free cardiac phases proved to be very helpful and time-saving in every day reading. Automated segmentation of the coronary artery tree however is continuously improving and will hopefully soon no longer require manual editing and correction (17). Knowledge and understanding of these technical parameters and tools is essential in order to achieve the best possible image quality prevailing solid diagnostic information.

Properly applied cardiac MDCT allows for imaging of the coronary arteries with detection and quantification of coronary stenoses including assessment of plaque morphology. In several studies for all scanner generations the clinical accuracy of cardiac MDCT for the detection and quantification of coronary artery disease (CAD) has been evaluated. Results are continuously improving with values for sensitivity and negative predictive value in the end 90ies. At present the major strength of cardiac MDCT is ruling out relevant coronary artery disease rather than precise quantification of coronary artery lumen narrowing, especially as severe calcifications may hamper precise quantification of lumen narrowing.

However cardiac MDCT is not only capable of imaging the coronary arteries. Within the same ECG-gated examination also assessment of global cardiac anatomy, stent-patency (or stenosis), bypass-grafts, anatomical course and size of coronary veins, cardiac valve morphology and also left- or right-ventricular function is possible (18-25). Applying modified or additional scans also information on myocardial viability and myocardial perfusion can be obtained (26, 27).

Thus, a complete cardiac CT report includes evaluation of all cardiac structures and requires distinct knowledge of cardiac anatomy and pathology. Being able to utilize the options on hand cardiac MDCT offers the potential for a comprehensive examination of the heart in a single breath-hold examination.

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Honorary Lecture
Josef Roesch Lecture

2402.1

New frontiers in Interventional Radiology

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Collectively, as interventional radiologists we share a legacy of innovation. Year after year, decade after decade, we have witnessed sustained technical progress associated with the consistent creation of new, less-invasive non-vascular and endovascular therapies that deliver clinical benefits to patients and demonstrable value to health systems. But, what about our future with turf battles, financial turmoil, training challenges, crescendo friction spiraling on all sides, can we continue to move forward or is our momentum sapped. Has our wave run out of energy? Did we just hit the beach for good? Or are we simply getting into position for the next big one_the proverbial ride of our life, a tsunami of oncological opportunities, a swell of venous possibilities, a cresting wall of image-guided potential. Maybe or maybe not; what will determine our future? Is it what we've done or what we will do? Today, we examine the factors that will influence the new frontiers in IR what the future holds. We will examine the undeniable evolutions we have experienced in our field and explore the inevitabilities we will face in the future. How will we take advantage of the dynamic re-calibration of current medical priorities that emphasizes dynamic functional monitoring over fixed anatomic rendering; patho-physiology over pathology; in vivo tissue observation over ex vivo tissue examination; real-time image-guided navigation, tracking, and interventional guidance over procedural planning based exclusively on prior imaging exams, and the general trends of molecular biology and chemistry displacing histology and physics? What new therapies will be developed to better manage diseases we frequently encounter in our practices; what current techniques will be adapted to treat patients with lesions not presently addressed by IR; how will the application of completely new procedures introduce less invasive alternatives to patients who previously had only medical or open surgical options, and how will new image-guided intra-procedural monitoring help deliver on promises of safer, more accurate, faster, and less invasive interventions. So, as we peer into the crystal ball, is it grey, troubled clouds for the next generation or clear, blue skies for the future of IR?

Special Session
Venous disease

2702.1

Treatment of acute DVT

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Learning Objectives

1. To illustrate the typical clinical, imaging and lab features of acute DVT
2. To present the various Interventional techniques in acute DVT
3. To review the current evidence for interventional treatment of acute DVT

2009 will be remembered as a watershed moment in DVT treatment. After decades of research, data gathering, and planning, what should be the pivotal study in percutaneous treatment of DVT will begin enrolling patients. The ATTRACT trial (www.clinicaltrials.gov), a prospective randomized trial comparing standard anticoagulation therapy to catheter-directed mechanical and pharmacological lysis (plus anticoagulation), will hopefully emerge as the key evidentiary basis to bring DVT lysis from relative obscurity to front page news. This trial is long overdue; in the era of evidence based medicine, the stagnation that has occurred evidence-wise in DVT is inexplicable. ATTRACT is not the only trial; the CaVenT trial, comparing infusion lysis to standard therapy, is already enrolling (1). It is far beyond the scope of this presentation to review the topic of DVT treatment in anything but the briefest fashion. As a foundation, it is essential to remember the grades of evidence basis, with systematic reviews forming the highest levels of evidence, followed by randomized controlled trials (www.cochrane.org). For large portions of (non-interventional) DVT treatment, not only are there RCTs, there are enough RCTs to do systematic reviews and develop grade 1 recommendations. For catheter-directed lysis, the story is far less favorable; a single small randomized trial and at best grade 2 recommendations. Even so, just this year, the American College of Chest Physicians (ACCP) has upgraded its recommendations in that area (2), and ATTRACT and CAVENT, assuming they produce favorable results, should contribute far more. I will divide the discussion into two parts: evidence based recommendations for treatment of DVT, and similarly evidence based recommendations (to the extent possible) for technical aspects of DVT lysis. Systematic reviews in this area are available (3, 4). Thus, based on available evidence, what can be recommended in the treatment of acute DVT? The following are

drawn from the ACCP 2008 document (2). Pay careful attention to the level of evidence grading as it is both instructive and compelling as we look toward improving the evidentiary basis for what IR physicians offer in this area. Anticoagulation (AC) is front-line therapy for confirmed DVT and a variety of heparin anticoagulants including unfractionated and low molecular weight preparations are recommended with Grade 1A evidence. AC is recommended for highly clinically suspected DVT pending the results of diagnostic tests (Grade 1C). AC should be continued for at least 5 days or INR 2 for 24 hrs (Grade 1C), and vitamin K antagonists should be administered right away with the heparin (Grade 1A). Specifics as to heparin dosing are provided with Grade 1C evidence. Catheter directed thrombolysis, previously recommended only in the setting of limb salvage, i.e., phlegmasia cerulea dolens (5), is now recommended in patients who have been shown in trials to date to do well with such treatment (duration less than 14 days, iliofemoral location, good life expectancy (>1 yr), good functional status and low bleeding risks. The evidence basis for this is Grade 2B. This recommendation assumes "appropriate expertise and resources are available". The guidelines make recommendations to treat underlying lesions with PTA or stents; something we take for granted and yet the evidence basis is a paltry grade 2C. Likewise, mechanical techniques in addition to infusion lysis are recommended to shorten procedure time (again subject to resources and expertise and again only with grade 2C evidence). It will be very interesting to see if the CaVenT trial will change this in future guidelines; at very least, the evidence basis will be stronger. Interestingly, systemic thrombolytic therapy continues to be supported (if catheter directed therapy is not available) and also with grade 2C evidence. Thus, even after nearly two decades of catheter directed lysis, it is still lumped with an abandoned, decades old concept. This deeply underscores the need for RCTs in DVT catheter directed therapies. Also of interest is a grade 2C recommendation that mechanical thrombectomy ALONE not be done. The genesis of this recommendation is unclear, again calling for further research to support the existing early work in this area. Operative thrombectomy is supported in highly selected patients with grade 2B evidence; however, again, catheter directed therapy is felt preferable to surgery if not contraindicated. Indirectly, the guidelines thus recommend that a patient with contraindication to lysis and fresh clot (<7 days) go to surgery rather than mechanical alone CDT. Other recommendations include not using IVC filters routinely with AC therapy (grade 1A), support for IVC filters when AC is contraindicated (grade 1C), and anticoagulation even with a filter in place if the contraindication to AC subsequently resolves (grade 1C). Early ambulation is recommended (grade 1A). Asymptomatic DVT should be treated with AC (grade 1C). Compression stockings are strongly supported (grade 1A) and should be used for 2 years, a key point to remember when caring for patients with acute DVT. When examining technical aspects of catheter directed DVT treatment, an evidence based approach is presently difficult at best. One attempt has been made at systematic review (4). Interestingly, this review excluded the sole RCT in this area (6) because immediate thrombolysis was not reported. In brief, the authors point out that there are insufficient data to perform an analysis or make evidence based recommendations. An outstanding recent review by Vedantham (7), the principal investigator of the ATTRACT trial, makes similar observations and the dearth of long term data proving that CDT is beneficial in DVT. Nonetheless, the results of the Elsharawy study are sufficiently tantalizing to offer great hope that CaVenT and ATTRACT will lend strong evidentiary support to the practice. ATTRACT will allow use of either infusion alone, or Trellis (Covidien, Mansfield, MN) or AngioJet (Possis Medical, Minneapolis, MN) in conjunction with rt-PA infusion for up to 24 hours. Patients will be randomized to CDT plus AC or best medical therapy (AC) as above; estimated enrollment is 692 subjects and is hoped to be completed by 2014. The primary outcome measure is post thrombotic syndrome (PTS), with secondary measures including resolution of DVT symptoms, severity of PTS, valvular function, clot lysis and cost-effectiveness, as well as major bleeding, PE, recurrent DVT and death. Thus, the trial is poised to answer the burning clinical questions surrounding CDT for DVT as well as at least some of the technical ones (Trellis vs AngioJet). It will not address other mechanical therapies in use for DVT including US-enhanced lysis (EKOS, Bothell, WA and OnmiWave, OmniSonics, Wilmington, MA), the ATD (Helix, EV3, Plymouth, MA), and the PTD (Arrow/Teleflex, Reading, PA) which are supported by relatively low grade evidence at this point (as are Trellis and AngioJet pending ATTRACT outcome) (8-16). It will be incumbent upon those device manufacturers wishing to be a part of this field to construct adequately powered RCTs to support their tools in this area. Of note, ATTRACT is funded by the United States National Institutes of Health, with industry collaboration. The CaVenT trial, actively enrolling in Norway, compares infusion lysis with alteplase to best medical therapy and is expected to enroll 200 patients. The trial will allow inclusion up to 21 days from onset of symptoms, unlike ATTRACT which is limited to 14 days, and infusion up to 96 hours. Primary endpoints include 6 month patency by noninvasive imaging and postthrombotic syndrome at 24 months with quality of life and clinical status determination. It should be pointed out that the lower level evidence collected and published over the past two decades of CDT have formed the foundation of these trials; the Venous Registry (17) in particular taught us where the "sweet spot" of DVT CDT was: clot less than 10 days old, iliofemoral location, first DVT episode, and no cancer, to name a few, and these are reflected in the exclusion criteria (with some variation) of both trials. Further, the technical lessons learned from the venous registry and other studies (popliteal instead of jugular access, no need for filters, PTA and stent placement of underlying lesions) support not only these trials but our daily practice as well (18, 19). We owe those investigators a debt of gratitude, as we will certainly owe the present ATTRACT and CaVenT investigators when their studies are complete. In summary, after decades of waiting, we are poised to have strong evidentiary basis for DVT lysis within the next 5 years, and if the trials described above yield results anywhere near as good as those of the Elsharawy trial (which showed significant improvement in both patency and valvular reflux at 6 months for CDT compated with standard therapy) (6), the next ACCP document will not only recommend CDT as first line treatment for most patients, it will be supported with level 1 evidence. Assuming this occurs, CDT of DVT will dramatically increase worldwide. Those interested in CDT of DVT should pay close attention to the progress of these trials and be prepared for this growth when the time comes. In the meantime, IR physicians should practice evidence based treatment of DVT as outlined above and do so using those techniques with which they are most comfortable, as we do not at present know if one method is superior to another.

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2702.2

Imaging and diagnosis of chronic venous insufficiency

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Learning Objectives

1. To explain the basics of inferior limb venous anatomy
2. To review the clinical presentation of varicose veins
3. To review imaging and diagnostic work up in case of CVI

Chronic venous insufficiency (CVI) is prevalent, with an incidence between 0.5 and 3.0% in Europe and America; it results in venous hypertension, with up to 1.5% of European adults suffering a venous stasis ulcer in their lives. The management of CVI, along with the morbidity it carries, is costly. For imaging and diagnosis of chronic venous insufficiency, it is essential to know the pathophysiologic mechanisms involved at the macrocirculatory and microcirculatory levels, the relevant clinical signs, the deep and superficial venous anatomy and the different imaging techniques available. Finally, we must communicate with each other in a clear, standardized way. The author proposes to discuss in detail the relevant aspects of the various topics described below. The valve-containing deep venous system is the prime carrier of blood from the lower limbs, by means of muscular contraction. The superficial veins also contain valves, directing flow cranially, and connect with the deep system by means of perforating veins, with check valves, that pierce the deep fascia of the lower limbs. The intradermal and the reticular subdermal venous networks also direct blood flow toward the deeper venous system. Venous insufficiency, either primary or secondary, allows retrograde flow, accumulation of blood and increased pressure, potentially leading to failure of the next valve down, like a domino. The associated increased microcirculatory venous pressure damages the skin and the subcutaneous tissue. Chronic venous insufficiency manifests clinically as telangiectasias or spider veins (intradermal), reticular veins (subdermal) and varicose veins (subcutaneous). Edema, skin changes and ulcers are signs of advanced disease. The greater saphenous vein lies on the deep fascia of the medial thigh and leg, generally deep to the superficial fascia. It has some important, constant, tributaries; the tributaries at the fossa ovalis play a more important role in recurrence. The lesser saphenous vein ascends virtually in the midline in the calf, has no constant important tributaries and, unlike the greater saphenous vein, may penetrate the deep fascia at any point from the middle third of the calf upward. The perforator veins connect the superficial to the deep venous system either directly to the main axial veins (direct perforators) or indirectly to muscular tributaries (indirect perforators); they may be the source of venous hypertension that produce superficial varicosities; they are extensively located, including Hunter`s, Dodd´s, Boyd´s, Cockett´s and the infra-maleollar. Recognizing the normal anatomy makes identification of patterns of varicosities possible. Knowledge of the cutaneous nerves distribution is essential for percutaneous treatment strategies. Triplex US is the single most useful test of chronic venous disease. It permits a detailed study of the wall and the lumen of the deep and superficial veins of the lower extremities and a detailed analysis of the characteristics of venous flow, with a triple objective: thrombosis/post-thrombotic changes, reflux and the mapping of varicose and perforator veins. It should be systematically done in a bilateral and comparative way, with the patient standing up and lying down, being able to uncover the major origins of superficial venous reflux: the principal saphenous veins, the accessory saphenous veins, the perforator veins and the pelvic-originating veins. The study provides both anatomic and functional data and should involve hand-held transducer compression of the infra-inguinal veins and evaluation of the response of the different venous segments to Valsalva and "augmentation" manoeuvres; it should include diameter measurements and mapping of the varicose and incompetent perforator veins. Conventional venography is reserved for the cases that require additional diagnostic confirmation after noninvasive testing. In ascending venography, contrast injected into a vein on the dorsum of the foot is followed as it ascends the leg; tourniquets are used at the mid-calf and knee to compartmentalize the superficial veins and allow identification of retrograde flow from the deep system through incompetent perforating veins. Descending venography evaluates venous valvular incompetence, and requires a conventional femoral vein puncture. Contrast-enhanced 3D GRE MR venography can depict with confidence the deep and superficial venous systems of the lower extremities, assess varicose and postthrombotic changes as well as bypass suitability of the saphenous veins. It is being increasingly used, having the advantage of a better nephrographic profile and the lack of risk of

thrombosis. CT of the lower extremities veins has been widely used in the study of venopulmonary thromboembolism, combining angioCT of the pulmonary arteries and indirect CT venography of the lower limbs in one session. It is not generally used for the study of the superficial venous system, but can be complementary to Doppler US, particularly in unusual causes of varicose veins, with unexpected anatomic source. There has been an effort in the last years to achieve standardization in the diagnosis of chronic venous insufficiency, not only to select an appropriate treatment for a given patient but also to communicate properly and compare results of different therapies. The CEAP classification was devised in 1994 with this intent. It is a practical classification that takes into account the different relevant aspects of chronic venous insufficiency, namely the clinical signs (C), the aetiology of the insufficiency (E), its anatomical distribution and the pathologic mechanism of development (P); it also provides severity rating and disability scales.

2702.3

Treatment of chronic occlusive venous disease

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Learning Objectives

1. To present the various treatment techniques in chronic occlusive venous disease
2. To review the different occlusive disease treatment devices available
3. To discuss, with clinical cases, tips and tricks in chronic occlusive venous disease

A thorough history and careful physical examination is required from each and every patient. Ideally they should be seen in the IR clinic before the procedure, and then seen again when the results of imaging is available so that a detailed discussion of the risks, benefits and alternatives of the procedure may take place. Often patients are referred on the basis of abnormal imaging and it transpires they have few symptoms; although it is also fair to say that patients may sub-consciously modify their life style to diminish their symptoms, for example, young patients who do not like walking or dancing as their legs get tired and "tight", which they attribute to lack of fitness. Pre-operative imaging is essential for accurate treatment. Doppler US, in skilled hands, may be all that is required for limb problems, but it is somewhat operator dependent and I prefer to do all the scanning myself. Often veins that are regarded as "normal" by a sonographer may show a lack of distensibility, which is due to a prior DVT with scarring/recanalisation. This will affect the site of puncture and treatment plan. Increasingly, I use CT venography particularly for truncal venous problems (iliacs/IVC/SVC/brachiocephalics/subcalvians). This is very useful in assessing size of veins, occlusions, collaterals, venous anomalies, and acute thrombus. The basic aims of imaging are to determine the length of occlusion, the preferred venous access point, and to confirm the absence of acute or chronic thrombus. The patient is brought to the IR suite and placed in the appropriate position. It is sensible to clean and prepare two skin sites as often the first may be unsuccessful. I prefer to perform these procedures under conscious sedation rather than general anaesthetic. Passage more than about 1 cm outside the vein is painful and this is a useful hint to change direction or to use a different obliquity.

General rules: depending on the length of the occlusion, a variety of techniques may be employed comparable to those employed in treating arterial occlusions. Torqueable catheters, as well as the full gamut of hydrophilic wires are useful, and venography in a variety of obliquities are all critical to success. The use of long or large sheaths may be very helpful in providing firm support directly at the point of lesion traversal. Tumour compression is a special case, and surprisingly is usually easier to cross than occlusion secondary to DVT. This is because the vein is often not truly occluded, merely compressed, and this is not seen on cross sectional imaging, only on direct venography close to the causative lesion. Abolition of collaterals and rapid in line flow are the criteria of technical success.

Specific cases

Lower limb venous occlusion: each case is different but in essence, the more proximal the vein the greater its importance. The SFV duplicates relatively frequently, and unless very symptomatic, I will not balloon this. I prefer not to stent below inflow of the greater saphenous vein unless there is really very poor flow. The popliteal vein can scar severely after a DVT, and at least 6 months should elapse before attempting any work here following DVT. Inflammation is often quite severe up to 4 months. Common femoral vein occlusion is usually secondary to catheters or prior DVT, but, because of inflow from three main tributaries (SFV/PFV/GSV), occlusion is relatively uncommon

Iliac vein occlusion: usually common iliac vein secondary to prior DVT/iliac vein compression syndrome, initial US will assess patency of femoral vein as an access site. If patent, then a standard sub-intimal passage is usually successful, position confirmed in the IVC, and a long self expanding stent is chosen to bridge the gap.

IVC occlusion: difficulty increases with length of occlusion; for instance, if iliac veins also occluded then it may be more difficult. Use of the lateral projection is essential to monitor wire passage and trajectory. Usually, the IVC reforms above renal vein inflow. Stents need to be placed from an area of flow to an area of flow, and if this necessitates crossing the renal veins, then concerns about renal vein patency may be overstated (ref).

SVC occlusion: may be secondary to tumour or more commonly due to central venous catheters. The latter is more difficult as it more commonly involves the brachio-cephalic veins. This is the most common indication for sharp recanalisation, but this should only be undertaken if all other techniques have failed. The mediastinum obviously has a good number of critical structures which do not respond well to inadvertent puncure (although in truth, I have only seen disasters occur when the initial cannulation is followed by serial dilatation usually in the case of central venous access by non radiologists). Often the trick is to recognize the azygous which may have hypertrophied considerably and may resemble the SVC; oblique views will usually demonstrate a nipple leading to the SVC below the insertion of the azygous. 30 degree obliquities are useful to recognize this.

Axillary/subclavia/brachiocephalic vein occlusion: usually asymptomatic, or minimally symptomatic, unless there is an AV fistula for dialysis further down the arm. Collaterals will develop, and symptoms will usually abate. If an AV fistula is present, however, then the arm will be massively swollen with even a stenosis, so an occlusion will usually cause recirculation and poor functioning of the graft/fistula. In that case, a no holds barred approach should be taken to cross any occlusion. Stents are to be avoided between the post operative care. Full dose Low Molecular Weight Heparin is employed until an INR of 2-3 is attained. Class II compression stockings (thigh high) are utilised. Colour Doppler US or CT venogram is ALWAYS necessary on day 1 post op. If the flow is not perfect, or if the patients symptoms are NOT improving, then I will take the patient back to the IR suite immediately.

2702.4

Results of foam/laser/RFA ablation for varicose veins

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Learning Objectives

1. To show the basic steps/indication of RFA of varicose veins
2. To show the basic steps/indication of laser ablation of varicose veins

3. To show the basic steps/indication of foam injection in varicose veins
4. To discuss the comparative results of the 3 techniques

It is now generally accepted by most of those with a specific interest in the treatment of venous disease that surgery for varicose veins is a historical technique. Endovenous methods offer the following clear and indisputable advantages over traditional surgery: No requirement for general anaesthesia; No cuts or scars; No down time from normal activities; Fewer and less serious acute complications; and Reduced costs. In addition, the evidence so far indicates that the high recurrence rates after traditional surgery are not mirrored by the endovenous options. Patients are increasingly aware of the options available and are demanding non surgical treatment. Still the diehards persist in performing surgery and even many advocates of endovascular techniques claim that these methods are only suitable for 70% of patients who have had no previous surgery and only 20% of those who have had recurrence following surgery. Despite EVLA being developed by interventional radiologists, in many European countries it is the surgeons who have taken on the endovenous management of varicose veins. This is for historical reasons in that, as surgery has been the only effective treatment for this condition for many years, patients with varicose veins are still normally referred to surgeons. Varicose veins are common and can be a lucrative source of income. The surgeons receiving these referrals, therefore, are reluctant to refer to interventional radiologists for endovascular treatment as they have in the past for endovascular arterial work. Instead, they have purchased ultrasound equipment themselves and set themselves up as endovenous specialists. Interventional radiologists, especially those with a major interest in vascular disease, have a very close working relationship with vascular surgeons and being rather shy and retiring characters have not wished to start a local turf war and have let the surgeons get on with it. This is a great shame as the skills of the fully trained interventional radiologist are lost to these endovenous techniques and it explains the very low percentages of patients in practice considered suitable for and therefore offered endovenous options. Most cases of great or small saphenous reflux are simple to catheterize and treat but there remain many patients whose veins (particularly the anterolateral thigh vein) are tortuous or which go easily into spasm. It is this significant minority who are frequently either refused endovenous options or are converted to surgery. It is also this significant minority who, to interventional radiologists, are a welcome challenge rather than a chore to treat utilizing to the full our abilities with ultrasound tracking of small, superficial and tortuous vessels, needle, wire and catheter choice, guidance and manipulation. Perforator incompetence is of disputed importance almost certainly because it has traditionally been a very difficult problem to solve. Surgical options have been traumatic and fraught with complications. Accurate percutaneous cannulation of perforators is another challenge easily learnt by interventional radiologists but a step too far for most without extensive ultrasound experience. I suspect that many attempts to ablate perforators actually result in a perivenous rather than intravenous attack. Finally, embolisation techniques are essential in the proper control of reflux arising from internal iliac and gonadal veins a not uncommon problem in clinical practice but one frequently ignored. Although the original much cited reports on laser were at 810 nm wavelength, there are now many different lasers of a bewildering range of wavelength marketed for venous ablation. Patent protection in the US has spawned new fibre and catheter tips and some surgeons' reluctance to undertake perivenous anaesthetic tumescence has led to the development of laser fibres and wavelengths designed to eliminate the need for anaesthesia altogether. Most of the original studies on RF were undertaken using a totally different temperature and method and time of application to the models now on the market. Foam sclerotherapy is an art rather than a science. There is no manufactured approved foam sclerosant or standard means of making or applying the foam and each operator has his or her own recipe and technique. Many studies have been reported by doctors who have commercial interests with particular manufacturers each of whom is desperate to prove that their particular machine is better than the competition's. This background complicates the assessment and relevance to everyday practice of the results of studies on these new endovenous techniques as large numbers of case series have been reported in the surgical literature but there have been precious few RCTs looking at these techniques, using equipment now on the market, and which have been undertaken by interventional radiologists. This talk will analyse, summarize and try to make sense of the published results of EVLA, foam sclerotherapy and RF ablation in the management of all types of varicose veins and put that in perspective with the authors' own extensive experience of all three methods over the last 6 years.

Special Session
Future technology

2703.1

Nanotechnology: what can it bring for us

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Learning Objectives

1. To define what nanotechnology is
2. To review the potential use in IR
3. To provide additional information sources (websites, etc.)

Nanotechnology

Nanotechnology is a worldwide industrial and scientific enterprise that has engendered a new revolution in industry, health and medicine, computing, electronics, aviation, construction and many more areas. Major governmental funding is being poured into nano research. In the US, $500 million dollars was invested in nanotech research in 1997, rising to $3.5 billion dollars in 2004, and a projected $1000 billion by 2012. Nanotechnology holds the promise of revolutionising fields ranging from medical science to optical communication and potentially could lead to a new industrial revolution (Gary Stix). The NIH statement on nanotechnology is as follows: One envisions a world where diseases are diagnosed and prevented or treated at early stages. Implanted nanotechnological materials would become part of the body, a therapeutic agent would be delivered in the precise amount, at the site of action where they are needed. Obviously, the promise of nanotechnology is enormous. Nanotechnology refers to size. Nano means one billionth of a meter. The properties of atoms and molecules change at the nano level, in that one can see high wire resistance, low friction surfaces, high thermal conductivity, high electrical conductivity and variable porosity. This allows the potential of developing designer molecules. Nanotechnology can be defined as a study, design, creation, synthesis, manipulation, an application of functional materials, devices, insistence through control of matter at the nanometer scale (100 to 100 nanometers), that is, at the atomic and molecular levels, and the expectation of novel phomena and properties of matter at that scale. Put simply, nanotechnology is trying to manipulate or control molecules at a very small scale. For medicine and health the promise of nanotechnology include: diagnosing, treating and preventing disease, relieving pain and improving human health using molecular tools and knowledge. Essentially, this is a meeting between nanotechnology and biotechnology. Possible applications of nanotechnology include: gene therapy delivery, molecular imaging, molecular diagnostics, targeted drug delivery and in vivo imaging. Many fluorescent molecules and markers are currently being investigated in laboratories; these are often coupled with DNA, RNA, proteins, polymers etc. to diagnose specific diseases or malignancies. Ideally, in time, these molecular markers may bring a payload to the

site of disease for local, highly specific treatment. The idea that one could also monitor treatment at the same time is the Holy Grail. To this end, molecular imaging probes are also being developed for MR, PET and other imaging entities. For interventional radiology, we can expect improved catheters and balloons, with polymer nanocomposites, which will hopefully improve strength, stiffness and versatility of catheters and devices. New nanocomposites may provide stent coating that will not induce intimal hyperplasia and are non thrombogenic. Interventional radiology is ideally situated to take advantage of targeted drug delivery and intervene at the micro and nano scale. The future of this technology is certainly exciting and holds much promise for interventional radiology. Interventional radiologists are well poised to take advantage of the new nanocomposites that are even now being developed. However, collaboration with university basic science departments and laboratories performing nanotech research will be key for IRs.

2703.2

Gene therapy for critical limb ischemia

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Learning Objectives

1. To describe the different kinds of gene therapy available for the treatment of CLI
2. To describe the role of IR in the implementation of this treatment
3. To define the current limits and future possibilities

Following the pioneering works from EG Nabel who demonstrated the feasibility of vascular gene-therapy in vivo in the late eighties, gene transfer using several approaches was developed since 1996. Gene-therapy with the goal to increase or stimulate angiogenesis used mainly gene coding for growth factors such as vascular endothelial growth factor (VEGF)121, VEGF165, VEGF-C, fibroblastgrowth factor (FGF)-1 or hypoxia-inducible factor 1 (HIF-1) [8-13]. Initially, intra-arterial gene-therapy was used but systemic dilution of the gene-therapy product and diffusion of the atherosclerotic occlusion limited efficient transfer to the vicinity of the ischemic cells. For these reasons, direct intramuscular injection is hitherto the usual approach in peripheral arterial disease. It was demonstrated that intramuscular injection of naked plasmids is feasible, and that the plasmids remain in a non-replicative, unintegrated form that is thus unlikely to be complicated by insertional mutagenesis. Using this approach, plasmid expression could remain active for two months. In a pioneer phase I clinical trial, Baumgartner *et al.* used the same plasmid in 10 limbs of 9 CLI patients with non-healing ischemic ulcers or rest pain. A total dose of 4,000 µg of naked plasmid DNA encoding the 165-amino-acid isoform of VEGF165 was injected directly into the muscles of the ischemic limb. Gene expression was documented by a transient increase in serum levels of VEGF. The ankle-brachial index improved significantly (0.33±0.05 to 0.48±0.03, p=02) and newly visible collateral blood vessels were directly documented by contrast angiography in 7 limbs. Magnetic resonance angiography showed improved distal flow in 8 limbs. Ischemic ulcers healed or markedly improved in 4 of 7 limbs, including successful limb salvage in 3 patients initially planned for below-knee amputation. Complications were limited to transient foot and leg edema in 6 patients, an expected effect due to the vascular permeability role of VEGF. To date, more than 350 patients have been included in phase I and II trials. No serious side effects related to gene therapy were reported to date, but it is too earlier to conclude definitely on the efficiency of this new therapeutic approach. We will give a review of literature and discuss the potential problem raised by the stimulation of angiogenesis. The TALISMAN study is the only randomized study with gene therapy available to date. This study evaluated the efficacy and safety of intramuscular administration of NV1FGF, a plasmid-based angiogenic gene delivery system for local expression of fibroblast growth factor 1 (FGF-1), versus placebo, in patients with critical limb ischemia (CLI). In a double-blind, randomized, placebo-controlled, European, multinational study, 125 patients in whom revascularization was not considered to be a suitable option, presenting with nonhealing ulcer(s), were randomized to receive 8 intramuscular injections of placebo or 2.5 ml of NV1FGF at 0.2 mg/ml on days 1, 15, 30, and 45 (total16 mg: 4 × 4 mg). The primary end point was occurrence of complete healing of at least one ulcer in the treated limb at week 25. Secondary end points included anklebrachial index (ABI), amputation, and death. There were 107 patients eligible for evaluation. Improvements in ulcer healing were similar for use of NV1FGF (19.6%) and placebo (14.3%; *P*=0.514). However, the use of NV1FGF significantly reduced (by twofold) the risk of all amputations [hazard ratio (HR) 0.498; *P*=0.015] and major amputations (HR 0.371; *P*=0.015). Furthermore, there was a trend for reduced risk of death with the use of NV1FGF (HR 0.460; *P*=0.105). The adverse event incidence was high, and similar between the groups. In patients with CLI, plasmid-based NV1FGF gene transfer was well tolerated, and resulted in a significantly reduced risk of major amputation when compared with placebo. After the results of the new ongoing randomized study using NV1FGF:TAMARIS study, we will be able to confirm the potential role of gene therapy as a new armamentarium of PAD. Finally, from an evidence based medicine point of view, none of the gene- or cell-therapy published studies provide a definite answer concerning the efficacy and safety of the pro-angiogenic approach of CLI yet. They just demonstrate the feasibility of such a therapy, but definite answers will need larger randomized studies using amputation rate as major endpoint. Furthermore, the approach undertaken to date used either a single gene or at odds multiple crude cells from bone-marrow or mobilized peripheral blood. It remains to be analyzed if the administration of several genes, combination of gene- and cell-therapy, or the use of an optimized and more specific cell therapy product could achieve a more potent stimulation of angiogenesis. Several other major questions remain unanswered: which patients should be considered best for cell- or gene-therapy, what is the best route of delivery and is it necessary to perform additional transplantations or gene injections, what is the optimum number of cells or yield of plasmids to inject and is it safe to stimulate angiogenesis in the long term? All these questions demonstrate if necessary that we still are in the prehistoric age of this fascinating and promising development.

2703.3

Pancreatic islet cell transplantation

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Learning Objectives

1. To describe the current technique
2. To review the results in 2009
3. To describe the role of IR in the selection of patients, implementation of the technique

Type 1 dependent diabetes mellitus (T1D) is consecutive to loss of insulin production due to autoimmune destruction of β pancreatic cells (islets of Langerhans). Classical treatment is based on insulin therapy to normalize blood glucose levels and prevent acute and chronic complications of type 1 diabetes. Transplantation of human islets began in the 1970s but it was not until 1989 that the first patient was able to stop exogenous insulin. The success rate improved dramatically in 2000 with the "Edmoton Protocol" based on the need to transplant high quality islets in sufficient number and the use of steroid-free immunosuppressive therapy. General admitted criteria for allogenic islet cells transplantation are C-peptide negative type 1 diabetes for more than 5 years with previous kidney transplantation

or T1D with poor diabetes control including episodes of severe hypoglycemia, hypoglycemia unawareness, wide swings of blood glucose levels or consistently high HbA1c levels (>8%).

Islets isolation: islets are processed from pancreas procured from cadaveric heart-beating donors. The procedure of islets isolation consists in placing the harvested pancreas in a digestion chamber after injection of an enzyme (collagenase or liberase) in the main pancreatic duct. Islets are purified from the obtained preparation by gradient in a cell separator. Islets are then cultured in adapted solution. All the processing is done under sterile conditions. To be suitable for transplantation, the islet preparation isolated from a donor must contain more than 250,000 islet equivalents and viability up to 80%. The goal is to infuse 10,000 islets equivalent/kg of body mass of the recipient, though it is frequently necessary to perform one or two subsequent grafts.

Procedure of transplantation: the transplantation of islets is performed in a heterotopic location in the liver via the portal vein. The access to the portal vein is obtained by either trans-hepatic venous catheterization or through a mesenteric vein during a mini-laparotomy. The percutaneous image-guided trans-hepatic route is mainly used. This procedure can be done under local anesthesia and conscious sedation. An intra-hepatic portal branch is punctured generally in the right lobe of the liver. Ultrasonic guidance allows succeeding and securing the puncture. The remaining procedure is performed under fluoroscopic control. A guide wire is placed through the needle in the portal vein and a 4 to 6 French catheter is then pushed up to the portal trunk. Prior to islets infusion, an angiogram is performed to check the position of the catheter, the distribution and the patency of the portal tree. The pancreatic islets (size about 150 µm) suspended in albumin solution are infused by gravity, along with heparin to embolize in the whole liver parenchyma. Portal pressure monitoring shows usually a slight elevation during infusion of cells. At the end of the delivery, as the catheter is withdrawn, the trans-hepatic tract is usually occluded by embolic agent. A prophylactic anticoagulation is continued for several days to reduce the likelihood of an instant blood mediated inflammatory reaction. Exogenous insulin is given in the early post transplant period to prevent islet damage caused by hyperglycemia. The majority of serious adverse events related to the infusion procedure consist in bleeding complications mainly (13% of procedures) and portal vein thrombosis more rarely (4% partial or complete). The use of heparin has been shown to limit the incidence of thrombosis but to increase the rate of procedural bleeding. Sealing intra-hepatic tract has demonstrated a reduction of the incidence of post-procedural bleeding. The most frequently administered immunosuppressive protocol uses Sirolimus and Tacrolimus in combination as maintenance therapy and one or more induction agents (i.e., anti IL-2 receptor) at the time of the first islet infusion.

Results: the report published by the Collaborative Islet Transplant Registry (CITR) in 2008 about 325 recipients of 624 islet infusions shows at three years 23% insulin independence, 29% insulin dependence with detectable C-peptide, 26% loss of graft function and 22% missing data. Severe hypoglycemic events decrease dramatically from 85% of patients before transplantation to less than 5% in the first year. High numbers of infusion, greater number of islet equivalents infused, lower pre-transplant HbA1c, processing center related to the transplant center and larger islet size are factors that favor the primary outcomes. In our Swiss-French multicenter study GRAGIL 2 concerning 18 T1D patients with poor glucose control (34 infusions), we report significant decrease of HbA1c levels (≤7%) in 67% of recipients, decrease of insulin requirement ≥30% in 89%, C-peptide ≥ 0.5ng/ml in 83% and no severe hypoglycemia in 67% at one year after transplantation.

Conclusion: transplantation of isolated pancreatic islet has presently become a clinical option to be considered in the treatment of T1D after kidney transplantation or in case of unstable T1D despite optimal insulin therapy.

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2703.4

The future of catheter guided cancer therapy

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Learning Objectives

1. To describe the role of new targets and cellular mechanisms of cancer
2. To explore the potential interest of addressing these targets by intra-arterial delivery
3. To explain where the local delivery of therapeutic agents can go in the future

In this brief report, we will present some of the most promising new concepts involving transcatheter intraarterial therapies for hepatocellular carcinoma.

A. Anti-VEGF antibodies in combination with TACE: HCCs are vascular tumors and increased levels of vascular endothelial growth factor (VEGF) and microvessel density have been observed. High VEGF expression has been associated with inferior survival. Therefore, inhibition of angiogenesis represents a potential therapeutic target in HCC. Interestingly, and in contrast to the traditional belief that tumor ischemia is favorable, several recent studies have shown that tumor ischemia and hypoxia up-regulate several molecular factors, including VEGF, provide resistance to cell apoptosis and stimulate the growth of hepatocellular carcinoma cells. Moreover, the degree

of VEGF expression is reported to be associated with HCC tumor size and histologic grade. Bevacizumab (Avastin™, Genentech Inc, San Francisco, CA), a humanized monoclonal antibody that binds vascular endothelial growth factor (VEGF) and prevents its interaction to receptors on the surface of endothelial cells, has recently emerged as an important therapeutic agent in colorectal cancer and has been added to the triple chemoembolization cocktail for patients with primary and metastatic liver cancer. In addition to its direct antiangiogenic effects, bevacizumab may enhance chemotherapy administration by normalizing tumor vasculature and decreasing the elevated interstitial pressure in tumors. A recent pilot study suggested that bevacizumab can be given safely at both 5 and 10 mg/kg in HCC patients with localized unresectable HCC, preserved liver function and no significant esophageal varices. In another pilot study, selected HCC patients undergoing transcatheter arterial chemoembolization (TACE) additionally received intravenous bevacizumab, which was well tolerated and prolonged disease control. Currently, there are two NCI phase II trials evaluating the safety and efficacy of bevacizumab in patients with primary unresectable liver cancer. In our institution, a phase II Trial of bevacizumab with TACE for HCC has just started enrolling patients. TACE is designed to be performed on day 1 of a 42 day therapy cycle and IV administration of bevacizumab (10 mg/kg) will be administered on days 7, 8 and 22. Data from these trials may guide the development of novel antiangiogenic liver cancer regimens. It is important to note that successful execution of these trials depends not only on the transfer of expertise from the bench to the bedside, but also on the productive collaboration of clinicians in a multidisciplinary oncologic setting.

B. Drug-eluting beads for TACE: Currently, there is intense research activity in the area of nanotechnology and drug-delivery systems. The ideal drug-loaded carriers should deliver the agent precisely, release it in a controlled and sustained manner, and achieve high intra-tumor drug concentration for a sufficient period, without damaging the surrounding hepatic parenchyma. Several drug-delivery systems for intraarterial treatment of hepatic lesions, such as polyvinyl alcohol microspheres and plcg-microspheres, have been recently tested. Polyvinyl alcohol (PVA) hydrogel microspheres can be loaded with a single chemotherapeutic agent, such as doxorubicin or irinotecan, and infused intrarterially for selective tumor targeting. Doxorubicin-eluting beads (DC Bead™ for loading by the physician and PRECISION Bead™ preloaded with doxorubicin, Biocompatibles UK Ltd, Surrey, UK) were initially tested on the rabbit Vx-2 tumor model and demonstrated consistent drug release over time with excellent tumor control. These recently published animal data have shown that the concentration of doxorubicin within the tumor remains high up to seven days post transcatheter infusion, suggesting continuous release of doxorubicin from the microspheres, whereas systemic drug concentration is kept at minimal level. However, further clinical studies need to support this initial report of efficacy for this drug-delivery system.

C. 3-Bromopyruvate intra-arterial injection for liver cancer-preclinical studies: 3-Bromopyruvate (3-BrPa) is an example of a drug disrupting a metabolic pathway, which has been recently tested via transcatheter infusion. 3-BrPa is a potent ATP inhibitor of glycolysis. In a recent study, conducted on human hepatoma cell lines, 3-BrPa induced HCC cell apoptosis, besides inhibiting ATP production. This apoptotic cell type of death was likely responsible for the full effect of 3-BrPa on growth suppression, as induced apoptosis reached over 90% within 6 h of treatment. It should be noted that previous studies have suggested that apoptosis is an ATP-dependent process. In another study, cell death induced by 3-BrPA was shown to contain both apoptotic and necrotic components, in a ratio depending on the 3-BrPA concentration. This study also demonstrated that 3-BrPA preferentially kills cancer cells with mitochondrial defects and tumor cells in a hypoxic environment. Preliminary studies on the rabbit VX2 liver tumor model with direct intra-arterial infusion of 3-BrPa showed complete tumor destruction without affecting the surrounding normal liver parenchyma. In a more recent VX2 animal study, 1-hour intra-arterial injection of 1.75 mM of 3-BrPa resulted in tumor cell death in all treated animals. Moreover, the 1-hour intra-arterial infusion of 3-BrPA resulted in complete tumor destruction and was significantly greater than that of serial bolus injection. In addition, animals treated in this manner had no liver toxicity. Nevertheless, the exact mechanisms of resistance of normal cells against 3-BrPa, as well as the exact pathway of 3-BrPa action are still under investigation.

Conclusion: knowledge of the molecular basis of hepatic tumorigenesis continuously evolves. Main areas of interest include the development of new cytostatic agents that interact upon some disrupted pathways, inhibit angiogenesis and limit chemotherapeutic dose-related toxicity. Phase I/II/III studies are currently testing whether anti-angiogenesis agents, inhibitors of growth-factor-signaling and cell cycle enzymes, nonspecific growth inhibitory agents, specific antagonists of HCC tumor markers, and anti-inflammatory agents, may have a potential impact on the treatment of liver cancer. Advances in drug delivery should also prove to be extremely beneficial and allow transcatheter approaches to play an even greater role in the management of patients with HCC.

QUESTION: What pathway do cancer cells use for their energy needs?
A. Krebs cycle
B. Pentose pathway
C. Neoglucogenesis
D. Glycolysis
E. All of the above
ANSWER: D.

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Special Session
Bone tumours

2704.1

Cementoplasty for bone tumours

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Learning Objectives
1. To describe the indications, techniques and devices for bone tumour cementoplasty
2. To describe follow-up and main complications of bone tumour cementoplasty
3. To discuss, with clinical cases, tips and tricks in bone tumour cementoplasty

No abstract available

2704.2

RF ablation

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Learning Objectives

1. To describe the indications, techniques and devices for bone tumour RFA
2. To describe follow-up and main complications of bone tumour RFA
3. To discuss, with clinical cases, tips and tricks in bone tumour RFA

Introduction: the interventional procedures are largely used in cancer pain management. Indeed, pain management in terminally ill patients with **tumors** involving **bone** can be challenging. Conventional therapeutic options for pain control include radiation therapy and/or chemotherapy, surgery, and the use of opioid and other analgesics. Existing minimally invasive techniques for the treatment of primary and secondary bone tumors include: ethanol ablation, cementoplasty, radiofrequency ablation, laser photocoagulation, radiofrequency cavitation, and cryoablation. Aspects of each ablation technique including mechanism of action, equipment, patient selection, treatment technique, and recent patient outcome are presented. Consensus indications in oncology are ill-defined, despite widespread proliferation of the technology. A review is presented of the current status of image-guided thermal tumor ablation. The benefits and limitations of each technique are discussed.

Thermal ablation procedures

Radiofrequency ablation: radiofrequency ablation (RFA) is one of the most promising thermal techniques for the treatment of localized tumors. The use of radiofrequency ablation was first reported in 1990 for the treatment of hepatic tumors. The major advantages of RF ablation in comparison to chemical ablation (ethanol) are the better delimitation of the ablation zone without any risk of leak. The difficulty of bone tumors thermal ablation lies in the surrounding tissue and structures particularly nerve roots. The thermal diffusion is well limited by thick cortical bone (5 mm). However, in cases with thin (≤ 1 mm) or ruptured cortical bone, the thermal diffusion made the procedure hazardous. The surrounding temperature (soft tissue) during RF ablation depends directly to the thickness of the cortical bone lamella and the distance from the periosteum. In these cases, the ablation should be very careful and use of different methods of protection of the surrounding structures and monitoring of the temperature is mandatory. The temperature mapping with MRI is very promising in this field.

Mechanism: alternating electric current operated in the range of radiofrequency (RF) can produce a focal thermal injury in living tissue. Shielded needle electrodes are used to concentrate the energy in selected tissue. The tip of the electrode conducts the current, which causes local ionic agitation and subsequent frictional heat, which leads to localized coagulation necrosis. Basically, the term radio frequency refers not to the emitted wave but rather to the alternating electric current that oscillates in the range of high frequency (200-1,200 kHz). Schematically, a closed-loop circuit is created by placing a generator, a large dispersive electrode (ground pad), a patient, and a needle electrode in series. A bipolar RF could achieve with a unique electrode with two different polarities or with insertion of two probes. A multipolar RFA is achieved with insertion of two or more electrodes in the tumor.

Equipment: each radio-frequency device consists of an electrical generator, electrode, and ground pad. Each manufacturer has a different probes electrode design. For bone tumors, the needle shape probes are easier to insert than multitined expandable electrodes. However, in lytic tumors, any type of probes can be used. Bipolar technique is particularly useful for a better delimitation of the ablation. The generators used in our department are all impedance-based RF ablation system. For cases with proximity of neurological structures or other organs, one or more thermocouples (temperature sensors) were positioned percutaneously in contact with the structure that should be protected. The thermocouples can be inserted coaxially through and 18 spinal needle. A side arm fitting was used to fix the thermocouple inside the spinal needle and the side arm allowed the injection of solution for the cooling of the structures if necessary. Using CO_2 for insulation in the adjacent structures was particularly useful in spinal tumors. The CO_2 was injected in the epidural space particularly in tumors of the posterior aspect of spine or in paravertebral spaces for insulation of surrounding organs in contact with the tumor (colon). The use of thermocouples was systematic even after injection of CO_2. The gas insulation is very efficient in the protection of the surrounding organs but not enough and injection of fluid for cooling is necessary if the temperature of the structure exceed 43°C. The temperature diffusion

is particularly dangerous in the epidural space and a large insulation with gas or fluid is necessary to protect the nerve roots surrounding the tumor in a perimeter of 3 cm with RF ablation without bone interposition. The number of thermocouples used depends on the structure closer than 3 cm to the tumor without bone interposition. Interposition of bone increases the insulation but depends on the thickness of the bone lamella. Bitsch and et al. investigated heat conduction and dissipation in cortical bone during RF ablation and their results show temperatures directly at the periosteum of 50-70°C for several minutes, which would imply significant damage to nerve tissue and adjacent structures. Temperatures only decreased below the 45°C mark at 10 mm from the periosteum in all specimens without perfusion. Only the 5 mm lamella thickness group did not reach this mark at 5 mm from the periosteum. Dupuy et al. underline the difference of thermal diffusion in bone and soft tissue. In their experimentation, the temperatures generated were consistently lower within the vertebral body than those in paraspinal muscle for similar treatments. For example, at 10 min, the maximum temperatures observed in bone were 48°, 41°, and 39°C at a distance from the radiofrequency electrode of 5, 10 and 15 mm, respectively, compared with a maximum of 84°, 62°, and 58°C, in paraspinal muscle

Patient selection and technique: consensus indications in oncology are ill-defined, despite widespread proliferation of the technology. A review is presented of the current status of image-guided tumor ablation therapy. Image-guided, local tumor treatment relies on the assumption that local disease control may improve survival. For a complete ablation, the tumor size should be less than 5 cm in diameter.

Palliation in painful bone tumors: ablation strategies must vary with the size of each lesion. On the basis of a 3-cm thermal injury, tumors less than 2 cm in diameter can be treated with one or two ablations, tumors 2-3 cm require at least six overlapping ablations, and tumors greater than 3 cm require at least 12 overlapping ablations. The length of a single procedure depends on the number of ablations performed. The guidance system is chosen largely on the basis of operator preference and local experience. We are using routinely for bone tumors ablations the CT guidance. Fluoroscopy is particularly useful in some localization (spine) or when a cementoplasty should be associated to the ablation.

Patient outcome: MR imaging was performed one month after the procedure. The ablation zone appeared hypo- or non-enhancing. Complete necrosis was associated with no enhancement inside the tumor best seen on dynamic sequences. The best results were obtained in large metastases of thyroid cancer. As a matter of fact, the treatment has been performed in two steps: to begin the radio frequency ablation with destruction of more than 90% of the lesion followed by 131-iodine therapy to complete the ablation of residual tumor. Complete necrosis was observed in 85% of cases. Radio-frequency ablation of bone metastases was promising in pain management with 78% of satisfactory results.

Laser photocoagulation: the first interstitial thermal ablation of a tumor performed with laser therapy was reported in 1983. Since then, experimental studies have shown that a reproducible thermal injury can be produced with near-infrared wavelengths lasers (neodymium yttrium aluminum garnet Nd:YAG, diode laser 800 to 1000 nanometer wavelengths). ND:YAG lasers have been used to treat tumors of the esophagus, stomach, colon, and pulmonary bronchus. The first use of lasers to treat patients with bone tumors was reported in 1993.

Mechanism: lasers are intense light sources and they use photons - light energy - to produce their tissue effect. These properties enable reliable and direct transmission of high amounts of energy over long distances. Laser energy, with its powerful and precise ability to ablate, coagulate, and vaporize dense tissues as well as its transmissibility in optical fiber, is an ideal tool for use in percutaneous ablations. Interstitial laser photocoagulation (ILP) consists of percutaneous insertion of optical fibers into the tumor. The tumor is coagulated and destroyed by direct heating. From a single, bare 400-mm laser fiber, light at optical or near-infrared wavelengths will scatter within tissue and be converted into heat. Light energy of 2.0 W will produce a spherical volume of coagulative necrosis 1.6 cm in diameter in bone. Use of higher power results in charring and vaporization around the fiber tip. For producing larger volumes of necrosis (>1.6 cm), it is necessary to fire multiple bare fibers arrayed at 1.5- to 2-cm spacing throughout a target lesion.

Equipment: portable solid-state diode lasers (Diomed®, Cambridge, England) are now available with power outputs up to 60 W. This energy can be delivered through fibers over 10 m in length with the great advantage of being fully compatible with MR imaging.

Patient selection and technique: the indications and contraindications for laser ablation are the same as those for radio frequency. With a low-power laser technique, a very well defined coagulation volume of predictable size and shape can be obtained in bone tissue. However, the small size of the coagulation necrosis limits its use in large tumors. Indeed, laser ablation is only used in palliation in cases with contraindication of RF (metallic implants).

Cryoablation: cryosurgery is the oldest thermal ablation method and was first performed in the mid-nineteenth century. Since the development of cryosurgical systems capable of delivering liquid nitrogen, organs in various regions have been treated with cryosurgery. The development of percutaneous technology using Argon allows ablating tissue under imaging monitoring. The indications are similar to RFA. However, image-guided percutaneous cryoablation appears to require less analgesia than RF ablation. Two 10-minute freeze cycles, which were followed by an active or passive thaw, were performed per lesion. Spiral CT was used intermittently to monitor the ice ball. The major advantages of cryoabaltion are: the ice ball is well delimited and visible under CT guidance; better delimitation of the ablation zone; procedure is less painful; possibility of using multiple probe (up to 25); and short learning phase. The disadvantages are: the cost of the procedure and cryoshock phenomenon in case of very large ablation.

Discussion: the main advantage of radio-frequency ablation is the ability to create a well-controlled focal thermal injury with minimal morbidity and mortality to date. Unlike alcoholization (ethanol ablation), radio-frequency ablation creates a well-demarcated lesion. Radio frequency is particularly useful in the indication of ablation technique as a tumor therapy and, alcoholization is preferred in palliative bone metastases pain management because of its simplicity and low cost. The size of the thermal injury created by a single radio-frequency ablation is larger than that created by a single laser ablation; hence, there is less chance of missing large tumor. However, for small tumors like osteoid osteoma, laser photocoagulation is an excellent alternative to other techniques. Nd:YAG or diode lasers are usually available in the majority of medium to large-sized hospitals as specialists of other disciplines also use it. With low power (typically 2 W), the laser source can produce a predictable size of necrosis in proportion to the energy delivered, which is much more precise than the other techniques. The management of patients with bone tumors requires consideration of many factors: histology of the tumor with differentiation of benign and malignant tumors; careful evaluation of the patient's general condition; an understanding of the disease process; an appreciation of the degree of bone destruction (consolidation); and a working knowledge of available treatment options is required. A multidisciplinary approach is essential to determine the course of treatment that best alleviates pain, preserves function, and optimizes the quality of life remaining in the patient with malignant and metastatic diseases.

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2704.3

Embolization of bone metastasis

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Learning Objectives

1. To describe the indications, techniques and devices for bone metastasis embolization
2. To describe follow-up and main complications of bone metastasis embolization
3. To discuss, with clinical cases, tips and tricks in bone metastasis embolization

Endovascular embolization has been largely developed many years ago to reduce the blood lost during surgical tumour ablation and then demonstrated its efficacy for pain releases in inoperable cases, but this pain release does not have a long tumour efficacy and we developed some years ago chimioembolisation to add the effect of chemotherapic agents to embolization to improve the efficacy of embolization. Actually, endovascular embolization remains useful in preoperative management of bone metastases especially when there are hypervascularised. It can be used for pain release when the lesion is inoperable and not accessible to tumour destruction by RF ablation or cimentoplasty. In such cases, chemo embolization offers better and more prolonged result than classic embolization, except when the lesion is not sensitive to chemotherapeutic agents (thyroid, renal). Complications are very rare. Tumour necrosis inducing pain and fever is only observed in large lesions, especially when we used small particles or direct injection of alcohol. Chemoembolization of antimitotic drugs, especially Carboplatine that has a neurological toxicity, can be responsible for radicular pain or deficit. It should be used with larger particles in arteries supplying nerve roots. Skin necrosis is exceptional but particular attention should be taken when the skin had been previously deteriorated by irradiation. If palliative embolization can improve the quality of life by reducing pain and transitory reduction of the size of the tumour, chemoembolization should be more accurate in all cases where it can be realised and it can give additional anti tumoral effect (partial or complete response) according to the tumour sensitivity.

2704.4

Benign bone tumours

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Learning Objectives

1. Overview, with clinical cases, of benign bone tumours and their treatment with special focus on non-operative procedures
2. Rationales for treatment, techniques and devices for BBT therapy
3. To present, with cases, tips and tricks in BBT treatment

The aim of this presentation is to describe the state of the art of the interventional radiology in the treatment of benign bone tumours. In the past years, minimally invasive surgical techniques in bone benign and malignant neoplasms management have been added to the therapeutic armamentarium as an alternative option to conventional treatments in order to improve patient's quality of life and duration of survival. For example, the diffusely utilized percutaneous vertebroplasty was first performed in 1984 in France by Galibert and Deramound for the treatment of a painful cervical aggressive haemangioma. Up to now, patient candidates for this procedure are carefully informed about features, benefits and risks bound to procedure. In order to minimise the risk of bleeding related to the percutaneous access, patient's blood coagulation profile is assessed and discontinued any anticoagulant therapy five days before procedure. The procedure is executed in supine or prone position depending on spinal level treated into angiographic suite utilizing a biplanar „C" arch or within CT room under combined CT-angiographic guidance. The vertebral approach is anterior in cervical levels, either transpedicular or intercostovertebral in thoracic levels and transpedicular in lumbar levels. The injection of PMMA is executed using 11-13 Gauge bone biopsy needle and is performed with lateral and antero-posterior fluoroscopic guidance. Post-procedural CT control is performed in order to visualise the distribution of cement within haemangiomatous lesion. The patients are kept under observation following the procedure and generally discharged on the following day. The minimally invasive techniques has rapidly

reached the standard of care for treatment of several benign bone tumours with medically refractory pain or which would require an extensive approach with conventional surgery. Another example is osteoid osteoma (OO) a small, self-limiting, benign osteogenic tumour. Successful treatment of OO requires complete resection or destruction of the nidus. Surgery, which consists of "en bloc" excision of the nidus, followed by internal fixation, bone grafting, or both, is successful in almost all cases but markedly intrusive. Actually patients undergo destruction of the nidus, under CT guidance, through a percutaneous approach using thermocoagulation or ethanol injection. Interventional radiology is distinctly utilized as preliminary step in osteolytic bone lesions characterization or as operative second step such as in bone aneurysmal cyst treatment. Aneurysmal bone cysts (ABC) are rare, benign, but locally destructive bone tumors. At present these lesions, typically observed in children, are treated alternatively to surgical excision through percutaneous approach with direct fibrosing agent injection (Ethibloc or others). Ethibloc in particular is a fibrogenic and thrombogenic agent proposed for the treatment of bone cysts. Complete healing of the osteolityc lesion is manifested by increased cortical and septal thickening. Minimal inflammatory reactions are observed with local pain and fever. No major complications such as deep infection, pulmonary embolism, epiphyseal necrosis or malignant degeneration are generally observed. The advantage of interventional radiology techniques, in comparison with conventional surgery, is their capability to be minimally invasive, safe, simple, and cost effective. Postoperative complications are rare and considerably reduced instead of surgery with an early return to normal activities.

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Special Session
Musculoskeletal intervention

2801.1

Radiofrequency ablation

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Learning Objectives

1. To review the lesions that can be treated by RFA
2. To review the technique of RFA in bone lesions
3. To review the results of RFA in bone lesions

No abstract available

2801.2

Complications of vertebroplasty

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Learning Objectives

1. To review the complications of vertebroplasty
2. To review methods to avoid and treat complications
3. To learn how to inform the patients in risky cases

Percutaneous vertebroplasty (PV) is widely used as a treatment for painful vertebral compression fractures (VCFs). Although generally considered a safe treatment, occasionally adverse events may occur during or after the procedure. Complications due to PV can be divided into two categories: complications related to polymethylmetacrylate (PMMA) cement leakage from the VCF or other complications. Cement leakage occurs frequently in PV, but is well tolerated in the vast majority of patients. Cement leakage in the para- or prevertebral soft tissue is almost always asymptomatic. Leakage into the spinal canal may occur when destruction of the dorsal wall of the vertebral body is present. This type of leakage is usually well tolerated if there is enough residual space remaining. Cement leakage into the foramen is rare, especially when applying the transpedicular approach. Cement leakage in the soft tissue dorsal to the vertebral body, such as cement spikes in the needle tract, may cause discomfort to the patient. Intervertebral disk leakage is common but asymptomatic. Some reports suggest it may have long-term mechanical consequences on adjacent vertebral bodies. Venous cement leakage occurs frequent but this is usually without clinical sequellae. Venous cement leakage may also extent into the inferior vena cava mostly without symptoms. Pulmonary embolism of PMMA may occur, usually due to unnoticed venous migration of cement into venes or the inferior vena cava. Complications such as arterial cement leakage or cement leakage into the brain have been reported, but are extremely rare. Factors that are likely to increase the rate of complications are cortical destruction, presence of an epidural soft tissue mass, highly vascularised lesions and severe VCFs. The complication rate is probably higher in PV for malignant diseases than osteoporotic VCFs. Little is known whether PV increases the risk of secondary fractures over time. Until now, there are no randomized controlled trials (RCTs) comparing the incidence of secondary fractures in patients with osteoporotic VCFs either treated with PV or treated conservatively. An increased fracture rate higher than of the natural history of the disease has not been definitively demonstrated. In a non-RCT comparing PV and conservative therapy, Diamond et al. reported secondary fractures in only few of the PV patients during midterm follow-up. The authors demonstrated no increased risk of secondary fractures between the control group and the PV group and no increased rate of secondary fractures of adjacent vertebral bodies. Systemic reactions may occur during PV in the absence of cement leakage, e.g., decrease in blood pressure, arrhythmogenic and cardiotoxic effect. Other general reactions need to be considered, such as pulmonary embolism caused by tissue debris or bone marrow expelled from the vertebral body with fat embolism or vasodilatating/vasovagal effects of the PMMA monomer. To prevent or minimize the risk of complications, correct patient selection is important. The main indication for PV in osteoporotic VCFs is intractable, local back pain at the level of the fracture. The VCF must be proven by plain radiography, CT or MRI. Absolute contraindications for PV are asymptomatic VCF, improvement of patient's pain on medication, non-correctable bleeding disorder, osteomyelitis or active systemic infection, allergy to bone cement and prophylactic PV. Relative contraindications include radicular pain, inability to lie in prone position for the duration of the treatment, lack of surgical or neurosurgical back-up and lack of patients monitoring facilities. Vertebra plana, VCF of more than 70% of the original vertebral body height and retropulsion of a fragment into the spinal canal are no longer regarded as absolute contraindications; however, only experienced interventionalists should try to perform a PV on these patients. Crucial ingredients for optimal treatment are understanding of the vertebral bone, nerve and vascular anatomy, high-quality fluoroscopy and patient positioning. Of paramount importance is a correct needle approach and placement, followed by accurate cement application under permanent fluoroscopy enabling early recognition of a potential cement leak. Intraosseous venography is advocated by some authors. This allows identification of potential sites of cement leakage along fracture lines before injecting PMMA. However, the value of venography remains controversial. PV is a safe and efficient therapeutic option for patients suffering from otherwise untreatable disabling local back pain caused by osteoporotic VCFs. Indications, contraindications, the technique and possible complications of the treatment have to be taken into account. PV has a low rate of clinical complications, but potential complications can be devastating.

2801.3

Cementoplasty in complex lesions/locations

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Learning Objectives

1. To describe the possible surgical/medical treatment of complex lesions/locations
2. To review the techniques and results of cementoplasty in complex lesions/locations
3. To review the complications of cementoplasty in complex lesions/locations

Bone is one of the most frequent sites of spread for many common cancers such as breast, prostate, lung, and kidney and is usually affected in multiple myeloma. In such case, when appropriate systemic treatment for the underlying cancer fails, usually hormonal treatment or chemotherapy, patients should be considered for specific treatment, the principal modalities being radiotherapy and bisphosphonates (1). These therapies leave approximately one third of cases with inadequate or undermanaged pain control (2-9). This failure prompted the search for other strategies aimed at bone pain control through local tumor ablation such as percutaneous radiofrequency thermoablation (RFA) (10-12) and cementoplasty/osteoplasty (13-18). There are some painful benign lesions (such as post-traumatic pseudoarthrosis, bone necrosis or geodes in rheumatoid arthritis) where medical treatment and surgery are unsuccessful or not feasible that can improve with cementoplasty/osteoplasty also.

In 1987 Galibert and Deramond first described percutaneous cementoplasty (PC) following the successful treatment of a painful vertebral body hemangioma by injecting acrylic cement in the bone through a large bore needle under fluoroscopic guidance (19). Since then, the procedure has been widely applied and is now performed with increasing frequency for the treatment of painful benign and malignant lesions of the spine (20-28). While it is proven that the procedure has excellent and durable clinical results if aimed at vertebral bodies (26, 27), preliminary and recent studies on the same technique applied on other bones (13-16, 29) demonstrated that the same good clinical outcome could be achieved.

PC can be performed, in most cases, under combined Computed Tomography (CT) and Fluoroscopic guidance; patients are positioned on a multislice CT scanner either in the prone or supine position (according to the lesion site) and a digital mobile C-arm is placed in front of the CT gantry to allow fluoroscopic monitoring of acrylic cement injection. Flat panel angiographic suite with integrated CT can also be used. Both systems allow precise positioning of the needle within the bone lesion. Due to the high definition of CT complex lesions with difficult location can be treated. In our experience 121

lesions were treated in 88 patients. Most frequently PC was executed in sacrum, hip and femur but this procedure was also successful and feasible in fingers, astragalus, calcaneus, ribs, sternum, etc. Local anesthesia is employed in most cases (deep sedation is used when RFA was planned in addition due to the pain induced by heating).

Bone lesions are localized on CT images, then the most adequate access point is identified by placing a metallic radio-opaque marker on the skin. Angle and distance from skin to lesion are calculated and local anesthesia is administrated along the tract using a 22-gauge spinal needle with 5 cc of 2% lidocaine hydrochloride. After a small skin incision at the puncture site, a dedicated vertebroplasty beveled needle 15 to 10 Gauges diameter is advanced first into the bone lesion. CT is then performed to verify the correct position of the needle tip inside the lesion.

Bone cement (polymethylmethacrylate - PMMA) is then injected under continuous fluoroscopic control either with a sterile 10 ml luer-lock polypropylene syringe or a pressure injector. After PC a CT scan of the treated region is carried out to assess the extent of lesion filling and to visualize possible PMMA leaks.

After PC the patients are discharged from the Hospital the same procedural day (Day-Surgery); a broad-spectrum prophylactic antibiotic treatment is then maintained in all patients for seven days. Technical success and complications are recorded for all patients during follow-up. Each patient is asked to prospectively quantify pain on an 11-point numeric visual analog scale (VAS) with values from 0 to 10 (where 10 indicates the strongest pain ever experienced and 0 absence of pain) before treatment, the day after treatment, after a week and subsequently on a monthly basis by telephone interview.

A difference in VAS equal to or more than 2 points, meaning at least a 30% reduction of pain, is considered a clinically significant result, as reported in previous studies (30). Records on pain medication (narcotic or non-steroidal anti-inflammatory) before and after the intervention need to be collected during follow-up.

In our experience PC was technically successful in all cases and no immediate severe complications were reported. As we treated also lesions with lost integrity of the cortical bone, asymptomatic leakage of PMMA in the soft tissues was observed in 8 of 88 patients (9%) but did not require any treatment. In one case, PC of the sacrum was complicated by a large cement leakage underneath the little gluteus due to the lost integrity of bone cortex but the patient remained asymptomatic during the first 36 months of follow up thus meaning, a part from durability of pain relief, that these leakages usually don't provide any consequence. In our opinion, to avoid major complications, the needle should be kept at safe distance from vital structures, including large peripheral nerves: precise CT guidance is mandatory to respect this.

Delayed complications are rare: in our series only 2 patients (2,3%) with metastases of the femoral diaphysis developed a fracture after the treatment. Toyota et al. (18) report a similar case, with the fracture occurring only after 2 day from treatment. In these cases regaining mobility and putting pressure on weight-bearing bones could play a role in the development of the bone fracture. It is now our opinion that lytic lesions of the long bones' shaft cannot be treated with PC due to high risk of fracture during ambulation.

In our experience pain reduction PC is virtually feasible in every bone lesion by means of combined CT and Fluoroscopic guidance and a good clinical outcome can be achieved either in metastases or in benign lesion. Flat panel angiography with integrated two-dimensional CT reconstruction can be employed to treat complex, small and difficult lesions allowing precise needle positioning and high-quality digital fluoroscopic monitoring of PMMA injection. PC, in our opinion, should be proposed in all patients with painful or invalidating bone lesions when conventional therapies fail or surgery is not feasible.

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2801.4

Percutaneous discectomy

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Learning Objectives

1. To summarize the technique and results of discectomy
2. To discuss the main complications and how to prevent them
3. To discuss the indications in regard to other treatment (medical, surigcal other percutaneous intervention)

The preferred initial therapy for radicular pain due to a contained disc hernia is rest and NSAIDs. Symptomatic patients after 6 weeks of conservative treatment (including physiotherapy, epidural or periradicular infiltrations) and yet without indication for surgical decompression may benefit from percutaneous discectomy. Numerous techniques have been used over recent decades among which are automated discectomy, microdiscectomy, chymopapain nucleolysis, laser disc decompression, coblation nucleoplasty, ethanol nucleolysis, and ozone nucleolysis. All techniques use the same principle: decrease intradiscal pressure and, as a result, reduce nerve root compression. A summary of the relevant literature based on the Cochrane library database and Medline is presented. This lecture focuses on CT guided percutaneous laser disc decompression (PLDD), a widely used, easy to perform, minimally invasive and effective technique. Clinical indications for PLDD include radicular pain greater than back pain due to a demonstrated contained disc hernia, a positive Lasègue's sign, decreased sensation with normal motor response and tendon reflex and a failure of 6 weeks of conservative treatment. Imaging indication consists of a contained disc protrusion compressing a nerve root and correlated to radicular pain. In some cases, discography may be used to confirm discal origin of radicular pain and to exclude severely degenerated discs or focal extrusions. Clinical exclusion criteria include less than 6 weeks of conservative treatment, nerve paralysis, back pain greater than leg pain, spinal stenosis, local infection, pregnancy and chronic pain lasting more than 2 years. Imaging exclusion criteria consist of disc height less than 4 mm, intradiscal gas, disc fragment sequestration, spinal stenosis, spondylodiskitis and spondylolisthesis. Previous surgery at the same level, hemorrhagic diathesis, significant psychological disorders and workplace injury with potential monetary gain also represent exclusion criteria. Imaging prior to PLDD should therefore always include a CT scanner, in order to track degenerative intradiscal gas (not seen on MR images). The procedure is performed under local anaesthesia with the patient lying prone on the CT table. An 18G needle tip is inserted at the level of the nucleus under triple slice CT-fluoroscopic guidance, allowing perfect positioning at the very centre of the disc in all planes. A 400 µm laser fiber is then inserted through the needle, with its tip extending 5 mm beyond the needle tip. Laser energy is delivered using a semiconductor diode laser (805 nm) with 1 second pulses at 15 W every 10 seconds. Nucleus vaporisation, which is easily seen with CT fluoroscopy, indicates the end of the procedure. The amount of gas, however, is not foreseeable. After PLDD, the patient should have bed rest for 4 hours and is discharged the same day. Return to work is generally possible within a week. A complimentary physiotherapy should always be performed in order to rebalance parapinal muscles. Clinical efficacy is widely recognized and illustrated in this first series of 200 consecutive patients performed in Portugal (Hospital Particular de Viana do Castelo). The study population consisted of 94 males and 106 females, with a mean age of 47 years. An independent observer assessed clinical outcome after a mean follow-up of 12 months (8-24), using clinical Mac Nab Criteria. Success rate of the procedure (good and fair responses) was 82% and complication rate was 0%. Successful procedures resulted in a return to work after a mean period of 6 days. The sciatic pain pattern allows predicting success within the day of treatment, with a VAS pain evaluation decreasing dramatically, whereas poor responses only allow a placebo-type response with a moderate improvement after the procedure. Potential complications of PLDD include spondylodiscitis and secondary sequestration. Nerve root and thermal vertebral endplate damage are easily avoided with CT fluoroscopic guidance.

Recurrence rate of sciatic pain is 5%, which is the same as after successful conservative treatment or surgery. In that case, a second PLDD or conventional surgery may be discussed according to symptoms. PLDD is not causing premature disc aging. This has been demonstrated by MRI-based semi-quantitative disc height follow-up during 4 years in a series of 30 patients. There is no significant disc height decrease after PLDD, compared to adjacent discs with low SI on T2WI. Cervical contained symptomatic disc protrusions may also benefit from percutaneous discectomy, using preferably a coblation technique, due to the narrow disc space and close relation with the spinal cord.

Conclusion: CT guided PLDD is an easy to perform, minimally invasive and effective treatment of symptomatic disc hernias resulting in greater than 80% efficacy for pain relief and allowing a quick return to home and work. It could represent a good alternative to surgery for patients with persistent sciatic pain but no evidence of neuropathy.

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Special Session
Carotid

2802.1

Trials update

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Learning Objectives

1. To give an overview of the latest CAS trials (incl. ongoing trials)
2. To discuss the trial results
3. To give recommendations for indication and treatment in symptomatic and asymptomatic patients

A recent systematic review published identified 10 randomised trials comparing carotid angioplasty and/or stenting with carotid endarterectomy in which outcome data was available for analysis.[1] Most of the early randomised trials were small and provided only data on short term safety comparison of stenting with endarterectomy. The meta-analysis reported that, overall, the comparison between stenting and surgery of the rate of any stroke or death within 30 days of the treatment favoured surgery (fixed-effect odds ratio 1.35), but the interpretation of the results was difficult because of heterogeneity between the trials. Endovascular treatment was significantly better than surgery in avoiding cranial neuropathy (odds ratio 0.15) and myocardial infarction (odds ratio 0.34) within 30 days of treatment. Most experts considered it likely that with improvements in technology, the safety of carotid stenting would improve with increasing experience, in contrast to the well developed technique of carotid endarterectomy. However, the most recent trials failed to confirm this hypothesis. The French multi-centre randomised trial of symptomatic patients, EVA-3S (Endarterectomy Versus Angioplasty in patients with Severe Carotid Stenosis Study) reported a significantly higher rate of stroke or death within 30 days of treatment after stenting with protection, compared to endarterectomy (9.6 versus 3.9%, p = 0.01).[2] Perhaps the most striking finding of EVA-3S was the low rate of stroke or death after endarterectomy compared to the previous symptomatic carotid endarterectomy trials, while the complication rate of stenting was similar to that reported in the earlier stenting trials. SPACE (Stent Protected Angioplasty versus Carotid Endarterectomy in symptomatic patients) conducted in German speaking countries, showed a slightly lower rate of stroke after stenting (7.7%) and a slightly higher rate of stroke or death within 30 days after endarterectomy (6.5%), but this trial failed to show that the early results of stenting were equivalent to those of endarterectomy.[3] The results of the International Carotid Stenting Study were not available at the time of preparing this abstract, but will be available for discussion at CIRSE 2009. The results of the other on-going trial of carotid stenting versus endarterectomy, CREST (Carotid Revascularisation Endarterectomy versus Stenting Trial) are not likely to be available until the end of 2009. Recent analysis of data from SPACE and EVA-3S suggest that much of the additional hazard of stenting occurred in elderly patients. It is also likely that anatomical factors may determine relative risk of the two procedures. Whatever the safety results of ICSS and CREST, it is likely that the future choice of treatment will be determined by individual risk factors. The planned pooled analysis by the Carotid Stenting Trialists Collaboration is likely to play an important part in guiding this choice. There is very little data on the long term effectiveness of carotid stenting compared to carotid endarterectomy. EVA-3S and CREST showed little difference in rates of recurrent ipsilateral stroke beyond the immediate post treatment period. However, follow up data was only available for a 2 year follow up period in SPACE and a 4 year follow up period in EVA-3S. The only longer term follow up data comes from the final analysis of CAVATAS (the Carotid and Vertebral Artery Transluminal Angioplasty Study), which showed no significant difference in stroke rates up to 11 years after carotid angioplasty with or without stenting, and carotid endarterectomy. However, there was a consistent trend for more events to occur in patients who were treated by endovascular techniques. The analysis of the ultrasound follow up showed that restenosis occurred significantly more often in the endovascular arm than in the carotid endarterectomy arm (hazard ratio 3.13) and the rate of ipsilateral non-perioperative stroke or transient ischaemic attack was significantly increased in patients with more than 70% restenosis (hazard ratio 2.08). Almost all the data available from randomised trials comparing carotid stenting with endarterectomy comes from the treatment of recently symptomatic patients. Virtually no data is available from randomised trials of asymptomatic patients, but further data should be available at the end of 2009 from the large number of asymptomatic patients included in CREST. Conclusions about the role of stenting in the treatment of carotid stenosis will depend on the results of ICSS and CREST. In the meantime, the current data suggest that endarterectomy remains the treatment of choice for suitable patients with symptomatic or asymptomatic carotid stenosis. However, the data support the use of carotid stenting in patients who are less suitable for carotid endarterectomy, or who are unwilling to undergo a surgical procedure.

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2802.2

Intracerebral PTA/stenting

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Learning Objectives

1. To describe the indications, techniques and devices for intracerebral PTA/stenting
2. To describe follow-up and main complications for native intracerebral PTA/stenting
3. To discuss, with clinical cases, tips and tricks in intracerebral PTA/stenting

Introduction: intracranial arterial occlusive disease has became a well recognised cause of stroke, particularly after the International Extracranial - Intracranial Bypass Trial in the 1980s. Since then, several epidemiological studies demonstrated that atherosclerosis affects more commonly the extracranial segments of the cerebral arteries in the Caucasian, having a preference for the intracranial arteries among the Asian, Afro-American and American-Hispanic population. In this population, the arterial disease is associated with multiple modifiable factors including smoking, hypertension, hyperlipemia and diabetes. Among the Caucasian population in the United States, Europe and also in the Mediterranean area, it may account for 8 to 10% of the ischemic strokes. The recent evolution in the non-invasive vascular diagnostic techniques - transcranial Doppler, MRA and CTA - has contributed to a better characterization and follow-up of these lesions.

The development and present status of intracerebral PTA/stenting: regarding the therapy of intracranial atherosclerosis, the WASID Trial - the warfarin versus aspirin for symptomatic intracranial disease - was a unquestionable turning point. This large clinical trial demonstrated that patients with intracranial arterial stenosis may have a risk of recurrent stroke as high as 20% in the first 2 years, despite best medical therapy. These results led to new therapeutic modalities for secondary stroke prevention, mainly anticoagulation therapy and interventional endovascular procedures, such as the intracerebral PTA/stenting. The first clinical devices used in intracranial angioplasty/stenting were Balloon Expandable Stents developed for coronary arteries. The stiffness of these stents decreased their navigability and increased the procedural risk. Recent developments in balloon design and self-expanding stents dedicated to the intracranial vasculature were responsible for a significant improvement in the clinical results and a simultaneous decrease in morbidity. Recently, the wingspan intracranial stent received approval from the U.S. Food and Drug Administration for the treatment of patients with a 50% to 90% stenosis, who have failed medical therapy. In our institution, we use a hybrid approach - starting with balloon angioplasty, generally with a gateway balloon catheter (Boston Scientific), immediately followed by the deployment of a self-expanding stent, like the wingspan stent system (Boston Scientific) or the Enterprise stent (Cordis-Codman). This strategy pretends to combine the safety of the balloon PTA with the maintenance of the endothelial integrity provided by the stent. It also prevents plaque recoiling and decreases the incidence of reestenosis. This procedure is always performed under double antiplatelet therapy beginning 5 days before the procedure - AAS - 100-300 mg/day and clopidogrel - 75 mg/day. This medication is maintained 3 months after the procedure and then reduced to monotherapy indefinitely. The endovascular intervention is performed under heparinization, with a 10.000 U Bolus, followed by 1500 U hourly, aiming at a ACT around 250-300 sec. In our institution, only the symptomatic patients, despite best medical treatment, with an arterial stenosis superior to 50%, are purposed for intracranial PTA/stenting. The review of the published literature reveals an average morbidity and mortality between 2 and 12% (ischemic complications, intracranial haemorrhage and vessel dissection). At the Santa Maria University Hospital, Lisbon, and the Sagrada Família - Enery Institute, Buenos Aires, we have registered a 14% rate of reestenosis after PTA/Stenting. Despite the publication of some studies concerning the use of the Enterprise and Wingspan stent in intracranial atherosclerosis, it is essential to perform new multicenter randomised trials. We are also in much need of new basic studies concerning the structural differences between the extra and intracranial arteries. This information will be essential to the development of new strategies for the prevention and treatment of intracranial occlusive disease.

2802.3

Management of carotid PTA complications

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Learning Objectives

1. To discuss main complications observed in carotid PTA
2. To describe the techniques and devices for carotid PTA complication management
3. To discuss tips and tricks in carotid PTA complication prevention and management

Introduction: the long-term prevention of stroke and death following placement of a carotid stent matches that of carotid endarterectomy. The eventual efficacy is largely dependent upon the complications within 30 days. If these are too high, then patients do not receive benefit in terms of long-term stroke prevention and carotid endarterectomy becomes a more attractive option. It is therefore extremely important that steps are taken to reduce the likelihood of a complication occurring, and when they do occur that they are managed appropriately.

Avoiding complications: the first stage in ensuring good results is to recognise those factors that lead to a high complication rate. Some predictors of poor outcome have been published in the literature and include elderly patients (>80 yrs old), emergent symptoms, symptomatic rather than asymptomatic, adverse anatomy, chronic renal failure, and experience [1-8]. Failure to use dual antiplatelets at the time of intervention significantly increases the risk of complications and patients on a statin at the time of intervention have a reduced risk [9, 10]. Our own analysis of nearly 1,000 patients would indicate that the use of dual antiplatelets, ocular rather than hemispheric symptoms, and experience all predict good outcome. We did not find that either age or recent symptoms resulted in higher complications. Old age I feel is simply a marker for adverse anatomy. These patients have more diseased aortas and more tortuous anatomy, which itself is high risk [11]. In addition, those patients who are treated early are more likely to have an ocular symptom (amaurosis fugax) than an unresolved hemispheric event and therefore will have a better outcome. Interestingly, there are as yet no hard data to show that the use of cerebral protection devices (CPDs) confer significant benefit, although they are widely used. The prophylactic use of platelet receptor IIb/IIIa inhibitors never was and never will be a good idea [12]. Clearly, it is not possible to modify all risk but the use of statins and dual antiplatelets at the time of treatment, and the avoidance of adverse anatomy will improve outcomes. The effect of learning should be recognised by focusing carotid artery stenting (CAS) into high volume centres.

Managing complications: groin complications are not infrequent because of the routine use of dual antiplatelet agents, high dose heparin and large sheaths. In our experience, the incidence has fallen with the routine use of closure devices but it is important that

ultrasound is used to ensure a common femoral artery puncture; the use of landmarks is inaccurate and results in puncture of profunda femoris or superficial femoral arteries. Both may be occluded with a closure device and have a higher incidence of false aneurysms compared to a CFA puncture. False aneurysms are managed in the usual way. The most common technical complication at the time of the procedure is no-flow in the internal carotid artery (ICA) whilst using a CPD. There are three possible causes for this: spasm, a full filter and dissection of the ICA. Only spasm is common; therefore, the initial management should be to presume that spasm is the cause. If the filter is moved slightly cranially out of the spasm, then flow will be resumed. Flow limiting spasm can then be treated using nitrate in the usual way. If moving the filter does not result in flow, then it must be assumed that the filter is full. A number of manoeuvres have been proposed at this stage. Some practitioners advance an aspiration catheter to below the catheter. Others suggest that thrombolytics should be administered into the filter. To my mind this lacks logic; the filter is full of atherosclerotic debris whenever we have analysed it and therefore would not be dissolved with lytic agents. My simple technique is to only partially close the filter and withdraw. Whichever technique is used, there appears to be a significant risk of cerebral event in this situation. Dissection is extremely rare and should be managed by placement of a further stent. Other technical complications are infrequent. Occasionally, atheroma protrudes through the stent struts. We have placed a second stent to further scaffold the atheroma. Others have used a covered stent. Either is logical and has merits. Either way, I think it would be safe to assume that there may be debris within the filter and partial closure is recommended. Sometimes, it is very difficult to retrieve the filter because the retrieval catheter will not pass the stent. Curved retrieval catheters are available for some CPDs (e.g., the FilterWire), which are easier to pass the stent. Changing the geometry by either rotating the neck or applying external pressure to the stent is almost always successful. Procedural stroke remains the most feared procedural complication. In our practice, with routine use of cerebral protection devices, we never find an occluded intracranial artery on angiography. MR scanning routinely demonstrates peripheral ischaemia, presumably as a result of micro-embolisation. Such a situation is very difficult to manage and is usually expectant. We perform a CT scan to exclude haemorrhage and place the patients on heparin to limit extension of thrombus. Our stroke physicians routinely do not use thrombolytics because of the presence of dual antiplatelet agents. If an occlusion of an intracranial artery is demonstrated, then management should be based upon the presumed nature of the occlusion. In a simple CAS, this is unlikely to be thrombus and therefore mechanical disruption or mechanical removal can be attempted. If there was a high probability of thrombus in the lesion before or after CAS, then intracranial catheter directed thrombolysis is logical. The most common complication after the procedure is hypotension. We agree with some other authors that this is benign and does not require intervention [13]. Almost always, this has resolved the day after the procedure; if not, all that is required is patience. Hypertension after CAS is potentially more important and is a risk factor reperfusion and cerebral haemorrhage. It is our practice to maintain BP not higher than admission BP. Reperfusion is little understood and most recommendations are hearsay. It may be more common in patients with tight bilateral disease and poor cerebral reserve. However, the sequelae of intra-cerebral haemorrhage remain a resistant problem. Patients should be warned that a headache within the first 4 weeks following CAS should be taken seriously and they should be admitted for tight blood pressure control.

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2802.4

Vertebral artery stenosis: indication, techniques and results

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Learning Objectives

1. To provide background information on and clinical features of vertebral artery stenosis
2. To describe the indications, techniques, devices and protocols for vertebral artery stenosis treatment
3. To discuss, with clinical cases, tips and tricks in vertebral artery stenosis treatment

Atherosclerotic disease of the vertebrobasilar vessels is the main cause of posterior or vertebrobasilar circulation infarction. Often the primary plaque, which is concentric, annular, smooth, and firmer than the one found in the carotid artery, develops at the origin of the vertebral arteries. About 25% of ischaemic strokes occur in the vertebrobasilar territory. The signs of vertebrobasilar ischemia are nonspecific and variable, making diagnosis difficult. The most frequent symptom is vertigo, often accompanied by headache. Other associated symptoms include dizziness, ataxia, perioral numbness, alternating paresthesia, dysphagia, dysarthria, drop attacks, visual disturbances and disturbances of consciousness. Not much is known about the natural course of vertebrobasilar stenosis compared with carotid artery stenosis. Figures on the prognosis of vertebrobasilar transient ischemic attack and minor stroke show that patients with vertebrobasilar events have a lower risk of successive stroke or death, once the acute phase (7 days) is over, compared

with patients presenting with carotid territory symptoms. On the contrary, patients presenting with vertebrobasilar events in the acute phase had a higher relative risk of subsequent infarction compared to patients with symptomatic carotid disease. Surgical treatment is technically challenging due to poor access to the vessel origin; this is why surgery is rarely offered in many hospitals. Surgery may entail vertebral endarterectomy or more often vessel reconstruction, which involves transposition of the vertebral artery, typically to the common or internal carotid artery. A retrospective review of 369 extracranial vertebral artery operations found low complication rates of the procedure and good long term patency rates (92% patent at 10 years follow up). Still, medical treatment alone so far has been the traditional treatment for posterior circulation crises. To date, there have however been no randomised trials of the use of different antiplatelet or anticoagulant drugs in cases of vertebral artery stenosis. In one study, medical therapy is reported to improve prognosis with a 13% relative risk reduction with no clinical advantage of warfarin over aspirin. Increasing literature reports advocate that percutaneous intervention at this site is safe and effective. There is less information available regarding PTA and stenting for intracranial vertebral artery stenosis but reports also imply that it may be a realistic option to best medical treatment since a surgical approach is no alternative for these lesions in symptomatic patients with a significant VA stenosis. Rather recently, a series of stent placements in 61 vertebral or intracranial arteries was reported. The series included 17 basilar and 23 vertebral arteries and a technical success rate for stenting of 95% was achieved. The 30 day post procedural stroke rate was reported to be 6.6%. Merely one randomised study comparing percutaneous treatment of vertebral artery stenosis with medical treatment is available. The results from this subgroup of CAVATAS advocate that endovascular treatment of vertebral artery stenosis attains good technical results and may be quite safe, even though 2/8 patients suffered from vertebrobasilar TIA at time of treatment. In practice, patients should have a complete history obtained and receive a neurologic exam before and after the intervention. Pre-treatment with clopidogrel (loading dose 300mg in emergencies) and ASS is recommended. All cervicocranial vessels to evaluate the lesion, collateral- and direction of flow should be depicted. The vertebral artery (diameter 3-5 mm) typically arises from the supraposterior aspect of the first part of the subclavian artery. In 6%, the left vertebral artery arises directly from the aortic arch. The vertebral artery branches almost at 90 degree angles to its feeding vessel. The intervention is usually performed via a femoral approach by balloon angioplasty (with the use of balloon expandable stents). Stenosis is crossed by way of catheter plus floppy tipped guide wire (0.035 or 0.018-in.) also to circumvent spasm. In tricky anatomy, an extra-stiff guide wire may be introduced. Post stent placement the balloon should not be placed beyond the distal edge of the stent to avoid dissection. Optimal blood pressure control during and post procedure is mandatory to avoid hypoperfusion syndrome. According to current opinion, distal protection is not customarily required. In 2009, there is still inadequate evidence to decide whether the risk benefit ratio favors endovascular intervention over conservative management regarding the reduction of the long term risk of stroke or death. It may be a good option in medically refractory patients. In any case, endovascular treatment of vertebral artery stenosis requires an individually tailored, but mutual decision of the involved medical disciplines. In this lecture, the indications, techniques, devices and study results on the topic of vertebral artery stenosis will be presented accompanied by background information and corresponding cases.

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Special Session
Vascular malformation

2803.1

Pulmonary AVMs

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Learning Objectives

1. To review the main clinical and anatomical features of pulmonary AVM
2. To review the technique and results of embolization
3. To discuss post embolization clinical and imaging surveillance and follow up

A pulmonary arteriovenous malformation (PAVM) consists of a feeding artery, an intervening aneurysmal segment or "sac," and a draining vein. If enough unoxygenated blood is diverted through the resultant right-to-left shunt, a PAVM can cause hypoxemia and dyspnea. Additionally, that direct communication between the artery and vein, i.e., without an intervening capillary bed, may allow paradoxical (right to left) embolization, with resultant systemic ischemia or abscess, often in the cerebral circulation. The majority (likely more than 70%) of people with PAVMs suffer that entity as part of the Osler-Weber-Rendu Syndrome, also known as Hereditary Hemorrhagic Telangiectasia (HHT). Conversely, of those with HHT, perhaps 30% (up to 50% in some series) have one or more PAVM. Much less commonly, PAVM may occur in people without HHT, e.g., in those with acute or chronic liver disease (usually severe); in those with non-cirrhotic portal hypertension; or as a congenital malformation. HHT affects approximately 1 in 5,000-10,000 people. It is a genetic disorder with autosomal dominance and variable penetrance, classically characterized by epistaxis (its most common presenting symptom), mucocutaneous telangiectases (most commonly in the fingers, lips, and oral cavity), and visceral arteriovenous malformations, predominantly in the lung, liver, brain,

and/or gastrointestinal tract. Diagnosis is based on clinical findings and may be confirmed by identification of mutations in either the ENG gene on chromosome 9q33-q34 (coding for endoglin, leading to HHT1) or the ACVRL1 (also known as the ALK1) gene on chromosome 12q13 (coding for activin receptor-like kinase 1, leading to HHT2). Endoglin and ALK1 proteins are specific endothelial receptors of the transforming growth factor (TGF)-beta superfamily that are essential for vascular integrity. Cerebral AVM and PAVM are more common in those with the ENG mutation, i.e., those with HHT1, while hepatic AVM and gastrointestinal bleeding are more common in those with HHT2. The presentation of patients with PAVM varies widely. Although most commonly diagnosed during adulthood, PAVM has been demonstrated in childhood and even in utero. The lesions can be found incidentally or during screening, e.g., on CXR, but often lead to presention with pulmonary (e.g. dyspnea on exertion) or cerebral (e.g., transient ischemic attack, stroke, or cerebral abscess) symptoms. 10-20% patients with HHT suffer TIA or CVA, while 5-20% develop a cerebral abscess. Rare presentations of patients with PAVM include hemothorax and hemoptysis. Interestingly, as with other patients with right-to-left shunts, migraines are common in patients with HHT. HHT with PAVM is well known to increase the risks of life-threatening events during pregnancy, including rupture of the PAVM, stroke, and death, all occurring in about 1% of gestations. First reported in the late 1970s, percutaneous embolization has become the accepted first-line treatment for PAVMs. Embolic closure of the PAVM(s) significantly decreases right-to-left shunting, hypoxemia, and dyspnea on exertion, and reduces the risk of systemic complications. A wide variety of devices has been used to close the arteriovenous shunts. Detachable balloons were among the earliest, but are no longer available. Metal coils have remained a mainstay, while newer devices such as detachable coils and vascular plugs have gained increasing popularity. Regardless of the device(s) and technique used to close these high-flow, low pressure shunts, appropriate placement of the device(s), complete, persistent closure of the shunt, and prevention of non-target embolization are the goals. Multiple studies have demonstrated that persistent closure of the majority of embolized shunts can be expected, but that a minority of treated PAVMs (perhaps 10%) can be expected to recanalize. Moreover, growth of untreated small PAVMs or development of new PAVMs, especially in patients with HHT, is not unusual (up to 25% in several series). Thus, it is imperative that patients undergo regular follow up evaluation after their embolization procedure. That follow up could consist of an outpatient clinic visit one month following the procedure, a clinic visit with chest CT one year following the procedure, and, if there has been no interval recanalization, significant growth of an untreated PAVM, or development of a new PAVM at that time, subsequent visits and imaging at 5 year intervals thereafter.

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2803.2

High-flow AVMs

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Learning Objectives

1. To review the classification of high- flow AVMs
2. To review the technique of embolization
3. To review the results and how to prevent complications

Classification: several classifications are used to define the AVMs

either in terms of architecture, haemodynamics, or management based on dynamics of flow. From the practical management point of view, the latter two classifications offer the simplest approach to lesion management. High flow AVMs may be divided into fistulas in which there is a direct communication between a single feeding artery and draining vein or veins such as in pulmonary AVMs, and malformations in which there is a nidus with several arterial feeders and several draining veins. The lesions may present early in life and the high flow may lead to cardiac strain in infancy. Around 40% are located in the head and neck, 20% in the trunk and 40% in the extremities. The lesions generally grow with age but may undergo sudden spurts of growth particularly after trauma and during periods of hormonal change such as puberty. Local signs such as pigmentation, pulsation and prominent veins are seen in superficial lesions. Steal resulting from the shunting may lead to ulceration and gangrene. Growth disturbance may be present relating to the high blood flow and hyperaemia. Late presentation of a high flow lesion in adult life is uncommon and the possibility of vascular tumours such as haemangiopericytomas or metastases from renal cell carcinomas should be entertained. Biopsy is to be considered in such circumstances. Management of all AVMs should be considered in the context of multi disciplinary team that includes interventionalists, vascular and plastic surgeons and appropriate physicians as well as supporting nursing and paramedical staff with full assessment of the clinical manifestations and status. Doppler ultrasound is a useful simple tool for detecting flow. MRI is, however, the imaging modality of choice. Illustration of the extent and nature of the lesion, the involvement of vital structures and pattern of vascularity provide the basis for treatment planning. Ultimately, catheter directed angiography will be required to define the vascular architecture when treatment is considered. Small high flow AVMS may be simply monitored and intervention is only undertaken in cases of haemorrhage or rapid growth. Large AVMs should be treated without delay to avoid the unwanted effects on the heart and circulation. The larger and more complex the lesion, the more difficult is treatment and the higher the potential complications. The goal of the treatment is frequently control of the AVM rather than cure. The mainstay is by embolization followed by surgical aesthetic procedures as necessary. It is now well established that surgical ligation of feeding vessels serves to worsen the situation and prevents direct access to the nidus of the malformation.

Embolization: AVMs: The goal of embolization is to occlude the nidus of the AVM. Multiple sessions are frequently required at 2-3 month intervals. Coaxial catheters are most commonly used to go beyond the normal branches. Direct puncture of the nidus or of the feeding artery may be required in certain circumstances whereas the transvenous approach provides the possibility of reducing the flow and therefore more control of the liquid agents. Balloon occlusion of the proximal artery may also be employed to reduce the flow in very high flow situations. The treatment may be carried out under sedation but prolonged procedures are preferably done under general anesthesia. The use of nonsteroidal anti inflammatory medications as well as steroids is frequently useful in the immediate post treatment phase. Steroids should be considered to reduce swelling when the AVM is in a critical location. Simple analgesics and site care are sufficient in the majority of cases, however. Palliation and control of the AVM may be expected in up to 60% of patients. Embolization agents are generally liquid or polymerizing agents. 1. Absolute or 95% ethanol: The toxic effect on the intima leads to dehydration, protein denaturaration spasm and thrombosis. Alcohol is pretty effective but it has a high complication rate including severe pain, skin necrosis, nerve and muscle damage, hemolysis, effects on the CNS including seizures and cardiac arrhythmias. The maximum recommended dose is 0.5-1 ml/Kg. Major complications are reported in 10% of patients with 50% as the overall figure. 2. Glue (N-Butylcyanoacrylate): This polymerizes when in contact with anions such as in blood. It will occlude the lumen and induce a local inflammatory reaction. Non ionic dextrose is used to flush the catheters and the vascular space before delivering the glue. The glue is usually mixed with iodized oil or tantalum powder to render it opaque. The more oil is added the longer it takes for the glue to set and that is judged based on the velocity of the contrast on the diagnostic angiographic run. The catheter should be withdrawn at the end of the injection and a new catheter is used. Tantalum powder should be avoided when treating superficial malformations particularly around the head and neck. Occlusion by glue is not necessarily permanent particularly if incomplete. Complication rate is reported at 10% and is mainly related to mixing the agent and timing the injection. 3. Onyx: This polymer is now used extensively in brain AVMs but its use and role in the periphery is still limited partly because of the expense of treatment and the need for multiple sessions in high flow lesions. The delivery of onyx should be done slowly starting close to the nidus and allowing the material to slowly fill in the nidus by accumulation and slow progression. The complications from treatment of brain AVMs have been low. AV Fistulas: Are best occluded with mechanical devices including coils, detachable balloons and modern tools such as the Amplatzer device or stent grafts. Occlusion of the proximal artery with a balloon catheter to reduce flow is a useful adjunct in large shunts. Success in treating pulmonary AVMs has been reported in up to 90% of cases.

Avoiding complications: the most important point is to inform the patient and the family of the anticipated outcome of the procedure, the plan of management and the potential complications of the various techniques. Detailed planning based on appropriate clinical assessment and imaging provides for a safer outcome. An appropriate imaging facility should be used and a meticulous catheterization technique must always be employed. Familiarity with the embolizing agents and with tools that can be used to occlude the vessels and also to retrieve devices in case of unwanted result is a must. Manoeuvers to reduce flow should always be considered particularly when handling liquid agents to avoid distant embolization. Have a high index of suspicion for the presence of PFO s and similar intracardiac shunts particularly in the pediatric population and request echography.

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2803.3

Low-flow AVMs

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Learning Objectives

1. To review the classification of low-flow AVMs
2. To review the technique of embolization
3. To review the results and how to prevent complications

Low flow vascular malformations are uncommon conditions with a wide spectrum of appearance and symptoms. Incorrect diagnosis and management is common, and best outcomes are obtained in centres with a high throughput and multi-disciplinary management. The classification generally used is that of the International Society for the Study of Vascular Malformations (Mulliken & Glowacki 1982). This divides vascular lesions by presence or absence of endothelial proliferation. Vascular malformations do not have endothelial proliferation and are regarded as disorders of morphogenesis. They are further subdivided into: Arterial (high flow); Venous (low flow); Lymphatic (low flow); Capillary. High flow lesions are very different from low flow in terms of presentation and treatment and are not discussed here. Malformations are generally present at birth or in early childhood, and often grow in proportion to the patient. They may grow more rapidly during puberty or pregnancy. They present with a variety of symptoms. The most common is a pigmented skin lesion, but they may also present with a mass, often painful. Other presentations include recurrent haemorrhage and haemarthrosis when the lesion is closely associated with a joint. The lesions may occur anywhere, but there is a tendency to involve facial structures, or the lower limb. Vascular malformations may also be part of a more generalized condition, such as Klippel-Trenaunay syndrome, where there is association of venous malformation in the lower limb with port-wine stain and hypo-plastic deep veins. Because of the diffuse sites and appearances, low-flow malformations may present to a number of medical specialties. In the past, much ill-advised treatment, particularly surgery, was carried out in these patients. A greater understanding and improved imaging may well reduce this in future. Diagnosis is usually clear on the basis of history and examination to an experienced clinician. Imaging is very helpful, and can often be specific. Ultrasound can be performed as an adjunct to the physical examination (Paltiel 2000). The appearance of a venous malformation is very variable, but includes disorders of architecture in muscle or soft tissues. Distorted venous elements are common, and usually exhibit very slow flow. Phleboliths are common, and appear as very dense areas with acoustic shadowing. Areas of thrombosis and recanalization are common. Ultrasound allows assessment of compressibility of the lesion and the proportion of volume related between venous element and background stroma. This may provide some prediction about outcome, as lesions with mainly fibrous stroma do less well. Lymphatic malformations are usually cystic on ultrasound and vary from a single large cyst to multiple tiny cysts. Again, this helps predict outcome as the former group responds better to sclerotherapy. The main limitation of ultrasound is that it may underestimate size and involvement of deep structures. MRI is the most helpful modality as it provides morphological information and provides a lot of information about the full extent of the lesion. Only limited sequences are required and in my institution we perform T1 sequences in a single plane, usually axial. We then perform fat-suppressed T2 or inversion recovery in two planes. Generally, vascular malformations are low or intermediate signal on T1 and high signal on T2. If the lesion is in a limb, we examine the whole limb and the buttock/pelvis in the case of the lower limb, as often the malformation is multifocal. Treatment should be planned in a multidisciplinary situation. Useful members of the team would include interventional radiology, plastic surgery and laser therapy. Depending on site, orthopaedic, facio-maxillary and other specialists may be required. Often no treatment at all is required. If the condition is explained, with the help of the imaging, and an idea of the likely progress of the lesion, many patients decide that the condition requires no current treatment. We leave the door open so that they may return if symptoms change. Surgery may be indicated if a lesion is amenable to resection. Smaller lesions which involve the skin and subcutaneous fat can be resected fully without significant residual deformity. It is vital to resect the lesion with a margin as otherwise recurrence rates are high. Unfortunately, only a small minority of lesions are amenable, as more frequently there is involvement of deep structures. Laser may be very effective in reducing the pigmentation in the cutaneous element of the malformation. If the lesion is purely causing a cosmetic issue, this may be all that is required. Laser is also useful in treating areas of local skin haemorrhage. The penetration of laser, even more modern varieties, is limited. The mainstay of treatment of venous malformation is percutaneous sclerotherapy. Agents used include alcohol (Yakes 1989), which is very effective, but is painful and requires general anaesthesia, and the detergent agents such as STD (sodium tetra decyl) and polidocanol (Burrows 2004). Other groups have used ethibloc. The detergents can be mixed with air and contrast to make large volumes of foam. This is very useful as the foam can treat a large area with a small amount of detergent. Also, the foam tends to stay where it is injected and not flow away into draining veins. Generally, the technique is to puncture venous elements, often using ultrasound guidance. An angiogram is performed, to assess lesion volume, and to look for drainage into other vein systems. A tourniquet may help in a limb to reduce venous drainage. The contrast is then replaced with sclerosant. Several areas can be treated at the same sitting. If the lesion is in a limb, a compression garment can be placed on the treated area. The procedure is generally painless and can be performed in an outpatient setting. More painful lesions and larger lesions in the face and oro-pharynx are best treated under general anaesthesia. Often multiple procedures are required, especially in larger lesions. It is important that the patient fully understands this when embarking on a treatment programme. Complications of sclerotherapy are uncommon. Skin necrosis or ulceration is very rare, although seen more commonly with alcohol. Systemic complications are seen with alcohol, which can produce pulmonary hypertension, and deaths have occurred due to this. Temporary nerve palsy, due to local pressure, is rarely seen in the facial nerve territory or the sole of the foot. Outcomes are variable. Sclerotherapy is very good at reducing the pain element. If the lesion is largely vessel rather than stroma, there may be significant reduction in size. Lymphatic malformations may also be treated by surgery when this can be done with resection of the entire lesion. Sclerotherapy is very effective and agents used include alcohol, bleomycin and OK 432. Lesions that contain one cyst or several large loculi have better results than lesions which contain multiple cysts (Alomari 2006).

Conclusion: low flow vascular malformations are uncommon and best treated in a multidisciplinary setting where there is a high throughput of cases. Imaging should include ultrasound and MRI. Sclerotherapy is effective and has few complications.1. To describe specific imaging features of low flow AVM. 2. To describe the techniques and approaches according to the anatomy. 3. To give an update on the results and complications.

2803.4

Paediatric AVMs

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Learning Objectives

1. To review the most current paediatric AVM that can be embolized
2. To review the basic/complex techniques and how to avoid complications
3. To underline the patients in which embolization should not be proposed

Diagnosis and therapy

Arterio-venous malformations (AVMs) are the least common of all the vascular anomalies, and are present at birth but tend to grow slowly with the patient manifesting often in the second and third decade. They can occur in isolation or associated with syndromes such as Parkes Weber Syndrome, Sturge weber Syndrome and the familial syndromes such Hereditary Hemorrhagic Telangiectasia, Osler Weber

Rendu syndrome and Capillary Malformation - AVM syndrome. CM-AVM syndrome is a more recently discovered syndrome associated with a RASA1 mutation. AVMs often demonstrate increased warmth and hyperhidrosis at the affected site. Uncommonly, pulses may have palpably increased intensity, and rarely visible pulsations and an audible bruit are observed. The intensity of the pulsations and warmth and associated soft tissue and bony hypertrophy are more likely to be present in children with AVF. In a small number of cases, there may be a history of repeated episodes of bleeding or a dental extraction with prolonged bleeding. More rapid growth at puberty may relate to hormonal influences. Schrobinger classified four stages; stage 1 - a cutaneous lesion with heat but no pulsatility or swelling, stage 2 - expansion with swelling and pulsatility, stage 3 - pain and bleeding associated with tissue ischemia and stage 4 - stage 3 and congestive cardiac failure. Stage 3 and 4 are not reversible and most difficult to treat. Depending on the type of lesion and its blood flow characteristics, either embolotherapy and/or sclerotherapy may be indicated. In some cases, it may be useful to use the direct puncture technique to access a high flow lesion and embolize the nidus directly. It is uncommon for a complete and lasting cure to be achieved after a single procedure. Most patients with AVMs require serial or staged treatments. Staging may be necessary for several reasons including long procedural time, contrast limitations and the frequency of residual arterial supply making recurrence more likely. Staging these procedures also allows time for new and recanalized arterial supplies to be identified and treated and helps reduce the possibility of overly aggressive treatment. Patients and their parents need to understand that a cure is often not possible and that there will most likely be two or three treatments before an optimal end point is achieved. Additionally, in some settings, percutaneous therapy is done as a pre-operative adjunct, and sometimes more than one procedure is required before the definitive surgery is performed. This possibility, as well as the timing of the radiologic procedure relative to the surgical procedure, needs to be understood by the families and patients so that scheduling is done as effectively as possible. Helping patients and their families form realistic expectations of the procedures and their outcomes is an important part of the pre-procedure discussions. High-flow AVM appear poorly circumscribed and show faint, if any, parenchymal blush identified. No tissue enhancement is seen. Direct AVF components may also be identified with rapid venous shunting. Arterial malformations are the most problematic and symptomatic of the vascular malformation group. In the past, the most widely used therapy was primary surgical excision; however, cures were uncommon. The best results have been seen in well-circumscribed superficial lesions that could be totally excised. Unfortunately, in the group of children with more extensive and complex malformations surgical results have been less than satisfactory. Because of their size and location some arterial malformations are inoperable or require extensive, potentially disfiguring resection or even amputation. Surgical ligation of the supplying artery or arteries alone has only led to temporary control, because interruption of the proximal supplying vessels inevitably results in the development of collateral arterial supply, which is often inaccessible to surgical ligation, and recurrence of the malformation. In addition, blood loss during and after the surgical procedure was often significant and sometimes fatal. However, over the past 15 to 20 years, significant technological advances in diagnostic and interventional radiology have created new treatment options, and interventional radiology has become an active participant in the team treating patients with vascular malformations. Trans-catheter embolization is now often the first therapeutic option and is an effective approach that can be used as a curative procedure or as an adjunct to a surgical resection. The factors necessary for the safe and successful performance of diagnostic and interventional procedures in children are different than those for adults. Although most procedures involving adults can be performed with local anesthesia alone or with intravenous sedation, pediatric patients require general anesthesia (GA). In general, GA is preferred for long procedures, those associated with significant pain or discomfort, and those that are technically demanding and require prolonged periods of immobility. GA is also useful when monitoring of the airway and physiologic parameters is important, when control of fluid status is required, especially in small infants, and when control of vascular tone, blood flow, and ventilatory rate is important to the outcome of the procedure. There are several important factors that should be kept in mind. Neonates and young infants lose body heat rapidly and require close attention to controlling and maintaining their body temperature. Warming blankets or chemical pads are frequently used and the head and body may be wrapped in plastic to retain body heat. Special padding, such as egg crate foam and gel pads and doughnuts, helps prevent pressure injury to skin and nerves during long procedures. Rigorous attention to fluid volume is essential because in the perinate and young infant the extra-cellular volume is approximately 80 mL/kg, and as a result, it does not take a lot of fluid to create volume overload. Indwelling bladder catheters are used to monitor urine output during longer cases. Pressurized systems for delivery of flush solution to sheaths and catheters help to control flow rate with flow check valves or infusion pumps. Careful attention is also paid to total contrast volume used, and it is important to keep and monitor the running total. Non-ionic contrast is the contrast of choice and should be the only iodinated contrast agent used in all children undergoing vascular interventional procedures. Although it is recommended that no more than a total of 5 mL/kg of intravascular contrast be given during an angiographic procedure, this goal may be impossible to achieve in certain types of vascular interventions, especially in neonates and- small infants. The contrast issue assumes less importance with the availability of low or iso-osmolar non-ionic contrast media (Visipaque).

Embolic agents: embolic agents are the agents of choice for transcatheter embolization and percutaneous sclerotherapy of high flow vascular malformations. The choice of embolic material to be used for vascular ablation is dependent upon multiple factors, including operator experience and preference, the size and type of catheter used, the desired level and duration of occlusion, the hemodynamics of the lesion, and the size and type of the lesion. Embolic materials can be classified on the basis of their duration of action (temporary or permanent), their site of action (proximal or distal), and their physical properties (liquid, particulate, tissue adhesive, metal).

Liquid agents: in the setting of high flow lesions with a vascular nidus and without high flow fistulous connections, liquid occlusive agents provide the most effective clinical outcome. These agents tend to produce more distal, permanent occlusion at the level of peripheral arterioles and capillaries, include absolute alcohol, NBCA glue and onyx. These liquid agents are versatile and may be delivered by either direct transcutaneous injection into the lesion or by transcatheter route. Tissue adhesives or „glues" (isobutyl acrylate (bucrylate) and N-butyl cyanoacrylate (Avacryl)) are liquids until they come in contact with ionic solutions such as contrast, saline, or blood, which causes instant polymerization and formation of a solid cast of the vessel or malformation with complete occlusion of the lumen. The cyanoacrylates also generate heat during the polymerization process and this, in addition to a mild inflammatory response, is felt to enhance their angionecrotic effects. Initially, tissue adhesives were thought to be permanent, but it is now known that recanalization does occur. The use of tissue adhesives is technically demanding, expensive, and requires interventionists experienced with the materials to perform the procedure. Onyx is a mixture of ethylene -vinyl alcohol colpolymer, dimethyl sulfoxide and tantalum. It is non-adhesive and precipitates as the dimethyl sulfoxide diffuses in the vascular system. These agents needs to be injected slowly increasing the procedure and fluoroscopy time but is highly effective in nidus obliteration and may be more effective than NBCA glue. Of the liquid agents currently available, absolute alcohol is the one most often

used. When administered intravenously or intra-arterially, alcohol acts on the intima of the vessel and denatures the cellular protoplasm. The vascular wall becomes denuded, resulting in coagulation necrosis, formation of organized thrombus, and obliteration of the vessel lumen, which together result in rapid cessation of blood flow. Ethanol causes its damage at the capillary level, resulting in complete devitalization of the tissue in the vascular distribution of the vessel(s) treated. Extreme caution and superselective catheter position are essential when using alcohol. In addition, it is important to be aware of the fact that alcohol is non viscous and easily flows with blood in small and large vessels alike. If concentrated alcohol passes into normal collateral pathways unanticipated and potentially severe complications may occur.

Particulate agents: particulate agents such as polyvinyl alcohol particles or spheres (PVA), super absorbent polymer and embospheres (PVA) can also be used in certain situations and more often in a pre-operative setting. These agents cannot be accurately sized to the vessel and often provide a more proximal occlusion allowing collateralization and subsequent recurrence of the high flow lesion. Collateralization in this setting may result in inaccessibility to the nidus for future procedures. PVA, as foam or in spheres, is a biologically inert substance that not only physically occludes vessels but also incites a mild inflammatory reaction that stimulates fibrosis, enhancing its occlusive properties. PVA is considered a permanent agent, but recanalization has been known to occur when vessel occlusion is incomplete. PVA particles range in size from 50 to 1500 µm. These agents cannot be accurately sized to the vessel and often provide a more proximal occlusion allowing collateralization and subsequent recurrence of the high flow lesion. Collateralization in this setting may result in inaccessibility to the nidus for future procedures.

Mechanical devices: mechanical occlusion devices are also frequently used for vascular ablation in the pediatric population including microcoils, macrocoils and detachable balloons that can be used alone or in combination with particulate matter. However, coils are infrequently used because of the propensity for a more proximal occlusion and ultimate recanalization. Detachable balloons were introduced in 1974 and have been used to treat carotid-cavernous fistulae, head and neck aneurysms, and AVF. Detachable balloons are now available and, although useful in specific situations, are rarely used. In general, mechanical devices tend to produce a proximal occlu[[Unsupported Character - Codename]]sion and are not used alone for treatment of AVM therapy because they act in a fashion similar to proximal arterial ligation, with occlusion of the artery at the site of deposition like a surgical ligature.

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Special Session
Renal fibromuscular dysplasia

2804.1

Classification and epidemiology

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Learning Objectives

1. To discuss pathology and epidemiology of FMD
2. To review the classification of renal FMD

Definition: early descriptions of the disease used the terms fibromuscular hyperplasia or fibroplasia, but now the term fibromuscular dysplasia (FMD) is used. McCormack *et al.* in 1958 reported a pathological description of fibromuscular hyperplasia in four patients with renovascular hypertension. In 1965, Hunt *et al.* observed that the disease was heterogeneous and not necessarily associated with hyperplasia, and introduced the term FMD. It was soon recognized that FMD could be present in carotid arteries without documented renal artery FMD or hypertension. FMD is currently defined as an idiopathic, segmental, non-inflammatory and non-atherosclerotic disease of the musculature of arterial walls, leading to stenosis of small and medium-sized arteries. FMD may be familial (OMIM #135580).

Pathological classification: a pathological classification of renal artery FMD was proposed by McCormack *et al.* and revised by Stanley. It was based on the dominant arterial wall layer involved: the intima, media or adventitia. Three main types of FMD have been identified: intimal, medial and perimedial, and these types have also been described in extrarenal arteries. Intimal FMD, which accounts for 5% or renal artery FMD cases, is characterized by irregularly arranged mesenchymal cells within a loose matrix of subendothelial connective tissue and a fragmented internal elastic lamina. Nearly 85% of all FMD stenoses in the renal arteries are medial FMD; the lesion is a homogeneous collar of elastic tissue that presents as multiple stenoses interspersed with aneurismal outpouchings, with a preserved internal elastic lamina. Perimedial FMD affects approximately 10% of dysplastic renal arteries and involves excessive tissue deposition at the junction of the media and adventitia. The three types are not mutually exclusive. Indeed, Stanley reported that medial and perimedial FMD lesions can coexist in the same arterial segment; and Alimi *et al.* analyzed arterial segments from 33 patients and found that more than one artery layer was involved in 25 (66%) of the 38 specimens studied. Since reports of successful outcomes of angioplasty in patients with renal artery FM, surgery has been used only rarely for patients with FMD and consequently histological verification is available for only a small minority of cases. As a result, contemporary reports infer the pathological type of FMD from the angiographic appearance of arterial lesions.

Angiographic classification: Kincaid *et al.* described angiographic features in 125 patients with FMD, including 60 patients who underwent surgery and provided arterial tissue for histological examination. They proposed an angiographic classification of FMD into four types. The multifocal type, with multiple stenoses and the 'string-of-beads' appearance, was present in 78 cases (62%); the tubular type, with a long concentric stenosis was present in 17 cases (14%); the focal type, with solitary stenosis less than 1 cm in length, was present in 9 cases (7%); and 21 patients (17%) had mixed-type stenoses. Among the 60 stenoses for which both radiological and histological assessments were available, all 38 multifocal stenoses were associated with medial FMD, whereas focal and tubular stenoses were not specifically associated with histological type. Similar results were obtained in a pathological-angiographic correlation study at the Cleveland Clinic. The "string-of-beads" sign is the most suggestive and most frequent aspect of FMD, whereas focal and tubular stenoses only differ by the length of the stenosis

with an arbitrary cut-off. A conservative conclusion is that multifocal stenoses with the "string-of-beads" feature is characteristic of FMD and probably denotes the presence of the medial type FMD, whereas other angiographic aspects cannot be related to specific histological lesions.

Distribution: most commonly affected are the renal and carotid arteries. Involvement of the axillary, iliac, basilar, hepatic and intracranial arteries has also been reported. In a comprehensive review of the literature, Mettinger and Ericson analyzed reports concerning a total of 1197 patients with FMD. Renal arteries were involved in 58% of cases, cervicocranial arteries in 32%, and other arteries in 10%. The type of FMD and any coexistence of FMD in several arterial beds were not reported. In a series of 104 patients with renal artery FMD documented at angiography, 81 (78%) had the string-of-bead sign; FMD affected both renal arteries in 54 patients. Among the 81 patients in whom the carotid arteries were examined, 9 (11%) had carotid artery FMD. In a series of 37 patients with carotid artery FMD, 23 (62%) had the "string-of-beads" feature; half the patients were hypertensive, but none underwent renal artery angiography.

Epidemiology: the prevalence of FMD is not precisely known. Ten to twenty percent of documented renal artery stenoses are the consequence of FMD, and renovascular hypertension is documented in less than 1 to 2% of hypertensive patients. Assuming a 20% prevalence of hypertension in middle-aged subjects, the prevalence of clinically significant renal artery FMD can be estimated to be about 0.4%. The prevalence of asymptomatic renal artery FMD is, however, one order of magnitude higher: four reports of angiographic findings for a total of 3181 potential kidney donors describe 139 subjects (4.4%) with evidence of FMD. The reports did not provide details concerning the radiological criteria used to define the condition, however. The number of reported cases of carotid artery FMD is about half that of renal artery FMD. Medial-type FMD and/or FMD showing the "string-of-beads" appearance at angiography are usually diagnosed in young adults and are more than four times as frequent in women as in men. A male predominance in found in cases with intimal-type FMD or with focal stenoses at angiography, but these cases make up only a minority of patients with FMD.

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2804.2

Imaging

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Learning Objectives

1. To discuss the various imaging strategies for the diagnosis of renal artery FMD
2. To review the workup for renal artery stenosis evaluation
3. To review the imaging technique to diagnose extra renal FMD

Fibromuscular dysplasia (FMD) of the renal arteries is classically associated with secondary hypertension in younger individuals, which may be treatable and even curable by percutaneous transluminal renal angioplasty. Although intra-arterial digital subtraction angiography (IA-DSA) is still considered the standard of reference test for the anatomical diagnosis of RAS, noninvasive techniques such as MR angiography, CT angiography, and duplex ultrasonography are promising alternatives that also allow functional characterization of RAS. We provide an overview of these techniques and discuss their relative merits and shortcomings. String of beads appearance (reflecting multiple stenoses), aneurysms, focal or tubular stenosis are classic angiographic appearances. The aim of this presentation is to illustrate the various imaging findings of renal artery fibromuscular dysplasia. Angiography of these renal arteries often displays „beaded" luminal abnormalities. The angiographic findings, however, may not accurately reflect the severity or precise location of the intraluminal obstruction. Pressure measurement enabled precise localization and treatment of the hemodynamically significant stenosis. Analysis of high-quality studies shows that both MR and CT angiography are significantly more accurate for the diagnosis of at least 50% atherosclerotic RAS than ultrasonographic techniques. At the beginning of our experience in 3D imaging, CT scan was evaluated in order to detect renal fibromuscular dysplasia. Helical CT angiography enabled successful diagnosis of fibromuscular dysplasia in all 20 patients. Helical CT angiography showed 31 of 34 pathologic arteries and 33 of 38 lesions. Aneurysms (>6 mm) on arteriography (n=12) were revealed in 83% of transverse sections, 75% of maximum-intensity-projection reconstructions, and 58% of shaded-surface-display reconstructions. Lesions that had a string of pearls appearance on arteriography (n=19) were shown in 53% of transverse sections, 84% of maximum-intensity-projection reconstructions ($p<0.05$ compared with transverse sections), and 74% of shaded-surface-display reconstructions. Stenoses (n=7 on arteriography) were revealed in 57% of transverse sections, 71% of maximum-intensity-projection reconstructions, and 57% of shaded-surface-display reconstructions. Maximum intensity projection alone revealed 30 (79%) of the 38 angiographic lesions; however, using both maximum intensity projections and transverse sections increased the sensitivity to 87%. The conclusion was that Helical CT angiography, especially the combination of transverse sections and maximum-intensity-projection reconstructions, can reliably reveal renal artery fibromuscular dysplasia. However, because some lesions may not be shown, arteriography with pressure measurements remains the only technique that can assess the physiologic significance of the dysplasia. With the possibility of multidetector CT scan to perform slices of less than 1 mm, sensitivity was increased. In our experience, MRI also evaluates and was an interesting tool for the screening of renal dysplasia. Fifty main renal arteries were analyzed, 35 of which demonstrated abnormal arteriographic features of FMD (stenosis, 22 arteries; string of pearls, 21 arteries; and aneurysm, four arteries). The sensitivity and specificity of contrast-enhanced MR angiography for the diagnosis of FMD were 97% (95% CI: 83%, 100%) and 93% (95% CI: 66%, 100%), respectively. Sensitivity was 68% (95% CI: 83%, 100%), 95% (95% CI: 74%, 100%), and 100%

(95% CI: 40%, 100%) for the diagnosis of stenosis, string of pearls, and aneurysm, respectively. Linear-weighted kappa statistics for inter- and intra-observer agreement regarding FMD diagnosis were 0.63 and 0.92, respectively. Our conclusions were that in patients with renal FMD, contrast-enhanced MR angiography can reliably facilitate diagnosis by demonstrating characteristic lesions. Now, we evaluate the interest of MRA without any injection of gadolinium in order to assess renal stenosis, with promising preliminary results. The primary strength of ultrasonography at present is its suggested ability to predict functional recovery based on preinterventional resistance index measurements. Because missing reno-vascular hypertension may have serious consequences the most important requirement for a screening test is that it has high sensitivity. Finally, imaging of other non-atheromatous lesion is also to know when the radiologist performs exams in order to assess the presence of a renal artery stenosis. A review of several aetiologies will be done such as spontaneous dissection or inflammatory lesion.

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2804.3

Techniques and results of angioplasty

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Learning Objectives

1. To discuss the indications for intervention
2. To discuss the techniques and results of angioplasty and stenting for renal FMD

Technique: the approach is different than for atherosclerotic lesions in several aspects for angiographic diagnosis as well as for interventional technique. The first step is a mandatory angiographic confirmation of the stenosis. For intimal FMD, angiographic imaging is usually straightforward and a tight stenosis can easily be depicted even on global angiography. In contrast, when dealing with medial FMD which usually corresponds to the string beads phenotype, the diagnosis of tight stenosis is much more controversial (see corresponding chapter). In fact, in this subset of patients, a tight stenosis is limited to a intra-luminal diaphragm and to ensure appropriate delineation of the stenosis, it is most of the time needed to use several projections during selective injection. The first image showing a jet effect can be great. Even with accurate and angiographic technique, it is sometimes impossible to rule out the absence or presence of a significant stenosis. The first step of the intervention consists is selective catheterisation of the stenosis using a .014 wire with a soft tip and enough support to allow balloon tracking. Use of a long sheath provides the ability to use control angiogram as needed. Guide wire progression through the stenosis should be very cautious because of the increased risk of iatrogenic dissection. Insertion of the balloon in the stenosis is generally not an issue because there is no calcification and the underlying aorta and iliac arteries are straight and soft. Balloon inflation allows relief of the stenosis at a pressure of around 6- 8 atm. But in some cases, higher pressure is required. In intimal FMD, it is sometimes very difficult to cure the stenosis, with inflation pressure up to 25 atm and even failure occurring. In these very resistant stenosis, use a cutting balloon have been tried but carries a very high risk of rupture in our experience and we tend to abandon it. It is important to keep covered stents in the lab to overcome dramatic rupture of the renal artery. Moreover, in case of rupture, even if final result is acceptable we advocate for systematic CTA control in the following 3- 6 months to rule out secondary pseudo aneurysm that could threaten the patient with delayed rupture. Use of a buddy wire (.014 wire in parallel to the balloon) acting like a "smooth" cutting device has been also advocated with encouraging results and less frequent rupture. The must and must not are as follows: never use a glidewire, no need of stent, fragile artery.

Results: results of angioplasty in these patients are generally considered as better than those in atherosclerotic lesions. Various explanation have been proposed such as absence on long standing hypertension and its peripheral vascular consequences, absence of atherosclerotic disease, and less coexisting cardio vascular risk factors. Our group is currently conducting a systematic literature review across 27 studies published from 1982 to 2008 and cumulating 841 patients. The combined rate of hypertensive cure seems to be 41% (95% CI, 34 to 48%; I^2=74%; phet<0.0001) and that of hypertensive improvement was 43% (37 to 49%; I^2=67%; phet<0.0001). In this work, it appears also that reported benefits of angioplasty varied considerably, and heterogeneity could be partly accounted for by differences in the definition of hypertensive cure and time to follow-up examination.

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2804.4

Extra-renal FMD

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Learning Objectives

1. To discuss the manifestations of extra-renal FMD
2. To review the indications and results of treatment

The renal arteries are most commonly affected by fibromuscular dysplasia accounting for 60% of cases. The extra cranial carotid and vertebral arteries are the second most common sites for FMD (34%), followed by involvement of the coeliac, mesenteric, iliac, femoral subclavian and coronary arteries in 2.5%. FMD is usually asymptomatic unless it causes a haemodynamically significant stenosis and symptoms will vary according to the affected site. Aneurysm formation and dissection are common complications of the disease. The diagnosis is frequently made angiographically but it can be diagnosed by non-invasive imaging such as ultrasound, CTA and MRA. However, subtle lesions can be missed on non-invasive imaging. The characteristic appearance is the same as in the renal arteries with the "string of beads" being the most common and representing the medial or subadventitial form of the disease. A long, smooth stenosis is seen in the intimal form. Rarely, there is involvement of only one side of the artery, creating diverticula in the wall which have the appearance of ulcerated plaques or pseudoaneurysms. In two-thirds of cases of FMD of the internal carotid artery, the disease is bilateral and may present with cerebral ischaemia or stroke. Up to one third of patients will also have associated intracranial aneurysms and renal artery FMD and 10% will have vertebral involvement. Spontaneous carotid dissection occurs in 10-20%. Asymptomatic patients require investigation to determine the presence of an intra-cranial aneurysm, but are otherwise treated with anti-platelet therapy. If a patient presents with a transient ischaemic attack or stroke, balloon angioplasty is recommended and a stent inserted only if PTA produces an inadequate result or dissection occurs. Carotid dissection due to FMD is normally treated with anticoagulants, but endovascular or surgical intervention may be indicated if there are recurrent neurological symptoms, expansion of concomitant pseudoaneurysms or a contra-indication to anticoagulant therapy. A recent review of stenting and stent-grafting in post traumatic or spontaneous extracranial carotid dissection showed 100% technical success, primary and 1 year patency rates with no mortality and an 11% stroke rate (Donas et al 2008). FMD involving other territories is reported. Involvement of the gastro-intestinal system presents more commonly as mesenteric ischaemia (ranging from abdominal angina to gangrene) but can also present as haemorrhage. Depending on the clinical presentation, treatment may be endovascular or surgical (Urrego et al. 2007, Mertens et al. 2005). On angiography, it may not be possible to differentiate FMD from other causes of vasculitis, unless there is the characteristic "beaded" appearance. It may be distinguished on the basis of absence of acute phase reactants. Many other arterial sites of FMD have been reported such as the iliac and brachial arteries (Kolluri and Ansel 2004). If symptomatic by virtue of causing a stenosis, such lesions are usually successfully treated by balloon angioplasty. If FMD of these vessels presents with an aneurysm or dissection, stenting, stent-grafting, embolization or surgery may be required (Atsuta Y et al. 2003). FMD may not be apparent as the underlying cause unless histological analysis of the artery is performed.

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PART 2

Free Papers

Abstracts of
free paper presentations
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sorted by presentation numbers

Cardiovascular and Interventional Radiological Society of Europe

CIRSE

Free Paper Session
Abdominal aortic stent grafting

1201.1

Endograft limb thrombosis following endovascular aortic repair: incidence, management and predisposing factors

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Purpose: we evaluated our experience with aortic endograft limb occlusion (ELO) following endovascular aortic repair (EVAR) to determine the incidence, clinical presentation, predisposing factors and assess treatment strategies.
Materials/Methods: demographic, anatomical and graft related factors as well as management and outcomes for those with ELO were recorded from a prospective database of all patients undergoing EVAR.
Results: between 1998 and 2008, 444 patients underwent EVAR (309 elective, 85 ruptures and 50 symptomatic), 245 bifurcated and 199 aorto uni-iliac. Follow-up ranged from 12 to 120 months (median 69 months). 20 patients (4.5%) developed ELO between Day 1 and 24.2 months (mean 90.25 days) following EVAR. 14 patients presented with critical ischaemia, 5 with claudication and 1 patient remained asymptomatic. 12 patients were treated with femoro-femoral cross-over grafts, 2 with axillo-femoral bypass, 2 with angioplasty and stenting 1 was asymptomatic and managed conservatively. Re-occlusions occurred in two patients. One patient died after thrombosis of axillo-femoral bypass. Multivariate logistic regression demonstrated that graft limb kinking was independently related to the occurrence of ELO ($p<0.0001$), as was younger age ($p=0.0074$). No significant association was demonstrated between ELO and other factors, including deployment of the distal graft limb in the external iliac artery (EIA).
Conclusion: ELO is a recognised complication of EVAR. Distal graft limb deployment in the EIA is potentially useful in the presence of a common iliac artery aneurysm. Our experience showed this did not increase ELO risk. Graft limb kinks should be treated early and aggressively even in the absence of symptoms.

1201.2

Evidence to support EVAR for ruptured AAA: design of the IMPROVE trial

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Purpose: to assess the quality of the evidence available to support the use of endovascular strategies to manage patients with ruptured abdominal aortic aneurysm (AAA) and present the design of a large randomised trial of endovascular management versus open surgery of ruptured AAA.
Materials/Methods: we performed a systematic literature review of endovascular aneurysm repair (EVR) of ruptured AAA 1994-2009 and designed the IMPROVE trial (Immediate Management of the Patient with Rupture: Open Versus Endovascular repair).
Results: seven systematic reviews were identified, all demonstrating a significant, but varying, reduction in mortality for EVR of ruptured AAA compared with open repair controls: only one included sensitivity analyses. Six recently published population-based studies from USA demonstrated low mortality rates associated with EVR (30-58%), but only a small proportion of ruptured AAAs were treated by EVR (2.5-12%). Both systematic reviews and population based studies raised concerns about patient selection and publication bias. A pilot randomised trial showed no difference in mortality. Two small randomised trials of haemodynamically stable patients who are anatomically suitable for EVR are in progress (AJAX and ECAR). A large trial of unselected patients randomised to either a strategy of immediate CT scan and EVR if possible versus immediate open repair is starting in 2009 (IMPROVE).
Conclusion: the outcome of EVR in a non-selected patient population remains unknown. One or more definitive randomised trials of unselected patients are needed to provide the level 1 evidence to resolve these issues.

1201.3

Endotension after endovascular treatment of abdominal aortic aneurysm, what to do?

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Purpose: to evaluate treatment option of endotension after stentgraft implantation for abdominal aortic aneurysm (AAA) by percutaneous translumbal puncture of aortic aneurysm sac with aspiration of its contents.
Materials/Methods: a total of 214 patients with AAA underwent endovascular treatment from April 1996 to March 2008 in our department. From these patients, 145 were followed-up one year or more after treatment, 25 patients were followed-up less than one year and 45 patients died or were lost from follow-up. In 14 patients, aneurysm sac increased in size and in 3 patients out of them (men, age 58, 70 and 70 years) endotension (aneurysm sac enlargement without evidence of endoleak) was diagnosed.
Results: in patients with diagnosed endotension, sac enlargement was found 2, 5 and 7 years after implantation of bifurcated stentgraft. Translumbal puncture of aneurysm sac and aspiration of its contents was performed in all patients. It was transudate and its culture was negative. Sac stopped to enlarge and sac size reduced after aspiration in all patients.
Conclusion: percutaneous translumbal puncture of aneurysm sac with aspiration of sac contents could be an easy and effective method of treatment in endotension. But a larger group of patients and long-term follow-up are needed.

1201.4

10 years of Zenith: a single centre experience

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Purpose: endovascular repair (EVAR) has become an established technique in the elective management of abdominal aortic aneurysms. This single centre study assesses the medium to long term outcomes with the Zenith stent-graft.
Materials/Methods: since 1995, all EVAR procedures and follow up details have been prospectively recorded in the endovascular database. All patients have annual surveillance with plain radiographs and CT. Procedures performed for aneurysm rupture or for primary iliac aneurysms were excluded from this analysis.
Results: during the period September 1998-December 2008, 326 patients (35 females: 10.7%) with non-ruptured AAA were treated with the Zenith device. Median age was 75 years (43-91) and maximum aneurysm sac diameter (D3) was 6.5 cm (3.4-14.5). Thirty-day mortality was 3.1% and median follow-up 18 months (1-111). Delayed complications included 2 ruptures and 1 graft infection. In addition, there were 10 instances of limb kinking/occlusion, 2 structural failures and 13 cases of endoleak (4 type I, 7 type II and 2 type III). Eleven of the 13 endoleaks were treated with an endovascular re-intervention resulting in complete

resolution for 7 and partial resolution for 4. Open re-intervention was required in 8 cases (2.5%) with 4 post-operative deaths. Cumulative survival was 87% at 1 year and 59% by 5 years.
Conclusion: the Zenith stent-graft has performed well over the last decade, largely because of the robust steel stent design. However, this relatively 'rigid' framework may sometimes have contributed to device failure and limb occlusion.

1201.5

Does a wide aortic neck compromise endovascular aneurysm repair?

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Objective: to establish the impact of neck diameter on clinical outcome after endovascular aneurysm repair (EVAR).
Method: retrospective interrogation of the unit's database was performed to compare the outcome of patients undergoing EVAR with wide necks (diameter >28 mm) and standard necks (diameter <28 mm). The primary endpoint was all cause mortality. Kaplan Meier analysis was utilised to compare outcomes.
Results: fifty-eight aneurysms with wide necks (Group A) and 189 with standard necks (Group B) were treated between January 2003 and May 2008 with a median follow up of 22 months (range 0-64). The 3-year all cause mortality rate in Group A was 28% compared to 16% in Group B (p=0.017). Most deaths in Group A were a result of cardiovascular disease, but binary regression analysis did not show a significant correlation between increasing neck diameter and the presence of ischaemic heart disease. Proximal stent graft migration was identified in 8 patients (14%) in Group A and 14 patients (7%) in Group B, but this did not reach statistical significance. There were also no statistically significant differences between the two groups for proximal type I endoleaks and secondary interventions.
Conclusions: performing endovascular repair of an aneurysm with a wide neck (>28 mm) does not result in a significant increase in complications. However, the higher mortality rates compared to aneurysms with standard necks may reflect the poor physical status of those patients with wide necked aneurysms and case selection may need to be modified.

1201.6

Usefulness of sac pressure measurements during and after endovascular repair of abdominal aortic aneurysm (EVAR)

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Purpose: 1) Define physiologic criteria predicting aneurysm exclusion during EVAR. 2) Quantify pulse pressure (PP) and mean pressure (MP) decrease a year after EVAR. 3) Establish pressure criteria detecting endoleaks after EVAR.
Material/method: wireless sensors were implanted during 50 consecutive EVAR's. Pressures were recorded before and after graft insertion. Pulse pressure ratio (PPR)= sensor PP/systemic PP. Pressures obtained at 1 day, 1 week, 3 months, and 1 year. Correlation made with intraoperative angiography and CTA (3 months and one year post implantation).
Results: in 12 patients (23.5%) less than a 70% decrease in PPR was observed after graft implantation indicating type 1 endoleaks. After ballooning and/or cuff insertion a greater than 70% decrease in PPR was observed in all patients. One type 1 endoleak was detected physiologically one day post operatively (36% decrease in PPR). At one year the average decrease in PPR and MP were 87.7 and 34%, respectively. The overall incidence of type 2 endoleaks was 27.4%. In 4 of these patients, abnormal sensor readings were obtained; an increase in MP or a less than 70% decrease in PPR. Aneurysm size increased in 2 of these patients with abnormal pressures. In the 4 patients with abnormal pressures, the endoleaks were treated successfully (embolization) as evidenced by normalization of pressures.
Conclusion: a decrease greater than 70% in PPR is a predictor of aneurysm exclusion intraoperatively. During the year following repair, a less than 70% decrease in PPR or an increase in MP indicates a significant endoleak.

Free Paper Session
Biliary interventions

1202.1

Comparison of mechanical vs. hydraulic percutaneous casts extraction with angiojet system in biliary cast syndrome after liver transplantation

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The biliary cast syndrome (BCS) describes the presence of casts causing biliary obstruction with its resultant biliary infection, hepatocyte damage and liver failure.
Material and Methods: 25 patients with BCS and acute cholangitis after liver transplantation conformed the study group. Two different methods were compared: mechanical cast extraction (n=18) vs. hydraulic cast extraction (n=7) of biliary system with a rheolytic-fragmentation-device (Angiojet System®).
Results: complete cast extraction was obtained in 3 patients (16.6%) in the mechanical group vs. 6 (85.7%) patients in the hydraulic group. Clinical success with recovery of liver function and normalization of biliary biochemical parameters as noted in 12 (66%) patients of the mechanical group and 6 (86%) in the hydraulic group. Bilrrubin returned to normal values in 11 (61%) patients in the mechanical group vs. 6 (86%) in the hydraulic group. Patients treated with mechanical extraction required more sessions before all the biliary casts were removed (4:1 ratio) or until a point where they remained technically irremovable. Whereas patients in the mechanical group referred significantly more pain during the intervention (Scale 6.6 of 10 points) requiring several doses of morphine analogs, whereas patients in the hydraulic group better tolerated the cast's fragmentation sessions (Scale 3.3 of 10 points).
Conclusion: hydraulic removal of casts in BCS yields better results, reduction in therapeutic time and significant reduction in peri-interventional pain by the patients. BCS treated with hydraulic casts fragmentation is effective and recommendable.

1202.2

Biliary manometric perfusion test in the evaluation of balloon dilatation treatment of benign biliary strictures

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Purpose: to evaluate the efficacy of biliary manometric perfusion test (BMPT) in the evaluation of percutaneous treatment success of

benign biliary strictures.
Materials/Methods: from February 2003 to December 2008, 21 patients (13 men, 8 women) with median age of 53.5 years after dilatation treatment for benign biliary strictures were subjected to BMPT. The results of evaluation by BMPT were retrospectively compared with another similar group of percutaneously treated patients where the standard clinical test was used for treatment success evaluation. The clinical test group was a group of 21 patients (9 men, 12 women, median age 51 years, range 31-77) treated for biliary strictures from February 1994 to November 2006.
Results: by analyses, the two groups were statistically similar and there was no significant difference in terms of age and gender. In 19 out of 21 patients in BMPT group, the pressures were less than success threshold and undergone catheter removal. Two patients out of these 19 required re-intervention 13 days and 11 months later. With Kaplan-Meier survival analysis, the probability of biliary patency at 1, 2 and 3 years was 88.4%. This was statistically compared with that of the clinical test group (Kaplan-Meier at 3 years 80%) and there was no statistical significance between the groups (Log rank test-p value 0.664).
Conclusion: BMPT is an alternative method for the evaluation of treatment success of benign biliary strictures. It is simple, less time consuming, economic, safe, effective and more comfortable for the patients than the clinical test.

1202.3

Iatrogenic bile duct transection: long-term follow-up of percutaneous transhepatic management

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Purpose: to describe the technique and evaluate the results of combined radiologic-endoscopic intervention in the re-establishment of interrupted biliary ducts.
Methods and materials: a total of 31 patients with complete transection of the biliary tract were treated with a combined radiological-endoscopic technique. Traumatic interruption of the biliary tree manifests either with acute symptoms related to bile leak or with progressive jaundice due to bile duct obstruction. Biliary damage was secondary to trauma in two cases and to laparoscopic/laparotomic surgical complications in 29 cases. In all cases, a Rendez-Vous technique was used to retrieve a guidewire crossing the interrupted tract, and dilatation and long-period stenting were performed.
Results: recovery of the biliary tree was achieved in all patients. Biliary drainage was successfully carried out, allowing the cessation of acute symptoms and bile leak. Three patients underwent subsequent surgical repair. In the other 28 patients, the biliary catheters were replaced by plastic endoprostheses. Complete healing of the biliary damage after endoprosthesis removal was seen in 19 patients and they remain asymptomatic at 9-36 months. Nine patients have not still completed the treatment and prostheses are still in situ (asymptomatic at 4-18 months).
Conclusion: the radiological-endoscopic approach is often the only therapeutic option in those patients with complete interruption of the biliary tract. It could potentially avoid or delay surgery for acute symptoms.

1202.4

Percutaneous one-step versus staged stenting for malignant biliary obstruction

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Purpose: to compare efficacy and safety of one-step percutaneous biliary stenting (O-PBS) with the widely-used staged procedure (S-PBS) in the treatment of obstructive jaundice in cancer patients.
Materials/Methods: we analyzed retrospectively 120 interventions performed between January 2000 and December 2007. The study included 61 patients (mean age 65.6 years [31.1-92.7]), who were all suffering from obstructive jaundice caused by a primary malignancy or metastases. O-PBS was performed in 30 and S-PBS in 31 patients. Technical as well as clinical success rates, complications and length of stay of the two different procedures were compared.
Results: on average, 2.6 sessions were performed per patient in the S-PBS group and one session in the O-PBS group to place metallic biliary stents. Cholangitis was present at the first intervention in 23.3% (O-PBS) vs 29% (S-PBS). There was no significant difference in the anatomical level of the obstruction or the type of stenting (mono, Y- .or T-configuration) between the two groups. The immediate technical success rate was 100% for both groups. The O-PBS minor complication rate was 6.7% (2/30) vs. 9.7% (3/31) in the S-PBS group. The major complication rates were 16.7% (5/30; O-PBS) and 51.6% (16/31; S-PBS), [p=0.03]. The procedural mortality was 0% for both groups. The mean length of stay was 9.2d (O-PBS) vs. 20.6d (S-PBS).
Conclusion: O-PBS seems safer than S-PBS and is likely to be more cost-effective due to shorter hospital stay.

1202.5

Covered versus non-covered biliary stents in percutaneous palliation of primary malignant biliary obstruction: preliminary results of a prospective randomized trial

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Purpose: to compare the patency rate of covered versus non-covered stents for percutaneous palliation of primary malignant biliary obstruction.
Materials and Methods: between May 2002 and July 2007, 52 patients were included in a prospective randomised trial. Inclusion criteria were: obstructive jaundice caused by non-metastatic disease (cholangiocarcinoma, pancreatic adenocarcinoma), no surgical options, and Karnovsky score of at least 50%. Exclusion criteria were: primary tumor known for more than 3 months, endoscopic drainage for more than 14 days and previous surgical derivation. Patients were randomized into 2 groups receiving either covered stents (Viabil biliary endoprosthesis, Gore) or non-covered stents (ZA biliary stent, Cook), introduced percutaneously.
Results: in the covered stent group (N=28), median survival was 12.4 weeks (range 0.1-156.4), with N=17 (61%) patients having biliary obstruction before or at time of death. In the non-covered stent group (N=24), median survival was 12 weeks (range 0.1-156.4), with N=12 (50%) patients showing recurrent biliary obstruction before or at time of death. Four (8%) patients of the whole study group had major complications (sepsis or shock) leading to death within 2 weeks after biliary stenting. Kaplan-Meier and Fisher Exact test showed no statistical significant difference in survival and biliary patency between both groups (P=0.56 and P=0.58).

Conclusion: in primary malignant biliary obstruction, patency rates of percutaneously placed covered and non-covered stents were not significantly different. There was no difference in survival.

1202.6

Evaluation of prognostic factors in the development of biliary complications in pediatric liver transplant patients

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Purpose: to investigate the incidence of biliary complications and prognostic factors in pediatric liver transplant patients.
Materials/Methods: 265 transplants were performed in 236 patients over 12 years. A prospective transplant database was utilized. Patients with biliary complications following transplant were included. Patient age, height, weight, gender and race were evaluated. Primary diagnosis, type of anastamosis and type of transplant were compared in transplants with and without biliary complications.
Results: 14.7% (39/265) of transplants had biliary complications, 9.8% (26/265) demonstrated biliary strictures and 5.3% (14/265) demonstrated leaks. The incidence of biliary complication was 20.4% (11/54) in transplants with cirrhosis, compared to 13.5% (5/37) in acute fulminant hepatic failure (AFHF), 12.8% (14/109) in biliary atresia and 10.3% (3/29) in metabolic disorders [p=0.69]. Duct-to-duct anastamosis was performed in 29.1% (77/265) of transplants. Roux-en-Y anastamosis was performed in 70.5% (187/265). Biliary complications occurred in 12.9% (10/77) of transplants with duct-to-duct anastamosis compared to 15.5% (29/187) with Roux-en-Y [p=0.80]. Whole liver transplants were performed 56.6% (150/265) of the time. Partial transplants were performed 43.4% (115/265). Biliary complications developed in 14.7% (22/150) of whole transplants compared to 14.9% (17/114) in partial transplants [p=0.73]. Actuarial survival rates at 1 yr and 3 yrs in uncomplicated patients were 92 and 89%, and they were 94 and 90% in patients with biliary complications [p=0.82]
Conclusion: primary diagnosis, type of anastamosis and transplant type do not influence the frequency of biliary complication. Patients with biliary complications can expect similar survival outcomes when compared to transplants without biliary complications.

Free Paper Session
Carotid artery stenting and neuro interventions

1203.1

Reduction of vascular coil artifacts on MDCT: a novel technique using helical retrospective tagging

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Purpose: starburst artifacts caused by metallic devices like vascular coils impaire severely the image quality in computed tomography (MDCT). Instead of increasing tube voltage, we propose a new technique to minimize the impact of streak artifacts using helical retrospective tagging (RT) and shifts in the reconstruction window (RW) within the gated cycle.
Methods: eight patients with previously coiled cerebral aneurysms received CT-angiography (CTA) within the routine follow-up once in the conventional spiral technique (CST) and once with RT using a 64-row MDCT scanner (rot. time 400 ms). To achieve the best temporal resolution (50 ms) using RT that occurs only at a dedicated frequency, an external pace maker was cable-connected to the MDCT. The area, the orientation of streak artifacts and impairment of vessel image quality in the vicinity of the coils were assessed on axial images and multi-planar reconstructions by two experienced neuroradiologists.
Results: 1. The area of windmill artifacts in CST could be reduced significantly using RT to one main streak artifact (1483 vs 437 mm2, $p<0.05$). 2. In different RW (increments of 10%), streak artifacts revealed variable orientation. 3. In CTA, 67% of uninterpretable vessel segments adjacent to the coils in the CST could be turned with RT and variable RW into one that could be evaluated unimpaired.
Conclusion: retrospective tagging and the use of different reconstruction windows is a novel promising technique to reduce the amount and to change the position of artifacts; these can be rotated such that the starburst rays of high and low attenuation do not cross the region of interest, subsequently allowing an unimpaired assessment of adjacent vessels.

1203.2

Preoperative percutaneous direct injection of n-butyl cyanoacrylate and onyx in head and neck paragangliomas

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Purpose: preoperative transarterial embolization of head and neck paragangliomas using particulate agents has proved beneficial for decreasing intraoperative blood loss. However, the procedure is often incomplete owing to extensive vascular structure and arteriovenous shunts. We report our experience with preoperative embolization of these lesions by means of direct puncture and intratumoral injection of N-butyl cyanoacrylate (NBCA) or Onyx.
Materials/Methods: nine patients aged 32-82 years who were referred for preoperative embolization of seven carotid body tumors and two jugular paragangliomas were retrospectively analyzed. Intratumoral injections were primarily performed in four cases that lack significant feeding branches from external carotid artery and adjunctive with transarterial embolization in five cases with incomplete devascularization. Punctures were performed under ultrasound and injections were performed under roadmap fluoroscopic guidance. Detailed angiographies were performed before and after embolization procedures.
Results: control angiograms showed complete devascularization in all tumors. Two tumors with no significant feeder arteries were treated with primary NBCA injections. Two tumors necessitated transarterial embolization after primary injection of NBCA in one and Onyx in another. Five tumors showed regional vascularization from vasa vasorum or branches of internal carotid artery following transarterial approach. These regions were embolized by NBCA injections. The tumors were surgically removed following embolization. No technical or clinical complications related to embolization procedures occurred.
Conclusion: preoperative devascularization of head and neck paragangliomas with percutaneous direct injection of NBCA or Onyx is feasible, safe and effective in paragangliomas with lack of significant feeders and in cases of incomplete devascularization following transarterial embolization.

1203.3

Intraoperative glue embolization of low flow orbital vascular malformations: the Vancouver General Hospital experience

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Purpose: review our experience with intraoperative percutaneous phlebography and glue embolization of low flow intraorbital vascular

malformations (LFVM) as an aid to operative resection.
Materials/Methods: retrospective review of interventional neuroradiology Database for patients in whom intraoperative glue embolization was performed of LFVM.
Results: fourteen consecutive patients (6M:8F; average age 39 years) were identified from August, 1996 to July, 2008, with a total of 17 procedures performed. Lesion distribution was evenly split between right and left orbits, with all lesions assessed using CT imaging, 13/14 patients had venous lesions embolized, with 5/13 having venous varices treated. Two patients had intra-lesional thrombus identified on pre-procedure imaging, confirmed on intraoperative phlebography. One patient had two lymphatic lesions treated in the same orbit. Lesion access was obtained using either 22 or 24 gauge angiocatheter cannulae, with glue embolic ratio (typically 33-50% glue) determined by flow characteristics. All embolizations were technically successful, with surgical removal of 16/17 lesions following the percutaneous procedure. In one patient, no surgery was performed due to adequate lesion control by embolization alone. No complications occurred apart from one patient having glue leakage during embolization, without consequence, managed intraoperatively. Goals of operative resection were achieved in all patients, except in one, where the lesion was incompletely excised, as seen on followup imaging. No other recurrences were seen on followup.
Conclusion: intraoperative percutaneous phlebography and glue embolization of LFVM prior to lesion resection is a safe and highly efficacious procedure, reducing surgical morbidity and operative time.

1203.4

GORE EMPiRE clinical trial results using the Gore flow reversal system during carotid artery stenting

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Purpose: to assess the safety and effectiveness of the GORE Flow Reversal System to provide cerebral embolic protection during carotid artery stenting procedures. The primary endpoint was a composite major adverse event rate of death, stroke, TIA, and myocardial infarction at 30 days post-procedure.
Materials/Methods: the GORE Flow Reversal System provides neuro protection during carotid artery stenting by redirecting macro and micro emboli away from the brain. Flow reversal is achieved at the treatment site by selectively occluding the common carotid and external carotid artery blood flow. By establishing an arterio-venous shunt via the femoral vein, blood from the contralateral side via the Circle of Willis and collateral vessels flows toward the lower pressure venous return, and embolic particles are captured in an external filter. Fifty-six training cases and 245 pivotal subjects were enrolled at 29 sites. The patient population consisted of patients diagnosed with carotid artery stenosis requiring revascularization and at high risk for endarterectomy.
Results: the 30-day stroke, death, and MI rate was 3.7% (4.5% including TIA) and the death/any stroke rate was low, at 2.9%, as compared to other embolic protection trials. Importantly, the study also showed encouraging results in the most challenging patient populations with a low death, stroke, and MI rate of 2.6% for octogenarians and 3.8% for symptomatic patients.
Conclusion: flow reversal provides embolic protection prior to crossing the lesion and provides continuous protection during the critical stages of the carotid stenting procedure. The Gore EMPiRE Clinical Study met the primary, major adverse event endpoint.

1203.5

Carotid artery stenting: immediate and long-term results

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Purpose: to report results of carotid artery stenting (CAS) during an 11-year period.
Materials/Methods: data from 168 CAS procedures (symptomatic n=55, asymptomatic n=101, symptoms not leviable n=12) were retrospectively collected. Primary technical success rate, neurological events in-hospital, access-site complications and contrast-induced nephropathy (CIN; n=120) were evaluated. To evaluate the influence of experience in CAS on intraprocedural neurologic complications, patients were divided into two groups. Group 1 includes the first 80 treated patients and group 2 the following (n=86). Neurologic events during the follow-up and in-stent-restenosis (ISR) at last-follow-up examinations (n=80) were assessed.
Results: the overall primary technical success rate was 95.8%. The overall neurological complication rate was 6.0% (n=10; 4 major strokes, 1 minor stroke, 5 TIA`s) and the in-hospital stroke-death rate was 3.0% (n=5). Neurologic complications were markedly higher in group 1 (8.75%; 3 major strokes, 4 TIA`s) compared to group 2 (3.4%; 1 major and 1 minor stroke, 1 TIA) but without significance. Further complications were one (0.6%) access-site bleeding requiring surgical revision and one (0.83%) CIN. 21 (23.6%) patients had a more than 50% ISR during a mean follow up of 28.2 months. Out of them, one patient (3.2%) suffered from an ipsilateral major stroke.
Conclusion: contrary to the initial learning phase, advanced experience in CAS leads to a lower and acceptable neurological complication rate. In our patient cohort, ISR was high in long-term follow-up but without neurologic adverse events in almost all cases.

1203.6

Helical stent design elicits swirling blood flow pattern and inhibits neointima formation in porcine carotid arteries

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Background and aim: we conducted a (controlled) porcine carotid study (n=10) to confirm that a helical stent induces swirling flow, thereby augmenting wall shear stress (WSS) and inhibiting neointima formation relative to conventional straight stents in porcine carotid arteries.
Methods: computational fluid dynamics (CFD) was used to evaluate the effect of helix amplitude and pitch, on the magnitude of swirling flow and resulting WSS. The study demonstrated that WSS was proportional to amplitude of the helix and inversely proportional to the helix pitch. Helical stents (HS) and straight metallic stents (SS) were implanted contralaterally in porcine carotid arteries by standard endovascular technique, and angiographic as well as Duplex blood flow imaging was performed. One month after stent implant, angiographic and duplex imaging was repeated; stented carotid arteries were then harvested for histomorphometric analysis (histomorphometric data will be presented).
Results: a swirling pattern of blood flow was observed angiographically and using colour Doppler ultrasound in HS immediately after implantation and at restudy, but not in SS. QCA at time of explant revealed a larger lumen area in helical stents relative

to straight controls in all subjects (HS: 5.2±0.6 mm, SS: 4.7±0.6 mm p=0.053). A spatial correlation was observed between regions of low wall shear (as predicted by the CFD) and neointimal thickening within the stented vessel.
Conclusion: a novel helical stent design promotes swirling blood flow and inhibits neointima formation in stented porcine carotid arteries.

Free Paper Session
Experimental work in IR

1204.1

Functional magnetic resonance imaging in an animal model of pancreatic cancer

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Purpose: as catheter-directed therapies for pancreatic cancer are developed, functional targets, (i.e., tumor perfusion and water mobility) must be identified. This study tests the hypotheses that: a) transcatheter intraarterial perfusion (TRIP) and b) diffusion-weighted (DW) MRI can detect regional differences in tumor viability in an animal model of pancreatic cancer.
Materials and Methods: VX2 tumors were implanted in pancreata of six New Zealand white rabbits. MRI and DSA were performed 3 weeks later. With a microcatheter secured in the GDA, each rabbit was transferred to a 1.5T MRI scanner. DW- and TRIP-MRI were performed to differentiate necrotic tumor core from viable tumor periphery. We compared mean differences between tumor core and periphery for TRIP-MRI (maximum upslope) and DWI-MRI (ADC value) using 2 tailed paired t-test, (alpha=0.05).
Results: tumors were successfully grown in all rabbits, confirmed by necropsy. DSA and MRI were successful in 5/6 rabbits (11 tumors). The mean ADC value was higher in necrotic tumor core (2.1 mm2/s) than in viable tumor periphery (1.4 mm2/s). The mean TRIP MRI value was higher in the periphery (130 arbitrary units) than in the core (40 arbitrary units). Both differences were statistically significant ($p<0.05$).
Conclusion: functional MRI can be used to differentiate necrotic from viable tumor in an animal model of pancreatic cancer. Regions of necrosis have larger ADC values (DW-MRI) and reduced perfusion values (TRIP-MRI). These parameters may be useful as surrogate endpoints when testing novel transcatheter therapies.

1204.2

X-ray induced DNA double-strand breaks in patients undergoing angiographic procedures of different examination regions

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Purpose: to investigate DNA double-strand breaks (DSBs) in blood lymphocytes as markers of the biological radiation effects in angiography patients.
Materials/Methods: blood samples were collected before and up to 24 hours after exposure of 31 patients undergoing angiographies of different body regions. Determination of DSBs is based on the phosphorylation of the histone variant H2AX after their formation. Blood lymphocytes were isolated and distinct foci representing DSBs were enumerated using fluorescence microscopy after staining with a specific γ-H2AX antibody. Additional in-vitro experiments (50 mGy) were performed for evaluation of DBS repair.
Results: dose area product ranged from 337 to 37926 µGym2. 15 minutes after the end of fluoroscopy, values between 0.01 and 1.50 DSBs per cell were obtained. The DNA damage levels normalized to the dose area product were significantly ($p<0.05$) different for various examination regions: 0.099 (cardiac angiographies), 0.053 (abdominal angiographies), 0.023 (pelvic/leg angiographies), and 0.004 foci/cell/mGym2 (cerebrovascular angiographies). A linear correlation was found between γ-H2AX foci levels and dose area product (head: r=0.95, heart: r=0.81, abdomen: r=0.98; pelvis/legs: r=0.84). In-vivo on average 46% of DSBs disappeared within 1 and 70% within 2.5 hours, respectively. A prolonged fractionated irradiation led to an underestimation of DBS levels in-vitro.
Conclusion: in angiography, X-ray induced DNA damage level is dependent on the dose deposed, the anatomic region exposed, and the duration/fractionation of the X-ray exposure.

1204.3

Paclitaxel/OK432-eluting silicone/polyurethane membrane for GI stent

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Purpose: we expected both chemotherapy and immunotherapy using a stent-covering membrane with the combination of paclitaxel and OK432 in animal model.
Materials/Methods: the stent covering membrane was made from paclitaxel/OK432 containing polyurethane coated with silicone, which was dissolved in xylene. For evaluation of safety and anticancer effects, we used mouse tumor model for 4 weeks. The mice received 1×106 cells of CT-26 into the dorsal skin of mice prior to insertion of each membrane (control, paclitaxel only, OK432 only, and paclitaxel/OK432) for anticancer therapy. The tumor size was measured using calipers, and the body weight of the tumor model was monitored until 4 weeks after insertion of each membrane. The tumor mass was harvested on day 28 of the membrane treatment.
Results: when harvested on day 28 after the insertion of each membrane, the tumor mass was decreased in the group of paclitaxel/OK-432 (7151±1235 mm3 for control vs 1609±653 mm3 for paclitaxel/OK432). Body weights as an indicator for overall toxicity were not changed by the paclitaxel/OK432 membrane. In this study, we found that the local and controlled-releasing polyurethane membrane for paclitaxel/OK432 had more significant antitumor activity in the combination of paclitaxel and OK432, and did not exert systemic toxicity on the tumor model.
Conclusion: our data suggest that the paclitaxel-OK432-releasing membrane would be applied for the drug-eluting stent as local therapy of GI cancer.

1204.4

Quantitative computed tomography perfusion imaging of arteriogenesis in an endovascular model of rabbit hind limb ischemia

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Purpose: therapeutic stimulation of arteriogenesis is an attractive research field of leg ischemia treatment. We applied computed tomography perfusion (CTP) imaging of the process of arteriogenesis in an endovascular model of rabbit hindlimb ischemia.
Materials/Methods: unilateral femoral artery coil embolization

was performed in 10 New Zealand White rabbits using a novel approach through the auricular artery. CTP was carried out at 3,10, 20 and 40-day intervals with contrast injection through an auricular vein. A temporary intra-aortic balloon occlusion test was applied for further evaluation of peripheral exertional flow reserve on final day 40. Regional quantitative measurements of resting and exertional blood flow (BF), blood volume (BV), mean transit time (MTT) and permeability surface area product (PS) of the ischemic limbs were taken (GE Healthcare). Results were expressed as the percent ratio of ischemic hindlimbs to contralateral normal controls.
Results: immediate technical success of femoral artery embolization was 100%. Resting BF and BV in the embolized limbs showed a gradual linear recovery owing to progressive tissue arteriogenesis, exceeding the contralateral normal limbs on day 10 and escalating to +57 and +46% on day 40, respectively ($p<0.05$). However, collateral vascular flow reserve was completely abolished in the ischemic group (>50% reduction of exertional BF and BV compared to normal limbs). MTT exhibited a linear decrease to -10%, whereas PS increased to +58% on day 40 (both $p<0.05$).
Conclusion: CTP is a promising imaging modality for non-invasive monitoring and quantification of ischemia-induced arteriogenesis. Blood conductance of resting collaterals was significantly higher than native femoral arteries, but a notable exertional flow deficit remained.

1204.5

Drug delivery rate of DOXO-DEB in non-tumorous pig liver embolisation model

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Purpose: preclinical studies of Doxorubicin eluting beads (DOXO-DEB) have demonstrated that toxic levels of drug could be maintained in the target tissue for at least 90 days (Namur et al. CIRSE 2008). However, we do not know what is the amount of drug that is still retained inside the beads. We have investigated the drug delivery rate of DOXO-DEB in a non-tumorous pig liver model using previously validated FTIR microspectroscopy (Namur et al. CIRSE 2007).
Materials/Methods: fifteen pigs underwent left lobe hepatic artery embolization with: group 1: DEB 700-900 µm+37.5 mg DOXO/mL DEB; group 2: DEB 100-300 µm+37.5 mg DOXO/mL DEB; group 3: DEB 100-30 µm+saline. Livers were sampled at day 28 (D28) or day 90 (D90) after embolization. Thin tissue sections were cut and analyzed with FTIR-MS. The amount of DOXO retained inside DEB was assessed using standard FTIR signal-DOXO concentration curves (lowest limit of quantification=1mg/mL, $R^2=0.981$).
Results: the signal of DOXO was absent from control unloaded DEB. The concentration of DOXO in DEB was 15±5 mg/mL in group 1 (n=11) and 22.5±13 mg/mL in group 2 (n=57) at D28. At D90, DOXO concentration in DEB significantly decreased to 7±1 mg/mL in group 1 (n=3) ($p=0.0240$, MW) and 4±3 mg/mL in group 2 (n=19) ($p<0.0001$, MW). The amount of drug retained in beads was not significantly different between the two groups at both time points.
Conclusion: DOXO-DEB may provide a drug delivery for approximately 3 months in a non-tumorous liver model: DOXO delivery rate is 52% of initial load at day 28 and 89% at day 90.

1204.6

Pulmonary artery embolisation using irinotecan eluting beads: drug delivery and pathology in a sheep model

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Purpose: to assess irinotecan (IRI) delivery from drug eluting beads (DEB) and local toxicity in a sheep lung embolisation model.
Materials/Methods: 24 sheep divided into four groups based on IRI-loaded doses were embolised with 2 mL of DEB (300-500 µm) preloaded with IRI at 0 (control), 10, 25 or 50 mg/mL (maximum DEB loading capacity). DEBIRI were superselectively delivered into the posterobasal branch of the left pulmonary artery using a microcatheter. Sacrifice of the animals was performed at 4 days or 4 weeks. Drug delivery was evaluated by IRI quantification in plasma by liquid chromatography-fluorescence detection (Cmax, AUC, T1/2) and in both the surrounding lung tissue and inside DEB by infrared microspectroscopy. Local toxicity was also evaluated by pathological examination of the lungs.
Results: IRI was present in the systemic circulation within a few minutes after embolisation and for several hours in groups 10 and 25, and for 24 hours for group 50. Cmax and AUC increased significantly with IRI-loaded dose ($p=0.0078$ and 0.0008, respectively, MW). IRI was no detected inside DEB and in the surrounding tissue at 4 days. No sign of lung toxicity was observed except for group 50 in which hemorrhagic angionecrosis was found at 4 days (but not at 4 weeks). Inflammatory response on beads was moderate in all groups.
Conclusion: lung embolisation with DEBIRI was well tolerated with an acceptable safety profile and may offer an alternative beneficial treatment for lung cancer in the future.

Free Paper Session
Fibroid therapy

1205.1

Uterine fibroid embolization in women with pedunculated fibroids

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Purpose: presence of a pedunculated subserosal fibroid (PSF) is considered a relative contra-indication for uterine fibroid embolization (UFE). PSF is defined as a fibroid with a stalk which is less than 50% of the maximum diameter of the fibroid. Purpose of this study was to evaluate the risk of UFE in symptomatic women with PSF.
Material and Methods: twenty-nine symptomatic women with 31 PSF underwent UFE. Prior to and three months after UFE, MR imaging was performed in all women. Using MR data, change in stalk diameter and volume reduction of both PSF and uterus were calculated. In addition, infarction rate of PSF and overall infarction was assessed. A questionnaire was sent to all women inquiring about possible UFE

complications. Statistical analyses were performed using the paired samples T-test. Significance was inferred when p<0.05.
Results: the PSF was never solitary present and was the dominant fibroid in 15 women. The mean stalk diameter changed from 2.64 to 2.29 cm (p<0.001). The mean PSF volume reduction was 33% (168 to 113 ml) (p<0.001). The mean uterus volume reduction was 37% (600 to 377 ml) (p<0.001). The mean PSF infarction and mean overall infarction rate were for observer 1: 87 and 92% and for observer 2: 88 and 92%, respectively. All women returned the questionnaire. In none of the women a UFE related complication occurred. Four women underwent a hysterectomy due to persistent clinical complaints (pollakisurie n=1; persistent blood loss n=3).
Conclusion: UFE in symptomatic women with PSF can be safely performed.

1205.2

Revisiting the randomized trial of embolization versus surgical treatment for fibroids (REST) patient cohort at five years: primary outcome measures, treatment failure and pregnancy

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Purpose: the randomized trial of embolization versus surgical treatment for fibroids (REST) investigators concluded in 2007 that there was no significant difference in primary outcome measures (SF36 quality of life) or incidence of complications at one year. There was a 9% incidence of further invasive therapy at one year in the UAE group. UAE was more cost-effective at one year. We present five year follow up of the primary outcome measures, treatment failure and pregnancies.
Materials/Methods: utilising the original REST cohort five years since the initial therapy, we assessed the primary outcome measure, the number of patients who required further invasive therapy (repeat embolization/hysterectomy) and the number of pregnancies.
Results: at 5 years, 21 patients in the UEA group required a hysterectomy, 17 due to continuing symptoms; MRI in 9 of these patients showed no enhancement of the fibroid at follow up. Eight patients underwent repeat embolization, 7 due to continuing symptoms and one due to recurrent symptoms; of these 8 patients, 4 had no enhancement at MRI after the second UAE. In the UAE group, there were 10 pregnancies resulting in 3 live births. One patient in the myomectomy group had two pregnancies resulting in 2 live births. The results of the primary outcome data are imminent.
Conclusion: UAE is a durable alternative to hysterectomy. In UAE patients requiring hysterectomy, approximately half had non enhancing fibroids. Reintervention with UEA resulted in complete infarction in half of these patients. Fertility can be preserved with UAE.

1205.3

Uterine fibroid embolization with Embozene microspheres under electroacupuncture as an outpatient procedure: preliminary results

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Purpose: to evaluate the safety and effectiveness of uterine fibroids embolization (UFE) with embozene microspheres under electroacupuncture, as an outpatient procedure.
Materials/Methods: prospective study with 37 consecutive patients (age range, 21-53 years; mean age 41.5 years) undergoing UFE. Twelve patients chose to perform UFE under electroacupuncture (Group A) while 25 patients were treated under local pharmacological anesthesia (Group B). Pain scores (rated from 0 to 10) in both groups during, after the procedure, before discharge, at discharge and the next morning were assessed. The outcome of UAE was evaluated at 6 months.
Results: the mean pain score during embolization was 0.35 in group A and 0.87 in group B; after embolization and before discharge was 3.02 in group A and 4.48 in group B; at discharge it was 1.02 in group A and 2.14 in group B. These differences were statistically significant after embolization till discharge (p=0.04; p=0.0005). All patients were discharged from the hospital 4 to 8 hours after the procedure, with no readmissions. At 6 months, there were no significant differences in the clinical outcome or in the uterus and dominant fibroid volumes reduction.
Conclusion: uterine fibroids embolization with embozene microspheres under electroacupuncture, as an outpatient procedure is safe and effective. There was a statistically significant post embolization pain reduction in the patients treated under electroacupuncture, but no differences were found on the outcome of UFE at 6 months.

1205.4

Post-UFE surgical reinterventions: a prospective clinical study

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Purpose: to assess clinical and reproductive outcomes of women with post-UFE surgical reinterventions.
Materials/Methods: 184 premenopausal patients (mean age 36 years, mean diameter/volume of dominant myoma 63 mm/193 cm3, 63% with reproductive plans) treated with UFE were followed and indicated to surgery depending on their symptoms, morphological findings (US, MRI, hysteroscopy) and reproductive plans. Supported by Grant IGA NS 9798-4.
Results: reintervention was performed in 67 patients: 58 myomectomies (15 abdominal, 26 laparoscopic, 17 hysteroscopic), 8 hysterectomies (all elective, in women with no further fertility plans), 5 vaginal assistances to transcervical myoma expulsion, and 1 hysteroscopic endometrial ablation. 5 patients had more than one procedure and the average interval between UFE and reintervention was 14 months. Recurrences of symptoms and/or significant uterine cavity deformation were the most frequent indications. In comparison to patients with myomectomy without previous UFE, no significant difference in peri- or post-operative parameters except for histology (completely necrotized myomas in post-UFE cases) was observed. 7 reinterventions were urgent for severe pain associated with myoma expulsion or infection. No major complication was observed. 20 women from this group have already tried to conceive with pregnancy rate 70% and delivery rate 45%. In total, 10 full term deliveries, 9 missed abortions, 1 pregnancy termination, and 2 ongoing pregnancies have been recorded until now. The mean follow-up was 40 months.
Conclusion: post-UFE surgical reintervention is a safe and in majority of cases a minimally invasive procedure, which may improve reproductive results of women with otherwise poor fertility prognosis.

1205.5

Prospective assessment of safety/efficacy of rotational angiography for uterine artery embolization (UAE)

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Purpose: to assess the usefulness of rotational angiography for UAE.
Materials/Methods: 18 consecutive women (36 arteries) average 41.6 y.o. underwent bilateral UAE for myoma (n=16) or adenomyosis (n=2) between September 2008 and January 2009.
UAE was performed using a standardized protocol as follows: selective left IIA opacification using rotational angiography (7 sec injection, 3 cc/sec), 3 D arterial reconstruction (iPilot live). The optimal angiographic projection was chosen and fade-in/fade-out fluoroscopy was used to catheterize the uterine artery (UA) using a micro-catheter (Terumo Progreat). According to the angle of the UA origin the simple J or the double J (0.16 guide wire) was chosen. Time to catheterization using a stopwatch and dose-area-product (DAP) were prospectively recorded for the rotational acquisition and for the whole intervention.
Results: successful catheterization of the UA was achieved in 52 ± 60 sec [5-300 sec] (median=30 sec). The guide wire was simple J (n=27) and double J (n=9). Rotational angiography accounted for 7% the DAP (average total DAP=28002 µGy·m2).
Conclusion: rotational angiography allows fast catheterization of the uterine artery with a negligible effect on radiation dose to the patient.

1205.6

Pregnancy viability and morbidity following uterine fibroid embolization

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Purpose: to evaluate morbidity and viability in pregnancy after uterine fibroid embolization.
Materials/Methods: uterine fibroid embolization (UFE) was performed in 468 patients, 62 wanted to become pregnant. Polyvinyl alcohol particles (PVA) or embozene microspheres were used to embolize the uterine arteries.
Results: from the 62 patients who wanted to become pregnant, 20 (32.2%) had spontaneous pregnancies. Their age ranged 31-43 years (mean 36.1 years). The time between UFE and conception ranged between 4 and 20 months (mean 11.1). Three of them had a previous unsuccessful miomectomies. UFE was performed with PVA in 18 patients and with embozene microspheres in 2 patients. One of the pregnant women induced abortion because she was taking isotretinoina and in 5 the evolution of pregnancy has been normal and are waiting for term. All the others had successful pregnancies with live births (70%). There were 6 cesarean sections and 8 vaginal deliveries. The gestations lasted 36 weeks in 2 patients. The gestation of the remaining women ranged from 38 to 40 weeks (mean 39 weeks). The weight of one of the newborns with 36 weeks gestation was 2.325 Kg. The weight of the remaining newborns ranged between 2.610 and 4.910 kg (mean 3.241 Kg). All the babies born presented no significant neonatal problems. There were no cases of hypertension, abnormal placenta implantation or pos-part bleeding.
Conclusion: pregnancy after uterine fibroid embolization is viable with low morbidity.

Free Paper Session
Oncologic embolization

1206.1

Optimal method of doxorubicin loading and elution in superabsorbent polymer microspheres: in vitro analysis

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Purpose: to determine the optimal loading method and amount of doxorubicin on superabsorbent polymer (SAP) microspheres (Hepasphere).
Materials/Methods: a 10 mM MES, 150 mM NaCl (pH 6.0) solution served as the diluent/buffer. Two types of doxorubicin (pre solubilized and lyophiolized dry), and method of reconstitution of 50-100um dry SAP microspheres (dry in vial, 0.9% saline, sterile water, 14.3% hypertonic saline, and non-ionic contrast (Iodixanol 270 mgI/mL)) were tested in an in vitro model with subsequent measurement of uptake and elution over a 28 day period utilizing a validated high pressure liquid chromatography system (HPLC) of the most efficient systems. Cumulative uptake of doxorubicin into the diluent was measured up to 28 days for 100 mg doxorubicin. Top two loading methods were then examined with 50, 75 and 100 mg loaded doses of doxorubicin.
Results: top two loading methods consisted of dry SAP microspheres loaded with lyophilized doxorubicin and rehydrated SAP microspheres (0.9% saline) with lyophilized doxorubicin. Consistent rates of elution were demonstrated with 50, 75 and 100 mg of doxorubicin loading of SAP with both methods. Optimal loading/handling of doxorubicin was 75 mg lyophilized doxorubicin dissolved in 10mL 0.9% normal saline with 25 mg of 50-100 um SAP, demonstrating dry/hydrated microsphere elution of 28 vs 23% at 7 days with improved handing of the microspheres with the SAP microspheres reconsitituted in 0.9% normal saline.
Conclusion: 50-100 um dry SAP microspheres are optimally loaded with 75 mg of lyophilized doxorubicin. Prehydration of dry SAP and lyophilized dox with 0.9% saline demonstrated reliable loading and elution up to 28 days.

1206.2

Comparison of chemoembolization with doxorubicin eluting beads and bland embolization for HCC

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Purpose: to evaluate the added role of the chemotherapeutic in transarterial embolization (TACE) of hepatocellular carcinoma (HCC). The issue is of major importance since hypoxia is a potent stimulator of angiogenesis as suggested by recent evidence that shows that bland embolization increases the serum levels of angiogenic factors. Several studies provide evidence that chemoembolization performs better than bland embolization but the variability of the TACE techniques compromises the strength of these results. The hypothesis was that since DEB-TACE allows a standardized and reproducible TACE, the comparison with bland TACE can readily

reveal the potential added value of the chemotherapeutic.
Material and Methods: two groups of patients were enrolled in this prospective study: group A-treated with doxorubicin DEB-TACE (n=42) and group B (n=43)-treated with bland embolization. Patients included were BCLC stage B, randomized for tumor diameter.
Results: tumor response was evaluated with the RECIST criteria using the EASL amendments. In group A, complete response at 6 months was seen in 13 pts (30.9%) and in 6 patients (13.9%) of group B. Partial response was achieved in 20 (47.%) and in18 (41.8%) in groups A and B respectively. Time to Progression (TTP) was 41.1 months for Group A and 36.2 for Group B.
Conclusion: DEB-TACE presents a trend for better short term local response than bland embolization. However, survival benefit has to be addressed in future papers to better assess the clinical value.

1206.3

Transarterial chemoembolization reduces drop off risk for patients with HCC on the liver transplant waiting list

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Purpose: the objective of our retrospective, cohort study was to ascertain whether TACE reduces the drop off risk for patients on the liver transplant waiting list for HCC.
Materials/Methods: the study included 74 consecutive patients with HCC placed on the liver transplant list (Milan). 47 patients were not treated with TACE (control group), while 27 patients were (test group). Patient demographics, tumor morphology, type and degree of liver cirrhosis were calculated for both groups. We also calculated the overall and disease free survival for the two groups. We compared the two groups using the log rank test. We calculated the risk of dropping off the liver transplant waiting list using Kaplan-Meier curve and person-time statistics.
Results: the groups were matched for age, gender and MELD. Overall median survival (at time of data collection) was 128+99 weeks and 147+126 weeks for the non-TACE and TACE groups, respectively (P>0.05). Disease free survival also was 128+101 and 131+126 weeks, respectively for the non-TACE and TACE groups (>0.05). Six of the 47 (13%) non-TACE and 1 of the 27 (4%) TACE patients dropped out during the transplant waiting period (p=0.048, one-tailed). This was valid for patients who were on the list for at least 4 months.
Conclusion: for patients placed on the liver transplant list for HCC, TACE appears to reduce the risk of drop off during the waiting period. This benefit vanishes if the waiting list is shorter than 4 months.

1206.4

Treatment of hepatocellular carcinoma (HCC) with drug eluting beads before liver transplantation: imaging and histology results

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Purpose: to evaluate the efficacy of transarterial chemoembolization (TACE) with drug eluting beads (DEB) to manage hepatocellular carcinoma (HCC) in potential liver transplant (LT) candidates.
Materials/Methods: over a 30 months period, 28 HCC-patients considered for liver transplantation underwent repeated DEB-TACE. 15 were initially outside the Milan criteria. Mean tumoral diameter was 5.5 cm (range 1.6-8.1) and mean number of nodules was 2.1 (range 1-5). 100 Mg of Doxorubicine loaded in DCbeads of 500-700 micron were injected at each session (med 2.8 sessions/patient).
Results: according to the EASL criteria, an objective response was observed in, respectively, 23 (82%) and 25 (89%) patients after first and last DEB session with a complete response rate of, respectively, 11 and 32%. Among the 15 patients initially exceeding the Milan criteria, 12 (80%) were sufficiently downstaged to be actively listed for LT and 3 were withdrawn because progressive disease. Up to now, 17 patients has been transplanted (median delay of 8.5 month after first DEB-TACE), 7 are still on the waiting list and 1 expired before transplantation secondary to comorbidities. Explant histological review (n=17) and necropsy (n=1) demonstrated complete, partial (>80%) and incomplete HCC necrosis in, respectively, 9 (50%), 8 (44%) and 1 (5%) patients. At 11 month follow-up, recurrent HCC on the graft occurred in 1 patient (6%) transplanted despite poor downstaging.
Conclusion: DEB-TACE treatment is effective to control HCC during the waiting time before transplantation and to downstage patients primarily not eligible. The high rate of necrosis observed at histological examination is promising.

1206.5

Toxicity of irinotecan eluting beads in the treatment of hepatic malignancies: results of multi-institutional registry

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Purpose: to evaluate the predictors of toxicity of the irinotecan (Camptosar) DC/LC bead in the treatment of hepatic malignancies.
Materials/Methods: a total of 330 patients were enrolled in a prospective open-label, multi-center, multi-national single arm study receiving the DC/LC bead. Complications were graded by the CTCAE for adverse events version 3.0. All events requiring additional physician treatment or requiring extended hospital stay or readmissions within 30 days were included.
Results: a total of 109 patients received 187 DC/LC bead irinotecan (range 1-5) treatments. The most common histology was metastatic colorectal cancer 76%, Cholangiocarcinoma 7%, and other metastatic disease 17%. There were 35 patients (19%) with irinotecan treatments who sustained 158 treatment related adverse events, median grade of event being 2 (range 1-5), with the most common event being post-embolic symptoms (42%). Multivariate analysis looking at all pre-treatment and treatment related factors identified. The lack of pre-treatment with hepatic arterial lidocaine (p=0.005), ≥3 treatments (p=0.05), Going to complete stasis (p=0.04), treating with >100 mg at one treatment (p=0.03), and treating patients with bilirubin >2.0 and >50% liver involvement (p=0.05) as predictors of adverse events and significantly greater hospital length of stay.
Conclusion: irinotecan DC/LC beads are safe when appropriate technique and treatment is utilized. Adverse events can be predicted based on pre-treatment and treatment related factors and can be part of the informed consent process. Continued standardization of this device and technique will lead to less adverse events and improved quality of life in these patients.

1206.6

Reduced liver and cardiac toxicity in intermediate hepatocellular carcinoma patients treated with PRECISION TACE with drug eluting beads: results from the PRECISION V randomized trial

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Purpose: to evaluate the extent of liver toxicity following PRECISION TACE with DC Bead compared with conventional TACE (cTACE).
Materials/Methods: a series of 212 intermediate-stage HCC patients (185 males, 27 females, mean age 67years) were enrolled in the PRECISION V clinical study and randomised to receive PRECISION TACE with doxorubicin-loaded DC Bead (PRECISON TACE) or cTACE with doxorubicin. Patients received one treatment every 2 months and were followed-up for 6 months. Adverse events were classified according to the South West Oncology Group critera (SWOG).
Results: the most commonly occurring treatment emergent serious adverse events (TESAEs) were of the gastrointestinal or liver organ systems. Of the 12 TESAEs reported relating to liver toxicities, 3 events occurred in the PRECISION TACE group compared to 9 events in cTACE group. Observed post procedural increases in the liver enzymes AST and ALT were significantly less in the PRECISION TACE group than in the cTACE group. Mean maximum ALT increase in the PRECISION TACE group was 50% of that in the cTACE group (95% CI 39-65%, p<0.001) and mean maximum AST increase in the PRECISION TACE group was 59% of that in the cTACE group (95% CI 46-76%, p<0.001). Cardiac function was maintained in the PRECISION TACE group whereas there was a deterioration in left ventricular ejection fraction in the cTACE group (PRECISION TACE +2.7±10.1 percentage points, cTACE -1.5±7.6 percentage points, p=0.018).
Conclusion: PRECISION TACE with DC Bead results in less serious liver toxicity and less cardiotoxicity compared to cTACE.

Free Paper Session
Oncologic interventions 1

1207.1

Lung radiofrequency in single lung patients: feasibility, tolerance and efficacy

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Purpose: to evaluate feasibility, tolerance and efficacy of lung radiofrequency ablation in single lung patients for primary and secondary lung malignancies.
Materials/Methods: from July 2003 to October 2008, 14 single lung patients (mean age 62 years) underwent 15 sessions of radiofrequency ablation for single or multiple pulmonary tumors. We retrospectively evaluated clinical tolerance and abnormal image from CT obtained during RFA procedure and follow-up CT, which was performed at 3, 6, 12 months and 2 years after treatment.
Results: 10 patients had primary lung cancer and 4 had metastases from colorectal adenocarcinoma (n=3) and uterine leiomyosarcoma (n=1). 20 tumors measuring 4 to 37 mm (15±8) were treated. All tumors depicted have been treated in a single session. One patient had two sessions due to occurrence of new tumors. Expandable electrodes were used in 12 procedures and cooltip electrodes in 3 procedures. No procedural death occurred. Procedural complications were 25% pneumothorax and 25% minor parenchymal haemorrhage depicted on CT during RFA procedure. All pneumothoraces were definitively cured with chest tube placement. Postprocedural complications included 1 case of pulmonary infection and 2 cases of hemoptysis. Overall survival and cancer-specific survival rates were 71 and 93% after a median follow-up of 18 months. Lung recurrence rate was 50% after a median follow-up of 10 months, including only one local recurrence in the ablated area (7%).
Conclusion: in this short series, radiofrequency ablation seems to be a reasonably safe option in single lung patient, without additional morbidity compared with two lung patients.

1207.2

Phase II feasibility study on the combination of two different regional treatment approaches in patients with colorectal „liver-only" metastases: hepatic interstitial brachytherapy plus regional chemotherapy

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Purpose: to evaluate feasibility, safety and efficacy of combined treatment with hepatic interstitial brachytherapy (HIB) and hepatic arterial infusion (HAI) of chemotherapy after interventionally implanted port catheter systems.
Materials/Methods: thirty-three patients with unresectable "liver-only"-metastases of colorectal cancer were treated with both HIB and HAI during the course of their disease. Of those, n=15 received HAI first and were then consolidated with HIB, n=9 started with HIB and were continued with HAI after hepatic disease progression, and n=9 received the inverse sequence. Patients were evaluated for treatment characteristics, side effects, and efficacy. Comparisons between treatment groups were also performed.
Results: the median tumor diameter of metastases treated with brachytherapy was 4.6 cm (1-12 cm). The median minimal irradiation dose inside the tumor margin was 18 Gy administered to a mean of two metastases in 69 interventions. Minor (n=4) and major (n=3) complications occurred in 10% of interventions. WHO Grade III adverse events of the regional chemotherapy were observed in 7 patients, and Grade IV in one patient. At a median follow up of 28 months (range: 7-74 months), the median time to disease progression intra- and/or extrahepatic after HAI was 11 months (range:3-35). Sixteen local recurrences occurred in 138 metastases treated by brachytherapy (mean: 12.3 months, range: 3-45). No signs of hepatic failure were observed in any of our patients.
Conclusion: combinations of two minimal-invasive therapeutic methods are feasible with acceptable complications rates and provide promising results in colorectal cancer patients with unresectable hepatic metastases.

1207.3

Morphologic origins of pneumothorax complicating lung radio-frequency ablation: study in a porcine model

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Purpose: to investigate the morphologic origins of pneumothorax complicating lung radio-frequency ablation (RFA) procedure.

Material and Methods: in 3 anesthetized and ventilated swines, 6 RFA procedures (right and left lungs) were performed using a 14-gauge unipolar multi-tined retractable 3 cm radiofrequency LeVeen probe with coaxial introducer positioned under CT fluoroscopic guidance. From a RF generator, we applied a stepwise increasing thermo-ablation protocol complying with literature guidelines. Pre- and post- RFA procedure helical CT images were acquired to detect and evaluate pneumothorax. Three percutaneaous 19-gauge lung biopsies were also performed on a 4th swine under CT guidance. Swine were sacrificed for lung ex vivo examinations, scanning electron microscopy (SEM) and pathological analysis.
Results: three benign (50 ml) pneumothorax were detected. In each case, pathological examination revealed a fistulous tract between ablation zone and pleura. This tract was widely open in the 3 cases of severe pneumothorax, and clearly visible on post procedure CT images and SEM examinations. Tract from RFA differed from needle biopsy tract. Specific coagulative and emphysematous histological changes in RFA tract's wall were related to thermal lesions. These histological changes showed appropriated structural properties to keep RFA tract open after needle withdrawal. In case of alveolar airways opening in the RFA zone, this tract leads to significant pneumothorax.
Conclusion: our study demonstrates for the first time a fistulous tract along the needle path between thermo-ablation zone and pleural space after lung RFA. This condition is expected to cause significant pneumothorax complicating lung RFA procedure.

1207.4

The clinical evaluation of treatment for hepatocellular carcinoma combined with arterio-portal fistula using NBCA

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Purpose: to evaluate the clinical application value of embolization therapy using N-butyl 2-cyanoacrylate (NBCA) for hepatocellular carcinoma (HCC) combined with arterio-portal fistula (APF).
Materials/Methods: eighty patients with HCC and APF underwent embolotherapy with NBCA (NBCA group, 26 patients) or absolute alcohol (alcohol group, 54 patients). The APF was treated first with liquid embolic agent during the TACE procedure. We used NBCA-lipiodol mixtures in concentration of 20-50% according to the different circulation times of these APF in NBCA group. Absolute alcohol plus gelfoam or other materials were used for embolization of APF in alcohol group. The pain reaction during the procedure, influence for liver function ($\chi 2$ test), occlusive successful rate after single embolization (Fisher's Exact Test) and the survival rate of 1 year (Log-rank analysis) between two groups were compared after the embolotherapy.
Results: there were 4 patients in NBCA group and 52 patients in alcohol group, respectively, felt painful during the procedures. There was obvious statistically difference between two groups ($P<0.001$, $\chi 2 = 58.86$). The APF disappeared after only single embolization in 24 (92.3%, 24/26) cases of NBCA group and in 37 (68.5%, 37/54) patients of alcohol group. There was also statistically obvious difference between two groups ($P=0.024$). There were no statistically differences in the post-embolization liver function change and 1 year survival rate between two groups.
Conclusion: the embolization therapy using NBCA for HCC combined with APF is safe, effective and more accurate. It can be provided as a new technique for these patients.

1207.5

Volumetric arterial enhancement fraction for the prediction of tumour recurrence after hepatic radiofrequency ablation

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Purpose: The aim of this study was to investigate if image based 3D analysis of the hepatic arterial enhancement fraction (AEF) allows prediction of tumor recurrence in patients undergoing hepatic radiofrequency ablation.
Materials/Methods: we used prototype software with automatic non-rigid registration in order to anatomically align triple phase MSCT liver scans and calculate AEF in 3D. After registration, unenhanced CT data were subtracted from arterial phase and venous phase images to obtain volumetric hepatic arterial enhancement (HAE) and portal venous enhancement (PVE). AEF was calculated as HAE/PVE. 53 patients (mean age 65±10 years) with liver metastasis from colorectal (n=41) or breast cancer (n=12) with a minimum follow-up of 4 months after hepatic RF-ablation were included in this study. AEF was calculated for the each segment of the liver, the metastasis as well as the margin of the ablation zone. Data was analyzed with ROC curves.
Results: a total of 268 MSCT examinations were available. 259/268 (96.6%) were included in the data analysis. 9 examinations had to be discarded due to variations in the contrast injection protocol. Mean AEF in the tumour free liver parenchyma was 35±17%. In untreated metastases, mean AEF was 59±16% ($p<0.0001$). Area under the curve on ROC analysis was 81%. There was a 75% probability of recurrent metastasis in case of an elevated AEF ≥49%.
Conclusion: volumetric AEF allows differentiation of metastatic from tumour free liver parenchyma. Changes of the AEF over time provide a starting-point for early detection of hepatic tumour recurrence.

1207.6

Suicide gene therapy for hepatocellular carcinoma

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Purpose: interventional radiology has the potential for targeting cancer gene therapy. Our aim was to assess the feasibility and efficacy of intra-arterial (IA) and intra-tumoral (IT) suicide gene delivery and therapy of hepatocellular carcinoma (HCC) in an orthotopic rat model.
Materials/Methods: rats (n=17) with syngeneic HCC implants in the liver underwent either IA (common hepatic artery) or IT injection of adenoviral vector carrying the suicide gene construct, Herpes Simplex Virus Type I mutant Thymidine Kinase (Ad-CMV-HSV1-sr39tk). On the day of intervention, [18F]-FDG MicroPET images were performed to confirm tumor growth followed by daily intra-peritoneal administration of the therapeutic pro-drug Ganciclovir for 7 days. On day 4 and 7 post intervention, [18F]-FDG MicroPET images were repeated to assess tumour response to therapy. Additional rats (controls, n=15) received either IA (n=5) or IT (n=5) gene delivery but no GCV and 5 rats received neither gene delivery nor GCV.
Results: IA and IT injection was successfully performed in all rats. Significant therapeutic effect was seen in rats treated with IA gene delivery compared to the untreated group (11 vs 94% increase in tumor size, p=0.028). When comparing IA to IT gene delivery,

IA delivery demonstrated greater therapeutic effect but was not statistically significant (p=0.290). Significant therapeutic effect was seen, however, in all treated rats with either gene delivery route, compared to all untreated rats (p=0.026).
Conclusion: suicide gene therapy is feasible and efficacious in an orthotopic rat model of HCC. Further studies are warranted to determine the optimal route of gene delivery.

Free Paper Session
Peripheral vascular interventions 1

1208.1

First-in-human clinical trial of a nitinol self-expanding everolimus-eluting stent for prevention of restenosis following infrainguinal endovascular intervention: the STRIDES trial

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Purpose: the purpose of the first-in-human STRIDES trial was to evaluate the safety and efficacy of an everolimus-eluting nitinol stent for the treatment of superficial femoral and proximal popliteal arterial occlusive disease.
Materials/Methods: an everolimus-eluting nitinol self-expanding stent loaded with everolimus 225 µg/cm2 stent surface area using an ethylene vinyl copolymer was developed. In experimental animal models, the drug is released slowly over the first 90 days and arterial drug levels measurable over the first 180 days. 104 patients were enrolled at 11 European investigative centers between May 2007 and January 2008. As expected, the population had severe vascular disease, including a significant proportion of patients with critical limb ischemia (17%), diabetes (40%) and single-vessel outflow (26%). The overall lesion length was 9.0±4.3 cm, with 45% of arteries being totally occluded and 9.4% having undergone prior intervention.
Results: successful device placement was achieved in 98% of cases. Serial blood sampling for everolimus was performed in 26 patients over the first month; maximum systemic everolimus concentrations varied from 1.83±0.05 to 4.66±1.78 ng/ml depending on the number and length of stents implanted. Patients were followed with serial imaging studies including duplex ultrasound at 1, 6 and 12 months and repeat angiography at 12 months. One-year clinical and imaging results will be presented.
Conclusion: the everolimus-eluting self-expanding nitinol stent can be successfully implanted in patients with severe peripheral vascular disease; systemic everolimus concentrations are maintained well below established limits for toxicity.

1208.2

Percutaneous transluminal angioplasty versus devalvulated saphenous vein bypass graft surgery for infragenicular disease in critical limb ischemia: comparison of patency and limb salvage rates

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Purpose: to determine and compare patency and limb salvage rates of percutaneous transluminal angioplasty (PTA) and devalvulated saphenous vein bypass graft (DSVBG) surgery for infragenicular disease in individuals presenting critical limb ischemia (CLI).
Materials/Methods: from January 2000 to January 2007, 402 patients presenting CLI were submitted to PTA or DSVBG. From this group, individuals with infragenicular disease were treated by PTA (47 patients, 51 limbs) or DSVBG (85 patients, 87 limbs). During follow-up, there were 6 salvage procedures in the PTA group and 12 in the surgical group. Patients were followed in a surveillance protocol based on periodic clinical and duplex scan examinations.
Results: the cumulative primary patency, assisted primary patency, secondary patency and limb salvage rates in 24 months for the surgical group were 57.1, 66.3, 68.8 and 79.5%, respectively. For the PTA group, these values were of 45.2, 52.7, 63.2 and 73.9%. No statistic difference of function rates were observed between groups (Log Rank; P=0.43, 0.10, 0.28 and 0.16, respectively). Poor runoff and TASC C and D lesions were indicative of patency and limb salvage failure for both surgical and PTA groups. However, the surgical group presented better results of limb salvage than PTA when extensive lesions (TASC C and D) were present (Log rank, p<0.05). Differently, no difference for limb salvage between PTA and surgery was observed when proper runoff was absent.
Conclusion: PTA and DSVBG had comparable results of patency and limb salvage in infragenicular arterial disease presenting with CLI.

1208.3

Interim report on the Zilver® PTX™ for treating in-stent restenosis

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Purpose: this is an interim report on clinical evaluation of the performance of the Zilver® PTX™ drug eluting stent (Cook Medical) for treating in-stent restenosis in the above-the-knee femoropopliteal artery.
Materials/Methods: a multi-center, multi-national registry is ongoing to evaluate the performance of the Zilver® PTX™ Drug Eluting Stent in the above-the-knee femoropopliteal artery (SFA) in 792 patients. Follow-up includes evaluation of stent integrity, event-free survival (EFS) and freedom from target lesion revascularization (TLR).
Results: approximately 15% of patients enrolled in this study presented with in-stent restenosis at the time of enrollment. Average lesion length in this subgroup was 12.4±8.6 cm, average percent diameter stenosis was 87±14%, and an average of 2.3 Zilver® PTX™ stents were used per lesion. Twelve-month follow-up is currently available for 89 patients (98 lesions) from this subgroup. Interim results indicate that stent integrity was maintained in 98.3% of Zilver® PTX™ stents, the EFS rate was 74 and 78% of lesions were free from TLR. These results compare favorably with the available 12-month results for the entire study (98.4, 86 and 88%, respectively; n=458 patients (530 lesions)).
Conclusion: these interim results indicate excellent device integrity for Zilver® PTX™ stents placed within previously implanted stents, no safety concerns, and favorable freedom from TLR with Zilver® PTX™ drug eluting stents in this challenging subgroup of SFA lesions with in-stent restenosis.

1208.4

US guided angio-seal deployment in antegrade common femoral arterial access: our experience in 1817 consecutive patients

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Purpose: to evaluate feasibility, safety and efficacy in reducing puncture-site related complications of US guided deployment of

Angio-Seal in order to seal antegrade common femoral arterial accesses.
Materials and Methods: from January 2007 to December 2008, 1817 consecutive patients have been treated for CLI with endovascular procedures requiring antegrade common femoral arterial access in order to perform distal revascularization in BTK lesions. 95% of patients were diabetic with foot lesions included in Texas University Classifications IC-IIID. A total of 2119 antegrade arterial accesses have been performed under US guidance (7.5 MHz linear probe, peripheral vascular preset) with a 20G single piece non mandrinated needle in a plaque- free anterior arterial wall tract. A total of 2109 Angio-Seal STS 6-8F have been deployed under US guidance in order to be sure of the device's anchor correct placement. All patients have been monitored and dismissed after one hour from the cath-lab.
Results: 2098/2109 (99.5%) correct deployments (pull-out =11). Total complications: localized hematomas no treatment requested n=5; major complications: death n=1; retroperitoneal bleeding n=6 (endovascular treatment); acute arterial occlusions n=4 (endovascular treatment).Total complications rate 0.8%.
Conclusions: US guided arterial puncture and Angio-Seal deployment seem, in our experience, feasible, safe and effective in obtaining a significative complications reduction respect to Literature'data. Particular attention to obese patients.

1208.5

Clinical outcomes of a large, multicentre study with a new self-expanding peripheral stent

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Purpose: the newly developed self-expanding nitinol stent, Misago, is expected to improve long-term outcome in the treatment of superficial femoral (SF) or popliteal arteries. Our aim was to study this stent in a large patient population and to assess clinical outcome at 6 and 12 months.
Materials/Methods: MISAGO 2 registry enrolled 770 patients undergoing percutaneous intervention of totally occluded or stenotic lesions in SF or popliteal arteries in 79 centres across Europe. In total 916 stents were implanted. Data are entered electronically and clinical events are adjudicated by independent clinical event committee. Primary endpoint was absence of clinically driven target lesion revascularization at 6 and 12 months.
Results: patients (67% male) were 68±9 years old, 60% were smokers and 35% had diabetes. Average lesion length was 64±38 mm, diameter stenosis 86±21, with 36% of the lesions being totally occluded and 12% classified as TASC C or D. The technical and procedural success rates were 99.2 and 98.7%, respectively. Six months follow-up is ongoing and data are available for 207 patients. Two patients (1.0%) died and 5 (2.4%) underwent repeated revascularization. The restenosis rate, assessed by duplex sonography, was 6.2%. Mean Ankle brachial index improved in 84% of the patients, and Rutherford index in 90% of the patients. There were 4 (0.4%) cases of suspected stent fracture.
Conclusion: preliminary results of this large multicentre registry are very encouraging and study is expected to bring valuable information about long term treatment effects with this innovative stent. Complete 6 months follow-up will be presented.

1208.6

Cryoplasty versus conventional balloon angioplasty of the femoropopliteal artery in diabetic patients: long-term results from a prospective randomized controlled study

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Purpose: to report the immediate and long-term results of cryoplasty versus conventional balloon angioplasty in the femoropopliteal artery of diabetic patients.
Materials/Methods: the study was approved by the Hospital's Scientific Committee. The study included 50 diabetic patients (January 2005-October 2007; 41 males, mean age 68 years) who were randomized to undergo either PolarCath Cryoplasty (Group A; 24 patients with 31 lesions) or conventional balloon angioplasty (Group B; 26 patients with 34 lesions) of the femoropopliteal artery. Technical success was defined as <30% residual stenosis without the need for adjunctive stenting. Regular clinical and angiographic follow-up was scheduled at 6 months, 1 year and annually thereafter. Primary patency and re-intervention rates were calculated with life-table survival analysis.
Results: technical success rate was similar; 58% in group A vs. 64% in group B. Mean follow-up period was 32±1.9 months in both groups. There were no significant differences with regard to overall mortality (12.5% in group A vs. 11.5% in group B) and limb salvage (3.4 vs. 6.5% in groups A and B, respectively). 24-month angiographic primary patency was not significantly different between the two groups (59% in group A vs. 55% in group B). On the contrary, significantly more re-interventions because of recurrent symptoms were required in the cryoplasty group up to 24 months (66 vs. 40% in the balloon angioplasty group; $p<0.05$ log-rank test).
Conclusion: cryoplasty seems to be comparable to conventional balloon angioplasty in the femoropopliteal artery of diabetic patients. However, cryoplasty was associated with significantly more clinically driven repeat procedures.

Free Paper Session
Venous interventions

1209.1

Aggressive approach to giant free-floating thrombi in IVC

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Purpose: to assess feasibility of an aggressive approach to giant free-floating thrombi in renal or suprarenal segment of IVC when conventional means for prevention of PE such as implantation of a caval filter (CF) is impossible.
Materials/Methods: since 1994, we had 171 consecutive patients with floating thrombi in IVC on the level of renal veins or above. In 163 of them, thrombi were originated from iliac veins, in 2 from renal veins, in 2 from gonadal veins and in 4 from occluded infrarenal CF. In all cases, endovascular thrombectomy by means of specialy manufactured Trex device was performed. Temporary CF were implanted in 151 of patients, and 20 avoided CF implantation. No specific complications except neck haematoma in 11 were observed.
Results: as a result, in 110 patients all thrombi were removed completely and the patency of IVC was restored, and in 61 it was restored partially with some residual thrombi in infrarenal segment. Long term follow-up 2-56 (mean 18) months later showed patency of

IVC in 100 patients and only 1 patient had symptoms of PE.
Conclusion: in patients with giant free-floating thrombi, endovascular thrombectomy can provide removal of floating part of the thrombus, which allows for an infrarenal implantation of CF and prevents descending venouse thrombosis of contralateral extremities.

1209.2

Massive pulmonary embolism: treatment with the Rotarex thrombectomy system

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Purpose: to evaluate the efficacy and safety of percutaneous mechanical thrombectomy (PMT) for acute massive pulmonary embolism (PE).
Materials/Methods: fourteen patients (8 men, 6 women) with a mean age of 54 (range, 38-71) years with acute massive PE initially diagnosed by computed tomography (CT) and confirmed by pulmonary angiography. All patients presented with acute PE symptoms and hemodynamic compromise. Each patient was treated with Straub Rotarex thrombectomy device and five patients received thrombolysis.
Results: technique success and clinical improvement were achieved in all patients without major complications. The post-PMT mean pulmonary artery pressure (PAP) deceased from 37.6±6.6 to 29.0±6.4 mmHg ($p<0.01$). Partial arterial pressures of O2 (PaO2) increased from 61.1±9.2 to 88.0±5.1 mmHg ($p<0.01$). The Oxygen saturation (Sat.O2) increased from 81.3±4.7 to 93.4±3.3% ($p<0.01$) after PMT procedure.
Conclusion: the preliminary experience in our series suggests that the Straub Rotarex device, which has been utilized in peripheral arteries, is also useful in the treatment of acute massive PE. More and larger series are required to validate this method.

1209.3

Initial results of the PEARL (peripheral use of AngioJet Rheolytic thrombectomy with mid-length catheters) registry for deep vein thrombosis

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Purpose: to report registry data in which deep vein thrombosis in lower and upper extremities were treated with rheolytic thrombectomy.
Materials and Methods: a voluntary registry of the Possis Angiojet catheter used in the treatment of 116 patients with upper and lower extremity DVT was examined. An electronic data capture case report form was filled out by physician and staff tabulating patient DVT history, procedural information, post-case device performance assessment and acute adverse events. Three month clinical follow up was obtained to document continued symptomatic improvement. Cases were performed over 24 months at 31 U.S. clinical sites.
Results: a total of 116 patients were treated including 73 male and 51 female (mean age 52; range 21 to 86). 19 upper extremity and 105 lower extremity DVT cases were included. 90 patients (78%) reported symptoms of less than 14 days. Combination therapy using Power Pulse Spray or Rapid Lysis techniques were used in 82% of cases (102/124). 86% of cases were completed in less than 24 hours, and 96% in less than 48 hours. Substantial or complete lysis was achieved in 92% of all venous segments treated. Adjunctive procedures including angioplasty and/or stent placement were performed in 72 patients (62%). Three month follow up was available for 84/124 (68%) of patients and 66 patients (79%) report continued symptomatic improvement.
Conclusion: rheolytic thrombectomy combined with adjunctive measures form an effective and safe strategy for comprehensive vascular treatment of lower and upper extremity DVT.

1209.4

Short and long term retrievals of an IVC filter: safety demonstrated through a pathologic study

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Purpose: to evaluate the safety of early and late retrieval of the ALN vena cava filter with a pathologic study.
Materials/Methods: between end of 1999 and November 2008, 505 ALN filters for which the retrieval is not limited in time were placed for definitive or temporary contraindications to anticoagulant mainly due to acute bleeding (52%), major planned surgery (33%), recurrent DVT/PE despite correct anticoagulant therapy (13%) and PE prophylaxis in very high risk patients (2%). 162 of these filters were retrieved after implantation periods up to 25 months (range 6 days-25 months). For 72 of them pathologic examination was performed.
Results: pathologic examination reports were divided into five main categories: organizing thrombus, acute thrombus, vessel fragments associated or not with organizing thrombus and acute ones. No correlation could be found between the delay of retrieval and the few difficulties during retrieval procedure. No link could be established between the duration of implantation and the type of pathologic examination report. None of these reports could be attributed to endothelization around a strut of the filter.
Conclusion: this pathologic study confirms the safety of early and late retrieval of the *ALN filter thanks to its non aggressive struts, its conical shape with nine free legs. It confirmed as well the easiness of retrieval procedures.

1209.5

Failure to retrieve prophylactic inferior vena cava filters in trauma patients: how concerned should we be?

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Purpose: retrievable inferior vena cava filters (R-IVCFs) are increasingly deployed prophylactically in high-risk trauma patients. However, many patients fail to return for retrieval or the filter cannot be retrieved due to endothelialisation. These patients end up with a de facto permanent filter. Studies on permanent filters revealed complications of recurrent DVT and leg swelling. This study was to see if retention of R-IVCFs has adverse effects.
Materials and Methods: we interrogated our trauma database to find patients who had undergone prophylactic filter placement between 1/4/03 and 1/7/07. These were then cross-referenced with the Radiology Information System (RIS) to see which patients had filters retrieved. We attempted to contact patients with retained filters and invite them to return for lower limb duplex and cavogram.
Results: 82 (23%) of 357 prophylactic filters were not retrieved in patients surviving to discharge. In 34 patients (41.5%), attempted retrieval was unsuccessful. In 48 (58.5%), non-retrieval was due to either patient failure to attend or failure to recall them. We were able to recall 31 of 81 surviving patients (34%). The remainder was uncontactable or unwilling to return. All 31 patients recalled had normal cavagrams and normal lower limb venous duplex studies. No patient had been treated for DVT or had suffered leg swelling.

Conclusions: our study demonstrates no evidence that retained R-IVCFs cause problems in the first few years after implantation. Our retrieval rate is better than some published studies. It is important to maximise retrieval rates as long-term effects are still not known.

1209.6

Single institution review of recanalization of occluded filter-bearing inferior vena cava

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Purpose: to review results of stent recanalization of filter-bearing inferior vena cava (IVC).

Material and Methods: endovascular recanalization was performed in 30 patients with symptomatic occluded filter-bearing IVC and iliac veins. Standard thrombolytic techniques were used to eliminate acute thrombus. Self-expanding stents were used to compress clot-bearing filters against the wall of the IVC, sequestering the filter and restoring outflow. When indicated, temporary IVC filters and arteriovenous fistulas were placed to prevent pulmonary emboli and improve inflow, respectively. Complications, technical success rates, and clinical outcomes were reviewed.
Results: occluded inferior vena cava filters included: Gunther Tulip (9), Simon nitinol (7), TrapEase (5), Greenfield (3), Celect (2), OptEase (2), Bard Recovery (1) and Vena-Tech (1). Immediate technical success angiographically and based on post operative day-1 ultrasound was 100%. Clinical improvement was noted in 22 patients (73%), with no improvement in one and 7 lost to follow-up. The follow-up period ranged from few days to 7 months. There were no serious complications.
Conclusion: filter-bearing thrombosed IVC can be safely and successfully recanalized by stent placement.

Free Paper Session
Bone and soft tissue intervention

1901.1

Vertebral body stenting: in vitro comparison of balloon kyphoplasty with a new method for vertebral augmentation

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Purpose: vertebroplasty and ballon kyphoplasty (BKP) are well-established minimally invasive treatment options for osteoporotic vertebral compression fractures. Possible procedural disadvantages, however, are incomplete fracture reduction or a significant loss of reduction after balloon deflation. A new method called "vertebral body stenting" (VBS, Synthes GmbH, Switzerland) was tested and compared with BKP in-vitro. VBS uses specially catheter-mounted stents that can be implanted extra- or transpedicularly and expanded inside the vertebral body.
Materials/Methods: 24 fresh frozen human osteoporotic vertebral bodies (T11-L5) were used. After generation of typical compression fractures (Genant grade 3), vertebral bodies were reduced by BKP (n=12) or by VBS (n=12) under preload (110N) and then stabilized with PMMA. Each step of procedure was performed under fluoroscopic control and analysed quantitatively. Finally, biomechanical tests were performed.
Results: there was a significant loss of reduction after balloon deflation in BKP compared to VBS, and a significant total height gain by VBS (mean±SEM in %, $p<0.05$), demonstrated by: i) anterior height loss after deflation in relation to preoperative height [BKP: 11.7±1.8; VBS: 3.7±1.1], ii) anterior height loss after deflation in relation to initial reposition height [BKP: 58; VBS: 21], and iii) total anterior height gain [BKP: 8.0±2.7; VBS: 13.3±2.2]). Biomechanical tests showed no significant stability differences between both systems.
Conclusion: VBS is an innovative method that allows for the complete ballon assisted reduction of vertebral compression fractures and helps maintaining the restored height by means of a stent. The height loss after balloon deflation is significantly decreased by VBS compared to BKP, as such offering a new promising option for vertebral augmentation.

1901.2

Prospective evaluation of the management of painful pelvic bone metastasis of renal cell carcinoma with embolisation-radio frequency ablation and cementoplasty

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Purpose: the aim of this study was to assess the efficacy of a sequential interventional management of painful pelvic bone metastasis of renal cell carcinoma (RCC). Interventional management consisted in embolisation followed by radio frequency ablation and cementoplasty (ERC).
Materials/Methods: between 01-2008 and 01-2009, 22 consecutives patients, mean age 63 years were referred for ERC. Pain and narcotic dose were evaluated using visual analog scale (VAS) before, at discharge and 30 days after ERC. Anti-angiogenic was stopped before ERC.
Embolization was first performed (Embosphere 700-900 2 ml) followed by radiofrequency ablation and cementoplasty. Target lesions were reached using C-arm flat panel CT.
Results: 25 procedures were performed to treat 1.2±0.3 lesion/patients [range, 1-5]. Mean lesion size were 30±9 mm [range, 12-55 mm]. Technical success was obtained in all procedures. The only complication was one reversible buttock claudication related to internal iliac artery embolisation. Mean VAS score decreased from 7.2±1.5 [range, 5-10] before procedure to 2.8±1.8 [range, 0-7] at discharge and 1.7±1.1 [range, 0-4] at 1 month ($p<0.0001$ Wilcoxon test). At discharge, the narcotics were divided by 2 in 12 patients (55%) and at 1 month in 17 (77%) patients. One patient had complete pain relief at 1 month.
Conclusion: this specific approach is efficient and safe for bone metastatic RCC patients. These preliminary results are positive enough to allow the next step, which will be ERC under continuous administration of anti-angiogenic drugs.

1901.3

MR fluoroscopy-guided injection therapy for patients with low back pain in an open high-field scanner

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Purpose: to evaluate the feasibility and technical features of MR-guided lumbosacral injection therapy in an open high-field MRI (1.0 T Panorama HFO, Philips Healthcare, NL).

Materials and Methods: in a CuSO4.5H2O phantom and 5 human cadaveric spines, fluoroscopy sequences (PD, T1, T2w TSE; bSSFP, T1, T2w GE) were evaluated using a MRI-compatible 20-G Chiba-type needle (Cook, Bloomington, IN, USA). Artifacts were analyzed by varying needle orientation to B0 (0-100°), frequency-encoding direction and slice orientation. Image quality was described with CNR. Subsequently, a total of 192 MR-guided periradicular, sacroiliac- and facet joint injections were performed in 56 patients. An in-room monitor, custom-made wireless MR-mouse for operator-controlled navigation and a flexible surface coil were used.
Results: in vitro, PDw TSE (TE/TR 10/600 ms; TF 36; fa 90°; res. 0.9x1.9x5) yielded superior image quality with the best needle-tissue contrasts (CNRneedle-fat, -muscle, -root, -bone, -sclerosis=45, 18, 15, 9, 8) and optimal artifact sizes (1.5-5 mm) in almost all puncture angles to B0. Artifact sizes were found to correlate with needle orientation. Changing the frequency-encoding direction or slice orientation had no significant influence on the artifact. In vivo, PDw TSE confirmed to have superior image quality. The acquisition time of 2 s facilitated near real-time MRI guidance. Needle placement was adequate in all cases. No complications occurred.
Conclusion: MR-guided lumbosacral injection therapy in an open high-field MRI is feasible and accurate. A fast PDw TSE sequence permitted the greatest range of interventional angles, while rendering optimal artifacts and excellent contrast characteristics.

1901.4

Pain reduction and its effect on systemic pain medication following vertebroplasty for osteoporotic and tumor induced vertebral compression fractures

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Purpose: despite the literature supporting the efficacy of vertebroplasty in general, few reports exist determining its impact on concomitant systemic pain medication. To evaluate pain reduction and pain medication after vertebroplasty of painful osteoporotic vertebral fractures in osteoporotic and tumor induced painful vertebral compression fractures.

Materials/Methods: a prospective trial evaluating three months outcome after vertebroplasty for osteoporotic and tumor induced vertebral compression fractures. Follow-up examinations included pain evaluation [VAS] and analgetic utilization (systemic analgetics, including opioids and nonopioids). Additionally quality of live, mobility and gastrointestinal symptoms (antiemetic, laxative agents) were assessed by selected items of the EORTC questionnaire and Numerical Rating Scales (NRS). Data were analyzed using descriptive and confirmatory statistics.
Results: thirty patients (20 women, 10 men) were treated (n=13 osteolytic bone metastases, n=17 osteoporotic vetebral compression fractures). The mean age was 68 years. All patients were available at each follow-up interval. The mean VAS score at baseline was 8.53 and 3.58 at the first day, 3.48 at one week and 2.5 at three months after vertebroplasty. The mean morphium-dose decreased from 170 mg/d at baseline to 37 mg/d at the end of follow-up. Systemic nonopioid pain medication was stopped or decreased in 85% of patients.
Conclusion: vertebroplasty provides significant and durable pain relief in patients with osteoporotic and tumor induced vertebral compression fractures. With the reduction of pain, patients experience an immediate improvement in the quality of life and mobility. Moreover, the analgetic effect gives the chance to decrease significantly the required systemic opioid and nonopiod pain medication.

1901.5

Percutaneous vertebroplasty: results and complications in 4547 patients treated in six Italian EVEREST (European vertebroplasty research team) centers

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Purpose: the purpose of this work was to retrospectively evaluate results and complications of percutaneous vertebroplasty performed in 6 different Italian centers belonging to the European Vertebroplasty Research Team (EVEREST) in a large series of patients.
Materials and Methods: four thousand five hundred forty-seven patients (3211 females and 1336 males; mean age 70.2 years) underwent percutaneous vertebroplasty (PV) for a total of 13,437 treated vertebrae. Exams were performed by using fluoroscopic guidance or combined CT-fluoroscopic guidance. All patients underwent local anesthesia except for cervical vertebras treated with trans-oral approach.
Results: four thousand and four of 4547 (88.06%) patients had significant pain relief (difference > or = 2 point in pain evaluated with an 11-point visual analog scale; p<0.0001) within 48 hours: an average of 7.7±0.4 dropped to 1.8±0.6 in the osteoporotic patients; 8.3±0.4 to 2.4±0.4 in metastases; 8.3±0.4 to 1.7±1.0 in myeloma; 6.2±3.5 to 0.3±0.2 in hemangioma and 7.4±0.4 to 1.4±0.9 in trauma. Four-hundred-thirty osteoporotic patients (13%) were retreated for a subsequent fracture; in 302/430 patients (70.2%), the new fracture occurred in the contiguous vertebra. No major neurologic complications were reported and venous leakage was the most frequent mild one (20.5%).
Conclusions: the large series of patients confirms that percutaneous vertebroplasty is an effective and safe procedure in the treatment of vertebral fractures, especially when high-quality radiologic guidance is used. Best results are obtained in the treatment of myeloma and osteoporosis.

1901.6

PET-CT guided interventions of metabolically active bone lesions: first results

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Purpose: positron emission tomography has gained widespread acceptance for staging of malignant tumours and can visualize metabolic changes caused by metastases prior to the evolution of morphologic changes. Given the therapeutic impact of distant metastases, histological verification of PET findings is mandatory, especially in case of singular occurrence of suspicious findings without confirmative structural changes.
Materials/Methods: interventions were planed based on PET-CT information and the presentation of the metabolically active lesion. Interventions were performed under multi-modal image-guidance using an integrated whole-body PET-CT scanner in step-by-step technique. Patients were repositioned and intervention was performed based on a subsequent single-bed PET-CT acquisition of the concerning region. The needle was introduced under CT-guidance in step-by-step technique and the correct needle position in the centre of the FDG avid lesion was assured by repetition of a single-bed PET-CT acquisition before sampling.
Results: we report the results in PET-CT guided interventions in 15 patients with suspicious bone lesions (4 breast cancer, 4 NSCLC,

2 melanoma, 1 osteosarcoma, 2 uterussarcoma, 2 multipe tumors). Technical success rate for metabolically active lesions was 100%. Mean diameter of lesions was 13 mm, mean depth 7 cm. No major adverse effects occurred.
Conclusion: PET-CT guidance for percutaneous interventions is feasible and may be a promising new method in order to make metabolically active lesions - especially those without distinctive morphological correlate - accessible and to reduce the risk of false-negative biopsies.

Free Paper Session
Cardiac and vascular imaging

1902.1

Stenosis grading in celiac trunk and superior mesenteric artery: what non-invasive modality

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Purpose: prospective evaluation of diagnostic accuracy of duplex sonography, iodine-enhanced 64-row computed tomography angiography (CTA), and gadolinium-enhanced 1.5T magnetic resonance angiography (MRA), versus digital subtraction angiography (DSA) as reference standard, in stenosis grading of celiac trunk and superior mesenteric artery.
Materials/Methods: institutional review board approval and informed patient consent were present. 52 subjects were enrolled (mean-age, 71; range, 44-87). Six subjects did not allow sufficient duplex sonography, three subjects could not undergo MRA due to cardiac pacemaker, and in one subject the images of CTA were lost. In a consensus fashion by two readers, image quality grading 1 (insufficient), 2 (bad), 3 (moderate), 4 (good) or 5 (excellent), and stenosis grading 1 (<25%), 2 (≥25% and <50%), 3 (≥50 and <75%) or 4 (≥75%) were evaluated. Two-sided chi-square tests were used to prove for significant correlation in stenosis grading between modalities, and weighted Cohen's kappa was calculated to assess the strength of correlation.
Results: mean image quality grading was 3.8±0.7, 3.1±1.0, 4.4±0.7, and 3.8±0.9 for DSA, duplex sonography, CTA, and MRA, respectively. For both celiac trunk and superior mesenteric artery, stenosis grading reached significant level of correlation between each non-invasive modality with DSA, with p<0.001 each. Weighted Cohen's kappa value/asymptotic standard error were for duplex sonography, CTA, and MRA for celiac trunk 0.94/0.17, 0.93/0.15, and 0.74/0.17, respectively, and for superior mesenteric artery 0.64/0.09, 0.91/0.07, and 0.56/0.08, respectively.
Conclusion: based on overall best image quality, CTA proved to be most efficient non-invasive modality for stenosis grading in celiac trunk and superior mesenteric artery.

1902.2

A new hybrid reformation algorithm for multidetector CT angiography in peripheral arterial disease: accurate stenosis detection without axial source images?

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Purpose: to determine the accuracy of a new hybrid multidetector CT angiography (MD-CTA) reformation algorithm for the detection of significant stenosis (≥50%) of peripheral arteries in comparison to digital subtraction angiography (DSA).
Materials and Methods: 50 patients with peripheral arterial disease were prospectively included and underwent MD-CTA prior to DSA using a 16-row MD-CT scanner. Following reformations were created using a semi-automatic toolbox: Maximum Intensity Projections (MIP), Multipath curved planar reformations (mpCPR) and a hybrid reformation of these both (MIPmpCPR). For evaluation, 21 vascular segments were defined in each leg and compared to DSA. In a first MD-CTA reading session MIP, mpCPR and axial source images were available. In a second session, only hybrid images were evaluated by two experienced radiologists independent of each other.
Results: out of the 50 patients, 1350 vessel segments were analyzed by both MD-CTA and DSA. MD-CTA including axial images reached an overall accuracy of 98.8% for the detection of significant stenosis, ranging from 97.9% (iliac arteries) to 99.3% (infrapopliteal arteries). Evaluating only hybrid images, a statistically significant (p<0.001) lower accuracy of 91.2% (reader 1) and 87.6% (reader 2) was achieved. The accuracy of hybrid images ranged from 86.0% (femoral arteries) to 92.0% (infrapopliteal arteries).
Conclusion: using MD-CTA including axial source images, significant stenosis were assessed with high accuracy compared to the DSA. Since the accuracy of the new time-saving hybrid reformations was statistically significant lower, additional usage of axial source images is still recommended. Further improvement of this reformation algorithm is necessary.

1902.3

Intra-operative endoleak detection with DynaCT in endovascular abdominal aortic aneurysm repair

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Purpose: to evaluate the usefulness of intra-operative angiographic computed-tomography (DynaCT, Siemens, Germany) in assessing the primary technical success of endovascular abdominal aortic aneurysm repair (EVAR).
Materials/Methods: a retrospective study was designed to evaluate the effectiveness of DynaCT in assessing the radiological outcomes in patients undergoing an EVAR (September 2007-December 2008). All patients had a routine uniplanar angiography followed by a DynaCT. Patients also had a color-flow Duplex scan prior to discharge. The data were analysed for endoleak and graft complication detection rates.
Results: a total of 102 cases were analysed (95 infra-renal vs. 7 fenestrated stent repairs). The concordance rate between intra-operative angiography and DynaCT was 69.6% (n=71/102). DynaCT detected leaks in 27.5% of cases not identified by angiography (n=28: 3 type 1a; 1 type 1b; 23 type 2; 1 type 3). All potentially clinically significant leaks (Type 1a/b, 3) were corrected during the procedure. Other technical complications detected by DynaCT and treated during the procedure included graft thrombus, iliac limb compression and insufficient iliac limb extension. DynaCT reduced the potential need for early re-intervention by 7.8% (8/102) in the cases that could have been clinically significant. There were 3 further complications requiring intervention detected by pre-discharge imaging but missed intra-operatively (2 Type 1a leaks; 1 iliac limb stenosis).
Conclusion: angiography alone is not sufficient to assess the technical quality of endovascular aneurysm repairs. This study demonstrates the usefulness of DynaCT in reducing the need for re-operation by identifying and treating graft related complications in the intra-operative period.

1902.4

Usefulness of cardiac-CT to validate the mitral valve stents: feasibility study

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Purpose: after endovascular aortic and pulmonary valve replacement, is the transapical mitral valved stent implantation the latest development. The aim of the study was to evaluate the ability of cardiac-CT to depict the accuracy of mitral stent valve placement, its relation to the native cusp and the left ventricular outflow tract (LVOT).
Materials/Methods: ten pigs underwent transapical off-pump mitral valved stent implantation. After the procedure, 6 pigs received a cardiac scan in a 64-slice cardiac-CT. Heart rates were above 100 bpm. Image and function analysis was performed by two cardiac-CT experienced radiologists and a cardiac surgeon. In addition, all stent valves were evaluated by transesophageal echocardiography (TEE). After imaging stent valve placement was controlled in situ. In all examinations the accuracy of stent valve placement, and its relation to the native cusp and the left ventricular outflow tract (LVOT) was determined.
Results: cardiac-CT gained high quality in spite of the animal study design and increased heartrate. The position, atrial fixation and the cusps of the atrioventricular stent could be exactly shown. There was no migration or wrong positioning. These results were confirmed by the in situ findings. Due to fewer artifacts, the relative stent position to the LVOT could be evaluated better in cardiac-CT than in TEE. Neither a valvularstent insufficiency nor a paravalvular regurgitation were seen in cardiac-CT or TEE.
Conclusion: cardiac-CT is proper to evaluate the outcome of transapical mitral valved stent replacement. TEE and cardiac-CT complement one another in morphologic and functional stent valve analysis.

1902.5

Imaging appearances and role of magnetic resonance imaging in the diagnosis of restrictive heart disease caused by endomyocardial fibrosis

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Purpose: endomyocardial fibrosis (EMF) is a rare cause of restrictive heart disease that mimics constrictive pericarditis at clinical and hemodynamic evaluation. Early diagnosis is essential for optimal therapy. Imaging features are poorly documented only as isolated case reports and role of magnetic resonance imaging (MRI) in diagnosis is not defined.
Materials/Methods: we have studied the above in 12 consecutive patients of EMF who underwent echocardiography, MRI and catheter angiography. Diagnosis was established by typical angiographic appearances and endomyocardial biopsy.
Results: there were 8 males (age range, 17-60 years). Involvement was bi-ventricular in 8 and right ventricular in 4. Ventricular involvement was manifested by obliteration of apex, altered trabeculations, intra-cavitary thrombus, out-pouching along free wall, wall edema, fibrosis, dilatation of atrium, atrio-ventricular regurgitation and dilatation of RV outflow tract. Systolic ejection fraction was reduced. Pericardial effusion was present in 5. Calcification was not seen. MRI showed a typical global delayed enhancement in the involved ventricle. Whereas MRI showed all above features and was diagnostic in all patients, wall abnormalities, intra-cavitary thrombus and systolic function were not well evaluated by catheter angiography. Echocardiography did not show wall abnormalities.
Conclusion: EMF is an uncommon cause of restrictive heart disease that produces typical imaging appearances. MRI is able to detect mural, cavitary and functional changes, is adequate for diagnosis and obviates the need for catheter angiography.

1902.6

Endovascular treatment of the abdominal aorta: role of the "inner-inner" measurement in stent-graft selection

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Purpose: pre-operative evaluation of the aorta can be considered crucial to achieve technical success in the endovascular treatment of abdominal aortic aneurysms (AAA) especially for long term results. Correct measure of the aortic diameters can avoid complications due to stent-graft migration or incorrect wall adhesion. We would like to analyze the efficacy of aortic evaluation using the “inner-inner” measurement technique.
Materials/Methods: we retrospectively analyze CTA images of 476 patients who underwent endovascular treatment for AAA in the last 10 years. Images were evaluated on the axial plane, in the arterial phase. An “inner-inner” wall measurement of the aorta was performed at the level of the proximal neck: renal arteries origin, 0.5 cm and 1 cm below. Data were compared with the size of the stent-graft implanted and an analysis was performed comparing the aortic diameter, the stent-graft calibre, the immediate technical success and the complications occurred during the follow-up.
Results: a correct evaluation of the aorta was done in 285 cases (59.8%). In 182 patients (38.2%) an incorrect measure of the aortic neck was performed, at the initial time of the procedure, with consequent incorrect stent-graft selection, considering a 20% oversize: too large=45 cases (24.7%); too small=89 cases (48.9%). An overall complication rate of 10.9% (52 cases) was reported: stent-graft migration in 25 cases (5.4%), type I endoleak in 17 cases (3.6%).
Conclusion: “Inner-inner” aortic-wall evaluation seems to be a valid method to achieve correct stent-graft selection also in case of tortuous or calcified aorta.

Free Paper Session Embolization

1903.1

Embolization for multicompartimental bleeding in hemodynamically unstable patients: factors associated with survival and hemodynamic improvement

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Purpose: to evaluate the efficacy of transcatheter arterial emboliaztion (AE) in severely injured and hemodynamically unstable trauma patients with multicompartimental bleeding (defined by an association of intra-peritoneal bleeding with one of the following: retroperitoneal, thoracic or musculoskeletal bleeding on CT) and identify the parameters associated with technical success and clinical outcome.
Materials/Methods: data were collected from trauma registry and angiographic records. Between January 2001 and April 2008, out of 87 polytrauma patients embolized, 18 had injuries in at least two compartments (intra-peritoneal and other). X% were unstable at arrival (with SBP<90 mmHg at arrival were considered unstable hemodynamically AAST criteria). Effectiveness of AE was defined as

both angiographic (cessation of angiographic bleeding) and clinical evidence of hemodynamic improvement (immediate and sustained improvement of 20% of SBP after embolisation with decrease or cessation of vasoactive drugs) as well as survival.
Results: injury severity score (ISS) ranged from 16 to 68 (mean=42.7) necessitating high volume of i.v. fluid for ressucitation (mean 4.4l) and vasopressive drugs. Embolization of all bleeding territories was performed in every patient leading to immediate hemodynamic improvement in 14. Four patients died after angiography failed to control bleeding. In 14 patients who responded hemodynamically to embolization, 5 died during follow-up due to associated brain traumatic lesion.
Conclusion: in patients with multiple bleeding injuries, AE is efficient to control bleeding and improve hemodynamic condition in 77% of cases. However, survival is related to pre-embolization hemodynamic condition as well to associated brain trauma.

1903.2

Preliminary experience with Onyx embolization in the treatment of acute peripheral arterial bleed

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Purpose: to describe our clinical experience using transcatheter embolization with Onyx (Ethylene vinyl-alcohol copolymer) in the treatment of acute arterial bleed at varied musculoskeletal sites.
Methods/materials: prospective study between 2006 and 2008, of 35 patients with active contrast extravasation or pseudoaneurysm formation who underwent Onyx embolization. Sites of embolization included: extremities, pelvis, abdominal and chest walls. Angiography was performed immediately following embolization to confirm that haemorrhage had stopped and that collateral branches did not reconstitute the bleeding artery. All patients were followed clinically after embolization.
Results: transcatheter embolization with Onyx was successful in all 35 patients (100%), who exhibited complete cessation of bleeding. During the follow-up period there was no recurrent bleeding or ischemic complications.
Conclusions: the authors' experience supports the role of transcatheter embolization with ethylene vinyl-alcohol copolymer (Onyx) as a primary means of therapy for acute arterial bleed as it showed to be a feasible and effective method to control and achieve haemostasis. The advantages of Onyx over conventional liquid embolic agents and coils are discussed.

1903.3

Arterial embolotherapy for endoscopically unmanageable acute hemorrhage from gastroduodenal ulcers: predictors of early bleeding recurrence

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Purpose: severe bleeding from gastrointestinal ulcers is a life-threatening event that is difficult to manage when endoscopic treatment fails. Transcatheter embolisation has been proposed but factors that influence the angiographic outcome are not well documented. We aimed to identify predictors of recurrent bleeding within 30 days after transcatheter embolization for refractory hemorrhage from gastroduodenal ulcers.
Materials/Methods: this retrospective single-center study of 60 consecutive emergency embolization procedures included hemodynamically unstable patients (41 males, 19 females, mean age 69.4±15 years), referred from 1999 to 2008 for selective angiography after failed endoscopic treatment. Predictors of early rebleeding were tested with univariate analysis and a multivariate logistic regression model.
Results: the procedural success rate was 95%, the primary clinical success rate was 71.9% (41/57), and secondary clinical success was achieved in 3 patients (77.2%) after repeat embolization. No major catheterization-related complications occurred. Periprocedural mortality was 26.7% (16/60). Early bleeding recurrence was associated with coagulation disorders (P=0.007), longer time to angiography (P=0.0005), greater preprocedural blood transfusion volume (P=0.0009), > 2 comorbidities (P=0.005), and use of only coils (P=0.003). Two factors were found to be independent predictors of embolization failure: coagulation disorders (odds ratio=6.18; P=0.027) and the use of coils as the only embolic agent (odds ratio=6.24; P=0.022). The median follow-up time was 7 months (range of 1 day to 103 months).
Conclusion: angiographic embolization should be performed early in the course of bleeding, and not with coils alone, in critically ill patients. Correction of coagulation disorders remains essential all through the procedure.

1903.4

Proximal versus distal embolisation for splenic trauma: which better preserves immune function?

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Purpose: to evaluate the effect on splenic immune function of splenic artery embolisation (SAE) for blunt trauma, and to compare the effect of proximal versus distal SAE. IgM memory B cells develop in the marginal zones of the spleen. They are reduced in the blood of splenectomised patients. Lack of IgM memory B cells is responsible for the increased vulnerability of post-splenectomy patients to pneumococcal infections.
Materials and Methods: SAE was performed in haemodynamically stable trauma patients with evidence of contrast extravasation on CT. The choice of proximal embolisation of the splenic artery, or distal embolisation of one of its branches, was at the discretion of the interventional radiologist. Follow-up CT and blood test were performed after at least 6 months.
Results: 8 patients underwent proximal and 6 distal SAE. IgM memory B cell levels were twice as high after distal SAE as proximal (IgM memory B cells as % total B cells 10.38 vs. 5.72). IgM memory B cell levels were higher in both embolisation groups than in splenectomised patients (3.13). There was no difference in splenic volumes between proximal and distal SAE, and no correlation between splenic volume and IgM memory B cell levels. In no patient were Howell-Jolly bodies detected.
Conclusions: preservation of splenic volume and reticuloendothelial function does not guarantee preservation of splenic immune function. Proximal SAE by lowering the perfusion pressure of the entire spleen may cause infarction of the splenic marginal zones. However, even proximal SAE may preserve immune function better than splenectomy.

1903.5

Image guided percutaneous sclerosis of low-flow vascular malformations

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Purpose: to evaluate the efficacy of image-guided percutaneous sclerosis in the management of low-flow vascular malformations.
Patients and Methods: in patients aged seven months to 41 years

(mean±SD 16.4±10.5), with low-flow vascular malformations, MRI was performed for assessment prior to sclerotherapy. Two patients were excluded: vertebral giant cell tumour and treated maxillary hemangioma. US guidance (32/34) or CT guidance (2/34) was used for sclerotherapy. In six children, general anaesthesia was required. A 4:1 mixture of sodium tetradecyl sulphate (STDS) 2% and Xylocaine 2% was used for sclerosis. Further sclerotherapy was directed by response assessed by MRI. End-point was ≥80% reduction in lesion volume.

Results: 34 patients, five are current, and four patients discontinued therapy. Lesion location was: face - 9, head and neck - 3, hand - 6, lower limb - 9, forearm - 4, spine - 1 and trunk - 2. Pre-treatment lesion volume was - (Mean±SD, range) 77.0±140.0 ml, 1.3 to 619.1 ml. In 25/36 patients with completed sclerotherapy: Pre-injection lesion volume - 66.0±129.6, 1.3 to 619.1 ml; Post-injection volume - 6.4±12.1 ml, 0.0 t o58.3 ml; Number of sessions - 3.2±2.2, 1 to 8; Volume of STDS injected - 16.8±14.7 ml, 2 to 60 ml; Reduction in lesion volume - 88.9±13.6%, 42.3 to 100%. Two patients had secondary infection requiring surgical referrals following successful sclerotherapy. Satisfactory response, i.e., ≥80% reduction in lesion volume achieved in 20/25 patients. With patients who discontinued therapy as controls, RRR=0.8 (95%CI 0.56, 0.90), ARR=0.8 (95%CI 0.64, 0.96) and NNT=1.25 (95%CI 1.04, 1.55).

Conclusions: cutaneous image-guided sclerotherapy of low-flow vascular malformations is safe, effective, minimally invasive, without major complications and useful as the first line of management.

1903.6

Embolization of pulmonary arteriovenous malformations with the Amplatzer vascular plug: safer and quicker than coils but not applicable to all lesions

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Purpose: Amplatzer vascular plugs (AVPs) may be used to treat PAVMs. Limited data are available regarding the length of time taken to achieve vessel occlusion; the additional need for coils; and the size of the delivery catheter precluding distal PAVM occlusion. The purpose of this study is to validate the role of AVPs in the treatment of PAVMs.

Materials/Methods: an ethically approved retrospective analysis was performed on data from 68 patients (27 male, 41 female; mean age 45 years) who underwent embolization of PAVMs between September 2006 and December 2008, incorporating AVPs into previously optimized embolization protocols.

Results: 102 of 140 PAVMs with feeding arteries ranging between 3 and 13 mm in diameter were successfully and optimally treated by AVPs alone. In many cases, this was at a more distal site than would have been achieved with coils. In no case was it necessary to position coils on top of an AVP to achieve vessel occlusion. Smaller feeding arteries to complex PAVMs required coil occlusion in 26 lesions. 12 additional PAVMs with small tortuous feeding arteries were treated with coils alone. The occlusion of large (5-12 mm) arteries was achieved more rapidly and simply than would have been achieved by conventional coils.

Conclusion: the majority of PAVMs can be treated effectively with Amplatzer vascular plugs. Distal feeding artery occlusion can be achieved with these devices in all but the smallest and most tortuous feeding arteries. Optimal positioning and release of these devices is often safer and faster than coils.

Free Paper Session
Haemodialysis and central venous access

1904.1

Novel technique of implantable central venous port in upper arm

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Purpose: radiological placement of central venous port via the forearm is a useful method to reduce the procedure-related complications such as pneumothorax, pinch-off of the catheter, etc. as compared with insertion through the subclavian vein. However, cracking and kinking of catheter sometimes occurs due to bending of the cubital joint. To address this problem, we devised a novel technique of central venous port in the upper arm. The purpose of this study was to evaluate this novel technique.

Materials/Methods: one hundred eighty-four patients, an average of 68.0 years, were implanted with this method under local anesthesia, and median follow up period was 380 days (20 to 997 days). A basilic vein was punctured and a heparin-coated catheter was inserted over the guidewire. The catheter was fluoroscopically positioned to the superior vena cava. The proximal site of catheter was pulled through the U-shaped subcutaneous tunnel and connected to the implanted port at the lateral side of the upper arm.

Results: the catheter placement succeeded technically in all patients, and no complications such as malinfusion or damage to the catheter due to bending of the cubital joint were encountered. Temporary drip insufficiency was observed in 7 patients, all of them were recovered with flush of saline. Other complications were observed in 17 cases (9.2%); infection of implanted port in 6 (3.3%), failure of the sutures in 4 (2.2%) and phlebitis in 7 (3.8%).

Conclusion: we conclude that this new procedure may be a useful method to place an implantable central venous catheter system.

1904.2

Percutaneous dilatation of the radial artery in nonmaturing autogenous radial-cephalic fistulas for hemodialysis

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Purpose: to review retrospectively the outcomes following angioplasty of the radial artery in nonmaturing radial-cephalic fistulas for dialysis.

Materials/Methods: Over a period of 7 years, 74 patients underwent angiography of a nonmaturing fistula that showed either stenosis or an insufficiently developed radial artery, which was treated by percutaneous dilation. Success, complications and need for secondary interventions were recorded according to consensus definitions. Patency following angioplasty was estimated with the Kaplan-Meier method.

Results: mean patient age was 70 years; 44% were women, 69% had diabetes, 23% were smokers, 76% had hypertension; 64% had coronary and 46% peripheral arterial occlusive disease. Median time from fistula creation to fistulography was 2.7 months. Concomitant venous stenosis was diagnosed in 39 patients. Arterial stenosis was more than 5 cm long in 53 cases (72%). Technical success was achieved in 73/74 cases following angioplasty. All but 2 fistulas were then successfully used for dialysis. Transient dilation-induced rupture occurred in 13 cases (17%) but required stent placement in only 2 cases. Six cases (8%) of subsequent hand ischemia developed within

1 month of dilation and were treated successfully by ligation of the distal artery. Primary patency rates at 12 months were significantly better in cases of pure arterial lesions, with 65% compared to 42% in cases of concomitant venous stenosis (p<0.02). Secondary patency rate was 96% at 1 year in both groups.
Conclusion: abnormalities of the radial artery are not uncommon in nonmaturing fistulas and they respond to percutaneous angioplasty better than veins.

1904.3

Long-term results of percutaneous angioplasty and stent placement of upper extremity central venous obstruction in hemodialysis patients

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Purpose: to compare long-term results of percutaneous transluminal angioplasty (PTA) and percutaneous transluminal stenting (PTS) of central venous obstruction (CVO) in hemodialysis (HD) patients.
Materials/Methods: HD patients who underwent successful endovascular treatment for CVO from January 1998 to October 2007 were retrospectively evaluated. Stenotic lesions greater than 50% or inducing extremity swelling were subject to treatment. Primary treatment was PTA. PTS was accomplished in PTA resistant CVO. PTA was the primary treatment for recurrence after PTS. Additional stenting was reserved for PTA resistant recurrences.
Results: 147 veins in 126 patients (63 men, 63 women) aged between 15 and 82 years (mean, 50 years) primarily underwent 101 PTA and 46 PTS interventions. Mean follow-up was 22.14±16.31 months. Average number of interventions per vein in PTS group (2.74±2.41) was significantly higher than PTA group (1.47±0.95). Mean primary patency rates were significantly higher in PTA (24.54±1.66 months) than PTS groups (13.43±1.99 months). Mean assisted primary patency rates of PTA (31.38±1.98 months) and PTS groups (31.02±4.68 months) were equivalent. Overall mean primary patency was 21.05±1.40 months and assisted primary patency was 31.71±2.46 months.
Conclusion: endovascular treatment of CVOs with PTA or PTS is a safe and effective procedure in HD patients. Multiple interventions are easily performed to reach the patency rates comparable with surgical approach. PTS has significantly lower primary patency rates than PTA but adds to longevity of the vein patency in PTA resistant lesions and should be considered only in PTA resistant lesions.

1904.4

Implantation of central venous access systems in the forearm: technical and clinical experience in 762 patients

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Purpose: to evaluate the effectiveness and safety of subcutaneously placed arm port devices including follow-up.
Materials/Methods: between 01/2006 and 10/2008, peripheral venous port devices were implanted in 762 consecutive patients (293 men; 469 women; mean age 59 years) under sonographical and fluoroscopic guidance. Under local anaesthesia and sterile conditions, the devices (Cook, Bjaeverskov, Denmark; BARD, Salt Lake City, Utah) were inserted via a peel-away-sheath. All catheters were tunnelled subcutaneously. Early (<30 days) and late complications (>30 days) as well as technical success were retrospectively analysed according to SIR-criteria.
Results: technical success rate was 99.3%. Mean catheter life was 430 days (total 327499 d; range, 1-1032 d). Early complications were observed in 32/762 patients (4.2%) and included catheter tip migration, infection, dysfunction, or thrombosis. Late complications (catheter tip migration, catheter fracture, infection, dysfunction, port disconnection, or thrombosis) were observed in 80/762 (10.5%) patients. The most common complications were infected port devices in 35/762 patients (4.6%), and thrombosis in 69/762 patients (9.1%). 61/762 ports (8.0%) were explanted due to end of therapy, 35/762 ports (4.6%) as a result of infection, and 5/762 ports (0.7%) as a result of thrombosis. Six dislocated catheter tips (0.8%) were corrected during a second interventional procedure.
Conclusion: subcutaneous implantation of central venous access systems in the forearm is a safe and effective interventional procedure, with a relatively low rate of early and late complications. Late complications have to be mainly attributed to inadequate handling of the port devices in daily practice.

1904.5

Interventional revision of acute dysfunctional hemodialysis fistulas: analysis by interventionalist's level of experience, by time of day, and by specific lesion type

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Purpose: prospective analysis of the efficacy of interventions in acute dysfunctional hemodialysis fistulas, considering the interventionalist's level of experience, the time of day, and the specific lesion type.
Materials/Methods: institutional review board approval was present. From 2005 to 2007, all (n=280) patients with acute dysfunctional hemodialysis fistula immediately underwent angiography with potential interventional revision, irrespective of the time of day. Interventional revision could be performed in n=241 cases. Procedural success rates were calculated as follows: total, by interventionalist's level of experience (high; intermediate; low), by time of day (routine working hours, 07:00 a.m.-04:00 p.m.; emergency working hours, 04:00 p.m.-07:00 a.m.), and by specific lesion type (stenosis; sclerotic occlusion; thrombotic occlusion; mixed stenosis/occlusion). To prove for significant differences within the groups of interests, chi-square tests were used with p<0.025 for two-sided level of significance.
Results: the total success rate was 62% (149/241). The success rates by interventionalists were 71% (79/111) for high level of experience, 54% (15/28) for intermediate level, and 54% (55/102) for low level, with p=0.022. The success rates by time of day were 68% (93/136) for routine working hours, and 53% (56/105) for emergency working hours, with p=0.017. The success rates by specific lesion type were 82% (94/104) for stenosis, 39% (13/33) for sclerotic occlusion, 18% (6/33) for thrombotic occlusion, and 59% (36/61) for mixed stenosis/occlusion, with p<0.001.
Conclusion: 1) The interventionalist's level of experience influences success rates in interventions in acute dysfunctional hemodialysis fistulas significantly. 2) During routine working hours, acute dysfunctional hemodialysis fistulas are more likely to be treated successfully. 3) Interventions in stenoses are very likely to be successful, while they are not in thrombotic occlusions.

1904.6

Angioplasty with stent graft versus bare stent for recurrent cephalic arch stenosis in autogenous arteriovenous access for hemodialysis

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Purpose: we have published significantly improved short term restenosis rates and long term patency resulting from use of stent-grafts in angioplasty for recurrent cephalic arch stenosis compared with bare stents. Because this prospective study included only 25 patients and more than half died or were transplanted at one year, we carried out a retrospective study including all cephalic arch stents.
Materials and Methods: indications for stent insertion were recurrent cephalic arch stenosis >50% within three months of successful balloon angioplasty, poor outcome for angioplasty alone and extravasation or occlusion during angioplasty. Restenosis was defined as >50% narrowing of the stent lumen or the adjacent vessel up to 0.5 cm from the stent. Primary patency was time until first intervention for >50% stenosis. Secondary patency was time until occlusion of the access or until insertion of an additional stent graft into the stent in the study.
Results: sixty-one consecutive patients were treated from January 2005 to August 2008, 17 with bare stents and 44 with stent grafts. Life table analysis at 6 and 12 and 24 months showed significantly improved primary and secondary patency for the stent graft group (p=0.024 and p=0.009, respectively). There were also fewer maintenance interventions per patient year in the stent graft group (p<0.001). During follow up, 15 (25%) patients died and only two patients had renal transplants.
Conclusion: the use of stent grafts in angioplasty for recurrent cephalic arch stenosis significantly improved short term restenosis rates and long term patency compared with bare stents.

Free Paper Session
Oncologic interventions 2

1905.1

Irreversible electroporation in a swine lung model

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Purpose: analyze effects of IRE on lung tissue in a swine model.
Materials/Methods: this study was approved by the animal IRB. Nine anesthesized swine had 15 percutaneous IRE lesion creations (6 with bipolar and 3 with monopolar electrodes) under fluoroscopic guidance with neuromuscular blockade and EKG gating. IRE electrodes were placed into the central and middle third of the right lung in all animals. Post procedure PA and lateral chest radiographs were obtained to evaluate for pneumothorax. Three animals were sacrificed at 2 weeks and 6 at one month. Animals underwent high resolution CT scanning or radiographs one hour before sacrifice. The lungs were removed enbloc, perfused with formalin and sectioned. Gross pathologic and microscopic changes after standard H and E staining were analyzed.
Results: no significant adverse events were identified. CT showed focal areas of spiculated high density ranging in greatest diameter from 1.1 to 2.2 cm. Upon gross inspection of the sectioned lung, focal areas of tan discoloration and increased density were palpated in the areas of IRE. Histological analysis at 2 wks revealed areas of fibrin, hemosiderin with fibrosis, chronic inflammation and reactive metaplastic epithelial cells. At 4 wks, the lesions were well defined with more fibrosis and hemosiderin respecting the boundaries of the interlobular septa. The bronchioles and blood vessels adjacent to the areas of IRE were well preserved.
Conclusion: IRE creates localized areas of tissue injury that heal with fibrosis and with minimal effect on adjacent parenchymal structures. Short term safety in swine appears satisfactory.

1905.2

Percutaneous cryoablation for renal cell carcinoma: efficacy and 3-year survival outcomes

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Purpose: the objective of our prospective study was to establish the efficacy of percutaneous cryoablation for renal cell carcinoma. Secondary objective was to calculate overall and disease free survival rates.
Materials/Methods: 100 renal masses in 86 consecutive patients were treated with CT-guided, percutaneous cryoablation. Biopsy was performed in all patients prior or at the time of the cryoablation. Follow-up protocol consisted of 3-, 6-, 12-months clinic visits and contrast enhanced CT or MRI and yearly after that. Efficacy was determined based on size and enhancement pattern on follow up imaging (MRI or CT). Overall and disease specific survival was calculated at 1-, 2- and 3-years.
Results: technical success was 100% (M:F=46:40, median age 69+10 years). Lesion size was 2.7+1.7 cm (1-10 cm). 14 of the 100 Bosniak III-IV lesions were benign. Overall and disease-specific survival was 98 and 100%, respectively (median follow-up 69+31 weeks, 12-141 weeks). For the patient group with median follow-up of 3 years (n=11), both overall and disease-free survival was 100%. Primary and secondary (re-ablation) efficacy (image based) was 96.8 and 98.4%, respectively. No patients with disease confined to the kidney developed metastatic disease during the follow up period and no patients developed new localized disease.
Conclusion: percutaneous cryoablation is a highly effective treatment modality for localized renal cell carcinoma. For lesions up to 4 cm, percutaneous cryoablation should be the treatment of choice replacing resection, unless lesion is not approachable percutaneously. Non-operative patients with larger lesions (4-10 cm) can also be treated with cryoablation.

1905.3

Long-term results of radiofrequency ablation (RFA) in patients with cirrhosis and HCC (≤5 cm)

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Purpose: to assess the long -term prognosis of patients with cirrhosis and HCC ≤5 cm treated by RFA.
Patients/Methods: from January 2001 to Jun 2007, among 311 patients HCC treated by RFA, we selected all naive with 3 or less HCC ≤5 cm: 235 patients (mean age 65±10 years; cirrhosis Child-Pugh A/B (205/30) with 307 HCCs (mean diameter of the larger tumor: 2.9 cm, 53 multinodular forms). In case of recurrence, treatment by RFA was repeated when possible.
Results: a complete ablation was obtained in 222 patients. Three major complications occurred: one death, related to shock, one

neoplastic seeding and one liver abscess. After a mean follow-up of 813±611 days, 82 patients died, including 61 death related to HCC progression, 29 patients were transplanted.124 patients were alive and non transplanted (103 without detectable tumor). In intention-to-treat, 3 and 5-years overall and HCC free survival rates were 60 and 40% and 56 and 31%, respectively. In multivariate analysis, factors associated with HCC free survival were: total bilirubin: OR 1.6 (1-2.6) p=0.04, serum AFP: OR 1 (1-1) p<0.0001, multifocal tumor: OR 1.8 (1.19-2.6) p=0.004. In patients with unique HCC and bilirubin ≤15 mg/dL (n=82), the 3 and 5-years overall survival rates were 75 and 61%, respectively. The size of the tumor was not predictive of survival.
Conclusion: RFA of HCC ≤5 cm in patients with cirrhosis non eligible for resection had a low morbidity and high survival rates particularly in patients with a unique HCC and bilirubin ≤15 mg/dL.

1905.4

Radioembolization of advanced hepatocellular carcinoma using ^{90}Y-resin microspheres: mid-term results in a single institute experience

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Purpose: to evaluate the efficacy and effectiveness of a group of patients (pts) with multinodular and unresectable hepatocellular carcinoma (HCC) who underwent 90Y Radioembolization at midterm follow-up.
Materials/Methods: 60 pts with unilobar and bilobar HCC were treated. 35% of pts had previous treatments. Lobar, segmental or superselective treatments were performed according with the tumor sites, hepatic function, and vascular dynamics. None of them had liver replacement >50%. Overall response rate, recurrence and survival rate were evaluated. Follow-ups were performed at three-month intervals. Assessment of response rate was based on multiphasic CT evaluation.
Results: median follow-up was 14 months (range: 3-28). 51 pts were evaluable: 36 were Child-Pugh Class A, 15 Class B. The median activity of SIR-Spheres delivered was 1.60 GBq. 10 pts had unilobar or main portal vein thrombosis (21%). 5 pts (10%) showed decrease in size of nodules while 9 pts (17%) showed also tumor growth arrest, absence of intralesional neo-vasculature, increasing rate of necrosis. Survival rate was compared with risk groups (P<0.0001) (median rate of survival: 14 months for Child Class A pts and 8 for Class B pts). 26 pts (52%) showed partial response and recurrence rate, while 15 underwent re-treatment with other techniques (Drug delivery embolisation, or RFA) obtaining good control of disease. No complications related were shown. In seven pts, improving of portal vein thrombosis was revealed (50%).
Conclusion: radioembolization is a safe and effective treatment in pts with advanced multifocal HCC and in portal vein thrombosis.

1905.5

Temperature mapping in MR-guided radiofrequency ablation for a prediction of the coagulation zone

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Purpose: to evaluate if proton resonance frequency (PRF) temperature mapping performed after RF ablation can be used to predict the coagulation zone.
Materials/Methods: ten patients with primary liver lesions or liver metastases were treated by radiofrequency ablation using a wide-bore 1.5 T scanner (Magnetom Espree, Siemens Medical Solutions, Erlangen, Germany) and two bipolar RF applicators. Phase images generated by a gradient echo sequence were used for temperature mapping in different slice positions (n=22 temperature maps, TR=51 ms, TE=18 ms, FOV=256, resolution 128x128, bandwidth 150 Hz/pixel). A baseline image was performed before energy application. Phase differences before and after energy application were used to calculate temperature maps. Tissue with a temperature above 60°C was considered to be treated. T1 weighted, contrast-enhanced images acquired one month after therapy were registered on the temperature maps. The non-enhanced necrotic area was segmented and compared to the area with a displayed temperature above 60°C on the temperature map (Matlab, The Mathworks, Natick, USA). Sensitivity and positive predictive value of the temperature map was calculated, using the control imaging as a gold standard.
Results: temperature mapping reached an acceptable image quality in 18/22 cases. Sensitivity, i.e., the rate of correctly detected coagulated tissue was 0.82±0.08. Positive predictive value, i.e., the rate of voxels in the temperature map over 60°C that actually developed necrosis was 0.90±0.07.
Conclusion: the prediction of the coagulation zone was possible with temperature mapping with a stable positive predictive value. Patient interscan motion decreases image quality in some cases.

1905.6

^{90}Y Microsphere therapy in patients with extensive liver-dominant colorectal (CRC) metastases failing multiple lines of systemic chemotherapy: a matched-pair analysis

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Purpose: to assess safety and efficacy of 90Y-resin microsphere therapy in patients exhibiting progressive CRC liver-dominant metastases following multiple lines of systemic chemotherapy.
Materials/Methods: a matched-pair analysis for overall survival was conducted in patients with extensive CRC liver metastases. Patients were matched on: tumour load, synchronous/metachronous metastases, ALP increase, CEA>200 U/mL. All patients demonstrated tumor progression prior to therapy. Adverse events post-90Y-microsphere therapy were documented. Overall survival for 90Y-microsphere therapy and control were calculated via Kaplan-Meier analysis from last progression on chemotherapy prior to 90Y-microsphere therapy to date of death. The effect of prognostic factors on survival was assessed using Multivariate Cox proportional hazards.
Results: 58 patients were recruited (29 therapy; 29 control) with extensive liver tumour involvement: median 30%vs.25%. Lack of 90Y-microsphere therapy (HR=4.0) was the only negative predictor for overall survival (p<0.001). Patients receiving 90Y-microsphere therapy following chemotherapy failure survived significantly longer than control patients (median survival: 8.3 vs.3.5 months; p<0.001). This benefit was clearly evident at 3 months post 90Y-microsphere therapy (97 vs. 59% survival) and sustained through 12-months follow up. Patients receiving 90Y-microsphere therapy showed increased tumour stabilisation compared to controls (median PFS: 5.5 vs. 2.1 months, p<0.001). Other than reduced Karnofsky status and increased tumour markers due to progression, one case of sepsis (3%), one case of abdominal pain (3%), and three possible cases of radiation-induced liver disease (10%) following 90Y-microsphere therapy were reported.
Conclusion: 90Y-microspheres provide substantial benefit as evidenced by prolonged overall survival in salvage patients with extensive CRC liver metastases.

Free Paper Session
Peripheral vascular interventions 2

1906.1

Limb salvage following isolated infrapopliteal angioplasty: our experience with patients in end-stage renal failure versus those with no known renal impairment

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Purpose: fewer reports on infrapopliteal angioplasty amongst a small series of renal failure patients included substantial femoropopliteal revascularisations, potentially confounding long term results. We report our experience with angioplasty for isolated infrapopliteal disease in end-stage renal failure (ESRF) versus those with no known renal impairment (NKRI).
Materials/Methods: from January 2005 to December 2008, 132 patients with no iliofemoropopliteal disease had angioplasty for infrapopliteal disease. Thirty-five patients with ESRF (mean age 61±11.9 years; male 68.6%) underwent angioplasty in 38 legs for critical limb ischemia (defined as rest pain, ulcer or gangrene). Sixty-four patients with NKRI (mean age 66.6±10.4 years; male 57.8%) underwent angioplasty in 67 legs. Mean follow-up was 8.5±10.9 months and 13.4±12.9 months. Arterial segments angioplastied were 76 and 124: tibioperoneal trunk-7/13, anterior tibial-31/49, dorsalis pedis-7/7, posterior tibial-15/27 and peroneal-16/28.
Results: technical success (<30% residual stenosis in all lesions in the segment) was 85.5% (ESRF) and 76.6% (NKRI). Straight line flow to foot (along at least 1 calf vessel) was achieved in 97.5 and 94.4%. Six legs (between 5 to 316 days) underwent re-angioplasty. One procedure was complicated by distal embolism and two by flow-limiting dissection. No stents were placed. One had distal surgical by-pass. Limb salvage (avoidance of above foot amputation) was 54.5% (ESRF) and 76.2% (NKRI) (p=0.04) at 6 months and 48.5 and 76.2% (p=0.01) at 1 year. Thirty day mortality was 8.6 and 3.1%.
Conclusion: isolated infrapopliteal angioplasty in ESRF showed a high technical success rate comparable to NKRI but a significantly low limb salvage rate.

1906.2

Helical stent geometry improves mechanical performance in the superficial femoral and popliteal arteries

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Background and aim: superficial femoral artery (SFA) and popliteal artery stenting currently suffer from two major clinical complications; stent fracture and restenosis. A helical stent geometry offers mechanical and anti-restenotic haemodynamic advantages over conventional straight stents. We evaluated mechanical performance of helical stent geometry in this study.
Methods: we compared the mechanical performance of helical and straight stents in a human cadaveric lower limb model. Each limb (n=6) was implanted with three 80 mm long stents, overlapped by 10 mm from the popliteal artery to the mid SFA. Three limbs were implanted with helical stents while three limbs were implanted with three different commercially available straight stents. The stented regions were imaged angiographically while the leg was bent from the straight (0°) through sitting (~90°) and fully flexed positions (>135°). CT scans were later performed with the limbs placed in similar positions.
Results: upon implantation, minor helicity was observed in the helical stents. During bending, the helical stent, recovered towards its helical geometry allowing the artery to shorten in a controlled fashion by taking up excess arterial length particularly in the popliteal fossa. No kinks were observed in the helical stents, while in two of the three limbs stented with straight stents, kinking occurred behind the knee. Similarly, while kinking of the artery occurred distal and proximal to the straight stents, none was observed in the limbs stented with helical stents.
Conclusion: a helical stent geometry improves mechanical performance of stents in the SFA and popliteal arteries.

1906.3

Long-term follow-up of endovascular visceral artery treatment for chronic atherosclerotic occlusive disease

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Purpose: endovascular treatment is an increasingly used therapeutic option in patients with chronic visceral artery occlusive disease. Purpose of this study was evaluation of patency and mortality in patients treated with visceral artery PTA and/or stent including long-term follow-up.
Materials/Methods: a retrospective review of 20 consecutive patients (5 women, 15 men) with visceral artery PTA and/or stent treatment for symptomatic chronic mesenteric ischemia from 1998 to 2004 was performed. The follow-up period was 4 to 10 years. Patient demographics, interventional details, primary and/or secondary patency and mortality were recorded. Cumulative mortality and patency rates were determined using Kaplan-Meier life table analysis.
Results: thirty interventions (PTA alone n=17, PTA and stent n=13) were performed in 20 patients with symptomatic chronic visceral artery occlusive disease. Interventions were performed in the superior mesenteric artery (n=14), celiac artery (n=10), and hepatic artery (n=6). Of these interventions, 23 were primary and 7 were secondary (re-intervention rate of 30.4%). Re-interventions were performed in the superior mesenteric artery (n=5), celiac artery (n=1), and hepatic artery (n=1). Cumulative 1-year results were primary patency 73% (SEM 11.1), secondary patency 84% (SEM 8.3), and survival 80% (SEM 8.9). Cumulative 10-year results were primary patency 61% (SEM 11.7), secondary patency 78% (SEM 9.9), and survival 65% (SEM 10.7).
Conclusion: ten-year follow-up post endovascular visceral artery treatment for chronic mesenteric ischemia demonstrated a considerable secondary patency rate of 78%. In the future, innovative treatment options such as stent-grafts or drug-eluting stents should be evaluated to lower restenosis rates.

1906.4

Transfemoral and transtibial combined approach in subintimal recanalization of SFA obstructions extending on popliteal and distal vessels origin

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Purpose: to propose our technique, to obtain the optimal recanalization to the foot in case of long SFA occlusions involving the popliteal trifurcation, using a combined antegrade and retrograde subintimal approach in patients presenting critical limb ischemia (CLI), secure candidate in amputation.
Materials/Methods: from January 2003 to December 2008, 723 diabetic patients were treated for limb salvage classified TASC 3 C-D. In 57 with SFA, long occlusions involving the leg vessel tree were performed subintimal antegrade and retrograde (posterior tibial artery in 32 and anterior tibial artery in 25 cases) approach. The preliminary evaluation of regular patent portion of the runoff vessel was previously assessed by angio-MR and angio-TC and confirmed during preliminary DSA study. The puncture of distal vessels was performed under ultrasound Doppler guidance. A subintimal channel rendezvous was performed to allow snaring of the guidewires. Subsequent balloon dilatation was performed.
Results: we achieved 96.49% technical success. At Doppler-US mean follow up of 18.5 months, the patent vessels was 68.4%, but we had a 92.7% in limb salvage with complete healing of limb lesions and rest pain resolution . The oximetry value showed an increase from mean original value of 17.6 to 44.6 mmHg at 6 months follow-up.
Conclusion: in patients with SFA occlusion involving the popliteal trifurcation, combined antegrade and retrograde subintimal recanalization approach is suitable and efficacious endovascular option to obtain a direct flow to the foot and so an high percentage of limb salvage.

1906.5

BTK interventions using pedal-plantar-loop technique

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Purpose: we aimed to appraise clinical results following PTA of foot vessels exploiting a novel technique, based on the recanalization of both pedal and plantar arteries and their anatomical anastomosis in order to restore direct arterial in-flow from both anterior and posterior tibial vessels, defined as pedal-plantar loop technique.
Methods: we prospectively collected baseline, periprocedural and mid-term data of all consecutive patients with CLI in whom PTA was attempted using the pedal-plantar loop technique between January 2007 and September 2008. The primary end-point was acute technical success. Secondary end-points included limb salvage rate, major and minor amputation, change in Rutherford class and TcpO2, reocclusion/restenosis, re-hospitalization, and repeat revascularization after 12 months.
Results: a total of 1331 consecutive patients with CLI were treated using PTA at BTK vessels and 114 (10.6%) were approached with the pedal-plantar loop technique to recanalize the foot arteries too. Acute success was achieved for tibial PTA in 100% of the cases, achieving adequate angiographic results without periprocedural complications, whereas acute success for the pedal-plantar loop technique was 84%. Clinical improvement was obtained and maintained after an average of 12 months, with a significant improvement of TcpO2 after 15 days, 51±16 mmHg in the group of patients with foot arteries revascularizated , versus 42±12 mmHg in the two BTK vessels at the ankle level with partial out-flow in the foot .
Conclusions: PTA revascularization of foot arteries is feasible and safe, and appears to provide positive clinical results at both acute and mid-term follow-up.

1906.6

Interim report on the Zilver® PTX™ for long SFA lesions

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Purpose: this is an interim report on clinical evaluation of the performance of the Zilver® PTX™ drug eluting stent (Cook Medical) for treating lesions > 14 cm long in the above-the-knee femoro-popliteal artery.
Materials and Methods: a multi-center, multi-national registry is ongoing to evaluate the performance of the Zilver® PTX™ drug eluting stent in symptomatic above-the-knee femoropopliteal artery (SFA) lesions in 792 patients. Follow-up includes evaluation of stent integrity, event-free survival (EFS) and freedom from target lesion revascularization (TLR).
Results: approximately 25% (198) of patients in the study presented with lesions >14 cm long at the time of enrollment. The average lesion length in this cohort of patients was 22.1±5.1 cm and an average of 3.5 Zilver® PTX™ stents were used per lesion. Twelve-month follow-up is currently available for 122 patients (124 lesions) in this long-lesion cohort. Interim results indicate that stent integrity (freedom from fracture) was maintained in 98.1% of stents, all of which were overlapped with at least one other stent. In addition, the EFS rate was 77% and 77% of lesions were free from TLR. These results compare favorably with the available 12-month results for the overall study (98.4, 86 and 88%, respectively; n=458 patients [530 lesions]).
Conclusion: these interim results demonstrate that even long SFA lesions can be treated with Zilver® PTX™ stents, with excellent safety and efficacy up to one year.

Free Paper Session
Thoracic aortic stent grafting and fenestrated grafts

1907.1

Stent graft placement in aortic arch pathologies treated with or without a debranching procedure: results from the restore registry

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Purpose: to compare efficacy, safety, and short-term follow-up of thoracic endovascular aortic repair (TEVAR) with a newly designed stentgraft in patient subgroups with and without metachroneous aortic rerouting procedures.
Materials and Methods: basis of the analysis is a prospective European multicenter monitored clinical registry (RESTORE) of patients treated with acute or elective TEVAR with the Relay stentgraft (Bolton Medical, Sunrise, FL, USA). Patients were assigned to one of two groups without (n=115) or with (n=80) a debranching procedure before stentgraft placement. Debranching procedures

included: left subclavian transposition (n=47); subclavian and left carotid transposition (n=21); triple rerouting (n=12). For each group, endpoints were: technical success, complication rate, occurrence of endoleaks and mortality.
Results: for the groups without and with debranching procedures, respectively, technical success was 98.3 and 97.5% (p=1.00). Complication rates were 19.1 and 16.3% (p=0.71). Early endoleaks (within 30 days) occurred in 5.8 and 6.3% (p=1.0). Late endoleaks occurred in 8.2 and 11.1% (p=0.58). Overall mortality was 11.3 and 11.7% (p=0.77).
Conclusion: in the RESTORE dataset, no significant differences and, more importantly, similar outcome can be observed in the patient groups without and with supraaortic debranching procedures before TEVAR with the Relay stentgraft. The data support the hypothesis that debranching procedures are a safe option to extend TEVAR treatment into the aortic arch.

1907.2

Modern treatment of juxtarenal abdominal aortic aneurysms with fenestrated endografting and open repair: a systematic review

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Purpose: endovascular treatment of infrarenal abdominal aortic aneurysms (EVR) has significantly reduced 30-day mortality and has comparable long-term outcomes to open repair. Advances in endovascular technology have led to the introduction of fenestrated stents to treat juxtarenal aneurysms (JRA), previously deemed unsuitable for standard EVR. This paper examines current evidence for management of JRAs.
Materials/Methods: a systematic review exploring reports published after 2001 of fenestrated endovascular aneurysm repair (f-EVR) or open surgery presenting 30-day mortality was performed. Secondary endpoints of renal impairment, vessel patency and re-intervention rates were examined.
Results: no randomised studies were identified. 9 cohort studies reporting 390 f-EVR cases and 12 cohorts reporting 1164 open repairs of JRAs were identified. Outcome measure analysis found the f-EVR and open cohorts to be homogeneous. Combining studies, there was an increased 30-day mortality after open repair when compared to f-EVR (Relative risk (RR) 1.02, 95% Confidence interval (CI) 1.01-1.04, P=0.02), corresponding to a 2% increased mortality. No difference was identified in post-operative permanent dialysis dependence (RR 1.00, CI 0.99-1.01, P=0.80). Transient renal failure was more common following open repair (RR 1.07, CI 1.01-1.12, P=0.02), early re-interventions were less common following open repair (RR 0.89, CI 0.85-0.93, P=0.0001).
Conclusion: selective f-EVR appears to have reduced peri-operative mortality compared with traditional open surgery. Selectivity within the study groups prohibits more robust comparison. Equally, there is no rigorous classification system of JRA morphology that would allow comparison of complexity. Promising short-term results confirm a role for f-EVR in management of complex abdominal aneurysms.

1907.3

Aortic arch endografting by retrograde fenestration: technique and experimental results in acute and chronic animal models

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Purpose: an experimental animal model was developed for endovascular repair of aortic arch by using a cerebral circulatory system.
Materials/Methods: eleven pigs were used for the acute experiments and 2 for the chronic. Dacron-graft was anastomosed to the abdominal aorta for stent-graft access. Bilateral carotid, left subclavian and right femoral arteries were exposed. Right femoral to right carotid bypass circuit was established with roller pump. The off-the-shelf Valiant-stent-graft was used to cover the aortic arch. Prototype balloon centered and anchored needle puncture catheter, and radiofrequency puncture-catheter were used for in-situ fenestration of the stent-graft through the contralateral carotid and the left subclavian arteries, respectively, in retrograde route. Covered-stents including iCast were implanted into the fenestrations to complete the reconstruction.
Results: total arch reconstruction was accomplished in 11 of the animals without hemodynamic insult in the acute studies. In chronic study, retrograde RF fenestration and arch reconstruction was successful in both animals. The first animal expired after 8 hours due to prolonged operating time and excessive blood loss. Second chronic animal survived to 28 days. The condition of the arch reconstruction was examined by angiography and dissection. Both reconstructions appeared fully functional without evidence of remarkable flow changes, implant degradation or branch junction dislodgement. There was greater tissue adhesion to the stent graft and branch conduits in the 28 day animal as can be expected.
Conclusion: endovascular arch reconstruction technique represents an alternative therapy for aortic arch pathologies. Development of specific conduits and stent-grafts will make this procedure safe and simple.

1907.4

Self-expanding nitinol stent implantation for treatment of aortic coarctation

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Purpose: to assess the efficacy of self-expandable nitinol aortic stents in the treatment of coarctation of aorta (CoA).
Methods: 21 patients (14 males and 7 females) with CoA and a mean age of 19.2 years (11-34) underwent self-expandable stents (Sinus-Aorta/OptiMed) implantation. The diameter of predilation balloon was selected based on the CoA anatomy by five times the stenosis diameter. The stent diameter was chosen by 20-30% more than that of normal portion of the aorta.
Results: all procedures were successfully performed without any complications causing surgical intervention. The balloon predilation and postdilation was performed in 12 and 14 procedures, respectively. The mean diameter of the stents was 21.6±2.3 mm (18-26). The mean peak systolic pressure gradient decreased from 57.4 to 1.2 mmHg (p<0.001). Stent upward jumping occurred in 3 patients, 2 of whom were treated by a second stent overlapped with the previous stent. The third patient was treated with 3 overlapped stents (second stent distal migration). We had these stent dislodgements in the initial patients treated using shorter stents without antijumping markers. None of the patients had dissection, arterial rupture or other complications. On follow-up, one patient had recoarctation and minor stent migration (after 18 months) that was treated by another stent deployment. No evidence of aneurysm formation was seen.
Conclusions: CoA can be successfully and safely managed with self-expandable nitinol aortic stents without aortic wall complications. It seems that it can be prevented of self-expandable stent dislodgements using oversized stents having antijumping markers.

1907.5

Aneurysmal chronic type B dissections may be stented to expand the true lumen prior to definitive hybrid revascularization and/or endovascular repair

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Purpose: a hybrid and/or endovascular approach to repair a thoracoabdominal aortic aneurysm arising as a result of a chronic type B aortic dissection may be hampered by a narrowed proximal true lumen. We report our experience.
Materials and Methods: patients with chronic type B dissections treated with endovascular intervention were identified from a prospectively collected database of thoracic aortic interventions. Demographics and outcome data were analysed.
Results: 184 patients had thoracic aortic stents, of which 37 were for chronic aortic dissections with aneurysmal expansion. 13/37 were treated by a hybrid procedure with visceral revascularisation and thoracoabdominal aortic stent grafting. 2/37 had branched and/or fenestrated stent grafts and 22/37 had thoracic stent grafts. For 6/13 hybrids and 1 of the fenestrated grafts (all Crawford type II aneurysms), a thoracic stent was deployed in a separate session in order to expand the true lumen to maintain flow in the visceral vessels prior to definitive repair. For the 6 hybrid repairs requiring prior true lumen stenting compared with the other 7 hybrid repairs: 3/6 had neurological complications (2/3 reversible) (versus 0/7) and 30-day mortality was 1/6 (versus 0/7). However, a prior type A repair had occurred in 4/6 of these patients (versus 2/7).
Conclusion: a stent graft may improve the flow in a narrow true lumen proximal to an aneurysm enabling successful hybrid and/or endovascular stent grafting. However, the patients in whom this is applicable tend to have more extensive dissections, resulting in a poorer outcome.

1907.6

Percutaneous management of aortic dissection with malperfusion: a single-institution experience with fenestration and stenting

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Purpose: to report our single-institution experience managing ischemic complications of aortic dissection (AD).
Materials/Methods: from February 1996 to the present, 356 arteriograms were obtained in 306 patients (232 males mean age 57 years, range 24-87, and 74 females mean age 60, range 26-82) with 308 AD's (150 Type A, 113 acute and 37 chronic, and 158 Type B, 115 acute and 43 chronic). All had malperfusion based on clinical, laboratory, or imaging findings involving the mesenteric (M) (n=122), renal (R) (181), lower extremity (L) (101), or spinal cord (C) (21) arterial supply. Malperfusion was diagnosed by manometry, intravascular ultrasound, and selective arteriography. Treatment included aortic fenestration with supplementary stenting for dynamic obstruction, and stents in branch arteries for static obstruction.
Results: malperfusion was present in 237 and treated in 218 patients with overall 30-day mortality of 22%, including 38% in acute type A, 16% in acute B, 25% in chronic A, and 7% in chronic B. In particular, M malperfusion was present in 145 patients (74 of 122 suspected, plus an additional 71 not clinically suspected), 30-day mortality 25%; R in 177 (115 of 181 suspected, plus 62), mortality 19%; L in 152 (92 of 101 suspected, plus 60) mortality 22%; and C in 9 (8 of 21 suspected, plus 1) mortality 33%. 139 patients had malperfusion in 2 or more territories.
Conclusion: clinical exam and CT imaging underestimate the prevalence of malperfusion in AD. Endovascular treatment effectively reduces the mortality of this dreaded complication compared to historical controls.

Free Paper Session
TIPS and pediatric liver interventions

1908.1

Use of an external constricting balloon expandable stent during TIPS creation to maximize control of portosystemic pressure gradient reduction: initial experience with a novel technique

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Purpose: use of the Viatorr stent for creation of transjugular intrahepatic portosystemic shunts (TIPS) has led to markedly improved long term patency. The proper sizing to achieve an optimal pressure gradient can be difficult. Under-sizing may cause inadequate portal decompression while oversizing may increase the risk of acute hepatic dysfunction. We describe a technique in which an external balloon expandable stent (BES) is initially placed along the hepatic track to achieve a controlled expansion of a subsequent coaxial Viatorr stent to a diameter determined by final balloon dilatation.
Materials and Methods: we retrospectively reviewed all primary TIPS performed at our hospital since the introduction of the Viatorr stent.
Results: over a 7 year period, 53 of 56 attempted TIPS were successful. An external constricting BES was used in 19 cases, with initial diameters ranging from 7 to 9 mm and final diameters 8 to 12 mm. The nominal diameters of the Viatorr stents in these 19 patients were 12 mm (13 patients) and 10 mm (6 patients). No complications occurred related to placement of the external constricting stent. The PSG was low (< 5 mmHg) in 1 of 19 patients when an external BES was used and in 4 of 34 patients without an external constricting BES.
Conclusion: use of an external constricting BES during TIPS creation with a Viatorr stent resulted in more precise control of the final PSG and may reduce complications related to excessive reduction of the PSG.

1908.2

Hepatic encephalopathy in patients treated with expanded polytetrafluoroethylene-covered stent grafts: initial results of a randomized trial of 8 versus 10 mm Viatorr stent graft to evaluate HE rate and clinical efficacy

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Purpose: to report initial results of a randomized trial comparing 8 vs 10 mm Viatorr stent-graft (WL-Gore) to evaluate the clinical efficacy and the postprocedural encephalopathy (HE) rate.
Materials/Methods: a total of 21 consecutive cirrhotic patients, candidates to transjugular intrahepatic portosystemic shunt (TIPS) for variceal bleeding or refractory ascites, were enrolled and randomized. All procedures were performed by the same radiological group using a standardized technique. Moreover, all patients were

followed up by the same medical group, according to a prospective protocol for a correct diagnostic workup and surveillance strategy. The two groups were comparable for age, sex, etiology and severity of cirrhosis, pre-TIPS HE stage.
Results: after TIPS, the porto-systemic pressure gradient (PSG) significantly decreased in both groups; however, the PSG value was higher in the 8 mm group, 8.3±2.1 vs 5.5±1.9 mmHg; p=0.007. The incidence of HE was similar in the two groups (χ2 test p=0.89). The recurrence of persistent ascites was significantly higher in patients with the small stent (four cases vs nine cases; p=0.03). Also in these patients, the PSG after TIPS was higher (9.7±2.5 vs 6.3±2 mmHg; p=0.008). In the 8 mm Viatorr group, two patients had persistence of large varices (p=0.65) not observed in the 10 mm group. Shunt dysfunction and rebleeding episodes did not occur in both groups.
Conclusion: preliminary results suggest that TIPS created with expanded polytetrafluoroethylene-(e-PTFE) covered stent graft with smaller diameter seems to have a minor clinical efficacy, probably related to an inadequate decrease of the PSG without any advantage in the reduction of post-TIPS HE.

1908.3

Efficacy of percutaneous intervention for biliary leak in pediatric liver transplant patients

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Purpose: to investigate the efficacy of percutaneous management of biliary leak in pediatric liver transplant patients.
Materials/Methods: 265 transplants were performed in 236 patients over 12 years. A prospective transplant database was utilized. Inclusion criteria were the presence of biliary leak post transplantation. Transplants with biliary leak treated exclusively by surgery were excluded from analysis. Patients with biliary strictures were excluded from the control group. Graft revision, graft loss and survival were evaluated following percutaneous intervention.
Results: 5.3% (14/265) of transplants demonstrated biliary leak post transplant. 85.3% (226/265) had no biliary complications. 85.7% (12/14) of these cases were treated percutaneously. Surgical revision was necessary in 25.0% (3/12) of the transplants with leak compared to 10.2% (23/226) of transplants without biliary complication (p=0.13). In cases with biliary leak, 8.3% (1/12) of percutaneously treated transplants proceeded to graft loss compared to 8.8% (20/226) in control cases (p=1.00). The cause for graft loss in patients treated for biliary leak was non-biliary related. Patient survival rates at 1 year and 3 yrs in patients with biliary leak were 100% compared to 92 and 89% in the control group (p=0.80).
Conclusion: biliary leak in the pediatric liver transplant population can be successfully treated by percutaneous intervention without leading to an increase in reoperation, increase in retransplantation or decrease in survival when compared to transplant cases without biliary complications.

1908.4

US-guided biopsy of pediatric liver: 10 years of experience

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Purpose: to retrospectively review our experience in US-guided liver biopsy in pediatric patients. To assess safety, accuracy and clinical outcome of this technique.
Materials/Methods: in our children reference centre, we reviewed the data available about US-guided liver biopsies since January 1999 until December 2008. Clinical evaluation, procedural data, technical notes and histological data available were collected. Coagulation prolonged time (INR>1.5) and low platelet count (<50,000/μL) were the absolute contraindications considered. All procedures were made under general anesthesia.
Results: we performed in 256 patients, 419 liver biopsies under US-guidance (n=302 in transplanted livers; n=101 in unclassified diffuse liver disease and n=16 in focal liver lesions). Needle used was a 16G tru-cut. Minor complications occurred in 39 patients (8 patients with mild pain; a small amount haemorrhage in 24 patients and mild in 7 patients). Major complications occurred in 2 patients, one gastric perforation and a severe peritoneal haemorrhage (but no surgery was needed). Procedure was diagnostic in 418 patients; In 1 case, material sampled was inadequate/insufficient to pathologic analysis (a focal liver lesion).
Conclusion: US-guided liver biopsy is safe and accurate particularly when there is a dysmorphic liver or small implant in cases of living donor. Percutaneous approach varies according patient and the liver or lobe to be punctured. Confidence and expertise need to be acquired to minimize complications. A thicker sampling with a 16G needle may facilitate the pathologic diagnosis. It is the most frequent interventional technique used after liver transplantation.

1908.5

Hepatic venous outflow obstruction after piggyback liver transplantation: endovascular approach and treatment with prosthesis

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Purpose: to evaluate retrospectively the endovascular management of hepatic venous outflow obstruction with use of stent after piggyback orthotopic whole liver transplantation (OLT) performed in a cohort of nine patients.
Materials/Methods: from 1997 to 2008, nine male patients, with an age range of 53-62 years, underwent hepatic venous outflow obstruction after piggyback OLT. Endovascular treatment with use of stent was performed in our centre. Before the procedures, informed consent was obtained from all the patients. Primary stent placement was performed in five patients and primary venoplasty alone was performed in one patient, but required a stent one week later. Short balloon-expandable stents were used to minimize jailing of branch vessels and to resist recoil. Ultrasonographic guide was used in five patients for a transparietohepatic approach. The remaining procedure was performed using a right internal jugular approach. Follow-up (including venography, cross-sectional imaging, and laboratory tests, pre- and postprocedural pressure gradients, and laboratory values) are studied.
Results: technical success (pressure gradient <3 mm Hg) was achieved in all patients with mean follow-up of 962 days (range, 100-1825 days). Traumatic hemothorax as a complication occurred in one patient after the transparietohepatic approach. No significant re-estenosis was encountered after stent placement.
Conclusion: hepatic venous outflow obstruction is an uncommon but potentially fatal complication of piggyback OLT. Balloon-expandable stents are an effective, safe, and apparently durable treatment under an endovascular approach.

1908.6

Transjugular intrahepatic portosystemic stent-shunt in children: long-term results

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Purpose: to evaluate the technical feasibility and long-term results of TIPSS in children.
Materials/Methods: during a 16 year period, TIPSS was performed in our institution in 493 patients, including 17 children aged 2.5 to 14 years (med 6.5). Indications include acute (3) and recurrent (14) variceal bleeding mostly related to biliary atresia. A conventional jugular approach (enhanced by direct portal targetting in 4) and a pull-through transhepatic-transfemoral technique were used in, respectively, 13 and 4 patients. Bare stent calibrated between 6 and 9 mm were inserted.
Results: TIPSS succeeded in all patients. The mean reduction of the portosystemic gradient was 61% (34-74). Complications included 1 arterial injury, 1 portal rupture and 1 acute shunt thrombosis successfully managed non-operatively. No recurrent bleeding was observed within 1 month. During the follow-up (median 7.9 year), delayed rebleeding due to shunt obstruction occurred in 4 patients and asymptomatic stenosis were observed in 7. All strictures were successfully managed by PTA (3) or redo-stenting (8). Among the 15 patients primarily listed for transplantation, 8 were electively transplanted (delay 4-83 mo), 3 have been removed from the waiting list because improved liver function, 2 remain candidate and 2 died from sepsis. The 2 remaining patients initially not considered for liver transplantation sufficiently improved their general status to become candidate.
Conclusion: TIPSS in children is feasible and should be considered mainly as a bridge to liver transplantation. However, a preserved liver function associated with a good long-term shunt patency may delay or even obviate the need for transplantation.

Free Paper Session
Late breaking abstracts

1909.1

Factors predicting spinal cord ischaemia after complex thoracoabdominal aortic stenting

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Purpose: spinal cord ischaemia (SCI) causes significant morbidity following endovascular thoracic and thoracoabdominal aortic intervention. We aim to identify predisposing risk factors.
Materials and Methods: all elective and emergency cases of endovascular thoracic aortic intervention between 2004 and 2009 were identified from a prospectively collected database. Indications, history, co-morbidities, procedure and perioperative observations were analysed and post operative CT scans were assessed.
Results: two hundred and thirty-two patients underwent thoracic aortic stent grafting. Seventy-nine were thoracic aortic stent grafts alone. The remainder were more complex procedures, of which 14 were branched or fenestrated thoracic grafts, 69 were arch hybrids and 70 were visceral hybrids. The global incidence of SCI for all procedures and indications was 20/232 (8.6%). This was higher for the more complex procedures (11.8%) than for uncomplicated thoracic aortic stent grafts (2.5%). Recovery of function was seen in 7/20 (35%). Patient age (70.1 v 66.3), lowest recorded intraoperative blood pressure (92.5 v 94.9 mmHg), use of a spinal drain (14/17 v 110/165), and previous aortic intervention (8/19 v 72/190) were not associated with SCI. However, duration of procedure (463.5 minutes v 307.2; p=0.001), blood loss (4.58 v 2.78L; p=0.02), and number of stents deployed (4 v 2; p=0.001) were significantly higher in patients who developed SCI.
Conclusion: the risk of developing SCI following thoracic and thoracoabdominal aortic endovascular intervention is increased for complex interventions, and associated with long procedures, increased blood loss, and the number of stents deployed. The degree of risk should be carefully considered in both selection and consenting of patients.

1909.2

1-year results of the VERTOS II trial: vertebroplasty versus conservative therapy

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Purpose: presenting the results of a randomized controlled trial (RCT) comparing clinical outcome and cost-effectiveness of vertebroplasty (VP) versus conservative therapy (CT) in patients with painful osteoporotic vertebral compression fractures (VCF).
Materials/Methods: a prospective, multicenter RCT was conducted in the Benelux in November 2005. Inclusion criteria: VCF with bone edema on MRI, local back pain (<6 weeks), age of 50 years or older and osteopenia. A total of 200 patients are randomized, 100 in each arm. Radiological imaging results and standard questionnaires addressing clinical symptoms, pain medication and visual analogue scale (VAS) will be compared to baseline and between groups. Significant pain relief is defined as a reduction in VAS-score of 50% or more. Cost-effectiveness of both therapies will be obtained and compared. Follow-up is at regular intervals over 1-year period. Secondary fractures, necessary additional therapies and complications of both treatments are recorded.
Results: 1-year results will be obtained in July 2009 and presented at this year's CIRSE meeting including clinical results, cost-effectiveness, complications and adverse events.
Conclusion: first-time presentation of the Vertos II results, the world's first large RCT designed to assess the value of VP in patients with acute osteoporotic VCF.

1909.3

A randomized trial of balloon kyphoplasty and nonsurgical care for acute vertebral compression fracture: 2-year results

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Introduction: balloon kyphoplasty is a minimally invasive procedure performed in patients with painful vertebral fractures with the goal of reducing pain and improving quality of life. We performed a

randomized trial to assess its efficacy and safety.
Methods: patients with acute vertebral fractures were randomly assigned to kyphoplasty (N=149) or nonsurgical care (N=151). The primary outcome was the difference in the SF-36 physical component summary at one month. Quality of life measurements and spine radiographs were assessed through 24 months of follow-up.
Results: the mean SF-36 physical component summary (PCS) score improved 5.1 points (95%CI, 2.8-7.4; p<0.0001) more in the kyphoplasty group than the controls at 1 month. Kyphoplasty improved the Euroquol-5D (EQ-5D) by an average of 0.13 points (95% CI, 0.04–0.22; p=0.004) more than controls over the two years of follow-up. Kyphoplasty resulted in more pain relief on a 0 to 10-point numeric rating scale (1.5 points; 95% CI 1.0–1.9; p<0.0001), less Roland-Morris back disability (2.9 points; 95% CI, 1.6–4.1; p<0.0001) and 2.2 (95% CI 1.1–3.7; p=0.0008) fewer days of limited activity (within a two-week period) when averaged over 2 years. There was no significant difference in the number of patients with adverse events or serious adverse events in the kyphoplasty and controls. New radiographically detected vertebral fractures were not statistically different between groups at 2 years.
Conclusion: compared to nonsurgical care, balloon kyphoplasty improved quality of life and reduced back pain and disability and did not increase adverse events including the risk of vertebral fracture over 2 years.

1909.4

Therapeutic effect of adipose tissue-derived mesenchymal stem cells transplantation for cirrhosis rats

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Purpose: to evaluate the therapeutic effect of adipose tissue-derived mesenchymal stem cells transplanted through caudal or portal vein for cirrhosis rats.
Materials/Methods: forty-five healthy SD rats were randomly divided into control group, portalvein group and caudal-vein group. All rats were subcutaneously injected carbon tetrachloride oily mixture continuously for 8 weeks. At the sixth week, portal-vein group and caudal-vein group were transplanted with rat adipose tissue-derived mesenchymal stem cells 2×106 each rat, respectively, from superior mesenteric vein and caudal vein. The control group was injected isometric cell culture media. Liver function of rat was examined before and after cell transplantation. The degeneration and necrosis of hepatic cells and the degree of liver fibrosis were observed under microscope. Pathological evaluation was made according to observation results.
Results: the liver function of portal-vein group and caudal-vein group was improved significantly in comparison with that of control group. The transplantation of adipose tissue-derived mesenchymal stem cells inhibited the degeneration and necrosis of hepatic tissue and improved liver fibrosis of the rats. The difference of pathological evaluation between cell-transplanted group and control group was statistically significant (P<0.05).
Conclusion: the transplantation of adipose tissue-derived mesenchymal stem cells through portal and caudal vein has therapeutic effect for the hepatic cirrhosis model of rats.

1909.5

Single centre phase II trial of transarterial chemoembolization with drug eluting beads for patients with unresectable hepatocellular carcinoma: initial experience in the USA

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Purpose: This prospective phase II pilot study evaluated safety and efficacy of transarterial chemoembolization (TACE) with drug eluting beads (DEBs) loaded with doxorubicin in patients with unresectable hepatocellular carcinoma (HCC).
Materials/Methods: Twenty patients with unresectable HCC (75% Child's A, 90% ECOG 0-2, 50% BCLC C, tumor size 6.9 cm) underwent 34 DEB-TACE sessions. Primary endpoints were tumor response, assessed by contrast-enhanced MR imaging at 4 weeks following treatment, using size (RECIST), contrast-enhancement (EASL) and apparent diffusion coefficient (ADC) values, and safety assessed by NCI CTCAE. Secondary endpoints included feasibility, progression-free survival and overall survival.
Results: DEB-TACE was successfully performed in 34 sessions and demonstrated a favorable safety profile. Postembolization syndrome was observed in 1 patient. On initial (4 week) post-procedural MR imaging, targeted lesions had a mean decrease in size of 4% (p=0.1129). Using RECIST, partial response was achieved in 2 patients (10%) and 18 patients (90%) had stable disease. Targeted tumors demonstrated mean decrease in venous contrast-enhancement of 64% (p<0.0001). By EASL criteria, 12 patients (60%) had objective tumor response, and 8 (40%) had stable disease. No patients had progression of a targeted lesion while undergoing treatment. Mean tumor ADC increased by 18% (p=0.035). At six months, the disease control rate was 95% using RECIST. Overall survival rates at 1 and 2 years were 65% and 55%; median overall survival was 26 months.
Conclusion: This pilot study provides clear evidence of the efficacy and safety of DEB-TACE in obtaining local control in patients with unresectable HCC.

1909.6

Comparison of the embolic agents bead block and embosphere for uterine artery embolization: a prospective double-blind randomized study

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Purpose: to determine the degree of fibroid infarction and volume reduction after uterine artery embolization (UAE) performed with Bead Block and Embospheres.
Materials/Methods: this is a multi-center prospective randomized trial comparing the outcomes after UAE with 700-900 u Bead Block (Biocompatibles) or 500-700 u Embosphere (Biosphere Medical) microspheres. The technique protocol was recommended by both the FDA and the manufacturers. The end points assessed included fibroid volume and fibroid perfusion on contrast-enhanced MRI performed prior to UAE and 1, 12, and 26 weeks after UAE. Symptom severity and QOL were assessed 3, 6, and 12 months after UAE using a validated instrument. Outcomes were scored by blinded readers.
Results: forty-six patients were enrolled in this study. Twenty-three patients received Bead Block and 23 received Embosphere

microspheres. More than 90% of fibroids in both treatment groups were completely devascularized after UAE with no differences seen between the two groups (p=0.04). All patients experienced decreased symptom severity and improved QOL with no differences seen between the two groups (p=0.05).
Conclusion: using optimized technique for both agents, there is no statistical difference in the rates of fibroid devascularization, volume reduction, and QOL when UAE is performed with Bead Block and Embosphere microspheres.

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PART 3

EPOS

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Abdominal and GI tract intervention

P-1

Fluoroscopy-guided metallic stent placement for malignant colonic obstructions proximal to the descending colon: the efficacy of coaxial technique using a stiff introducer sheath

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Purpose: to evaluate the efficacy of stent placement using coaxial technique and a stiff and long introducer sheath in patients with malignant colonic obstructive lesions proximal to the descending colon.
Materials/methods: self-expandable metallic stent placement was attempted under fluoroscopy-guidance in 77 consecutive patients with malignant colorectal obstruction. Stent placement was performed using an angiographic catheter and a guide wire. If the angiographic catheter could not be advanced over the guide wire into the obstructive lesions proximal to the descending colon, a 6-Fr introducer sheath was used. The technical success rate, clinical success rate, and complications were analyzed.
Results: successful stent placement was achieved in 75 of 77 patients (97.4%). The angiographic catheter failed to advance into the obstructive lesions of 11 patients (M:F=7:4; mean age: 65.5 years) whose lesions were at the level of splenic flexure or transverse colon. Therefore, coaxial technique was implemented in all 11 patients using a 6-Fr stiff introducer sheath; stent placement was successful. There were no complications related to the use of a stiff introducer sheath. Clinical success, defined as relief of clinical obstructive bowel symptoms, was obtained within 24 hours in all of patients.
Conclusion: coaxial technique using a stiff introducer sheath can increase the technical success of fluoroscopy-guided, self-expandable metallic stent placement in patients with colonic obstruction proximal to the descending colon.

P-2

Percutaneous transesophageal gastrotubing (PTEG): an institutional review

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Purpose: PTEG was developed in 1997 as a new method of esophagostomy for the patients with contraindications to percutaneous endoscopic gastrostomy (PEG) and those in whom a PEG would be technically difficult to place. We aimed to evaluate the safety and feasibility of PTEG.
Materials/methods: we performed retrospective review of 99 patients (female; 33, male; 66) who underwent PTEG placement between Sep. 2002 and Jan. 2009. We evaluated the complication during procedure, postoperative complication, and technical success rate. PTEG was placed as follows; 1) Insert the rupture free balloon (RFB) to the cervical esophagus via the nose. 2) Inflate the RFB and detect it by ultorasonography (US) from left supraclavian point. 3) Puncture the RFB percutaneously under US guidance. 4) Insert a guidewire into the RFB and then into the lower esophagus with the RFB. 5) The percutaneous route that was constructed by 4) was dilated. Finally, a tube was inserted through this route into the gastrointestinal tract.
Results: all patients, except two, had advanced metastatic cancer. Presenting symptoms were nausea, vomiting, and dysphagia. Median age was 61 (range: 38-86) years. Placement was successful in 99 patients (100%). There were four major complications that included two tracheoesophageal fistula, one bleeding from inferior thyroid artery, and one mediastinal abscess. No therapy related death was observed.
Conclusion: PTEG is safe and feasible procedure for the patients in whom it is difficult to perform a PEG.

P-3

Coil trapping of gastro duodenal artery for massive bleeding from duodenal ulcer: outcome and complication

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Purpose: to evaluate the efficacy and safety of transcatheter coil trapping of gastro duodenal artery (GDA) in patients with massive bleeding duodenal ulcer.
Materials/methods: fifty-five consecutive patients with bleeding or rebleeding after endoscopic therapy for duodenal ulcer were included in the study. The technical and clinical success rate, recurrent bleeding rate, procedure related complications and clinical outcomes were evaluated.
Results: the technical and clinical success rates were 100 and 89%, respectively. There was no ischemic complication. Recurrent bleeding occurred in six patients and performed second TAE (n=5) or surgery (n=1). No patient died with continuous bleeding.
Conclusion: high technical and clinical success was obtained with coil trapping of GDA in patients with massive bleeding duodenal ulcer after endoscopic therapy.

P-4

Interventional treatment of iatrogenic abdominal hemorragic complications

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Purpose: to evaluate the safety and efficacy of transcatheter treatment in iatrogenic abdominal hemorragic complications.
Materials/methods: in the last five years, 35 patients (mean age 52 years) underwent embolization procedures for iatrogenic vascular lesions of abdominal vessels. In 15 cases, we treated hepatic artery lesions, in 5 gastro-duodenal artery lesions, 8 intra-renal artery lesions, 4 splenic artery lesions, 2 lesions of epigastric inferior artery and 1 lesion of diaframmatic artery. The iatrogenic artery lesions was determined by different surgical or percutaneous procedures (liver or renal biopsy, biliary drainage, paracentesis, ERCP, etc.) and we observed different iatrogenic vascular lesions.
Results: angiography revealed 15 pseudoaneurisms, 12 arterial lacerations and 8 arterio-venous fistula. Depending upon the presentation and localization, we use covered stents, proximal and distal embolization with coils or vascular plugs and selective embolizations with n-butylcyanoacrylate or PVA. In 34/35 cases, we successfully completed the procedure. In 1 case we had arterial spasm and the procedure was not performed. In 1 case, we had not selective embolization with partial loss of renal parenchyma.
Conclusion: interventional radiological procedures are effective in the management of iatrogenic lesions since they are minimally invasive, have a high success rate and low incidence of complications.

P-5

New fluoroscopic method for percutaneous gastrostomy in an animal model and clinical practice

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Purpose: percutaneous gastrostomies (PG) can be placed radiologically using T-bar suture fasteners (TF) fixing the stomach to the anterior abdominal wall. Follow-up (FU) to release the suture of standard fastener devices is required to prevent complications. We investigated a new introducer kit with innovative TF with resorbable sutures that allows easier deployment and spontaneous release of TF after PG, first in an animal study and then in the clinical setting.
Materials/methods: six farm pigs and 3 human subjects (HS) underwent radiologic PG placement using the introducer kit. In animals, 3 TF with resorbable suture were placed around a tentative abdominal stoma site using the Russell placement method. A second PG placed endoscopically used the Ponsky pull method, each animal serving as its own control. Procedural ease of use was evaluated, and stoma integrity assessed after 2-3 weeks.
Results: PG placement was successful in all animals and HS without complications. One animal died following PG due to anesthesia complications. Kit utility scored highly (90%). All HS and 5 animals had uneventful FU without evidence of infection, disruption or significant stoma leakage. In animals, gastric wall adhesions, (100% ctl and test: n=5), stoma thickness (mean+sem mm; ctl 14+1; test 12+1: n=4), inflammation (ctl 3; test 2: n=4), and fibrous tissue (ctl 4; test 4) scores were equivalent at FU.
Conclusion: radiographic PG placement using the new introducer kit with resorbable TF yields high utility scores, effective gastric anchoring, similar histological healing to standard PG procedures and may improve patient convenience.

P-6

Long-term efficacy of balloon dilations of rectosigmoid stenoses

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Purpose: establishing long-term efficacy of balloon dilations of rectosigmoid stenoses.
Materials/methods: over the past 8 years, we have performed 34 dilations of strictures of rectosigmoid colon under fluoroscopical guidance in 21 patients (11 females, 10 males) (17 benign, 4 malignant lesions) with balloons ranging from 12 to 30 mm in diameter. Follow-up was 3 months to 7 years, number of interventions was 1.62 per patient (range 1 to 4).
Results: technical success was achieved in all procedures, there were other 3 cases where we were unable to cross the occlusion and those were not included in this study. Usually the obstructive symptoms were satisfactorily relieved in 1 or 2 procedures (15 cases, 72%), 3 cases were later surgically resected (1 post-diverticulitis stricture, 1 post-radiation sigmoid stricture, 1 sigmoid adenocarcinoma), 2 cases had later recurrence treated with re-dilation (after 6 months and 3 years). We had one case of colonic perforation during attempt of stent implantation, minor complications included local non-penetrating fissures, postinterventional transitory bleeding, pain and recurrence. Large-diameter stent was implanted in 1 malignant stenosis, 1 attempt failed.
Conclusion: balloon dilating of rectosigmoid strictures in benign strictures is a safe, repeatable method, preferred in complex cases where surgery is not a first-choice option, with satisfactory long-term results. Malignant stenoses seem to be more fragile with higher occurrence of complications and gentle, cautious procedure should be undertaken.

P-7

Fluoroscopic placement of self-expanding metallic stent for the treatment of obstructing colorectal cancer

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Purpose: to evaluate the feasibility and effectiveness of fluoroscopic placement of self-expanding metallic stent for the preoperative colonic decompression or palliative treatment of obstructing colorectal cancer.
Materials/methods: from January 2004 to December 2008, 117 fluoroscopic placement of stents were attempted in 111 patients (M:F= 56:55, mean age: 66 years) with clinical and radiologic signs of malignant colonic obstruction. Sites, purpose of the stent insertion and type of the stent were evaluated. Technical and clinical success rates, complication rates of the stent were evaluated.
Results: site of the stent placement were rectum (34.23%), rectosigmoid junction (18.0%), sigmoid colon (44.1%) and descending colon (3.6%). 81 cases (69.2%) of stent insertion were done for preoperative colonic decompression and 36 cases (30.76%) were done for palliative purpose. 109 uncovered and 8 covered metallic self-expanding stents were used. Technical success rate of fluoroscopic stent placement was 95.7%. Clinical success rate was 88.9%. Among 81 cases of preoperative decompression, 74 cases underwent elective operation with primary anastomosis (91.4%). In the palliative group, the patency rates were 88.8% at 3 months, 77.7% at 6 months and 77.7% at 12 months. Complications associated with stent insertion were minor bleeding (57.3%), severe pain (14.5%), migration (3.4%), tumor ingrowth (3.4%). No procedure related mortality was noted.
Conclusion: fluoroscopic placement of self-expanding metallic stent for the treatment of obstructing colorectal cancer is feasible and effective. Also, this procedure gives good clinical results for the both preoperative colonic decompression and palliative purpose.

P-8

Embolisation of the gastroduodenal artery prior to selective internal radiotherapy (SIRT): first results of a prospectively randomized trial comparing standard pushable coils with retrievable long fibered coils (Interlock®)

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To compare procedure time, safety, and effectiveness of embolisation of the gastroduodenal artery (GDA) with standard pushable and retrievable Interlock® coils. So far, 15 patients (m:f 13:2; mean age 67.3±8.4 years) stratified for SIRT were prospectively randomized for embolisation of the GDA with either standard or Interlock® coils. Procedure time, fluoroscopy time and total time for embolisation, the number of embolisation devices, complications, and durability of vessel occlusion at follow-up angiography for SIRT were recorded. A t-test was used for statistical analysis. GDA embolisation time was significantly longer

for procedures with standard coils (11:53±2:04 min) as compared to Interlock® coils (3:16±1:27 min; p<0.0001). Likewise, fluoroscopy time for embolisations with standard coils was 5:46±3:15 min, which was longer than 2:56±1:36 min for Interlock® coils, but the level of significance was not reached (p<0.1). The time until occlusion of the GDA was noted was 15:51±8:02 min for embolisations with standard coils and 9:55±5:59 min for Interlock® coils (p=0.21). A mean of 5.6±1.2 coils were used for GDA standard coil embolisation, while no more than one Interlock® coil was needed for successful vessel occlusion except for one case, in which also a more proximal side branch was needed to be embolised (p<0.0001). In both groups, a procedure related complication was encountered and no vessel reperfusion was noted. Embolisation of the GDA with the Interlock® coil is safe, easy, effective, and more rapid as compared with standard pushable coils.

P-9

Partial thrombosis of gastric varices after balloon-occluded transvenous obliteration: frequency and long-term outcomes

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Purpose: to investigate frequency and outcomes of partial thrombosis of gastric varices following balloon-occluded retrograde transvenous obliteration (BRTO).
Materials/methods: we retrospectively reviewed consecutive 69 patients with gastric varices followed over 6 months after treatment by BRTO. All patients underwent postcontrast CT and gastroscopy before and after BRTO procedure. Imaging findings of gastric varices with a special concern about afferent veins, degree of thrombosis, and changes of gastric varices were investigated.
Results: based on pretherapeutic CT images, gastric varices were classified into two types of simple (less than three afferent veins) and complex (equal or more than three afferent veins). The initial follow-up CT showed complete thrombosis in 58 patients (84%), and partial thrombosis in 11 patients (16%). Partial thrombosis was observed more frequently in complex type varices (25 vs. 9%). Among 69 patients, no regrowth/recurrent varices were observed in complete thrombosed varices. Regrowth of gastric varices were observed at 6-24 months after BRTO in 5 patients, all of which were complex type and partially thrombosed varices. All 5 recurrent varices were successfully treated by repeated BRTO.
Conclusion: partial thrombosis after B-RTO can occur in complex type gastric varices, and has a high risk of regrowth. Additional techniques obtaining complete thrombosis would be required for complex type of gastric varices to achieve long-term efficacy.

P-10

NBCA embolization for endoscopically unmanageable acute nonvariceal gastrointestinal hemorrhage (indications and clinical results)

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Purpose: to assess the technical and clinical results of embolization with n-butyl cyanoacrylate (NBCA) in endoscopically unmanageable nonvariceal gastrointestinal hemorrhage (GIH).
Materials and methods: between January 2004 and December 2007, 39 patients with confirmed acute upper and/or lower GIH underwent emergency embolization for hemorrhage control; NBCA was used in 17 of them, all of whom were in shock despite blood transfusion. The results were studied retrospectively. Clinical parameters and embolization data were assessed for technical success and clinical success and outcome.
Results: technical success (bleeding target devascularization) was achieved in all patients. Two partial colonic infarctions were noted. Clinical success (no re-bleeding after 30 days) was achieved in 10 (59%) of 17 patients. Clinical success occurred in 5 of 8 patients (63%) with upper GIH and in 5 of 9 (56%) with lower GIH. The mortality rate was 29% (five of 17 patients). Cause of death was diffuse intravascular coagulation (DIC) in 4 patients and heart failure in one. Presence of coagulopathy or DIC significantly decreased clinical success, and increased mortality rate. Amount of transfused units of blood before embolization significantly increased mortality rate. Increased time to angiography after GIH (P = 0.059) tended to decrease clinical success, but the results were not significant.
Conclusion: NBCA embolization is an effective approach to GIH after endoscopy and is useful for achieving hemostasis.

P-11

Endovascular management of visceral artery aneurysms

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Purpose: the purpose of the study was to evaluate the various endovascular options for the management and the treatment outcome of visceral artery aneurysms.
Materials/methods: fifteen cases of visceral artery aneurysms treated endovascularly in our hospital since January 2005 were retrospectively analyzed. There were six cases of renal artery aneurysms, four cases each of hepatic artery, four cases of splenic artery and one case of gastroduodenal artery aneurysm. All these patients underwent DSA for confirmation of the aneurysm and were subsequently treated in the same sitting. Access was through right common femoral artery and the feeding artery was identified and selectively cannulated for embolisation.
Results: initial technical and clinical success was achieved in all patients (100%). All the aneurysms except one irrespective of the locations were treated with platinum fiber coils or GDC case. There were no immediate or late complications noted in our patient group. On clinical follow up ranged from 6 months to 18 months all patients were symptom free. Follow up Doppler scanning was available in 5 of the patients, which showed complete occlusion of these aneurysms.
Conclusion: endovascular techniques are highly successful in treating visceral artery aneurysms. These procedures can be done as emergency and procedure related morbidity and complications are nil and are the treatment of choice in these cases where surgery is associated with significant morbidity and complications.

P-12

Metallic stent placement in the palliative treatment of malignant gastric outlet obstructions: primary gastric carcinoma versus pancreatic carcinoma

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Learning Objectives: to compare the clinical effectiveness of metallic stent placement for relief of gastric outlet obstruction (GOO) caused by gastric carcinoma and pancreatic carcinoma.
Background: stent placement for GOOs caused by gastric and pancreatic carcinoma may differ technically and clinically, because of differences in tumor location and behavior.
Clinical findings and procedure details: 207 patients with GOO caused by inoperable gastric carcinoma (n=147) or pancreatic carcinoma (n=60) underwent metallic stent placement.
Clinical success was achieved in 97 and 93% of patients with gastric

and pancreatic carcinoma, respectively (P=0.286). The overall complication rate did not differ significantly between the gastric (30%) and pancreatic (23%) carcinoma groups (P=0.441). Stent collapse was significantly more frequent in the gastric (11%) than in the pancreatic carcinoma (2%) group (P=0.027), whereas serious complications, including gastrointestinal bleeding and intestinal perforation, occurred more frequently in the pancreatic (7%) than in the gastric (1%) carcinoma group (P=0.026). The cumulative survival period was significantly longer in the gastric (median, 153 days) than in the pancreatic (median, 90 days) group (P=0.041), but cumulative stent patency did not differ significantly between the gastric (median, 350 days) and pancreatic (median, 385 days) groups (P=0.415).
Conclusion: metallic stent placement was clinically effective in the palliative treatment of GOO in patients with gastric and pancreatic carcinoma. The two groups differed significantly in the rates of stent collapse and serious complications and in patient survival after stent placement.

P-13

Percutaneous transgastric pancreatic intervention to convert a pancreaticocutaneous fistula to a pancreaticogastric fistula

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Learning Objectives: to learn an interventional method for managing a pancreaticocutaneous fistula.
Background: a pancreaticocutaneous fistula is a disruptive condition with surgery thought to be the only curative procedure. If an alternative interventional curative method is possible, this would become the first treatment of choice to avoid surgery.
Clinical findings and procedure details: three female patients (age range, 7 to 48 years) underwent an interventional treatment method for pancreaticocutaneous fistula. This condition was caused by percutaneous drainage of a pancreatic pseudocyst in two patients, and postoperative leakage from the anastomosis between the pancreas and the jejunum in the other patient. The interventional treatment method consisted of percutaneous transgastric puncture of the pancreaticocutaneous fistula and balloon dilation of the newly formed fistula between the stomach and the old fistula. To date (seven years after intervention), there has been no recurrence of the pancreaticocutaneous fistula or pancreatic pseudocyst after tract conversion to the gastric cavity, and complications were not observed perioperatively and postoperatively.
Conclusion: percutaneous transgastric puncture for the treatment of a pancreaticocutaneous fistula is safe and economical, and may become the first treatment of choice in place of surgery.

P-14

Systematic review of balloon-occluded transvenous obliteration for the treatment of gastric varices

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Learning Objectives: to know the safety and efficacy of balloon-occluded retrograde transvenous obliteration (B-RTO) for the treatment of gastric varices.
Background: BRTO has been developed as an interventional treatment for gastric varices, and was spread in Asian countries. Although several papers showed quite good results of BRTO, the evidence is limited in relatively small number of patients in each study.
Clinical findings and procedure details: we reviewed English literature of B-RTO published from 9 institutions and ours. A total of 491 patients who had undergone B-RTO were evaluated. Technical success rate, amount of 5% ethanolamine oleate with iopamidol (EOI), balloon occlusion time, major complications, eradication of gastric varices (GV) and aggravation of esophageal varices (EV) on follow-up endoscopy was evaluated. Technical success rate ranged from 88-100% (median 95.9%). Average amount of 5% EOI used was 26.3 ml (3-77 ml). Balloon occlusion time was varied from 0.5 to 24 hr (0.5 hr in 3 institutions and 24 hr in 4 institutions. Major complications including pulmonary embolism (n=1), acute liver failure (n=1), renal failure (n=1), SMV thrombosis (n=1), ventricular fibrillation (n=1), anaphyractic shock (n=1), coil migration (n=1), liver abscess (n=1) were seen in 10 patients (0.02%). Procedure related death was seen in 3 patients (0.006%). On follow-up endoscopy, eradication of GV was seen in 79.6-100% (mean 96%) and EV aggravation was seen in 10-95%. Recurrent/regrowth of gastric varices was found in 11% during 3-90 follow-up periods.
Conclusion: our systematic review showed the B-RTO is the most effective and safe treatment for of the gastric varices.

P-15

Gastrostomy with fluoroscopy and CT fluoroscopy guidance: patient with self-inflicted facial shotgun wound

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A 65-year-old man presented with self-inflicted shotgun wound in the face. No possible facial-gastric access.
A 14G percutaneous gastrostomy was introduced guided by CT fluoroscopy for gastric puncturing, inflation and gastropexy. Portable fluoroscopy was used for dilatation and catheter insertion.

P-16

Endovascular treatment of deep vein thrombosis caused by pelvic lymphocele following radical hysterectomy: a case report

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We describe a case of deep vein thrombosis caused by pelvic lymphocele following radical hysterectomy treated by transcatheter ethanol sclerotherapy and endovascular stent placement.

P-17

Gastrointestinal "body floss" in a case of fistulating colonic carcinoma; a stabilisation technique for difficult tumor intubation

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Proximal colonic carcinomas are sometimes difficult to intubate with the stent device. We present a case of a gastro-colic fistula secondary to colonic carcinoma, intubated with the aid of ano-oral trans-fistula wire stabilisation; the G.I. "body floss" technique.

P-18

Obscure GI-bleeding: preoperative, CT-guided, percutaneous localization of the bleeding small bowel segment

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In a patient with obscure gastrointestinal bleeding, enteroscopy, angiography and surgery including intraoperative enteroscopy failed to identify the bleeding site. CT depicted active bleeding of the

small bowel. The bleeding segment was localized by percutaneous needle insertion and removed surgically.

P-19

Percutaneous drainage of complicated choledochal cyst in pregnancy

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Urgent percutaneous drainage of complicated choledochal cyst (ultrasonographic guidance) was performed in a 28-year-old primigravida with jaundice. An elective cesarean section was performed 7 weeks later.
Percutaneous drainage gives a chance for safe delivery and successful recovery of the mother.

P-20

Percutaneous treatment of anastomotic leak using combined Amplatzer vascular plug and N-butyl-2-cyanoacrylate: a case report

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We report the first use of the AVP and NBCA-lipiodol mixture for occlusion of anastomotic leak. AVP was deployed in the endoluminal space and fistula track, and NBCA-lipiodol mixture was injected into the AVP. The anastomotic leak was successfully closed.

P-21

Preoperative supraselective embolization of paraganglioma of the gastrocolic ligament

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We present the case of a 85-year-old man with a palpable abdominal mass. Preoperative, the tumor was supraselective embolizated with Gelitaspon. Complete surgical resection of the mass was performed. Histopathological study revealed a paraganglioma.

P-22

Recurrent GI bleeding caused by gastric arterial malformation treated by embolisation

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A rare case of a gastric arterial malformation, with multiple feeders causing gastrointestinal bleeding, was diagnosed on CT angiogram and definitively treated with embolisation using particles and coils following previous surgical and endoscopic treatments.

P-23

Complicated hepatic hydatid cyst: CT-guided percutaneous drainage

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CT-guided percutaneous drainage of a large hepatic hydatid cyst on a 76-year-old male was complicated by cysto-biliary and cysto-intestinal fistulas . A 3-month follow-up revealed clinical, imaging, and serological improvements. Surgery was performed because of patent cysto-intestinal fistula.

P-24

Stent-assisted coil embolization of pseudoaneurysm of the SMA

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We report three cases of spontaneous isolated dissecting aneurysm and a case of ruptured pancreatic pseudoaneurysm of the SMA, which were treated by stent-assisted coil embolization. Two types of stent-assisted coiling techniques were employed: either parallel or sequential.

P-25

Spontaneous SMA dissection treated by endovascular stenting

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We present a rare case of isolated SMA dissection causing mesenteric angina because of associated celiac axis stenosis. A self-expanding stent resolved symptoms

P-26 withdrawn by authors

P-27

Large gastroduodenal aneurysm treated by the use of a stent-graft

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A 68-year-old female was admitted with a 2-cm gastroduodenal artery aneurysm and was treated by using a low profile stent-graft. Final angiography showed normal graft patency. Stent grafting of visceral aneurysms is a safe, effective method.

Aortic stent graft

P-28

Type II endoleak embolization with real-time 3D-fluoroscopy needle guidance

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Purpose: type 2 endoleaks are often treated with percutaneous embolization, which is impossible with complex feeding vessels. CT or US guided direct puncture of the endoleak is also possible. A new alternative technique is real-time 3D-fluoroscopy guidance using cone-beam CT.
Material and method: 3D-Fluoroscopy uses a flat panel detector system, capable of rotating around the patient in 4-6 seconds. 3D-CT reconstruction of the acquired information is used for needle path planning. The calculated trajectory is then projected on the fluoroscopy image, producing a guiding path. After direct puncture of the endoleak, a digital subtraction angiography (DSA) is made, followed by pressure measurement and embolization with Tissucol®. Control CT (-angiography) after 1 and 3 months were performed.
Results: three patients presented with type 2 endoleak after

endovascular aneurysm repair (EVAR). No percutaneous embolization could be performed because of complex feeding vessels. All underwent real-time 3D-fluoroscopy with direct needle placement in the type 2 endoleak. DSA confirmed 3 or more complex tortuous feeding vessels. During pressure measurement, there was no difference in endotension with the systolic arterial pressure. After injecting the Tissucol® endotension disappeared. All patients showed successful embolization on control CT (-angiography).
Conclusion: 3D-fluoroscopy is a successful alternative for percutaneous embolization of type 2 endoleaks after EVAR. The advantages of this new technique are the possibility to perform DSA, pressure measurement and visualization of real-time embolization. This technique is quick with little discomfort for the patient and short hospitalization period. Primarily, treatment with 3D-fluoroscopy can be considered.

P-29

Outcome of proximal internal iliac artery coil embolization prior to stent-graft extension in patients previously treated by endovascular aortic repair

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Purpose: to assess the safety, feasibility and efficiency of coil embolization of the proximal internal iliac artery prior to stent-graft extension in patients previously treated by endovascular aortic repair.
Materials/methods: over a period of 9 years, 16 ipsilateral, proximal internal iliac artery coil embolization procedures were performed prior to stent-graft extension in 13 patients previously treated by an aortic stent-graft. In 10 out of 16 procedures, 0.018 inch microcoils delivered through a microcatheter were used. In the remaining 6 procedures, 0.035 inch vascular coils were used. Indication for coil embolization and concomitant stent-graft extension were: distal type I endoleak (n=9) and isolated iliac artery aneurysm (n=7); mean iliac artery diameter prior to coil embolization was 26.1 mm (range 15-35). Clinical and radiological follow-up (mean: 39 months; range: 6-102 months) was done in accordance to the Eurostar Registry.
Results: all but one procedure, using 0.035 inch coils, were successful. Clinically, buttock claudication was noted in 5 out of 13 patients (38%). No type II endoleak occurred through the coiled internal iliac arteries. The common iliac artery mean diameter at 6 months follow-up was 23.0 mm (range 14-30 mm) (p= 0.0005).
Conclusion: ipsilateral coil or microcoil embolization of the proximal internal iliac artery prior to stent-graft extension in patients previously treated by an aortic stent-graft seems to be safe and feasible with favourable outcome at midterm follow-up.

P-30

Complete percutaneous repair of aneurysms with severe neck and iliac angulation between 60 and 90° with the Aorfix® endograft

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Purpose: the development of flexible endografts with stable fixation has overcome the limitations of grafts with high columnar strength. Challenging anatomies with angulations of 90° in the neck and the aortic bifurcation or the iliac arteries can be treated effectively.
Material and methods: we report about 12 patients being treated with the Aorfix® device for aneurysms between 58 and 78 mm in diameter with a neck angulation of 70-90° and patients with common iliac angulations of 90-110°. The FU after1/ 6/12 months included plain X-ray and CT scan. The data were compared to the RADAR registry data with a maximum 36 month FU. The primary results and the technical and clinical success for the follow up period were evaluated.
Results: the technical success was 100%; intraoperative problems occurred in two patients with difficulties in the pushrod retrieval and in one patient with unintentional occlusion of the right renal artery in a 90° bended neck. No primary endoleak was detectable. In the FU period up to 36 months no rupture, migration, graft disintegration, secondary endoleak or aneurysm growth could be detected.
Conclusions: our Aorfix® patient data from outside and inside the ARBITRER II trial, from the in vitro testings and the RADAR registry show the potential for effective and durable treatment of severely angulated necks and iliacs over a period of 36 months.

P-31

Treating angulated necks and tortuous iliacs in infrarenal abdominal aortic aneurysmal disease using the Aorfix™ stent graft

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Purpose: to add clinical data regarding the performance of the Aorfix™ stent-graft for the treatment of 17 patients, all with hostile infrarenal abdominal aortic aneurysm (AAA) anatomy.
Materials/methods: between September 2005 and January 2009, 17 males (mean age 73.6 y, range: 63-89 y) with asymptomatic infrarenal AAA disease treated with the Aorfix™ stent-graft were prospectively observed regarding aneurysm related mortality, freedom from any type of endoleak, freedom from aneurysm related rupture and freedom from any interventions. Implantation criteria were as follows: proximal neck diameter from 18-30 mm with neck angulation >60° and/or severe iliac angulation/tortuosity. Duration of follow-up was from 2 to 40.5 months.
Results: the graft was successfully implanted in all but one patient. One conversion to aortouniiliac grafting was performed because of inability to insert the contralateral iliac limb. In one patient, bilateral renal artery angioplasty-stenting rescue was performed due to severe procedure related stenosis. No aneurysm related ruptures or deaths occurred during the follow-up period. One type I endoleak without migration at 3 y and one type II endoleak at 13 mo were observed. Freedom from any type of endoleak was 90.4% at 12 mo and 74.6% at 24 mo. Freedom from any intervention was 87.1% at 12 mo and 74.2% at 24 mo. No patency events and no stent fractures occurred during the whole study. Aneurysm sac shrinkage was evident in up to 80% of cases at 12 mo.
Conclusion: the Aorfix™ device seems to be safe and reliable in purely complex infrarenal AAA anatomy, revealing good mid-term clinical outcomes.

P-32

Transabdominal approach for the treatment of endoleaks after endovascular aneurysm repair of infrarenal abdominal aortic aneurysm

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Purpose: translumbar or transcaval approaches for the treatment of endoleaks after endovascular aneurysm repair (EVAR) of infrarenal abdominal aortic aneurysms are well-known methods. However, depending on the location of the sac of endoleak, transabdominal approach can be considered. This study was to evaluate the technical feasibility and clinical effectiveness of a percutaneous transabdominal approach for the treatment of endoleaks after EVAR.

Materials/methods: between 2000 and 2007, six patients with type I (n=4) or II (n=2) endoleaks were treated via percutaneous transabdominal approach by embolization using N-butyl cyanoacrylate with or without coils. Five patients underwent a single session of embolization, and one underwent two sessions of embolization. The mean time between EVAR and endoleak treatment was 25.5 (range: 0-84) months. Follow-up CT scans were evaluated for changes in the size and shape of the aneurysm sac, and presence or resolution of endoleaks. The mean follow-up period after endoleak treatment was 16.4 (range: 0-37) months.
Results: technical success was achieved in all six patients with seven sessions. Clinical success was achieved in four patients with complete resolution of the endoleak confirmed by follow-up CT scans. Clinical failure was observed in two patients. One eventually underwent surgical conversion and another was lost to follow-up. There were no procedure-related complications.
Conclusion: percutaneous transabdominal approach for the treatment of type I or II endoleaks after EVAR was a safe, and technically feasible and clinically effective method without major complications.

P-33

Hybrid procedures as a combined surgical and endovascular treatment for thoracic aortic disease

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Purpose: our purpose is to present our experience in performing hybrid procedures for treatment of thoracic aortic disease.
Materials/methods: from Sep 2004 to Nov 2008, 26 patients (mean age: 64) were treated with hybrid techniques. Aortic pathologies included 9 aortic dissections, 12 aortic arch or proximal descending thoracic aortic aneurysms, 4 penetrating atherosclerotic ulcers and 1 intramural hematoma type-B. Three patients were treated on an emergency basis. Eleven patients had total or partial aortic arch debranching, 8 had extra-anatomical by-pass, 4 had classic elephant-trunk procedure and 3 underwent Evita-open placement. Endovascular procedure was performed within 2 weeks from the surgical step in 24 patients and in the same stage in the remainder.
Results: deployment success was 100%. Thirty-day mortality was 8% (n=2): one patient with acute AD died for visceral ischemia, another patient with chronic AD and false lumen rupture died for multi-organ failure. There were no neurologic complications. At a mean follow-up of 20 months (range: 3 to 54), MDCT angiography showed complete aortic remodeling (false lumen/aneurysm thrombosis) in 22 patients. There was a 15% (4/26) endoleak (EL) rate: two early EL type-1, which closed spontaneously, one early EL type-2 and one late EL type-3 were successfully treated, respectively, with amplatzer vascular plug placement and with balloon dilatation.
Conclusion: hybrid techniques are feasible and can be achieved with relatively low rates of perioperative morbidity and mortality. We advocate that these procedures should be performed in a hybrid operative room with consistent advantages for patients and lower operative costs.

P-34

Treatment of type Ia endoleaks after EVAR of AAA with balloon-expandable stents

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Purpose: to assess the efficiency of treatment of type Ia endoleaks after EVAR of AAA with proximally implanted balloon-expandable stents (Palmaz, Johnson & Johnson).
Methods: after EVAR of AAA with bifurcated stentgrafts (Talent/Valiant, N=11; Excluder, N=3; Vanguard, N=1), 15 patients showed an early (N=14) or a late (N=1) type Ia endoleak. In all cases, the position of the stentgraft, whose proximal end was positioned within 3 mm of the caudal renal artery, ruled out a proximal elongation of the stentgraft. The Palmaz stents (14-25 X 30-47 mm) were mounted on 25 and 30 mm balloons for valvuloplasty. Then they were implanted at the proximal end of the stentgraft, overlapping the renal arteries. Inflation pressure was 4-8 atm.
Results: the stent placement was technically successful in all cases. After an observation period of 17 months, there was no endoleak in 10/15 cases, a type II endoleak in 3/15 cases, a lesion of the stentgraft-membrane in 1 case with a type III endoleak and a small persistent type I endoleak in 1 case.
Conclusion: the short- and middle-term outcome after secondary endovascular treatment of type Ia endoleak after EVAR of AAA with balloon-expandable stents justifies a regular appliance of this method, given the high risks of the surgical treatment alternatives.

P-35

Suitability for endovascular aortic aneurysm repair (EVAR) in an unselected population: a rapidly expanding procedure?

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Purpose: our aim was to determine the percentage of abdominal aortic aneurysms (AAAs) presenting to a county-wide vascular service that were suitable for EVAR and to examine the outcome of subsequent AAA repair in relation to aneurysm morphology. Comparison was made with identical evaluation performed 10 years earlier. The endovascular aneurysm programme at the Royal Cornwall Hospital is unusual as it serves an estimated finite population of 400000 people without accepting external referrals and has exclusively used the same stent-graft design during this time period (Cook-Zenith).
Materials/methods: all patients being assessed for AAA repair between January 2007 and January 2009 underwent computed tomography angiography (CTA) to determine aneurysm morphology and suitability for EVAR. The percentage of patients deemed suitable for EVAR and the percentage of patients subsequently having EVAR were recorded and compared with our previous data.
Results: 237 patients with AAAs underwent CTA assessment (previously 115). 103 (43%) had no contraindications to EVAR (previously 34%). 45 (19%) patients had at least one relative contraindication to EVAR and the remainder (38%) were deemed unsuitable. In total, 76 (32%) patients went on to have EVAR compared with 10% ten years earlier.
Conclusion: the number of patients assessed for AAA repair has doubled. Of these patients, the proportion deemed anatomically suitable for EVAR has increased by 9% and the proportion undergoing EVAR has increased threefold. Increased EVAR experience leads to an increase in the number of patients being considered for aneurysm repair. The threshold for morphological suitability increases with increased experience.

P-36

Long-term safety and stability after endovascular thoracic aortic aneurysm repair

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Purpose: thoracic endovascular thoracic repair (TEVAR) is an effective and safe treatment for a variety of aortic pathologies, including aneurysms. While short- and mid-term results are encouraging, there is limited information about the long term results after TEVAR for thoracic aneurysms. Aim of the present study was to evaluate the long term outcome after 8-11 years.
Materials and methods: in a retrospective analysis, our TEVAR database was searched for interventions on thoracic aortic aneurysms that were performed between 1999 and 2001. A total of 40 patients (mean age 70.3, 25 male) were identified. Due to the high cardiovascular comorbidity, only 8/40 patients were considered fit for open surgery before the intervention. Clinical records and follow-up data were reviewed. End points were mortality, major and minor complication rate, technical success, occurrence of early and late endoleaks.
Results: as of 01/2009, mortality was 18/40. Two patients died in-hospital within a week after the procedure due to complications of stentgraft misplacement and subsequent visceral ischemia. One patient died after aneurysm rupture 1 day postinterventionally. The remaining mortality was procedure-unrelated (cardiovascular events, cereral hemorrhage, neoplastic disease). Two patients underwent open conversion due to one late Ib endoleak and a persisting Ia endoleak. Other complications included a left posterior infarction in one patient.
Conclusion: TEVAR of thoracic aneurysms can be performed with acceptable long-term safety and stability of the exclusion. The observed mortality in the patient collective is mainly due to the complications of the high comorbidity.

P-37

Multi-layer hybrid nitinol-fabric graft for the exclusion of thoracic aortic aneurysm: preclinical evaluation in a large swine model

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Purpose: to evaluate the efficacy of an uncovered multi-layer hybrid Nitinol-fabric graft in a swine model of thoracic aortic aneurysm (TAA).
Materials/methods: TAAs were surgically created in 10 large swine (weighted 65-80 kg) using a PTFE patch (n=7, saccular type) or a segment of pulmonary artery (n=3, fusiform type). A self-expanding tubular prosthesis consisting of two nitinol and one polyester/nitinol layer of braid was implanted over the surgical aneurysm. The graft was anchored on the proximal end with a 3 mm length of braid rolled outward onto itself to create a localized area of high radial force. Grafts were deployed through an 11-Fr sheath and were able to be completely recaptured and repositioned if necessary prior to release. Animals were followed up at 1 week, 1 month and 3 months, and afterwards euthanized for pathology.
Results: angiographic aneurysm exclusion rates were 70% after implant, 50% at 1 week, 80% at 1 month, and 100% at 3 months. Three animals were implanted with second grafts; two at the implant procedure and one at a 1 month follow-up. All implanted grafts remained stable and in the implanted location throughout the course of the study. After 3 months, gross pathology demonstrated all grafts were covered with neointima. The aneurysm sacs were completely excluded and filled with organized thrombus in all animals.
Conclusion: endovascular repair of experimental TAA is feasible using an uncovered graft; this offers the advantages of using a low-profile delivery system and a prosthesis that is fully recapturable/repositionable prior to release.

P-38

Feasibility of fascial closure after percutaneous access for endovascular aneurysm repair (EVAR)

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Purpose: percutaneous access for EVAR limits groin dissection, reduces peri-operative bleeding and reduces post-operative wound seroma and infection. There are limited reports of subsequent haemostasis through closure of the overlying femoral sheath (fascial closure). The objective of this study was to evaluate the feasibility and outcome of fascial closure after EVAR.
Materials/methods: since February 2008, percutaneous access with fascial closure during EVAR has been adopted on a selective basis. Exclusion criteria included large body habitus, difficult access and high punctures through the inguinal ligament. This prospective feasibility study involved clinical and Duplex ultrasound follow-up at one month. Outcome measures were primary failure and post-operative complications.
Results: over a one year period, fascial closures of 69 percutaneous femoral punctures during EVAR have been attempted in 38 patients (34 male, 4 female), median age 75.5 years (52-88). Successful fascial closure was achieved in 59 arteries (85.5%). Ten primary failures (14.5%) underwent formal intra-operative arterial closure. 7 failures were seen in the first 34 attempts (20.6%) compared to 3 failures in the last 35 closures (8.6%). The one month complication rate was 11.6%, including 4 pseudoaneurysms (diameter range 0.6-0.97 cm), one stenosis and two iliac limb occlusions. One iliac occlusion was identified intra-operatively and managed through surgical bypass. All other complications were treated conservatively without sequelae. There were no wound complications.
Conclusion: fascial closure after percutaneous puncture for EVAR is feasible and safe, accepting that there is a learning curve and primary failure dictates formal arterial closure.

P-39

Results of endovascular management of late complications after open surgery for infrarenal aortic aneurysms

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Purpose: mortality after open re-intervention after aorto-iliac surgery ranges from 8 to 21%. The aim of the study was to find out feasibility of stent-graft implantation for late complications after open aortic repair.
Materials/methods: from 2002 to 2008, 21 patients aged 61-79 (20M,1F) underwent endovascular repair of false anastomotic and new true aneurysms developing from 2.5 to 12 years after conventional surgery. Sixteen patients were symptomatic, two of them had aorto-enteric fistula. In the five others, complications of previous procedures were accidentally found during follow-up. Ultrasonography and angioCT were performed in all cases. Fourteen Zenith COOK, five Excluder GORE, one Anaconda and one Wallgraft devices were used to manage the lesions. All procedures were performed under spinal anesthesia.
Results: true or false aneurysms were successfully excluded in all

cases. There were no procedure-related deaths. The follow-up period ranges from 4 to 96 months. Neither endoleaks nor stent-graft migrations were detected in ultrasonography and CT scans. One patient with aortoenteric fistula died from graft infection 6 months after secondary intervention, while the second one is alive awaiting stent-graft exclusion and extraanatomical by-pass.
Conclusion: this case series supports stent-graft repair as a feasible and successful technique that produces better results than re-do surgery. Technical advances in graft design and delivery systems may expand the ability to treat patients after previous open repair of aorta and iliac arteries. Lifelong follow-up with accurate imaging techniques is essential not only after EVAR but after open surgical repair as well.

P-40

Endoleak classification and therapy using angiographic C-arm CT

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Purpose: to assess the value of C-Arm-CT for classification and therapy of AAA endoleaks.
Materials/methods: 12 patients with AAA endoleaks underwent DSA for more precise classification or embolisation. In addition to DSA, a contrast enhanced C-arm CT was performed (100-150 mg iodine/ml, pigtail catheter in aorta, flow rate of 8 ml/s). The additional information provided by C-arm CT was recorded in 6 cases in which the DSA and C-armCT images were used to guide a therapeutic procedure. Since therapy was based on all available diagnostic methods, the additional information provided by the C-arm CT was assessed retrospectively.
Results: 11 endoleaks could be classified using C-arm CT. In one case, the temporal information provided by DSA helped to establish the diagnosis. 7 patients had type 2 endoleaks with stable sac. Thus, no immediate therapy was required. 5 patients were diagnosed with type 1 and 3 endoleaks. In 3 of these patients, the stent graft was extended, in one patient a fabric tear was covered, in one case with an increasing AAA sac diameter, embolization of the aneurym sac was performed using C-arm CT images for puncture guidance. In 2 patients, C-arm CT was assessed to be helpful and in 3 essential for procedure guidance.
Conclusion: C-arm CT has the ability to visualize soft tissue and vessels. In AAA, it provides information about aneurysm sac, endoleak and potential feeding arteries. The combination of DSA, fluoroscopy and C-arm CT enable precise procedure planning and therapy guidance.

P-41

Endovascular treatment of thoracic aortic aneurysms and type B dissections: technical aspects, results and complications after 8-year experience

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Purpose: to report 8-year experience in the endovascular management of thoracic aortic pathologies.
Materials/methods: from December 2000 to May 2008, 87 patients were treated. Aneurysms: 34 patients mean diameter 58.8 mm. In 14 cases, due to a short proximal neck (<2 cm), the origin of the left subclavian artery was intentionally covered by the endoprosthesis. Type B dissection: Fifty-three patients: 25 acute and 28 chronic. Three acute cases were complicated by renal ischemia solved with renal stenting. Two cases were complicated by visceral ischemia treated with SMA-stenting. The origin of the left subclavian artery was intentionally covered in 33 patients due to short proximal neck.
Results: aneurysms: Technical success was achieved in all patients. After a mean follow-up of 43.65 months, 32 patients are alive. Two patients died with a 30-day mortality of 11.1%. An endoleak was detected in 2 cases (5.8%) all originating from the excluded left subclavian artery. No cases of paraplegia occurred. Dissections: Two major complications (3.7%) represented by the development of a type-A dissection with antegrade extension of the false lumen into the aortic arch and the ascending aorta occurred. After a mean follow-up of 37.46 months, 49 patients (86.7%) are alive and in good clinical condition. Four patients (13.2%) died with a 30-day mortality rate of 3.7%. Two minor complication (3.7%) were recorded and an endoleak appeared in 15/53 cases (28.3%).
Conclusion: thoracic stent-graft has proven to be a more effective single-step treatment than traditional surgical procedures.

P-42

Multimodality evaluation of consecutive patients with abdominal aneurysm treated with endovascular graft: color-Doppler-US versus low-MI CEUS compared with 64-slice-CTA and MRA

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Purpose: to evaluate the efficacy of color-Doppler-US and low-MI CEUS in the assessment of endovascular graft treatment for abdominal aneurysm compared with 64-slice-angio-CT and angio-MRI.
Materials/methods: from February 2006 to January 2008, 150 consecutive patients (90 M; 30 F - mean age: 63) treated with endovascular aortic graft underwent color-Doppler-US, low-MI CEUS, 64-slice-angio-CT, angio-MRI and angiography if re-treatment was indicated. Sensitivity and specificity of ultrasound examinations were compared with CT and MRI as the reference standards or when available with the angiography. McNemar test was then calculated.
Results: twenty-one true endoleaks (type II: 19, Type III: 2) were identified (14%) by the FU or by angiography. Sensitivity and specificity of color-doppler-US, CEUS, angio-CT, and angio-MRI were: 50, 100, 83, 92 and 60%,100,100,100%, respectively. CEUS was significantly more accurate than US ($p<0.001$) and highly comparable to angio-CT and angio-MRI. Consequences to treatment occurred in 6 patients (29%).
Conclusion: CEUS is a feasible tool in follow-up of endovascular aortic aneurysm treatment since it may identify endoleaks missed at other imaging techniques.

P-43

Endovascular strategies for aortic arch and descending aorta: midterm follow-up

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Purpose: to review the outcomes of endovascular treatment of thoracic aortic pathologies performed at a single centre.
Materials/methods: 60 patients (47 men; 13 women, mean age 61.5±16.2 years) were treated for thoracic aortic disease. Indications for endovascular repair included aneurysm (21), type B (13) and residual aortic dissection (3), PAU (4), TAR (15), pseudoaneurysm after repair of aneurysm (1) and of aortic coarctation (2), mycotic aneurysm (1). Aortic arch was involved in 11 cases: in 5 and in 3 of them was, respectively, needed an extra-anatomic and an extra-thoracic bypass; in 6, LSA was intentionally sacrificed. Antegrade stent graft deployment was performed in 3 procedures. 23 procedures were performed on emergency basis.
Results: 85 stent grafts were successfully deployed in 60 patients.

2 patients admitted in haemorrhagic shock conditions died within 24 hours. One case of spinal cord ischemia with consequent paraplegia occurred in an urgently treated patient, who previously underwent to AAA open repair. At 28 month follow-up, actuarial survival was 93.3%. A secondary type Ia endoleak occurred twice in the same patient, and the second time it was complicated by aorto-oesophageal fistula. Both were treated with additional stent-grafts. Two patients died (3.3%), the first after CABG surgery, the latter for aortic arch rupture.
Conclusion: endovascular treatment is an effective option for thoracic aorta disease. It is attractive in critical conditions and acceptable in well-selected high-risk patients with aortic arch pathologies, features that imply higher procedural risks and worse prognosis. Clinical and imaging follow-up is mandatory in all patients.

P-44

Evaluation of major complications after endovascular aneurysm repair (EVAR) in patients with abdominal aortic aneurysm: a pictorial review

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Learning Objectives: describe and illustrate normal and pathological imaging findings after EVAR, with special emphasis to early and late complications demonstrated by conventional radiography, ultrasound and MDCT.
Background: management of abdominal aortic aneurysms has changed dramatically over the last 15 years, due to major advances in endovascular aneurysm repair, which has been used as an alternative to conventional open surgery. Advantages of endovascular procedures are less blood loss, shorter hospitalization times and quicker recovery. Many studies show that EVAR is safe and effective, even though some potential complications are well recognized.
Clinical findings: migration, "endoleak," rupture, occlusion, infection and structural changes of the prosthesis are the most prevalent complications. The abdominal plain film has an important role in the initial assessment of migration or structural changes of the prosthesis. Ultrasound has diagnostic value demonstrating the relationship of the upper limit of the prosthesis with the kidney vessels and showing areas of blood turbulence, suggestive of kinking or obstruction of the prosthesis. MDCT is used most commonly in the assessment of the complications described above, demonstrating a special value in detecting prosthetic "endoleaks" and determining the diameter of the aneurysm sac in the postoperative period, thus, enabling the evaluation of surgery success.
Conclusion: despite clear advantages of EVAR compared to the classical surgical procedure regarding complications peri-and postoperative, its occurrence is well documented and potentially life-threatening. Imaging techniques, mainly MDCT, play a decisive role in the early diagnosis and management of these complications.

P-45

Factors affecting the CT diagnosis of stent-graft migration

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Learning Objectives: to describe the factors which affect the diagnosis of stent-graft migration when using CT datasets.
Background: CT scanning is currently the gold standard for identifying stent-graft migration. Stent-graft migration can occur at the proximal and distal landing zones and can lead to severe complications including endoleak, graft thrombosis, aneurysm rupture and death. There are many factors that affect the ability of an observer to diagnosis stent-graft migration from serial CT scans. Such factors may include the CT acquisition protocol, knowledge of the stent-graft design, use of advance CT post-processing and measurement techniques and effects of the cardiac cycle and aneurysm remodelling.
Clinical findings and procedure details: the following review of the literature report aims to highlight the optimum imaging conditions for diagnosing and quantifying stent-graft motion. For the assessment of subtle stent-graft migration it is essential that observers are experienced in the radiological follow-up of EVAR, use central luminal line 3D measurement techniques and use multi-slice CT acquisitions with isotropic datasets. With the above in mind, it should be possible to identify subtle changes in endograft position.
Conclusion: early identification of stent-graft migration can potentially avoid adverse clinical sequlae. A thorough understanding of the factors that affect the diagnosis of migration is, therefore, essential to aid early diagnosis and avoid false negatives.

P-46

Endovascular treatment of symptomatic infrarenal aortic stenoses caused by soft-plaque with the endurant stent-graft

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The present report describes successful percutaneous treatment of two symptomatic infrarenal aortic stenoses by stent-graft, especially by the new Endurant stent-graft in two patients with soft-plaque of atherothrombotic origin in the aortic segment and consecutive high risk of peripheral embolisation.

P-47

Natural fenestration and stent placement in patient with peripheral vascular ischemic complication of Stanford type B aortic dissection

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We present the case of a 56-year-old man with type B aortic dissection with collapsed true lumen of infrarenal aorta. Natural fenestration was performed via the aperture of inferior mesenteric artery within dissection flap. Aortic stent was also placed.

P-48

Has endovascular aneurysm repair (EVAR) changed the management of secondary aorto-enteric fistula?

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We report our experience of using EVAR to manage severe gastro-intestinal haemorrhage due to secondary aorta-enteric fistula. Mean survival post-stent was 15 months (range 3-43). Whilst not definitive, EVAR may facilitate an acceptable outcome or allow pre-surgical patient optimisation.

P-49

Aortic arch aneurysm treated by a hybrid approach and without using iodinated contrast

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A 7.5 cm aortic arch aneurysm was solved with an aorto-carotid by-pass followed by a Valiant-Medtronic device that covered the aortic arch. A metallic thread of a compress sutured across the aortic wall allowed us precise deployment of the stent-graft.

P-50

Management of stent dislodgment in coarctoplasty of aorta with three overlapping self-expanding stents

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We describe a case of severe native coarctation of aorta treated successfully with three self-expandable nitinol stents (OptiMed). The first and second stents had migrated. Implantation of multiple overlapping self-expandable stents, if needed, is safe and possible.

P-51

Staged thoracic and branched endovascular repair of a chronic stanford type B aortic dissection

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A type B aortic dissection patient developed an AAA. Our novel staged approach used a thoracic stent to create a lumen capable of containing a branched stent resulting in successful exclusion of the aneurysm while maintaining the visceral blood supply.

P-52

Renal covered stent instead of fenestration: to solve "missing kidney" after thoracic endografting for aortic dissection

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We describe revascularization of the renal artery and sealing major re-entry at once.
At the completion angiography following thoracic endografting, one kidney was "missing". Entry was identified and covered stent was placed over it. Perfusion of the kidney was maintained.

P-53

Renal artery dissection during rescue of a maldeployed aortic endograft

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We encountered inadvertent renal artery occlusion during the endovascular AAA repair. We report a fatal case of renal artery dissection following the application of the downward pulling maneuver on the aortic endograft in order to salvage the occluded renal artery.

P-54

Embolisation of a type II IMA endoleak: a wander around the artery of Drummond

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Increasing aortic aneurysm sac dimensions were noted on a routine MDCT after successful EVAR. MDCT angiography demonstrated a type II IMA endoleak supplied by a large ‚Wandering artery of Drummond'. Therapeutic coil-embolisation was achieved by super-selective catheterisation via the SMA.

P-55

Simultaneous endovascular treatment of endoleak type II and iatrogenic iliac dissection: case report and literature review

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We describe the case of simultaneous endovascular treatment of endoleak type II and iliac dissection as complications in a patient who underwent aorto-uni-iliac stent-grafting for aortic aneurysm with previous placement of endovascular occluser device in common iliac artery.

P-56

Emergency endovascular treatment of sac rupture for type IIIa endoleak in thoracic aortic aneurysm previously excluded with endovascular repair

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We report the successful emergency endovascular management of post thoracic endovascular repair for thoracic aortic aneurysm rupture due to type IIIa endoleak. Type III endoleak is generally treated electively and less frequently. It is performed in emergencies.

P-57

Combined percutaneous and surgical management of remote erosion of a massive internal iliac artery aneurysm into the ureter and subsequent infection of the aneurysm sac post exclusion via percutaneous aortoiliac stent-grafting

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The percutaneous management of remote erosion of a massive internal iliac artery aneurysm into the ureter and subsequent infection of the aneurysm sac post exclusion via percutaneous aortoiliac stent-grafting in a 72-year-old male is described.

P-58

Iliac artery rupture during thoracic stent-graft placement: a case report

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We describe a case of catastrophic bleeding following removal of the delivery system of thoracic stent-graft and importance of maintaining guidewire access. This appears to be the most frequent serious complication of this procedure which has received little attention.

P-59

Full metal jacket for complicated type-A aortic dissection: complex hybrid surgery management

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A patient affected by complicated type-A aortic dissection with false lumen rupture and acute right lower limb ischemia was treated with fenestration followed by hybrid approach (elephant trunk procedure and placement of stent-graft to treat the descending thoracic aorta dissection).

P-60

Use of a stent-graft to cover the abdominal aorta followed by surgical removal of a retroperitoneal leiomyosarcoma involving the aortic wall

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In a male patient with a retroperitoneal leiomyosarcoma involving the aortic wall, an Excluder (Gore) 16x100mm endograft was implanted in the abdominal aorta providing proper conditions for aortic wall resection without excessive blood loss or aortic flow interruption.

P-61

Small bowel obstruction by a 18-cm aneurysm of the abdominal aorta

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Small-bowel obstruction caused by a very large aneurysm of the abdominal aorta was successfully treated by percutaneous drainage of the aneurysmal sac.

P-62

Ruptured abdominal aortic aneurysm with aortocaval fistula with subsequent endovascular repair

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A patient presented with ruptured abdominal aortic aneurysm and aortocaval fistula.
Subsequently stentgrafts were implanted into the abdominal aorta and vena cava. Due to persisting graft porosity, a second layer of stent grafts was successfully implanted.

Bone and soft tissue intervention

P-63

Utility of DynaCT in percutaneous vertebroplasty treating vertebral metastases

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Purpose: to evaluate the utility of DynaCT in percutaneous vertebroplasty (PVP) treating vertebral metastases.
Materials/methods: PVP was performed in 15 patients with diagnosis of vertebral metastases between December 2006 and October 2008. Osteolytic lesions were found in 17 vertebrae (6 thoracic vertebrae and 11 lumbar vertebrae). DynaCT technique was used as an aid for needle guidance. DynaCT and spiral CT were both used to observe continuity of cortical bone pre-procedure, and cement leakage post-procedure. The results of the two methods were compared.
Results: in the 24 punctures performed (10 unipedicular approach and 7 bipedicular approach), 6 were adjusted according to transversal DynaCT reconstruction image acquired while needle reaching the pedicle. The amount of cement injected varied from 2.0 to 6.0 ml, with mean of 3.6 ml. The findings of cement leakage and continuity of cortical bone of DynaCT was the same as spiral CT. Cement leakages occurred in 12 vertebrae (70.6%). There are 4 leakages of perivertebral soft tissue, 5 of perivertebral venous plexus, 1 of intervertebral disc, 1 of spinal canal, and 1 of both perivertebral venous plexus and intervertebral disc. 12 discontinuity of bone cortex were found in 11 vertebra before procedure. There were 11 osteolytic destructions and 1 basivertebral vein, resulting in 7 cement leakages.
Conclusion: DynaCT technique is useful in ensuring puncture accuracy. The role of demonstrating cement leakage and continuity of cortical bone by DynaCT is equal to spiral CT.

P-64

Percutaneous image-guided lymphatic ligation (PILL) as a treatment of symptomatic lymphocele: initial experience

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Purpose: to describe our initial experience with percutaneous image-guided lymphatic ligation (PILL) as a treatment of symptomatic lymphocele.
Methods: five patients (average age 48.2. 3 male, 2 female) with symptomatic lymphocele of the thigh and groin following surgery were referred for treatment. In two patients, previous sclerotherapy and surgery were unsuccessful. In three patients, PILL was the first treatment. Diagnostic lymphangiography was performed and using the lymphangiogram for guidance, percutaneous ligation of the leaking lymphatic vessels was attempted through skin incisions proximal to the leakage. In two patients, PILL was supplemented by sclerotherapy.
Results: in all but one patient, the pedal lymphangiogram demonstrated disruption of the lymphatic vessel and leakage of the lipiodol into the lymphocele. In one patient with drained lymphocele, the leakage of the contrast was questionable. In four patients, PILL resulted in resolution of the lymphocele within days after the procedure. In one patient, the initial procedure resulted in significant decrease of the output; however, the lymphocele recurred 3 months later. PILL of the additional leaking vessel that was imaged during the first procedure resulted in cure. In another patient, PILL and accompanied sclerotherapy were complicated by the transient lower extremity lymphedema. In the patient with questionable leakage of the contrast, the PILL was unsuccessful.
Conclusions: we believe that PILL can serve as a supplement to,

and possibly a replacement for and sclerotherapy in symptomatic lymphocele of the extremity. Clear identification and ligation of all leaking vessels is imperative for the success.

P-65

Radiofrequency ablation (RFA) in soft tissue tumors pain palliation

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Purpose: to estimate the efficiency of RFA in soft tissue tumors pain palliation.
Materials/methods: the retrospective study concerned 12 patients in palliative care, who underwent 14 RFA for their painful soft tissue tumors. We treated 5 primitive tumors (2 shoulder and 1 psoas muscle fusiform cell sarcomas, 1 retroperitoneal leiomyosarcoma, 1 undefined sarcoma of the tight and 1 sacro-iliac PECOMA), and 7 metastatic tumors (4 paravertebral locations, 1 piriform muscle , 1 shoulder and 1 tight location). Tumour size ranged between 2.6 and 20 cm (mean size 9.6 cm). The RFA was performed under CT or US guidance. We used RITA 1500 RF generator with the RITA needles to allow a 3 to 7 cm deployment.
Results: the RFA efficiency was estimated at short, middle and long-term changes in terms of drug medication after RFA. The patients were divided in three categories (complete, partial or no pain response). At short-term (day 0 to 3), we observed 100% pain response with 43% of complete response. At middle (1-6 week follow-up) and long-term (2-9 month follow-up), we observed respectively 70% and 83% of pain response. Moreover, the RFA provides in some cases other clinical symptoms improvements and allow in all cases the stabilization or the reduction of morphinic drugs doses with a better control of its side effect. One patient had a complication i.e., a sero-hematic collection in the RFA induced necrotic cavity.
Conclusion: RFA in soft tissue tumor pain palliation is an efficient improvement of usual treatments and can improve life quality in these patients.

P-66

Treating spinal metastases secondary to multiple myeloma, lymphoma, and plasmacytoma by a combination of plasma-mediated radiofrequency ablation and cement augmentation

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Purpose: vertebral body compression fractures (VCFs) secondary to advanced lesions of multiple myeloma (MM), lymphoma, or plasmacytoma of the spine can be complicated by cortical destruction and/or epidural extension, considered relative contraindications to conventional vertebroplasty or kyphoplasty. Extensive surgery carries high mortality/morbidity rates in this patient population. This study evaluated whether a combined technique using plasma-mediated radiofrequency ablation with bone cement augmentation allows for minimally-invasive treatment of these traditionally challenging patients.
Materials/methods: a bipolar plasma-mediated radiofrequency-based wand (ArthroCare Corporation, Austin, TX) created a void in the anterior portion of the tumor-infiltrated vertebral body into which bone cement was deposited. Retrospective assessments of CT images were performed before/after the procedures for 12 patients (16 levels) with VCFs secondary to advanced lesions of MM (n=6), plasmacytoma (n=4), or lymphoma (n=2). All patients reported pain scores (visual analogue scale - VAS) pre-procedure and 2-4 weeks afterwards.
Results: 75% of the cement was deposited in the anterior 2/3rds of the vertebral body in all but 2 levels. Minimal clinically-insignificant extravasation was noted in 11 levels (venous: 8, cortical: 2, discal and epidural: 1). VAS pain scores were available for 9 patients: 5 showed significant improvement (VAS reduction ≥4/10), 2 showed moderate improvement (VAS reduction ≥2/10), and 2 showed no change.
Conclusion: combining plasma-mediated radiofrequency ablation with bone cement augmentation safely treats advanced spine lesions in multiple myeloma, plasmacytoma, and lymphoma patients. The anterior part of the vertebral body is stabilized, which offers pain relief, and the bone cement is deposited in a predictable pattern. Cement extravasation was clinically insignificant.

P-67

CT-guided percutaneous laser disk decompression for lumbar disk hernia: experience of 347 cases in 11 years

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Purpose: percutaneous laser disk decompression (PLDD) under X-ray fluoloscopy was reported in 1987 as minimally invasive therapy for lumbar disk hernia. We evaluate the safety and effectiveness of CT-guided PLDD. We analyze 17 cases that were fair or poor response to the treatment to perform it more accurately.
Materials/methods: three hundred forty-seven patients, the mean age was 43.9 years old, were treated under CT guided PLDD between 1998 and 2008. Mac-Nab criteria were used for evaluation of patient response. The rate of recurrence and complication were also investigated.
Results: overall success rate was 88.2%. Four cases with post operative complications were observed and treated conservatively. The recurrence rate was 4.6%. Forty-one patients were reported to be fair or poor on Mac-Nab criteria. We analyzed consecutive 17 cases between 2004 and 2008. Affected levels were L5/S1 in more than half of the cases. The mean age of this group was 33.6 years old. It is younger than the mean age of good response cases, which was 43.1 years old. Nine out of eleven cases who were performed postoperative MRI, had lateral type hernia or extrusion with neural foraminal stenosis.
Conclusion: CT-guided PLDD is a safe and accurate procedure. Increase in overall success rate is expected by excluding lateral type extrusion in young patients.

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P-70

Percutaneous vertebroplasty in painful Schmorl's nodes

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Purpose: Schmorl's node represents displacement of intervertebral disk tissue into the vertebral body. Both Schmorl's nodes and degenerative disk disease are common in the human spine. The aim of this study is to evaluate the effectiveness and safety of percutaneous vertebroplasty in the treatment of painful Schmorl's nodes.

Materials and methods: we performed a retrospective study of the period from January 2003 to January 2007, evaluating thirty-seven patients affected by painful Schmorl's nodes, who underwent in our department percutaneous transpedicular injection of polymethylmethacrylate (vertebroplasty) in order to solve their back pain not responsible to the medical and physical management.
Results: 32 patients reported improvement of the back pain, nobody referred a worsening of symptoms. Improvement was swift and persistent in reducing symptoms.
Conclusion: pain, ineffective medical or physical therapy and quality life impairment, make painful Schmorl's nodes lesions adequately treatable by using vertebroplasty; growing in this way is the list of indications of this interventional radiology procedure.

P-71

Image-guided percutaneous laser disc decompression (PLDD) in an open high-field MRI

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Purpose: to assess the feasibility of MRI guidance and thermometry of percutaneous laser discectomies in an open high-field system (1.0 T Panorama HFO, Philips, The Netherlands).
Materials and methods: in 10 human cadaveric spines, a fluoroscopic PD-w TSE sequence (TR/TE 600/10ms; TF 36; fa 90°; TA 2.0 s) was used for interactive positioning of a laser fiber (600 µm, Frank Optic Products, Germany) and a temperature probe (reFlex, Neoptix Inc., Canada) within the targeted disc. Three fast GE sequences (TR 4,14,20; TE 2,7,10ms; fa 27°) were investigated in monitoring of laser tissue effects at 15 Watt using a Nd:YAG laser (1064 nm, Fibertom medilas, Dornier, Germany). Temperature distribution was visualized on the basis of T1 effects and the Proton Resonance Frequency method (PRF). Subsequently, PLDD was performed on 8 patients.
Results: MR-guided placement of the laser fiber into the targeted disk was precise. Laser effects were monitored online on MRI in all cases. A strong correlation between PRF-thermometry and actual temperature was established for the GE sequences, especially with a TE of 7 ms (r2 =0.94, 0.78 and 0.77 for GRE with a TE of 7, 2 and 10 ms, respectively). The macroscopic size of necrosis correlated well with the monitored temperature spread. In vivo, PLDD was technically successful in all cases. No complications occurred.
Conclusion: instrument guidance and laser monitoring in the open high-field MRI is accurate and safe with rapid image updates using fast TSE and GE sequence designs, which may render PLDD more safe and controllable.

P-72

MR guidance and thermometry of interstitial laser ablation of osteoid osteomas

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Purpose: to determine the feasibility and technical features of open high-field MR imaging in the guidance of interstitial laser ablation (ILA) of osteoid osteomas (OO).
Methods and materials: 6 patients with typical clinical and imaging findings suggesting OO underwent ILA in an open high-field MRI scanner (1.0 T, Panorama HFO, Philips, The Netherlands). A fluoroscopic T1-w TSE sequence (TE/TR 5.7/200 ms; TF 7; fa 90°; res. 1.5x1.5x5; scan duration 3 s) was used for interactive lesion localization, instrument guidance, drilling (bone biopsy set, In vivo, Germany) and positioning of the laser fiber (600 µm, Frank Optic Products, Germany). Thermal ablation with an Nd:YAG laser (1064 nm, Fibertom medilas, Dornier MedTech, Germany) was conducted via the biopsy canal. A GE sequence (TR/TE 4.3/2 ms; fa 27°; res. 2.8x2.8x4), with an image update every 4.5 s was investigated for monitoring of laser tissue effects at 2-3 Watt based on T1 effects and proton resonance frequency phase mapping (PRF).
Results: all lesions were successfully localized, targeted, and treated under MR fluoroscopy and thermometry. Laser effects could be monitored online in all cases. The color-coded technique (PRF) was found to be valuable in addition to conventional magnitude images (T1). No complications were recorded. All the patients were symptom free at 1-8 months follow-up.
Conclusion: MR guidance and thermal monitoring of ILA of osteoid osteomas is feasible in an open high-field MRI. Rapid image updates with fast TSE and GRE sequence designs are one step towards a safer procedure.

P-73

Percutaneous interspinous decompression for lumbar spinal stenosis

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Study design: our objective is to assess the feasibility, efficacy and the benefits of positioning an interspinous device under fluoroscopic guide, in patients with moderate or severe lumbar spinal stenosis under local anesthesia.
Materials and methods: since December 2008 to February 2009 in our center, we treated 12 patients with lumbar spinal stenosis (4 → L3-L4 and 8 → L4-L5). The inclusion criteria for this trial included groin pain with o without back pain relieved during flexion, ability to walk at least for 50 metres and sit for at least 50 minutes. The exclusion criteria included spondylolisthesis greater than grade I at the affected level, cauda equina syndrome, and previous lumbar surgery of the stenotic level or fixed motor deficit. All those patients have been evaluated with the Oswestry Disability Index (ODI) classification, with MR and CT images before and after the procedure.
Results: the mean preoperative ODI-score was 28 and at a 1 week follow-up was 21.
Technical success was achieved in 100% of our population. At a 1 week and at a 1 month follow-up a clinical evaluation was achieved and shows that the quality of life was raised up in our entire group.
Conclusions: in this preliminary study, we observed the ease of the insertion of the device under fluoroscopic guide, the efficacy in comparing the symptoms before and after the treatment, and the improved quality of life in all our patients.

P-74

Comparative prospective study between conservative treatment and percutaneous disc decompression for the treatment of intervertebral disc herniation

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Purpose: to compare efficacy and long term results concerning pain reduction and mobility improvement between conservative therapy and percutaneous disc decompression (PDD) for intervertebral disc herniation treatment.
Materials/methods: during the last 2 years, we prospectively studied and compared (t-test) 2 homogeneous groups of 31 patients each (17/14 male/female, mean age 36±5.8 years) suffering from sciatica due to disc herniation. Group A underwent conservative

therapy (analgesics, anti-inflammatory drugs, muscle relaxants, physiotherapy) for 6 weeks achieving pain reduction and mobility improvement, whilst group B after unsuccessful 6 weeks conservative therapy underwent PDD. Pain reduction and mobility improvement were recorded on 3, 12, 24 months with clinical evaluation and the Greek Brief Pain Inventory (0-10 VAS units).
Results: group A presented a mean pain of 6.87±1.92 VAS units prior to conservative therapy, which was reduced to 0.9±2.0 VAS units at 3 months after therapy, then increases to 3.96±3.44 VAS units at 12 months and further increases to 4.09±3.36 VAS units at 24 months. Group B presented a mean pain of 7.4±1.4 VAS units prior to PDD, which was reduced to 2.9±2.44 VAS units at 3 months after PDD, further reduced to 1.66±2.48 VAS units at 12 months and 1.6±2.4 at 24 months. No complications were noted.
Conclusion: PDD compared to conservative therapy presents statistically significant improvement at 12 and 24 months. It is an efficient, minimally invasive technique for treating symptomatic intervertebral disc hernias with significant (≥ 5.8 AVS units) and long lasting (≥ 24 months) results concerning pain reduction and mobility improvement.

P-75

Femoral head osteoplasty: a single center's experience upon pain reduction and mobility improvement

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Purpose: based on vertebroplasty efficacy in pain reduction (94%), application of this technique to femoral head using polymethyl-methacrylate (PMMA) was evaluated in a group of patients.
Materials/methods: during the last 3 years, a total of 7 patients with femoral head lesions and pain resistant to medication underwent percutaneous cement injection and were followed for 24 months with respect to pain reduction and mobility improvement. Pathologic substrate of femoral head lesions included sickle cell anemia (3 patients), arthritis (2 patients), osteonecrosis secondary to cortisone treatment (1 patient) and lytic metastasis (1 patient). Under general anaesthesia and fluoroscopy, direct access through the femoral neck was obtained by using 11-13G bevel shaped needles. PMMA for vertebroplasty was injected under fluoroscopic control. CT assessed implant position post treatment. Clinical evaluation included immediate and delayed follow-up studies of patient's general condition and neurological status. An AVS scale on a questionnaire adapted to Greek population helped assess pain relief degree and overall mobility improvement.
Results: comparing patients' scores prior (mean value 8.07±1.3 AVS units) and after (mean value 3.42±1.5 AVS units) treatment, patients of our study presented a mean decrease of 4.7±1.6 AVS units ($p \leq 0.01$) on terms of life quality improvement and pain relief. Overall mobility improved in 5/7 patients (2 were operated). No complication was observed.
Conclusion: percutaneous injection of cement in lesions of the femoral head seems to be a possible new technique for femoral head stabilization. Which patients will benefit from this new technique still remains a question that requires further study.

P-76 withdrawn by authors

P-77

Percutaneous vertebroplasty: risk or benefit in the treatment of pain due to vertebral body fractures related to osteoporosis

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Purpose: The treatment of vertebral body fracture by Percutaneous Vertebroplasty is associated with pain relief and clinical improvement due to stabilization and reinforcement of the vertebral body structure. However, potential complications includes discite, osteomielite, leakage of acrylic cement to the spinal canal, cement pulmonary embolism due to migration through the inferior vena cava and radicular compression. The authors showed through retrospective analysis the results after percutaneous treatment of the vertebral body fracture with acrylic cement.
Material and methods: From January 2004 to April 2008, 97 consecutive patients (n=177 vertebral bodies) were enrolled. The mean age was 79 y.o., range from 60 to 87 years-old and 62% were male. The clinical outcomes included pain relief assessed by a validated scale and the the presence of any complication assessed during hospital stay and at 1-month clinical follow-up. Under fluoroscopy, we carried out transpedicular vertebral body punch with patient in ventral decubitus under anesthetic sedation and local anaesthesia. Between the vertebral punched bodies, 69% (n=122) were at the lumbar level and 31% (n= 55) at the thoracic level. The mean procedure time was 40 ±(??) minutes.
Results: Immediate clinical improvement was obtained in 92% of the patients. Additional percutaneous vertebroplasty was undertaken in 9,6% (n=17) of patients due to recurrent pain. We reported one complication (0,6%) that was patient who was admitted with a radicular pain due to the presence of the PMMA (poli metyl meta acrylate).
Conclusion: In this retrospective Cohort percutaneous vertebroplasty was a safe and effective procedure with high rates of immediate clinical improvement and low rates of complications. Randomized studies are necessary confirm our results.

P-78

Percutaneous vertebroplasty for osteoporotic fractures: experience with high viscosity cement using a hydrolic injection device, the "CONFIDENCE" system

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Purpose: the study is conducted to assess the clinical feasibility of performing vertebroplasty on osteoportic compression fractures using ultraviscous cement injected by a hydrolic device to further control cement deposition.
Material and method: a series of 94 consecutively treated patients were identified for the review. There were a total of 163 levels that ranged from T3 to S1 vertebral bodies. The degree of leakage was assessed at each treated level using a strict 4-point scale (none, minimal, moderate, and severe). The pattern of any observed leakage was also characterized as: discal, venous, paravetebral, or epidural.
Results: there was no leakage in 50%, minimal leakage in 42%, and moderate leakage noted in 8% of cases. Both unipedicular and bi-pedicular approaches showed leaks in 50% of cases. The most frequent pattern of leak was venous indicated in 52% of leaks, the adjacent disc in 46%, and paravertebral in 5%.
Conclusions: vertebroplasty in osteoporotic fractures using a highly viscus cement that can be safely controlled and injected via a hydrolic system can be performed safely without significant complications.

P-79

Percutaneous management of challenging spinal tumours: how to deal with

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Learning Objectives: our purpose is to share our experience in challenging spinal tumour management and how to: deal with them, reduce major complication rate and get round difficulties.
Background: we have considered as challenging when the risk of complication was high: large rupture of the posterior wall, extension in the spinal canal, tumour close to neurological structures or adjacent organs, and hypervascular lesions.
Clinical findings and procedure details: we have reviewed retrospectively the challenging spinal tumour cases of the last 16 years treated in our department. In order to offer a curative or palliative treatment option to the patient, different percutaneous methods (vertebroplasty, alcoholisation, laser-, RF-, cryo-ablation, and RF cavitation) have been applied. To overcome difficulties, a number of techniques were used: tumour cavitation before vertebroplasty, thermal monitoring and insulation during ablation (thermosensors, fluid and/or CO2 injection). During the last 16 years, the progress of the technique allowed the approach and treatment of the majority of spinal tumours. We are reporting and commenting each complication we have encountered including an accidental ablation of S2 to S4 nerve roots, an L5 paresis, reversible cauda equina syndrome, cement leaks with pulmonary embolism or foraminal compression.
Conclusion: percutaneous management of the challenging spinal tumours requires a thorough knowledge of the different percutaneous techniques and the anatomy. Determining the therapeutic intention (curative or palliative) is mandatory in order to choose the most adapted and less disabling technique offering the patient the optimum treatment option.

P-80

CT-guided interventional procedures in the spine

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Learning Objectives: the possibility and techniques of all the procedures under the real-time Computed Tomography image guidance in the spine.
Background: the authors are specialized in the spine diseases. Based on a wealth of experiences under the CT-guidance, all possible procedures can be applied to these: percutaneous disectomy, vertebroplasty, nerve root block especially for cervical spine, MBB block, S-I joint block, synovial cyst aspiration, aspiration and biopsy, percutaneous facet screw fixation, and so on.
Clinical findings and procedure details: all the procedures performed with interventional CT-guidance. And these are performed under the local anesthesia with conscious sedation. 1. CT-guided aspirations of the discal, synovial and ganglion cysts using 18 gauge needles are possible. 2. Percutaneous CT-guided discectomy using endoscope is possible in C-T-L levels. 3. The approach methods of CT-guided percutaneous facet screw fixation in lumbar spine are decided by the shapes of spinal canals. 4. Nerve root blocks, not only lumbar spine but cervical and thoracic levels which are difficult to accurate approach, are possible with CT-guidance. 5. Other procedures such as S-I joint block, MBB block, aspiration and biopsy and vertebroplasty can be performed.
Conclusion: although CT-guided procedures need more clinical techniques, they are safer and more accurate than previous fluoroscopic procedures. In case of lumbar cysts aspiration, CT-guided procedures can be substituted by open surgery.

P-81

Usefulness of preprocedural reconstructed CT (3D-MPR CT) in percutaneous vertebroplasty

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Learning Objectives: significance of 3D-MPR CT imaging as a tool of preprocedual evaluation and planning in Percutaneous vertebroplasty (PV).
Background: all patients who undergo PV at our institution are routinely evaluated by reconstructed sagittal, coronal and axial image (MPR image) using MDCT in addition to MRI prior to procedure. CT imaging provides important information that is difficult to be obtained by MRI. We believe that preprocedural CT is essential for safe PV.
Clinical findings and procedure details: preprocedural CT is useful for following items: 1. To evaluate fractured line of the cortex through cement leakage may occur during PV. This is difficult to be detected by MRI. 2. To evaluate fracture of the pedicle, which is sometimes difficult to be detected by MRI. It is important to decide the indication of pediculoplasty for fractured pedicle, which can be a symptomatic lesion. 3. To differentiate between fluid and necrotic tissue from gas in the intravertebral cleft, which is sometimes difficult to be differentiated by MRI. It is important to detect gas filled intravertebral cleft. Coexistence of gas in intravertebral cleft and in intervertebral disc may indicate cement leakage into disc space. 4. To differentiate between Schmorl's nodes from intravertebral cleft that is sometimes difficult by MRI. 5. To evaluate sclerotic change in fractured vertebral body, which is often difficult to detect by MRI. 6. To prepare the inserting angle of a transpedicular needle of PV procedure under fluoroscopy.
Conclusion: preprocedural reconstructed CT images are essential for planning of PV and avoiding complications.

P-82

Vertebroplasty: outcome and complications

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Learning Objectives: To evaluate (&audit) percutanous vertebroplasty outcomes and complications.
Background: percutanous vertebroplasty (PVP) has been approved by NICE since 2003. Relatively few centres in the UK provide this service. There is a responsibility to monitor the progress of patients, report adverse effects and conduct audit. The first PVP was performed ten years ago in Raigmore Hospital. This audit is part of a plan to shed light, develop a data base, increase awareness and improve the quality of the PVP journey in this institute. Standards: Outcome measures: 1. Pain relief osteoporotic fractures 80%, malignant 60%. 2. Increased mobility 50%. 3. Reduced analgesia 90%. Complications less than 2% for osteoporotic fractures and 10% for malignant.
Clinical findings and procedure details: data collected for the patients who had undergone PVP over the last 5 years (n= 25, 14= malignant, 11 osteoporotic). 1. Pain relief in osteoporotic 73%, malignant 71%. 2. Increased mobility in 53%. 3. Complications, osteoporotic 1.8%, malignant 16% all minor.
Conclusion: all results are within acceptable limits, except the minor complications in the malignant aetiology group, which is slightly higher than the standard. Better patient selection would be of great benefit specially if combined with a more 'consensus multidisciplinary approach'. Perhaps a standard assessment and clinical evaluation from pre and post procedure to facilitate selection, subsequent monitoring and audit; attached below is a proposed form.

P-83

Kyphoplasty for traumatic vertebral fractures in young patients: when, how, and why?

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Learning Objectives: to describe and illustrate the technique, indications and tips and tricks of kyphoplasty in traumatic spinal fractures in young patients.
Background: kyphoplasty in vertebral fracture is performed to restore height, to inject biocompatible calcium phosphate cement (CPC), to allow fast pain relief, and to avoid the corset. Radio-opaque CPC (Jectos+) is more "physiological" and should be preferred in young adults. However, due to its high viscosity, CPC can only be injected if a prior cavity has been created (Kyphoplasty). Kyphoplasty was used in our department in the treatment of acute traumatic compression fractures of the vertebral body, type A1 (Magerl) in young non-osteoporotic patients. The treatment was performed within the first week after trauma.
Clinical findings and procedure details: the procedure was performed under fluoroscopy guidance and general anaesthesia because the inflation of the bone tamps is painful and the trocars are larger. In our series of 37 patients treated with kyphoplasty following acute traumatic fractures (mean age 30.8 years), complete pain relief was obtained in 34 patients with significant improvement of kyphosis in 20 patients. Four cases of minor leakage were the only complications.
Conclusion: kyphoplasty allows injection of biocompatible phosphocalcic cement with biomechanical properties similar to bone in traumatic fractures of the young patients. Only fractures involving the anterior and middle columns of the vertebral body are eligible for this percutaneous approach. This technique allows an excellent pain relief and early removal of corset and should be ideally performed within 7 days after the trauma.

P-84

Evidence-based comprehensive review on vertebral Intervention with radiographic findings (NM, MR, CT, and angiography)

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Learning Objectives: 1. Adjunctive role of vertebral intervention in the setting of tumor treatment or fracture. 2. Importance of creating a radiographic roadmap in order to ensure optimal vertebral intervention planning and monitoring post-treatment.
Background information/Purpose: prior to the advent of transarterial embolization, resections and other surgical management of hypervascular vertebral tumors consistently resulted in massive intra-operative hemorrhage. However, since the adoption of pre-operative embolization of bone tumors, this IR procedure has not only drastically reduced surgical blood loss by an average of 60-70%, but there has also been an improvement in the visualization of the operative field and a decrease in operating time. In this presentation, in addition to vertebral embolization, we will present comprehensive review of vertebral intervention including vertebral ablation, kyphoplasty, vertebroplasty, sacroplasty and nerve block.
Clinical findings: 1. Review of NM, MR, CT and angiographic images of vertebral bone tumor. 2. Up-to-date literature reviews and meta-analysis of current recommendations.
Conclusion: vertebral intervention is a safe and useful adjunct to currently available medical and surgical treatment options for vertebral tumors or fractures. With recognition of radiographic features, treatment planning, disease progression and treatment outcome can be effectively monitored for optimal patient management.

P-85

Pulmonary embolism caused by acrylic cement from prior vertebroplasty

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A pulmonary embolus of acrylic/polymethylmethacrylate cement was incidentally seen in an 81-year-old patient after percutaneous vertebroplasty for osteoporotic collapse. Chest radiograph and CT scan confirmed the presence of cement in the pulmonary arteries.

P-86

Successful embolization in a neonate with kassabach merrit syndrome and congenital haemangioma

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GI bleeding in a neonate with severe thrombocytopenia and extended lower limb congenital haemangioma. Platelet count steadily improved after tumor embolization and bleeding ceased. Further treatment was given with corticoids and vincristine. Normal child at 2-year follow-up.

P-87

Foreign body extraction from soft tissue using CT and fluoroscopic guidance: a new technique

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We report on a new minimally invasive technique performed under local anaesthesia for the retrieval of a surgical pin fragment, using double CT and fluoroscopic guidance, which accidentally migrated into the soft tissue of the shoulder in two patients.

P-88

CT-guided infiltration for the treatment of Alcock's syndrome

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We present a case of pudendal neuralgia due to nerve compression within Alcock's canal treated by CT- guided percutaneous infiltration (mixture of local anesthetic and slow-acting corticosteroid). It is a safe and efficient method that immediately reduces the pain.

P-89

A patient with multiple facial fractures in whom hemostasis was difficult to achieve because of disseminated intravascular coagulation: salvage using NBCA (N-butylcyanoacrylate) adhesive

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A patient with multiple facial fractures, in whom hemostasis was difficult to achieve because of perioperative DIC was successfully treated. Surgery was discontinued, and angiography detected bleeding from the distal maxillary artery, eventually controlled with an NBCA and lipiodol mixture.

P-90

Rare thoracic aggressive vertebral hemangioma managed by multi-level vertebroplasty and limited posterior spinal decompression

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A 50-year-old man presenting with spinal cord compression was diagnosed with an aggressive hemangioma centered at T7 with epidural extension, crossing the disks to involve T8 and T6. This was successfully treated with aggressive vertebroplasty and limited laminectomy.

P-91

Aggressive atypical vertebral haemangioma: endovascular and surgical management

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A 46-year-old man presented with aggressive atypical vertebral haemangioma with a soft tissue mass causing cord compression: a diagnostic and management dilemma. Following contrast MRI and CT-guided biopsy, he underwent successful treatment by subselective spinal embolisation and surgical resection.

Cardiac imaging

P-92

Incidental detection of occult left atrial appendage thrombus or spontaneous echo contrast in patients with suspected coronary artery disease on ECG-gated 64-channel MDCT

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Purpose: to evaluate the prevalence of occult left atrial appendage (LAA) thrombus or spontaneous echo contrast (SEC) in patients with suspected coronary artery disease by ECG-gated 64-channel MDCT and determine the diagnostic performance.
Materials/methods: from November 2007 to March 2008, 1198 patients with suspected coronary artery disease underwent ECG-gated 64-channel MDCT. Among them, 30 patients (M:F=16:14; mean age: 67.33±9.27 years, range: 47-86 years) had filling defects in the LAA. All fillings defects were considered LAA thrombus or severe SEC. In these patients, trans-thoracic (TTE) and trans-esophageal echocardiography (TEE) was performed less than 1 month. Demographics, TTE and TEE findings, and cardiac rhythm variables were analyzed.
Results: in all 30 patients, LAA thrombi were identified by TEE in 12 patients (40%) and LAA SEC (n=9, 30%), normal LAA (n=9, 30%) were identified. However, TTE could not evaluate the LAA in all cases due to limited echo windows. All 12 patients with LAA thrombus (n=12) had atrial fibrillation and LA enlargement. 9 patients with LAA SEC had atrial fibrillation in 6 cases (66.7%). However, 9 normal LAA patients had no atrial fibrillation and structural abnormalities.
Conclusion: the prevalence of occult LAA thrombus or SEC in patients with suspected coronary artery disease is not considerable. 64-MDCT has a potential to provide a non-invasive insight about the occult LAA thrombus or SEC in this population. However, we cannot recommend that MDCT be used as a screening tool for the detection of occult LAA thrombus or SEC.

P-93

Blood pressure monitoring: a noble method for stepwise decision making in percutaneous mitral valvuloplasty

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Purpose: to find out if systolic blood pressure changes during percutaneous Mitral comissurotomy (PMC) could be a reliable guide to staged decision making and evaluate stop point.
Materials/methods: 102 patients with moderate to severe mitral stenosis were chosen for PMC with Inue technique. Echocardiographic and homodynamic criteria were used as references for decision making during procedure. Systolic blood pressure changes were also evaluated by a fluid filled system at the end of each balloon inflation and deflation. To reach optimal results, balloon inflation was done only once in one case (0.98%), twice in16.66% and three times in 82.35% of cases. In every stage of balloon inflation, trans-mitral gradient was compared with changes in systolic blood pressure.
Results: correlation between systolic blood pressure drop and trans-mitral gradient changes were analyzed with Pearson method and via regression formula. Relation between final mitral orifice area and systolic blood pressure was also analyzed with T test. Significant relation was found in every stage: R: 0.63 in stage 1, R: 0.823 in stage 2, R: 673 in stage 3 in regression formula.
Conclusion: quick assessment of success during PMC is possible with monitoring of systolic blood pressure changes, an easy and practical way we could rely on.

P-94

Cardiac CT reports: how to do it!

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Learning Objectives: to learn how to do a cardiac CT report.
Background: reporting cardiac CTs is a special challenge for radiologists, since they have to learn the language of the cardiologists and they have to know in detail the complex anatomy of the heart. Furthermore, they have to deal with many new pathologies, which were not well known until now to "standard" radiologists.
Clinical findings and procedure details: this educational exhibit will demonstrate how to prepare a well-structured cardiac-CT report. It will show all important elements, which should be part of the "perfect" cardiac CT report.
Conclusion: preparing good cardiac CT reports is crucial in order to establish this relatively new method in your clinical surrounding.

P-95

Role of MRI in the diagnosis of various cardiac masses

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Learning Objectives: 1. To study the presentations of various cardiac masses, their MR appearances and role of MRI in the diagnosis. 2. To know and understand non-tumoral conditions presenting as cardiac masses.
Background: the cardiac masses may present in different manner depending upon the location and type of the lesion. The clinical setting also aids in proper modulation of the imaging technique to reach at a proper conclusion. We herewith present the appearances

of various masses that we encountered in our clinical MRI practice in a university hospital. The presentation, the historical setting of these patients make this "pictorial essay" interesting.
Clinical findings and procedure details: patients were subjected to cardiac MRI on a 1.5 T scanner. The patients were studied with dark blood (HASTE ± fat saturation) and True FISP Cine images in various planes as required. Contrast (post-gadolinium) scans were performed in all patients. The cardiac masses that we encountered were atrial myxoma (presenting features of pulmonary oedema), lymphoma with myocardial involvement, myocardial lipomatosis (iatrogenic), and cardiac haemangioma. The other conditions mimicking an intracardiac mass were endomyocardial fibrosis, ventricular thrombus, leak with thrombus in a patient presenting long after Senning's procedure.
Conclusion: the knowledge of the gamut of intracardiac lesions results in high index of suspicion thereby leading to more accurate diagnosis. The appearance of the lesions although might vary. Cardiac MRI plays an important role in giving reproducible objective information without the limitation of the acoustic window.

P-96

Transcatheter closure of a postmyocardial infarction ventricular septal rupture with an Amplatzer septal occluder

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A 70-year-old man with an acute anterior MI underwent emergency CABG. At third post-CABG day he developed tachycardia, hypotension, dyspnea and a new pansystolic murmur .Echocardiography,TEE and cardiac catheterization showed a VSD. Transcatheter closure was performed using the Amplatzer septal occluder.

Carotid artery imaging and intervention

P-97

Carotid ultrasonography: calculation of peak systolic velocity to predict a significant stenosis using catheter angiography and MRI angiography as comparative gold standard imaging

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Purpose: carotid endarterectomy is of proven benefit for stroke prevention in patients with TIAs and a stenosis greater than 70% in the ipsilateral carotid artery. Peak systolic velocity (PSV) at ultrasound has been shown to be reliable in predicting which patients would benefit from surgery. Guidelines at our institution use PSV>3.2ms-1 to indicate a significant stenosis and PSV>1.4ms-1 to suggest further imaging.
Materials and methods: carotid duplex scans, carotid angiograms and carotid MRI scans performed between August 2003 and September 2007 were identified on the computer record system. Cases of trickle flow or occlusion in either artery on duplex scan were excluded. Stenosis of greater than 70% on MRI angiography or catheter angiography was considered as the gold standard for comparison. Sensitivity and specificity plots were produced for Duplex PSV.
Results: 3681 patients had carotid duplex scans in the time period stated above. 117 had catheter carotid angiograms and 49 had MRI carotid angiography. After exclusions, 160 carotid arteries were available for comparison of which 31 had a significant stenosis on second line imaging. 95% sensitivity was achieved at 1.3 ms-1 and 95% specificity at 2.7 ms-1
Conclusions: patients with a PSV below 1.3 ms-1 can be considered as having a non significant stenosis. Patients with a PSV above 2.7 ms-1 should be considered for endarterectomy directly. Patients with PSVs between these values should have 2nd line imaging to determine the level of carotid stenosis and predict benefit from endarterectomy.

P-98

Pre surgical CT angiography (CTA) reconstructions for supraaortics trunks: what does the surgeon expect

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Learning Objectives: to show advantages and limits of each reconstruction type (axial slices, Maximum Intensity Projection (MIP), Volume Rendering (VR) and Multi-Planar Rendering (MPR) for the pre-surgical evaluation of supraaortic trunks. To show the necessary images for surgical planning illustrated by clinical cases and a literature review.
Background: carotid artery surgical planning needs a complete information concerning aortic arch and supra aortic trunks up to intra cranial segments. As MRI, the diagnostic value of CTA is well established for pre-surgical supra aortic vessels assessment. 64 MDCT has high spatial resolution with a small quantity of contrast media and disposes of various post-processing algorithms for vessel analysis.
Clinical findings and procedure details: advanced vessel analysis (AVA) provides various CTA algorithms for accurate assessment of supraaortic vessels, including axial viewing, three-D (3D)-MIP, VRT, and MPR algorithms: vessel extraction and skull removal. Axial slices remain the basic tool for diagnosis and the most efficient tool for aortic arch appreciation. 3-D MIP and VR provide useful anatomic visualization for surgical planning. MPR vessel extraction gives precise quantitative evaluation of stenosis but remains limited in intra-petrous segments because of bone artifacts. Skull removal, an efficient MPR tool to avoid calcification artifacts, allows the evaluation of intra-petrous segments, but eliminates anatomical landmarks as mandibula or external carotid artery, key points for the surgeons.
Conclusion: beside the written report, surgeon needs visual complete and synthetic information for carotid surgical planning. AVA software includes different algorithms to evaluate stenosis and arterial anatomy. Because of their limits, they remain complementary.

P-99

Unusual acute complications of carotid artery angioplasty and stenting: review and management options for the vascular specialist

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Learning Objectives: to describe the unusual acute complications of angioplasty and stenting of the extracranial internal carotid artery. What the vascular specialist needs to know to ensure timely identification, management and prevention of such complications to optimise successful management of carotid artery occlusive disease. Illustrated case guide of acute complications and potential management strategies with highlighted key teaching points.
Background: carotid artery angioplasty and stenting (CAST) has become an accepted method of management for treatment of carotid artery stenosis in select patient groups with extracranial carotid artery occlusive disease. Neurovascular complications secondary to intracranial embolism have been well described. We aim to highlight unusual acute complications that if passed unrecognized or are not managed in an emergent fashion will result in significant

neurological deficit or adverse patient outcome.
Clinical findings or procedure details: from a series of over 100 procedures performed primarily in a single institution, an illustrated case guide of complications, management strategies and outcomes will be presented. Cases include: acute stent thrombosis, carotid artery dissection, plaque rupture, stent prolapse, arterial vasospasm and hyperperfusion syndrome. Avoidance strategies will be discussed including roles of stent selection, patient preparation and procedural technique. The pharmacology of "rescue" thrombolytics, interventional rescue techniques and surgical intervention will also be reviewed.
Conclusion: an algorithim is suggested for prevention, early identification and management of acute complications.

P-100

Outcomes analysis of carotid artery stenting: evidence-based review of epidemiologic, anatomic, and clinicopathological factors

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Learning Objectives: to present evidence based review of the demographic, anatomic, clinical and pathological factors that could affect outcomes of carotid artery stenting (CAS) vs. carotid endarterectomy (CEA) to help decide on the appropriate treatment option.
Clinical findings and procedure details: 1. Demographic (age/gender/race/genetic), anatomic (site/length), clinical (symptoms, acuity) and pathological factors governing stroke and carotid stenosis. 2. Synopsis of trials and studies supporting/comparing carotid artery stenting (CAS) with or without distal protection and carotid endarterectomy (CEA). 3. Evidence based review of the demographic, anatomic, clinical and pathological factors that could affect outcomes of carotid artery stenting (CAS) vs. carotid endarterectomy (CEA).
Background and Conclusions: stroke is the third leading cause of death in the US and carotid stenosis is a common cause of embolic stroke. CEA is an accepted treatment as per the ACAS/NASCET data, and CAS with outflow protection has a beneficial role in the treatment of carotid artery stenosis. This exhibit attempts to present an evidence based review of the demographic, anatomic, clinical and pathological factors that could govern the appropriate mode of treatment (surgical, endovascular or conservative).

P-101

Characterization of atherosclerotic carotid plaque in symptomatic patients by virtual histology IVUS and microscopy MR

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Aim: to identify virtual histology (VH)-IVUS as a valid and practical alternative to microscopy MR in the carotid plaque evaluation.
Materials and methods: initial studies validated VH against histopathology of six human carotid plaque ex vivo. Forty-two cross-sections VH images were selected for the "pixel-by-pixel" basis analysis as demonstrating the most significant tissue features. Data were then submitted to histopathological examination and each specimen analyzed in light of the features defined by the VH evaluation (lipid core, fibrous tissue, necrotic core, calcifications). Then, we evaluated in vivo twelve symptomatic patients by use microscopy MR and VH. Everyone was candidated for the carotid artery stenting with stenosis <80%. VH study was always performed intraprocedurally. It was used analogue quantitive analysis for the twenty-seven images and percentage data were correlated.
Results: in an ex vivo study, VH was able to assess fibrous tissue, lipid core, necrotic core and calcifications with a sensitivity of 100, 94, 84 and 67%, respectively, and a specificity of 99, 84, 97 and 99%, respectively. In vivo evaluation, VH showed a sensitivity of 86, 93, 89 and 65% and a specificity of 84, 97, 99 and 98%, respectively. The correlation with microscopy MR was considered excellent.
Conclusions: the VH is a valid alternative to microscopy MR in the in vivo assessment of carotid plaque, although it was unable to evaluate inflammatory activity, visible by use of microscopy MR through fibrous cap enhancement.

P-102

Stent-graft placement and microcoil embolization for emergent treatment of acute carotid blow-out syndrome due to oral cancer

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Acute enoral hemorrhage due to oral cancer infiltration of proximal internal and external carotid artery was successfully controlled by distal microcoil embolization of maxillary and occipital arteries and subsequent carotid stent-graft placement without use of emboli protection device.

P-103

Internal carotid ergotism in a HIV patient

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A 44-year-old HIV+ man was admitted with neurological global deficit. Based on angiographic findings we made a diagnosis of Ergotism due to the use of ergotamine, and we treated the patient with intrarterial vasodilatators.

P-104

Internal carotid artery pseudoaneurysm in a 4-year-old child: stent-graft deployment

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A 4-year-old patient presenting a mycotic pseudoaneurysm complicating faringitys was treated successfully with percutaneous thrombin injection under US guidance. 48 hours later lesion patency was comfirmed. A covered stent graft was deployed. 1 year later, CT angiography was uneventful.

P-105

Staged endovascular treatment of left common carotid artery large aneurysm with gore hemobahn stent-graft after right common carotid artery stenosis angioplasty

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We describe a case of carotid artery stenosis and aneurysm with surgical aneurysmectomy history. After right carotid stenosis endovascular treatment, a Hemobahn stent-graft was placed through left carotid aneurysm. Endovascular treatment of carotid artery aneurysm is safe alternative to surgery.

P-106

Covered stent-graft treatment of carotid pseudoaneurysm in the setting of head and neck cancer, complicated by stent infection and septic emboli

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Case Report: a 65-year-old man underwent embolization of a tracheo-thyroidal artery fistula with placement of a covered-stent across a right common carotid artery pseudoaneurysm. 1 month later, patient presented with intracranial septic emboli from covered-stent placement.

P-107

Identification of intraluminal embolic plaque material during CAS by use of virtual histology-IVUS

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VH IVUS performed post CAS demonstrated an intraluminal lesion at the distal end of the stent, pertaining to ruptured plaque material. This case report demonstrates that intraluminal embolic plaque material can be identified by VH-IVUS during CAS.

Clinical practice development

P-108

Usefulness of cone-beam CT with flat-panel-detector system for the percutaneous drainage of difficult deep-seated abdominal abscess: a preliminary report

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Purpose: to evaluate the utility of cone-beam CT with flat-panel-detector (FPD) system for the percutaneous drainage of difficult deep-seated abdominal abscesses.
Materials/methods: between December 2006 and September 2008, a total of 192 percutaneous drainage procedures were performed. Among them, 17 percutaneous drainage procedures were carried out on 16 patients (M:F=13:3, average age 54.1 years) with cone-beam CT with FPD system (Allura Xper FD20; Philips). Etiology of the abscesses included post-operative leaks (n=9), hepatic abscess (n=4), Crohn's disease (n=1), pancreatitis (n=2), and bowel perforation (n=1). All abscesses were considered difficult access and hence cone-beam CT with FPD was used to attempt drainage. Procedure success rate, total procedure time, complication rate and length of catheter drainage time were recorded.
Results: successful drainage was accomplished in all 17 procedures (17/17, 100%). Total procedure time was on average 10.5 minutes (range 3~18 minutes). No significant complications were recorded in this population group, specifically no incidents of accidental trauma to surrounding bowel loops. Total duration of catheter drainage was on average 19.4 days (range 3-47 days).
Conclusion: cone-beam CT with FPD system allows real time visualization of deep-seated abdominal abscess and needle pathways and permitted safe catheter placement. Cone-beam CT with FPD system allows safe access to abscess cavities, which may be deemed too risky to drain under ultrasound or fluoroscopic guidance.

P-109

Improving the turnaround times for carotid intervention in symptomatic patients

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Purpose: it is accepted that risk patients should be treated within 48 hours. At RPH, definitive treatment was not performed until after 6 months. This paper shows how we have reduced our turnaround time with no additional resources.
Materials/methods: a prospective Carotid Registry was created for all patients undergoing Carotid US from March 2008 to January 2009. Data collected included demographic, indication, referring specialty, date of presentation, clinical assessment, further imaging, MDT and definitive treatment.
Results: 800 patients were entered into the registry. Initial outcomes (Mar - May 2008) showed a 2-week carotid US wait and an average 50-day turnaround. Problem areas identified were delays in referral, submitting request cards, multiple visits to hospital for clinics/imaging, delays in organizing treatment. By end of the study, the US wait was 5-days and the turnaround time had reduced to 30-days. Delays were reduced by prompt delivery of Doppler requests, additional imaging immediately after positive duplex or in urgently slots before vascular surgeon (VS) review. Patients with confirmatory imaging are discussed in next MDT and then reviewed by VS in next available clinic slot. Patient is then offered choice of CAS or CEA and treated ASAP. This has resulted in reducing turnaround to 31-days.
Conclusion: simple service reconfiguration can result in significant reductions in definitive carotid intervention in symptomatic patients without additional resources. We would aim to treat all patients with a high ABCD2 score within 48 hours by targeted use of additional resources to comply with the National Service Framework.

P-110

How to do a consultation for UFE: a cook book for the interventional radiologist

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Learning Objectives: to provide the interventional radiologists (IR) with basic clinical knowledge needed to start a consultation (CS) practice of uterine fibroid embolization (UFE).
Background: usually, IR are not familiar with the demand of women seeking council for UFE and may restrain their ability to consult because they may fear the "gynaecologic questions" that may arise during the CS. The CS is, on the contrary, is easy to perform, as soon as the IR behaves as a clinical-technical expert and is able to understand the basic questions that women will ask. This should also come with the acknowledgment of the principle that indications and follow-up should be done in close collaboration with in and out hospital gynaecologists.
Clinical findings and procedure details: this educational exhibit will provide the IR with a tool box to better understand, anticipate, answer the frequently asked questions (FAQ) by women referred for possible UFE. The presentation will be based mostly on tables, providing simple/short answers readily usable for clinical practice. The following topics (not limited) will be covered: The basics of drugs that women usually take before to come to the IR. The basics of common surgical approaches. The basics of normal gynaecological care of healthy women < 50 years. The FAQ of women on clinical efficacy, complications, pregnancy. What women need to know about sloughing and symptoms. Announcing serious complications.

Conclusion: CS for women seeking advice on UFE is a highly rewarding activity that can be easily started based on basic knowledge.

P-111

Infection control in the interventional suite: the optimal design of interventional facilities to minimise the risk of infectious complications

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Learning Objectives: to describe the measures that can be taken in the design of an interventional suite to reduce infective complications.
Background: the importance of infection control in the interventional environment has taken centre stage as the specialty has developed. The standards of asepsis as seen in the operating room have been aspired to by interventionalists as a group; however, in many areas definite guidelines are lacking.
Clinical findings and procedure details: the trend towards adopting surgical infection control procedures should be continued. Staff and patient movements should be strictly controlled using a one way system. The procedural area should be divided into two, for sterile and non-sterile operations. Regarding room size, guidelines exist suggesting at least 400 square feet and possibly 600 square feet for specialised endovascular suites. The room's interior should be specifically designed to minimise infection transmission. Smooth working surfaces, including electrical cables and seamless floors, permit easy sterilization. False ceilings promote dust accumulation and should not be used. Regarding air quality, similar standards to the operating theatre should be used. Positive pressure is needed with air renewed by filter between 20 and 35 times per hour. The ambient air should have a temperature of 18-24 degrees°C and a humidity of 50-55%. Hand washing should be performed with water containing no more than 100 colony forming units/100 ml after 24 hours at 37°C and contain no pseudomonas aeruginosa.
Conclusion: appropriate design of an interventional facility is vital to reduce the risk of infective complications from interventional procedures.

P-112

Critical limb ischaemia: borderline cases treated with interventional atherectomy

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The aim of this paper is to show the possibility of interventional treatment, antegrade and crossover, in five selected cases with severly calcified stenoses/occlusions (multisegmental and long distance), including arteria popliteal segment with critical limb ischaemia .

P-113

Pulmonary ossification: a rare entity

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Pulmonary ossification is a rare entity characterized by bone formation in the lung parenchyma, usually associated with diffuse chronic pulmonary disease, heart disease or other systemic disorders. We describe the diagnosis of this entity with CT-guided core biopsy.

Embolotherapy

P-114

Placenta accreta (PA): management with uterine artery embolization (UAE), 17 cases

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Purpose: to report the management of PA by UAE in 17 patients by comparing the preventive method (PA diagnosed in antenatal period, groups 1, n=6), and the curative method for patients with PPH (group 2, n=11).
Materials/methods: retrospective monocentric study (from January 2002 to May 2008). The patients were 34.6±5.5 years old in group 1 and 31.4±4.3 years old in group 2. The term of pregnancy was 35±2 WA in group 1 and 38±2 WA in group 2. In group 2, the diagnosis of PA was made during cesarean (n=8) or natural delivery (n=3).
Results: we report 100% immediate technical success of UAE for both groups. In group 1, a massive bleeding 2 days after attempt of placenta delivery justified a hysterectomy for haemostasis whereas a late bleeding (2 months) was controlled by a second UAE. Two uterine synechiae and an atrophy of the endometrium were found in group 1; a secondary amenorrhoea in group 2. There was between the two groups a significant difference in terms of delay of UAE (23.3±5.1 minutes in group 1 vs. 73±44.7 in group 2, $p<0.01$), and blood losses (0.7±0.8 liter in group 1 vs. 2.6±1.2 in group 2, $p<0.01$).
Conclusion: the antenatal diagnose of PA allows its preventive management, which reduces delay of embolization, blood losses and transfusions.

P-115

Nonoperative management of visceral artery pseudoaneurysms: treatment by transcatheter coil embolization using isolation technique

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Purpose: to describe our experiences with the treatment of visceral artery pseudoaneurysms (VAPA) by transcatheter coil embolization using an isolation technique, and to propose the indications for treating VAPA by this method.
Materials and methods: we performed 36 coil embolization procedures on 33 patients with VAPA. The procedures were performed in the pancreaticoduodenal arcade (n=15), hepatic- (n=10), renal (n=3), splenic (n=3), and left gastric, left gastroepiploic, superior mesenteric, adrenal, and internal iliac artery pseudoaneurysms (1 each). The predisposing conditions in the 36 patients were postoperative VAPA formation (n=14), inflammation (n=11), trauma (n=3), port-catheter implantation (n=2), invasion by malignant tumors (n=2), and duodenal ulcer (n=1). Before the procedures, CT and/or angiography confirmed presence of VAPAs in all patients, and vessels both distal and proximal sites of the pseudoaneurysm were embolized (isolation technique). Technical success on angiography was regarded as retention of contrast medium in the proximal artery.
Results: transcatheter coil embolization with the isolation technique was technically successful in 33 of the 36 procedures (92%). However, in one patient with pancreaticoduodenal arcade artery pseudoaneurysm after pancreatoduodenectomy, we introduced an uncovered self-expanding nitinol stent in the superior mesenteric artery before transcatheter coil embolization However, we were not

able to control the hemorrhage. In another patient with left hepatic artery pseudoaneurysm, rebleeding occurred in the proper hepatic artery 2 weeks after the procedure.
Conclusion: transcatheter coil embolization using the isolation technique is an effective alternative treatment for patients with VAPA. In particular, the isolation technique is useful in patients whose pseudoaneurysms present surgical difficulties.

P-116

Balloon-occluded retrograde transvenous obliteration of high flow arteriovenous malformation: repeated injection method with ethanolamine oleate

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Purpose: to show our technical development in embolization of high flow arteriovenous malformation (AVM). To evaluate effectiveness and safety of our technique.
Materials and methods: we performed balloon-occluded retrograde transvenous obliteration (BRTO) for renal and pelvic arteriovenous malformations by using repeated injection method with ethanolamine oleate (EO). The renal AVM was the massively cirsoid AVM in which most of the renal arterial branches were involved, and the pelvic AVM was intractable to several arterial embolization. Under balloon occlusion of the draining vein, 5% EO was injected into the niduses of AVM through the balloon catheter. The injection was performed under fluoroscopic control while avoiding retrograde flow into arteries, and therefore, the dose of the EO mixture injected ranged from 1.0 to 2.0 ml per an injection. About ten injections were repeated every five minutes.
Results: in the early injections, EO was filled into certain parts of niduses. After the parts were occluded, EO flowed into other parts of niduses. Thus, the niduses were embolized by turns, and finally, all of the niduses were completely occluded in the both two cases. The patients had favorable outcome only with minor complications that included minimum infarctions in the kidney or the prostate.
Conclusion: we designed BRTO by using repeated injection method with EO for embolization of high flow AVM. Though this study is preliminary, this technique would be an effective and potentially curative method for treatment of AVM.

P-117

Embolization of inferior pancreatico-duodenal artery aneurysms in patients with severe celiac artery stenosis

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Purpose: to describe our experience with embolization of inferior pancreatico-duodenal artery (IPDA) aneurysms in patients with severe celiac artery stenosis.
Materials/methods: from 1998 to 2008, 7 embolization procedures were performed for 9 symptomatic IPDA aneurysms in 7 patients (5 males; mean age 55) associated with significant (>75%) celiac artery stenosis. The medical records, imaging findings and biochemical markers were reviewed for demographics, indication, technique, complications and evidence of visceral ischemia. All patients were followed clinically for a median period of 3 years. Patients presented with epigastric pain (7/7), hemodynamic shock (2/7) and rectal bleeding (2/7). Selective and superselective arteriography was performed in all patients, attempting to coil-embolize the aneurysms.
Results: the IPDA aneurysms ranged in size from 0.5 to 4.0 cm (mean 1.5 cm). Two patients had >1 aneurysm and all others had 1. Transcatheter coil embolization was successful in 8/9 (89%) aneurysms in 6 patients. One aneurysm was treated successfully with direct CT-guided percutaneous injection of N-butyl-2-cyanoacrylate and ethiodol. No complications or mortality occurred. Celiac artery angioplasty and stenting was performed in one. No patient developed clinical, imaging or biochemical evidence of visceral ischemia following embolization, despite severe celiac artery stenosis. None had recurrent symptoms during clinical follow-up (median 3 years, range 0.42-11 years). Six patients had follow-up imaging with CT (range 4 days-5.8 years, median 188 days). None had recurrent IPDA aneurysms on CT.
Conclusion: IPDA aneurysms in association with celiac axis stenosis can be successfully treated with percutaneous embolization. There was no recurrence during our follow up period.

P-118

Long-term follow-up post bronchial artery embolization in patients with hemoptysis

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Purpose: to evaluate the effectiveness and safety of bronchial artery embolization in patients with hemoptysis including long-term follow-up.
Materials/methods: thirty-five vessels were embolized in 28 consecutive patients (9 women and 19 men, average age 42 years, range 20-82 years) treated for hemoptysis between January 1998 and October 2008 including patients with cystic fibrosis (n=9), lung cancer (n=6), chronic inflammatory disease (n=4), bronchiectasis (n=3), chronic obstructive pulmonary disease (n=2), and other (n=4). Bronchial artery embolization was performed using super selective microcatheter embolization techniques and polyvinyl alcohol particles. Patients were followed-up for a median of 23 months (range 1 month to 8 years).
Results: bronchial artery embolization was technically successful in all patients (bleeding stopped within 24 hours) and was clinically successful in 24 of 28 patients (86%). Recurrent bleeding was found in 4 patients with cystic fibrosis (14%) at 1, 16, 19, and 48 months, respectively. Thereof, multi-recurrence bleeding occurred in one patient. Patient survival rate was 89% (SEM 5.8) at 1 months, 86% (SEM 6.6) at 2 months, 82% (SEM 7.3) at 5 months, 78% (SEM 8) at 17 months, and 74% (SEM 8.7) at 8 years.
Conclusion: bronchial artery embolization therapy was mainly effective at long-term follow-up in patients with hemoptysis.

P-119

Clinical outcome of transcatheter arterial embolization with N-butyl-2-cyanoacrylate for acute arterial hemorrhage

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Purpose: to evaluate the clinical efficacy and safety of transcatheter arterial embolization (TAE) with N-butyl-2-cyanoacrylate (NBCA) for acute arterial hemorrhage.
Materials/methods: between February 2005 and December 2008, 37 patients with acute arterial hemorrhage who were treated by TAE with NBCA were investigated. The indications for choosing NBCA as the embolic material are: incomplete hemostasis with coil or gelatin sponge particles, inability to advance the microcatheter distal to the

bleeding site to achieve isolation. The sites of embolization included gastrointestinal tract (n=10), liver (n=1), kidney (n=2), mesentery (n=2), cystic artery (n=1), pancreatic arcade (n=11), chest or abdominal wall (n=8) and uterus (n=2). Microcatheter was advanced close to the bleeding site and embolization was performed using 1:2 to 1:9 mixtures of NBCA and iodized oil. The technical and clinical success rate, recurrent bleeding rate, and procedure related complication rate were evaluated.
Results: the technical and clinical success rates were 100% (37/37) and 83.8% (31/37), respectively. Recurrent bleeding was observed in 8 patients (21.6%), and 4 of them were successfully managed by second transcatheter embolization (n=3) and emergency surgery (n=1). Coil was used in 10 patients to control blood flow. No unintentional embolization was observed. One patient (2.7%) with lower gastrointestinal hemorrhage developed ischemic colon perforation and was successfully treated by surgical resection. In the other 36 patients, no major complications including end-organ damage or iatrogenic ischemia were observed.
Conclusion: TAE with NBCA is a safe and effective method for acute arterial hemorrhage.

P-120

Pharmacologically flow modulated chemoembolization (TACE) improves irradiation and control of tumor burden in HCC

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Purpose: assess effectiveness of pharmacologically flow modulated chemoembolization with respect to irradiation or control of tumor volume of HCC.
Material and methods: 16 patients, 10 male, 6 female, 40-57 years of age, Child-Pugh B and C were treated with 1-3 TACE and RF ablations to irradicate or control HCC.
Technique: 15-20 ng noradrenalin in 7 ml saline were infused into the main hepatic artery (flow rate 2ml/sec) to achieve preferential flow into tumor. This confirmed by an enhanced CT was followed with a 3 second delay by chemoembolization using 50 mg Doxorubicin in 8ml Ethiodol at a flow-rate of 1 ml/sec. A control CT was obtained at 1 month, repeat embolization and/or RF ablations at 3 months.
Results: in 6 explanted livers, 2 were free of tumor, 1 had minimal residual tumor, and 3 significant residual tumor. Of 10 patients followed only by CT, 2 were tumor-free, 4 revealed minimal tumor but 4 harboured significant residual tumor.
Conclusion: compared to our previous experience in 21 explanted HCC patients, flow modulated chemoembolization significantly improved irradiation and control of tumor burden (2 of 6, vs 2 of 21 tumor-free explanted livers; 5 of 16, vs 5 of 21 significantly reduced tumor volumes).

P-121

Endovascular treatment of virsungohaemorrhage

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Purpose: to investigate the effectiveness of endovascular treatment of patients with virsungohaemorrhage.
Materials/methods: between January 2005 and December 2008, 46 patients with endoscopically confirmed virsungohaemorrhage were observed. In all cases, pancreatic pseudocysts with arterial blood flow were revealed ultrasonographically. During angiography, pseudoaneurisms of celiac or mesenteric branches were found in 42 cases. In 7 cases, we found contrast filling defects of gastroduodenal or splenic arteries and consider this situation as temporary thrombosis of bleeding source. In all 46 cases, embolization of blood supply sources was performed using steel coils.
Results: in 2 cases, embolization was not effective and surgical intervention was performed. In these cases, only pseudocyst origin was embolized, because occlusion of arterial source branch was not possible (in 1st case - source was celiac trunk in splenic-hepatic bifurcation, in 2nd case - short mesenteric branch with danger of total mesenteric occlusion). In 3 cases, during 1-4 days after embolization residual intracystic blood flow was observed by ultrasound investigation and successful repeat embolization was performed. In other cases, successful pseudocyst dearterialization with good clinical result was detected without recurrent bleeding during investigation period. In 18 patients with big pseudocysts, subsequent elective surgery operation was performed without postoperation mortality.
Conclusion: embolization of feeding arterial brunch is a minimally invasive and effective method of hemostasis in patients with virsungohaemorrhage. Separate embolization of cyst origin is less effective and may be a cause of recurrent bleeding.

P-122

Ethanol embolization of peripheral vascular malformations

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Purpose: to assess retrospectively results, effectiveness and complications of ethanol embolization of peripheral vascular malformations.
Materials/methods: from 2005 to 2008, 18 patients with venous malformation (age range, 12-49 years, median 28 years) and 5 patients with arteriovenous malformation (age range, 12-75 years, median 42 years) were treated by ethanol embolization. All procedures were performed in general anesthesia. For embolization, 96% ethanol was used at amount of 0.2 ml/ kg. Therapeutic outcomes were established by evaluating the clinical outcome of symptoms and signs, as well as the degree of devascularization at follow-up MR or angiography.
Results: in 18 patients with venous malformation (VM) 53 procedures were together performed. Eleven of them were cured, 6 patients will need further treatment sessions for residual VM, treatment failed in 1 patient. In 5 patients with arteriovenous malformation (AVM), 22 procedures were together performed. All of them were cured. In a group of patients with VM, three complications occurred in 48 procedures (6%). In a group of patients with AVM, 4 complications occurred in 21 procedures (18%).
Conclusion: ethanol embolization has the potential for cure in the management of peripheral vascular malformations with acceptable risk of complications.

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P-124

Selective portal vein embolization to manage persistent post-traumatic hepatic bleeding despite arterial embolization

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Purpose: to report the efficacy of selective portal vein embolization to manage persistent massive bleeding despite complete arterial embolization after liver trauma.
Materials/methods: 3 patients (2M/1F, age 48, 45 and 38 years) suffering from post-traumatic active hepatic bleeding were initially treated by selective arterial embolization. Liver injuries were related to traffic accident (liver trauma grade III), pleural drain insertion and transjugular liver biopsy in one patient each. After transient hemodynamic stabilization following arterial embolization with coils or gelfoam pledgets, recurrent hemodynamic instability was suggestive of persistent active bleeding requiring redo-angiography, which disclosed persistent bleeding arising from a right portal branch on SMA venous return. An US-guided percutaneous left portal vein approach was performed in the 3 patients in order to embolize the injured right portal branch with glue.
Results: selective right portal vein catheterization confirmed a massive active bleeding from a peripheral portal branch in the 3 patients. Superselective embolization of the injured portal branch was performed through a progreat microcatheter (Terumo) by injection of 0.5-0.8 ml of mixture of glue diluted with lipiodol (40/60%). Immediate hemostasis and dramatic hemodynamic improvement was obtained in all 3 patients. No ischemic complication within the embolized area occurred. The percutaneous liver tract was occluded with coils.
Conclusion: persistent bleeding after complete arterial embolization for liver trauma may be due to associated portal vein injury. This rare condition should be kept in mind and could be managed efficaciously by direct super-selective portal branch embolization without risk of hepatic necrosis.

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Elevation in portal systemic pressure gradient after balloon-occluded retrograde transvenous obliteration for gastric varices and aggravation of esophageal varices

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Purpose: to evaluate the relation between the difference in portal systemic pressure gradient (PSPG) before and after balloon-occluded retrograde transvenous obliteration (BRTO), and the aggravation of esophageal varices.
Materials/methods: PSPG was monitored before and after BRTO in 19 patients. PSPG was obtained by subtracting central venous pressure from hepatic vein wedge pressure, and the difference was obtained by subtracting PSPG before BRTO from that after BRTO. The development of outflow vessels was classified into 2 grades: Grade 1, BRTO alone; Grade 2, coil embolization plus BRTO. Endoscopy was performed to evaluate gastric and esophageal varices before, within 1 month after, and 3-6 months after BRTO.
Results: eradication of gastric varices was obtained in all patients and aggravation of esophageal varices was seen in 11 patients. PSPG was significantly elevated by BRTO (p=0.0362). PSPG was significantly elevated in patients with Grade 2 compared with those with Grade 1 (7.7±3.7 vs. 3.3±4.3 mmHg, respectively; p=0.0314) and in those with esophageal varices before treatment compared with those without (7.4±4.0 vs. 3.2±3.9 mmHg, respectively; p=0.0482). The cumulative aggravation rate of esophageal varices was significantly higher in 11 patients with PSPG elevated by more than 5 mmHg, compared with 8 patients with PSPG elevated by 5 mmHg or less (p=0.0105).
Conclusion: BRTO induced a significant elevation in PSPG, with the degree of elevation influencing the aggravation of esophageal varices following BRTO.

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Biocompatibility, inflammatory response and recanalization characteristics of non-radioactive resin microspheres: histological findings

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Purpose: to describe the distribution of spheres within the pre-capillaries, the inflammatory response and recanalization characteristics after embolization with non-radioactive resin microspheres (NRRM) in the kidney and liver.
Material and methods: we performed a partial embolization of the liver and the kidney in 9 white pigs. Embolization was defined as the initiation of near stasis of blood flow. The hepatic circulation was not isolated so that the effects of reflux of microspheres into stomach could be observed. Animals were sacrificed at 48 hours, and 4 and 8 weeks and tissue samples from the kidney liver, lung and stomach evaluated.
Results: microscopic evaluation revealed some clusters of 10-30 microspheres in the small vessels of the kidney and liver. Aggregates were associated with focal ischaemia and mild vascular wall damage. After the infusion of the left hepatic artery, there was some evidence of arteriovenous shunting into the lungs, one case of cholecystitis and one case of marked gastritis and ulceration due to the presence of clusters of microspheres. Beyond 48 hours, microspheres were progressively integrated into the vascular wall by phagocytosis and lumen recanalized. Eight-week evaluation found that the perivascular inflammatory reaction was mild. Liver cell damage, bile duct injury and portal space fibrosis were not observed.
Conclusions: NRRM (18-25 microns) trigger virtually no inflammatory response in target tissues (liver and kidney). Clusters rather than individual microspheres were associated with a mild-to-moderate perivascular inflammatory reaction. There was no evidence for either a prolonged inflammatory reaction or fibrosis in the liver parenchyma following recanalization.

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Management of oral vascular malformations with ethanol sclerotherapy

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Purpose: vascular malformations (VM) treatment options include percutaneous embolization with different sclerosing agents. We report our experience with the intralesional injection of ethanol in VM of the oral cavity.
Materials/methods: twenty-six patients (12 male, 14 female) with oral malformations were treated. The diagnosis was established with clinical findings (n=26), MRI (n=7), arteriography (n=5) and direct percutaneous phlebography (n=2). Sclerosis was carried out using absolute ethanol through direct puncture. In all cases deep sedation was administered.
Results: twenty-eight VM of different sizes that had been presented for mean 13.6 years (0.2-54) in 26 patients, were treated. The median age was 44.50 years (12-87). Criteria for malformations treatment were: enlargement (n=8), local bleeding (n=11), risk of bleeding in case of tooth extraction (n=5), pain (n=1), esthetic problems (n=3). Locations of the lesions: 13 in cheek mucosa, 5 in vestibular gums, 4 in lip mucosa, 3 in tongue, 1 in pterygomandibular region

and 1 in the palate. The median ethanol dose used was 3.2 ml. The lesions disappeared after a single intervention in 19 patients, 2 sessions in 5, 3 sessions in 2, and after 5 sessions in 1. In 19 cases, lesions disappeared, a bluish macula persisted in 6 and mass effect in 2. Symptoms relieved in all patients. Complications associated with intralesional sclerotherapy were transient: local inflammation, perioral paresthesia in 2, and necrosis of the cheek mucosa in 1.
Conclusion: we consider sclerosing treatment with ethanol to be an effective procedure in patients with oral VM.

P-129

Software computed by X-ray manipulators for determination of hepatic tumor-feeding vessels during trans-arterial chemo-embolization

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Purpose: to evaluate the validity and the usefulness of a software (S) that determines tumor-feeding vessels (TV) for liver trans-arterial chemo-embolization (TACE) and that can be computed by X-ray manipulators.
Materials/methods: nineteen consecutive patients with 25 liver tumors measuring 21 to 96 mm (15 hepatocarcinomas, 10 metastases) were planned for selective TACE. Antero-posterior projection digital angiography (2D) and rotational angiogram (3D) were acquired in the common hepatic artery. Determination of TV was asked to 3 X-ray manipulators by computing S from 3D and to 3 experienced interventional radiologists, external to the cases, by retrospectively reviewing the 2D only and then 3D. Using 2D, 3D and all supplementary angiograms performed during TACE, a consensus of the findings was obtained with great details and considered as the "Ground-truth". Sensibilities and durations were compared. Concordance between interventional radiologists and concordance between X-ray manipulators were evaluated.
Results: reviewing 3D significantly increases the sensibility and the duration compared to 2D: 73 vs. 64%, p=0.036 and 94 vs. 187 seconds, p=0.0001. Sensibility of S (93%) was significantly higher than 2D (p=0.002) and 3D (p=0.005). Duration of computing S (135 seconds) was significantly lower than reviewing 3D (p=0.0001) and higher than 2D (p=0.0001). Concordances of reviewing 2D and 3D were 54 and 62%, respectively, and concordance for S was 82%.
Conclusion: software computing by X-ray manipulators seems very helpful to increase sensibility and compatible with real time use during TACE.

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Hemoptysis: the era of treatment with microcatheter embolization

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Purpose: to describe the major hemoptysis causes and imaging findings in the Portuguese population. To review the major indications, the different procedures and complications of bronchial artery embolization.
Materials/methods: retrospective review of the 2006-2008 radiology department database of all patients with the diagnosis of hemoptysis evaluated with bronchial arteriography. We analyzed the demographic data, the causes of the hemoptysis, the embolization techniques (with emphasis on microcatheterization) and agents used, the technical and clinical success rates, the complications, and recurrence rates.
Results: thirty-one patients underwent BA for hemoptysis. Pulmonary tuberculosis was the major cause (31%). The most reported bronchial artery branching pattern was the two on the left and two on the right pattern (n=11, 35.5%). BAE was attempted in 25 arteries with technical success in 23 (92.6%). The mean age of patients at first BAE was 51.61 years. The majority of BAEs (59.2%) were performed by using PVA microspheres. We used microcatheterization in 92.6% of the cases. The immediate clinical success rate after BAE (no recurrent bleeding within 24 hours) was 94.1%. The mean BAE rate per patient was 1.3. Major complications occurred in 6.3%.
Conclusion: the superselective technique of BAE with microcatheter is a safe and efficient treatment adjunct to control hemoptysis.

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Immediate toxicity and procedure related mortality rate of transarterial chemoembolisation (TACE) with anthracyclin in 126 patients

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Purpose: to evaluate immediate toxicity and short term mortality of non supra-selective TACE in patients with unresectable hepatocarcinoma.
Materials/methods: 126 patients (109 males, 63.9 years) were referred for TACE in accordance with Barcelona criterias. 276 treatments were performed (2.2/patients, median interval 2 months). Lipiodol was mixed with anthracyclin and slowly injected in proper, right, or left hepatic artery, followed by gelfoam embolization. We retrospectively report toxicity and immediate adverse events according to National Cancer Common Toxicity Criteria.
Results: four patients (3.2%) died within 30 days (2 acute liver failure, 1 septicemia, 1 pulmonary oedema). Two patients had major arterio-portal fistula contraindicating the procedure.14 patients with portal segmental thrombosis were treated without complication. 6 (4.7%) patients developed arterial occlusion after 1 (2 patients), 2 (2 patients) or 3 (2 patients) courses without biliary or septic complications. 6 patients developed groin hematoma, one required transfusion. Post-embolization syndrome occurred in 91 (72.2%) patients. Liver enzymes increase >5 times occurred in 29 (23%) patients, 4 (3.2%) patients developed acute hepatic failure and 2 led to death. One patient presented upper gastro-intestinal bleeding due to variceal rupture. No biliary complication or hepatic abscess was observed. Hematologic toxicity occurred in 14 (11.1%) patients, severe in 9 (7.14%). Temporary acute renal failure complicating a chronic renal insufficiency in one patient, reversed after hydration.
Conclusion: mortality rate and immediate toxicity are comparable to published data despite most of the chemoembolization was not supra-selectively performed.

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Staged embolotherapy for management of high-flow extremity arteriovenous malformations

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Purpose: to assess the efficacy of staged embolotherapy for management of high-flow arteriovenous malformations (HFAVMs) of upper and lower extremities.

Materials/methods: twelve patients with HFAVMs of extremities (lower limb; n=5, upper limb; n=2, hand; n=5) underwent staged embolotherapy using n-butyl cyanoacrylate (NBCA). Angioarchitectual classification of the 12 HFAVMs was two arteriovenous fistulae (type 1), seven arteriolovenous fistulae (type 2) and three arteriolovenules fistulae (type 3). The devascularized rate (DR) was evaluated as compared with contrast 3D-MRA taken before and after treatment.
Results: initial DR showed 80-99% was four (type 1 two, type 2 one, type 3 one), 60-79% was five (type 2 three, type 3 two), <60% was three (type 2). Direct screlotherapy was added in the five patients. Initial DR >60% was 75% in which type 1 was DR >80%. The DR <60% was seen in all type 2. During 9-28 months period after initial treatment, 8 patients received repeat NBCA embolization with additional screlotherapy in three and combined surgery in two. Final DR showed 100% was one (type 3), 80-99% was seven (type 1 two, type 2 three, type 3 two), 60-79% was three (type 2), <60% was one (type 2) at mean 15.3 months follow-up. Final DR >80% achieved 66.7%. The DR <80% was all type 2 which received repeat embolotherapy over three times.
Conclusion: staged embolotherapy using NBCA was an effective method for management of HFAVMs of the extremities. Regarding type 2, repeat embolotherapy is essential.

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Pregnancy after embolization of uterine arteriovenous malformations

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Purpose: to review the incidence of pregnancy after embolization of uterine arteriovenous malformations (AVM).
Materials/methods: eighteen women with severe menorrhagia were diagnosed with AVM by a combination of sonography, MRI and angiography. These patients were embolized with multiple embolic agents including n-butylcyanoacrylate adhesive, Gelfoam, coils and polyvinyl alcohol particles. Follow-up ranged from 14 months to 10 years. Retrospective chart review was performed to determine the incidence of pregnancy.
Results: eighteen women of child bearing age (range 22-43, mean 32) were embolized for menorrhagia secondary to uterine AVM. Eight women conceived and seven had normal full term pregnancies. One woman had a spontaneous abortion in the first trimester.
Conclusion: successful full term pregnancy is possible after embolization of uterine AVM.

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Yttrium-90 liver radioembolization (Y90-RE): 99mTc-MAA SPECT/CT tumoral uptake after angiographic redistribution of intrahepatic vessels

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Purpose: to evaluate the usefulness of redistributing arterial supply by microcoil embolization prior to Y90-RE in patients with arterial anatomical variants (AAV), in order to obtain a safe and effective delivery of Y90 microspheres from 1-2 feeding tumoral pedicles.
Methods: 24 patients with liver neoplasms and AAV underwent a 99mTcMAA SPECT/CT immediately after redistribution. Perfusion of lesions in redistributed segments (L-RS) was assessed by comparing their uptake of 99mTcMAA with that of lesions in non-redistributed segments (L-NRS), and graded as absent, reduced or normal. Y90 microspheres were injected from same sites. Tumor response after 3 months in L-RS was compared with that in L-NRS and graded as similar, better or worse. AAV were classified according to Michel.
Results: among 11 patients with type I AAV in which segmental vessels (mainly 2-3 or 4) were occluded, perfusion of L-RS was graded as similar (7) or reduced (4). Among the remaining 13 patients with AAV types III (3), V (4), VIII (3) and others (3) in which aberrant arteries were occluded, perfusion of L-RS was graded as similar (8), reduced (4) or absent (1). Globally, 99mTcMAA uptake in L-RS was present in 96% and similar in 62% of cases. Tumor response in L-RS was similar in 23 cases and worse in 1 case. No complications were recorded.
Conclusion: after angiographic redistribution, 99mTcMAA particles and probably Y90 microspheres are able to go across intrahepatic collaterals and access the microvasculature of TL-RS. Redistribution may allow a safe and effective infusion of Y90 microspheres.

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Bland embolization for hepatocellular carcinoma with very small precisely calibrated micro-spheres: one year follow-up

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Purpose: seventy to eighty percent of HCC patients do not get diagnosed early enough, and chemoembolization (TACE) and embolization (TAE) are considered effective treatments for this advanced cancer stage. However, it is still unclear if TACE is more effective than TAE alone. The objective of our study is assessing feasibility, local response and early clinical outcomes of TAE using 40 and 100 µm micro-spheres in patients affected by unresectable HCC.
Materials/methods: since October 2007, 28 patients underwent TAE with diagnosis of HCC based on MDCT, alfa-fetoprotein and biopsy. Thirty-nine target lesions were embolized with a super-selective technique using 40 and/or 100 µm Embozene™ Microspheres (CeloNova BioSciences, Newnan, GA, USA). MDCT was performed 24 hours after treatment and repeated at 1, 3 and 6 months. Local efficacy was defined according to RECIST criteria.
Results: technical success was 100%. Minor complications were observed in two patients. Major complication was noted in one patient who unexpectedly died 24 hours after TAE due to pulmonary embolism of necrotic neoplastic tissue and particles passed through a disrupted hepatic vein. All 28 patients have at least one month follow-up. One year follow-up on 16/28 patients shows a survival rate of 94%. Local outcomes on target lesions at 1 year follow-up are: 2 CR, 4 PR, 2 SD, and 7 PD.
Conclusion: our early clinical and local tumor results in treating HCC with TAE using very small precisely calibrated micro-spheres show potential and deserve further evaluations.

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Transcatheter arterial embolization with n-butyl cyanoacrylate for treatment of endoscopically unmanageable duodenal ulcus bleeding

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Purpose: to evaluate the clinical efficacy and safety of transcatheter arterial embolization with n-butyl cyanoacrylate for endoscopically unmanagable duodenal ulcus bleeding.
Materials/methods: a total of 18 consecutive patients (10 men, 8 women; mean age, 54.6 years) underwent emergency transcatheter embolization between October 2006 and February 2009 for

endoscopically unmanagable duodenal ulcus bleeding. Hepatic artery angiography was performed and then selective injection was done through microcatheter in the gastroduodenal artery in order to identify the site of the bleeding. Microcatheter was advanced to as close as possible to the bleeding site. Gastroduodenal artery and duodenal branches were embolized with N-butyl cyanoacrylate.
Results: the site of bleeding were identified in 10 patients with angiographically (56%). In 8 patients, bleeding site was not demonstrated (44%). Successful embolization of gastroduodenal artery and duodenal branches was achieved in all cases (100%). Clinically and hemodynamically bleeding was interrupted after embolization. There was no major complication in all cases. Neither end-organ damage nor organ ischemia was observed related to the procedure. Clinically and technically success were 100%. Recurrent bleeding was not shown within 30 days.
Conclusion: transcatheter arterial embolization with n-butyl cyanoacrylate for endoscopically unmanagable duodenal ulcus bleeding is a highly effective and safe treatment modality.

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Analysis of prognostic factors after y90-radioembolization of advanced hepatocellular carcinoma

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Purpose: Y90 radioembolization (Y90-RE) is an emerging loco-regional treatment for hepatocellular carcinoma (HCC). We have analyzed which factors related to the patient, the tumor and the treatment may influence the outcome after Y90-RE.
Material/methods: 72 consecutive patients with advanced HCC treated with Y90-RE in our institution were studied to detect which factors may have influenced response to treatment and survival.
Results: median overall survival was 12 months (95% CI 8.8-15.1). Survival was significantly better in patients with less than five lesions (22 vs. 8 months, p<0.005) and in patients with an alpha-fetoprotein < 40 ng/ml (18 vs. 11 months, p 40 ng/mL, and their survival was significantly worse (7 vs. 18 months, p<0.05)).
Conclusion: Y90-RE results in control of target lesions in the majority of patients with HCC but does not prevent the development of new lesions. Survival of patients treated with Y90-RE seems to depend largely on factors related to the aggressiveness of the disease (number of nodules, levels of alpha-fetoprotein, and presence of micrometastasis).

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Distribution of image-able beads during transcatheter arterial embolization

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Purpose: current practice of transcatheter embolization, especially TACE, is limited by a lack of understanding of the spatial distribution of embolic material and drug inside the target tissue. Drug eluting beads (DEBs) are designed to simultaneously deliver chemotherapeutics and embolic material in a single image-guided step. DEBs also provide a mechanism to make TACE more reproducible and effective; however, they are not image-able and cannot provide real-time feedback. The purpose of this study is to develop image-able embolization beads and investigate their spatial distribution in vivo.
Materials/methods: image-able beads were synthesized by suspension polymerization followed by incorporation of iodized oil. Transcatheter embolization of swine liver and kidney was performed with image-able beads and evaluated with intraprocedural fluoroscopy and CT as well as ex vivo with microCT.
Results: image-able beads provided sufficient stability and contrast during transcatheter embolization to be visualized in hepatic and renal vasculature with routine fluoroscopy and CT. CT imaging during embolization procedures demonstrated a dose response relationship in the number and size of visualized vessels growing from distal to proximal. MicroCT of liver and kidney detected image-able beads within vessels aligned in a columnar arrangement with large gaps between embolized arteries.
Conclusion: image-able beads are visualized with routine intraprocedural fluoroscopy and CT. These beads are useful to demonstrate the influence of technique, including bead dilution, catheter position and embolization end point, on bead distribution in the targeted tissue. Furthermore, these image-able beads provide real-time feedback and may provide intra-procedural identification of tissue at risk of under treatment.

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Percutaneous injection of liquid embolic material: an adjunct to the preoperative treatment of hypervascular lesions of the head and neck

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Purpose: the purpose of our study is to demonstrate our experience utilizing percutaneous injection of liquid embolic agents for embolization of hypervascular lesions of the head and neck. We will describe the technical aspects of the procedure and its efficacy in reducing intraoperative blood loss.
Materials/methods: we retrospectively studied 22 patients from January 2003 to January 2009, with 23 hypervascular lesions of the head and neck who underwent diagnostic angiography and subsequent embolization utilizing percutaneous injection of Onyx or n-BCA. Percutaneous injection of liquid embolic agents was performed under ultrasound and/or fluoroscopic guidance and utilized in tumor compartments incompletely devascularized with particulate material. Eleven paragangliomas, six juvenile angiofibromas, four arteriovenous malformations, and two venous malformation required percutaneous treatment. Documented blood loss was obtained from operative reports from sixteen patients.
Results: homogenous intratumoral penetration with progressive blood flow stasis was achieved during each injection. There were a mean of two needles placed percutaneously into the tumors (range 1-5). The mean intraoperative blood loss was 425 cc (range 40-2000 cc). In resected tumors, intraoperative blood loss was less than 100 cc in 8 patients (50%). Complete angiographic devascularization was achieved in 14 of 23 tumors. There were no complications from the percutaneous access or embolization of these hypervascular lesions.
Conclusion: the percutaneous injection of liquid embolic agents for treatment of hypervascular lesions of the head and neck is technically feasible and safe. Intra-operative blood loss appears less; however, further follow-up data is required.

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Preclinical evaluation of coated amplatzer vascular plug in a canine model

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Purpose: to evaluate the efficacy and recanalization rates of a newly designed amplatzer vascular plug in a canine model.
Materials/methods: the new coated amplatzer vascular plug (CAVP) is a cylindrical self-expanding device consisting of nitinol braided wires coated with a polyurethane/silicone blend membrane on each end. Twenty-four arteries of 3 adult dogs were embolized using transcatheter techniques. CAVP devices of diameters 4, 6 and 8 mm were delivered through a 5F guiding catheter into each side of the animal in the dorsal scapular, carotid, and axillary arteries, respectively. A 4 mm CAVP was also placed in the right internal thoracic artery. In the contralateral side, a single 4 mm standard AVP was placed as a control. Angiography was performed to monitor occlusion time after plug placement. The recanalization rate was monitored at 1 week, 1 month, 2 months and 3 months by follow-up angiography. The animals were sacrificed after 3 months follow-up and the specimens were harvested for pathological examination.
Results: complete occlusion was obtained immediately after releasing in all CAVP (n=21); the standard AVP had a mean occlusion time of 11 minutes after release (n=3). There were no recanalizations of the CAVP at follow-up timepoints, while all 3 of the regular AVP were recanalized at 1 week. Pathology revealed formation of organized thrombus in all CAVP.
Conclusion: the coated amplatzer vascular plug is a very effective vascular occluder, which blocks blood flow and provides immediate occlusion after deployment with no recanalization up to 3 months in the animal model.

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Transarterial radioembolization (TARE) for hepatocellular carcinoma

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Purpose: transarterial radioembolization (TARE) is an emergent technique with promising results for unresectable HCC. This study aims to quantify tumor response and patient survival in patients receiving TARE.
Materials and methods: all HCC patients treated with TARE using Yttrium -90 microspheres (Therasphere) from December 2006 to January 2009 were reviewed. Contrast enhanced CT imaging pre and post treatment was used to assess objective tumor response using RECIST criteria-1D, WHO criteria-2D and 3D tumor volume.
Results: twenty-seven patients were identified, 6 were excluded: clinical deterioration prior to treatment (3), aberrant hepatic arterial supply (1) and significant hepatopulmonary shunting (2). Twenty-one patients reviewed, mean age 62±15 years. Five patients had received previous TACE or RFA. Using the Barcelona Clinic Liver Cancer classification, 1 patient was early stage (A), 16 patients intermediate (B), and 4 advanced (C). Ten patients had multifocal and 11 solitary HCC, 6 had portal vein thrombosis. Mean AP tumor diameter pre treatment was 8.7±5.6 cm (1.7-23.5 cm), mean tumor volume 695.5±920 cm3 (8-3864 cm3). Objective tumor response demonstrated 52% partial response (n=11), 23.8% stable disease (n=5), and 23.8% progressive disease (n=5). Mean survival was 13.9±2 months (95% CI, 10-17.9), Median survival 11.1±2.7 months (95% CI, 5.9-16.4). One patient achieved down staging and surgical resection. One patient developed a gastric ulcer associated with treatment.
Conclusions: Yttrium-90 radioembolization is an effective treatment for unresectable HCC. Partial responses are seen in more than 50% of patients, according to WHO and RECIST criteria. Results suggest a survival benefit and an acceptable safety profile.

P-142

Analysis of complications associated with particle reflux during embolization and chemoembolization of liver lesions

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Purpose: to assess potential factors and risks for complications due to non-target embolization (NTE) during trans arterial chemoembolization (TACE) procedures.
Material and methods: in a period of 24 months, 308 TACE procedures were performed. Analysis of every procedure was performed searching for those patients having complications related to nontarget embolization (NTE). Amount of employed embolization material, type and size of embolic material, functional status of the affected organ and collateral perfusion were in every case evaluated.
Results: after image and statistical analysis, particle reflux was associated to the following complications in our series: liver infarction/abscess (2.7%), acute pancreatitis (1.9%), acute cholecystitis (1.4%), splenic infarction (1.4%), ischemic hepatitis (0.8%), gastrointestinal mucosal lesions (0.7%) and spinal cord injury (0.3%). The two most common observed mechanisms associated with particle reflux complications were the amount of refluxed material and size of particles (>300 μ) (Pearson's $\chi 2(1)=4.5000$, Pr=0.034, Fisher's exact test=0.040). The ratio between adverse events after TACE in patients who received a total volume of less than 2 ml of particles, comparing with those who's received more than 2 ml was 1:8.
Conclusion: clinical relevant statement: particle reflux is a dynamic process that should be well understood to permit better understanding of its effects and to prevent its development. It is a well-known event, but its pathophysiological basis (mechanisms) is poorly understood. This work is a first approach to the study of particle reflux that combines the results of experimental data and basic clinical research.

P-143

Pulmonary arteriovenous malformations: comparison of reperfusion rate following embolization with IDC and amplatzer devices

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Purpose: to compare long-term efficacy of interlocking detachable coils (IDCs) versus amplatzer vascular plugs (AVPs) in treatment of pulmonary arteriovenous malformations (PAVMs).
Materials/methods: between 2004 and 2009, 32 consecutive patients had 70 PAVMs treated by embolotherapy. Forty-two PAVMs were treated by IDCs in 22 patients and 29 PAVMs were treated with AVPs in 21 patients. Immediate success was defined as complete absence of flow through the PAVM after embolization without need for other embolization material. Long term success was defined either as a complete resolution of the PAVM nidus and the reduction in size of the draining vein on follow-up scans or an absence of flow through the PAVM on a subsequent pulmonary angiogram.
Results: all attempts at PAVM closure were successful initially. Imaging follow-up after embolization (17 months; 1-40 months) was

available in 35 PAVMs treated with IDCs and in 26 PAVMs treated with AVPs. Ten (29%) of 35 PAVMs treated with IDCs and 2 (8%) of 26 PAVMs treated with AVPs demonstrated recanalization. Recanalization was the only cause of PAVM reperfusion with either IDCs or AVPs. Mean feeding artery diameter was 3.5 and 5.1 mm, respectively, for PAVMs treated with IDC and AVPs (p=0.0003). The OR of developing reperfusion, adjusted for feeding artery size, is 7.2 (95%CI: 1-52) for IDC compared to AVP, (p=0.05).
Conclusion: embolization of PAVMs with AVPs was associated with a significantly lower recanalization rate than with IDC.

P-144

Thrombolysis of native arterial and bypass graft occlusions with intra-arterial alteplase: a single-centre experience over five years

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Objectives: a retrospective analysis of the results of thrombolysis for peripheral arterial occlusive disease at a university hospital over 5 years.
Design, **Materials and methods:** the results up to one year of all patients undergoing catheter directed thrombolysis (CDT) with alteplase for native arterial and bypass graft occlusions over the previous 5-year period were analysed. Outcomes were measured and correlated with frequency of surgical revascularization, amputation rate and amputation-free survival at 6 and 12 months. The complication rate was also recorded.
Results: complete data on 33 patients were available. Successful thrombolysis was achieved in 57% of cases (n=20), with a complication rate of 17% (n=6). Overall mortality at one year was 11.1% (n=3). Patients in whom CDT succeeded were less likely to require surgical revascularization or amputation in the subsequent six months than those in which it failed (28 vs. 73%, p=0.01) and had a superior amputation-free survival at both 6 months (89 vs. 67%, p=0.15) and 12 months (86 vs. 62%, p=0.19), although this did not attain statistical significance.
Conclusion: CDT is a relatively safe procedure that can play an important role in decreasing the likelihood of early surgical intervention and thereby reducing patient morbidity. Whether it significantly improves long term outcome remains to be confirmed.

P-145

Initial experience of TACE with drug eluting microsphere (DEM-TACE) for breast cancer liver metastases (BCLM) using HepasSphere

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Purpose: to estimate local effects of DEM-TACE with HepaSphere on tumor in case of unresectable BCLM who were failures for systemic chemotherapy or conventional TACE with HepaSphere.
Materials/methods: a total of 16 patients with BCLM with or without general metastases that had poor response for treatment of several times conventional TACE with HepaSphere were treated from July 2007 to December 2008. Epirubicin(10-30 mg), cisplatinum (20-50 mg), docetaxel (20 mg), oxaliplatin (50-100 mg), 5-FU (250 mg) or Avastin (50-100 mg) was loaded on Hepasphere (50-100 micron, 10-25 mg). The end point of embolization was elimination of tumor blush without occluding hepatic arteries. The same procedure was repeated two or three times. The local tumor effect was evaluated by CT examination after the treatment sessions according to the RECIST criteria.
Results: in all patients, the procedure was successfully done. There were no serious complications including severe post embolization syndrome or symptoms caused by undesired arterial occlusion during or immediately after the procedure. The local effects are 0% CR, 10.5% PR, 60.5% SD and 29% PD. The objective response rate was 10.5%. There were no adverse events higher than Grade 3 during treatment course.
Conclusion: DEM-TACE for BCLM using HepaSphere is feasible with low complications rate. The objective response rate was lower than the conventional TACE, because DEM-TACE was the second line treatment in this study. However, the rate of PD was only 29% even for patients who were failures for the first line treatments. A comparative study between the two procedures as the first line treatment will be required.

P-146

Percutaneous embolisation of visceral pseudoaneurysms: medium and long term results

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Purpose: to evaluate the efficacy and the results of percutaneous treatment of visceral pseudoaneurysms.
Materials/methods: fifty-five patients with visceral pseudoaneurysms were treated with percutaneous embolisation. Pseudoaneurysms were located in the extrahepatic region (n=11), intrahepatic region (n=8), hepatic vein (n=2), splenic artery (n=9), superior mesenteric artery (n= 3), celiac trunk (n=1), left gastric artery (n=1), subclavian artery (n=3), carotid artery (n=1) and renal artery (n= 17). Embolisation was performed using different materials: coils, gelfoam, plugs, alcool, thrombin glue, alone or in combination.
Results: embolisation was successfully performed in 52/55 patients (94.5%). In 2 cases, a reintervention was necessary to obtain the complete resolution of the pseudoaneurysm. In 3 cases (5.5%), the treatment resulted incomplete, while in 2 cases (3.6%) a surgical intervention was necessary to obtain the complete resolution of the psedoaneurysm. One patient (1.8%) died for the rupture of the pseudoaneurysm after an incomplete embolisation and before the surgical intervention. After a mean follow-up of 9.3 months, all patients are alive with exclusion of the aneurysm.
Conclusion: the embolisation of visceral pseudoaneurysms represents a safety and efficacious procedure to obtain the complete exclusion of the pseudoaneurysm reducing the high mortality rate of surgical intervention.

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P-148

Irinotecan drug eluting beads (DEB) TACE: experience and medium term survival data from a single centre

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Purpose: to evaluate and discuss the therapeutic efficacy, disease-free survival, complications and medium term survival of patients treated with irinotecan DEB for colorectal liver metastases.
Materials/methods: over a period of 18 months, 24 patients (28 procedures) presenting with colorectal liver metastases were treated with irinotecan DEB at our centre. Most patients had progressive disease despite conventional chemotherapy. Radiofrequency ablation was performed in 17 of the patients. 100-300 um sized beads were used in all cases, at a dose of 80-100 mg. Most of the patients (67%) had 2 or more lesions. 20 patients had 1 procedure,

4 patients had more than 1 procedure of TACE. The tumours ranged in size from 1.6 to 8 cm. All the patients were followed up clinically and initially with a 4 week CT scan to assess response. The modified RECIST criteria were used to assess response.
Results: 3 patients had a complete response, 11 patients had a partial response, and stable disease was seen in 5 patients. 5 patients had progression of their disease. 12 patients are alive and 12 patients have died (survival range 82-409 days) since their procedure.
Conclusion: the use of TACE using irinotecan DEB in patients with colorectal liver metastases is safe and well-tolerated. This mode of treatment has proven to be target specific, carries low toxicity and delivers a high chemotherapeutic dose so that there is increased tumor response.

P-149

Bone tumors and preoperative embolization: technique and results

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Purpose: to evaluate the impact of preoperative embolization in primary and metastatic bone tumors.
Materials/methods: from 1999 to 2008, preoperative bone tumors embolization was performed in 30 patients with tumors primary or metastatic bone lesions, followed by partial or complete surgical resection and stabilization. The tumors were embolized with polyvinyl alcohol particles (PVA) (150-500 µm) in 14 patients and with trisacryl (Embosphere®) in the remaining 16 patients. Metal coils were also used in 6 patients in order to avoid the embolization of non-target areas.
Results: embolization was complete in 8 patients, quite complete in 14 patients and partial in 8 patients. All the patients underwent a complete or partial surgical resection 24-96 hours after the embolization procedure. No complications were observed after performing the embolization, leading to a decrease in the intraoperative blood loss and improving the surgical resection.
Conclusion: bone tumour preoperative embolization is a safe, effective technique in the preoperative management of both primary and secondary lesions.

P-150

Distal protection of the gallbladder through embolization of the cystic artery prior to radioembolization: technical feasibility and safety

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Purpose: to evaluate the safety and efficacy of two different methods of proximal cystic artery embolization in patients undergoing Yttrium-90 radioembolization.
Materials/methods: 46 patients had cystic artery embolization performed immediately prior to Yttrium-90 radioembolization, either using gelfoam pledgets (n=35) or coils (n=11). Clinical symptomatology during the admission and angiographic findings at one month follow-up were retrospectively reviewed. Rates of collateralization or recanalization of the cystic artery were compared, as well as the frequency of post-procedural abdominal pain and need for cholecystectomy.
Results: technical success was achieved in all patients, and there were no procedural complications related to cystic artery embolization. Of the 11 coil-embolized patients, five demonstrated collateralization of the cystic artery at one month, and one demonstrated recanalization of the cystic artery. Of the 35 gelfoam-embolized patients, two had collateralized at one month, and 14 had recanalized. Two patients (one from each group) had post-procedural right upper quadrant pain, and one patient in the coil embolization group required cholecystectomy prior to angiographic follow-up.
Conclusion: proximal cystic artery embolization is safe and feasible and may be performed during liver-directed embolotherapy to minimize the exposure of the gallbladder to particulate, chemoembolic, or radioembolic agents.

P-151

Endovascular treatment of pelvic congestion syndrome: retrospective study in 132 patients

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Purpose: to present a retrospective series of 132 patients suffering from pelvic congestion syndrome (PCS) treated by embolotherapy.
Materials/methods: mean age of the patients was 37.1 years (range 23 to 53 years). Inclusion criteria were: patients with typical chronic pelvic pain for more than 6 months without evidence of other causes, increase venous caliber (>6 mm), findings of venous ectasia, venous reflux and presence of communicants (measured by transvaginal US Doppler) and venography demonstration. Both ovarian and hipogastric veins were embolised in all cases using different size coils. Pain level of the patients was assessed pre and post embolotherapy and one month post-therapy using a visual analogue scale (VAS). The patients filled in our own questionnaire to evaluate the grade of satisfaction and changes that affect their life quality. Clinical and US-Doppler studies were recorded in the follow-up (1, 3, 6 and 12 months, and every year after).
Results: technical success was achieved in 130 patients (98.5%) and clinical success (moderate improvement and disappearance of symptoms) in 112 patients (85.1%), with disappearance of all symptoms in 29 (25.8%) of the patients. No patient showed worsening of clinical status. Main complications were coil migration (2 cases), perforation of vein wall (5 cases), groin haematoma (3 cases), retroperitoneal haematoma (1 case). Mean follow-up was of 17.6 months (range 46-1460 days). The grade of satisfaction and clinical improvement recorded by the patient was positive in 90% of the cases.
Conclusion: endovascular treatment using embolisation of the ovarian and internal illiac veins is a good option in the management of symptoms of pelvic congestion syndrome.

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Single center outcomes of embolization for arterial upper gastrointestinal bleeding after failed endoscopic therapy

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Purpose: to assess results of embolization for upper gastrointestinal (UGI) bleeding.
Materials/methods: we retrospectively reviewed all patients undergoing embolization for arterial UGI bleeding between 10/97 and 9/08. Patient demographics, clinical course, transfusions, and embolization procedures were studied.
Results: 66 patients underwent UGI embolizations. Mean patient age was 61 (18-94). There were 43 males and 23 females. Average follow up was 319 days. 56/66 (84.8%) failed endoscopic therapy. 52/66 (78.9%) patients were embolized on initial angiography (23 with active bleeds identified, 29 empirically embolized-no bleeding site seen). 17/21 (81%) patients who underwent repeat angiography had no bleeding identified on initial angiography. 11 of these 21 (47.6%) underwent embolization for an active bleeding site. 14 patients had bleeding recurrence after embolization of which 6 died (3 had extensive GI cancers). 9 additional deaths occurred due to

other etiologies. None of the 15 deaths were considered operative candidates. 9/15 (60%) of deaths had no bleeding site seen on their initial angiogram. 23 patients had follow-up endoscopies, all negative for bleeding, ischemia or infarction. One patient developed renal failure due to contrast nephropathy. There were three technical complications of angiography (2 cases coils prolapsed into a main arterial branch - one coil was snared and removed; the other was left alone due to minimal prolapse). A microcatheter tip broke off within the coiled vessel in one patient.
Conclusion: embolization following failed endoscopic therapy for arterial UGI bleeding can be beneficial. Patients who have a negative initial angiogram have a high mortality rate.

P-153

Transarterial chemoembolization with doxorubicin-eluting beads in the treatment of hepatocellular carcinoma: one year survival results

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Purpose: retrospective study to evaluate local tumor control and survival data after transarterial chemoembolization with doxorubicin-eluting beads in palliative treatment of hepatocellular carcinoma at Hospital de São João.
Materials/methods: a total of 53 patients (mean age, 61.7 years; range 42-84 years) with unresectable hepatocellular carcinoma were treated with chemoembolization between April 2007 and November 2008. In total, 82 chemoembolization procedures were performed in superselective manner with microcatheter (mean, 1.55 sessions per patient). The local chemoembolization protocol consisted of doxorubicin-eluting beads mainly 300-500 micra but also 500-700 micra and 700-900 micra, loaded with 37.5 mg of doxorubicin to a maximum dose per session of 150 mg doxorubicin. Tumor response was evaluated with CT imaging. Change in tumor size was calculated and response was evaluated according to the criteria of the European Association for the Study of the Liver (EASL). Survival from first chemoembolization session was calculated according to the Kaplan-Meier method in the subgroup treated between April 2007 and January 2008. Follow-up imaging was performed until January 2009 or patient death.
Results: evaluation of local tumor control resulted in complete response (40.9%), partial response (27.3%), objective response (complete+partial) (68.2%), stable disease (18.2%) and progressive disease (13.6%). The 1-year survival rate after chemoembolization was 54.5%.
Conclusion: chemoembolization with doxorubicin-eluting beads is a minimally invasive, safe and effective therapy option for palliative treatment of hepatocellular carcinoma.

P-154

Transcatheter therapy for symptomatic, unresectable hepatic metastases of neuroendocrine tumors

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Purpose: to study survival benefits, radiological response and safety of transcatheter treatment with Y-90 and transarterial chemoembolization (TACE) in patients with symptomatic, unresectable and chemorefractory neuroendocrine tumor (NET) hepatic metastases.
Materials/methods: patients who underwent TACE/radioembolization for hepatic metastases of NET were studied. Imaging response was assessed by RECIST criteria. Complications are reported using NCI CTCAE (version3) criteria. Fisher exact test, independent T test, Kaplan Meier estimator with log rank test and Cox regression method were performed for statistical analysis.
Results: all 19 patients had bilobar multinodular liver metastases. Ten patients were treated with TACE and nine with Y-90. The overall median and mean survivals from the diagnosis of hepatic metastases were 675 days (285-1064) and 1330 days (787-1874). The survival rates at 1 year and 2 years and 5 yrs were 84 and 48% and 38%. The 1-yr survival rates from first transcatheter therapy in patients with carcinoid tumor (n=8) and other NET (n=11) were 38 and 75% (p=0.009). Partial response (PR) and stable disease (SD) were found in 26.3% (5/19) and 26.3% (5/19) of patients. Progressive disease (PD) by RECIST criteria was found in 31.6% (6/19) of the patients. The mean progression free duration was 447 days (48-1878). No procedure related mortality or hepatic failure was reported in patients treated with either modality. CTACE grade 4 clinical toxicity was reported in one patient treated with TACE.
Conclusion: transcatheter chemoembolization and radioembolization are safe and feasible for treatment of symptomatic, hepatic metastases of neuroendocrine tumors. Non-carcinoid neuroendocrine tumors appear to have a better survival after transcatheter treatment than carcinoid tumors.

P-155

Pilot study of transcatheter arterial chemoembolization during portal vein occlusion for unresectable hepatocellular carcinoma with marked arterioportal shunts

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Purpose: to assess the clinical effects of transcatheter arterial chemoembolization (TACE) during the corresponding portal vein occlusion (TACE-PVO) in patients with hepatocellular carcinoma (HCC) and marked arterioportal (AP) shunts.
Materials and methods: this was a prospective, nonrandomized study of TACE-PVO in patients with HCC who had marked AP shunts. The subjects were 21 patients with unresectable HCC and marked AP shunts who underwent shunt embolization with the use of coils and/or gelatin-sponge particles (group A: n=7) or by TACE-PVO (group B: n=14). Written informed consent was obtained and the study was approved by the hospital IRB. Clinical parameters and data on embolization of AP shunts and on tumor response were assessed prospectively.
Results: no major procedure-related complication occurred in either group. Effectiveness for AP-shunt treatment was significantly better in group B than in group A in terms of both immediate results (P=0.009) and subsequent results (P=0.028). Tumor response in the therapeutic target area was significantly (P=0.002) better in group B than in group A. The 1- and 2-year survival rates in group A were 28.6 and 0%, respectively, whereas the 1-, 2-, and 3-year survival rates in group B were 85.7, 64.3, and 42.9%, respectively. Survival was significantly better in group B than in group A (P = 0.008).
Conclusions: TACE-PVO may be a safe and useful therapy for selected patients with unresectable HCC and marked AP shunts.

P-156

Protecting the gut from toxic hepatic regional therapy

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Learning Objectives: identify equipment and techniques to improve protection of extrahepatic organs from injury during regional therapy to the liver.

Background: advances have been made in transarterial regional therapies for treating liver malignancies. Cytotoxicity may result in both improved tumor destruction as well as potential complications due to nontarget delivery to the gut caused by administration of agent that flows into arteries that arise from the hepatic arterial circulation and insert into nearby viscera. The various technical advances that have allowed GI ulcer rates to be reduced from 15% to approximately 1% will be reviewed.
Clinical findings and procedure details: cone beam CT permits multiplanar reformatted display of CT-like images to assess hepatic versus extrahepatic vessel perfusion as well as volume rendered display of complex vessel anatomy to assist microcatheter vessel selection. Recent microcatheter developments allow improved arteriographic imaging, agent delivery, and ability to select vessels with challenging anatomy. Shapeable and preshaped microguidewires have increased the ability to subselect targeted arteries. Microcoil technological advances include intentional detachability and expandable biopolymer coating. These microcoil features significantly improve controllability of deployment, safety from migration, and occlusiveness.
Each of the hepatosplanchnic arteries that may need to be occluded present unique challenges based on the vessel caliber, angularity and location of origin, branching pattern, and propensity for distal recanalization. Vessel-specific issues and techniques to employ for coil occlusion, vessel exclusion, or distal delivery of the cytotoxic agent are discussed.
Conclusion: specific equipment and techniques can significantly reduce nontarget injury during hepatic regional therapy.

P-157

Usage and applicability of Cyanoacrilate monomer: further vascular malformations

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Learning Objectives: to show the many and diverse interventional applicabilities of Co-momomer of N-Butyl-2-cyanoacrilate (Glubran®) in the vascular and also in the visceral field. We explain the technical aspects, tips & tricks, and the cautions for a proper usage. We present our experience over 125 cases showing differents examples.
Background: Glubran is a biocompatible acrylic glue with CE Mark. It is former indication was to treat vascular malformations mainly in neurorradiology. Cyanoacrilate is a colourless, water density, high adhesive and radiolucent liquid substance with a characteristic smell and haemostatic and bacteriostatic properties. It polymerises in contact with any biological fluid making a solid cast that causes an irreversible occlusion of blood vessels or visceral ducts. Polimerization time lasts 60 to 90 seconds at a temperature of 45ºC. After an embolization, glue is slowly removed by means of a hydrolytic breakdown process that takes months or years depending on the amount of glue and type of tissue.
Procedure details and clinical findings: we have to combine cyanoacrilate with lipiodol to get radiopacity. We also establish the ratio of glue/lipiodol in order to achieve different polimerization times. Catheter should be flushed previously with a non ionic liquid in order to prevent intra-catheter polimerization. The catheters required way and velocity of injection and product concentration are exposed and supported through the different cases.
Conclusion: Glubran® has a learning curve but it is a very useful, quick, chip and safe liquid when we have to do an irreversible embolization.

P-158

Pelvic trauma: bleeding vessels

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Learning Objectives: 1) To review the normal CT and angiographic pelvic vascular anatomy. 2) To demonstrate the spectrum of imaging findings in vascular injuries encountered in pelvic trauma. 3) To present successful endovascular treatment methods for pelvic vascular injury.
Background: haemodynamic instability related to pelvic fractures has an associated morbidity and mortality rate of up to 60%. Arterial haemorrhage detected at CT angiography, followed by emergency angiographic embolisation, plays a cardinal role in the management of these patients.
Clinical findings and procedure details: here, we present a pictorial review to illustrate the spectrum of vascular injuries seen in severe pelvic trauma. Arterial injuries and extravasation of the iliolumbar artery, the lateral sacral arteries, the superior gluteal artery, the internal pudendal and the obturator artery are demonstrated with angiographic images. Different embolization approaches are presented and discussed.
Conclusion: the combination of multidector CT of the pelvis and prompt angiography has a key role in the management arterial injury following severe pelvic trauma.

P-159

Angiographic embolization in unusual life-threatening hemorrhage

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Learning Objectives: to present a comprehensive pictorial review focusing the efficacy, safety, and predictors of outcome of angiographic embolization in the management of rare causes of major hemorrhage.
Background: angiographic embolization of bleeding vessels is increasingly used in patients not only with traumatic injuries, but also in iatrogenic situations, postoperatively and in some vascular malformations. This is especially true in emergency situations, where the hemorrhage can be life-threatening.
Procedure details: we retrospectively reviewed cases of acute hemorrhage with unusual origin presented at our emergency department, emphasizing the angiographics procedures to resolve them.
Conclusion: angiographic embolization is considered to be a safe and effective method for the management of major internal hemorrhage at emergency department. Beside curative purpose, angiography is also useful to confirm the diagnosis and to correlate the variety of symptoms with the extent of the lesion.

P-160

Diagnosis and endovascular management of uterine arteriovenous malformations

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Learning Objectives: to review the prevalence, pathophysiology and clinical presentation of uterine arteriovenous malformations (AVMs). To illustrate the typical imaging finding using ultrasound,

MRI and angiography. To demonstrate the role of embolotherapy in the management of these lesions.
Background: uterine AVMs are a rare but potentially serious cause of menorrhagia and recurrent abortions. Ultrasound is the first-line imaging tool for diagnosis, supplemented by MRI and angiography. Embolization is an effective alternative to hysterectomy that preserves the potential for future pregnancy.
Procedural details: using examples from our tertiary referral centre, we will: 1. Present diagnostic imaging findings included annotated ultrasound, MRI and angiographic examples. 2. Discuss endovascular interventional techniques for the treatment of uterine AVMs.
Conclusion: uterine AVMs should be considered in cases of refractory uterine bleeding. In this exhibit, the radiological findings and transcatheter techniques for the treatment of uterine AVMS are presented.

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P-162

The role of interventional radiology in the management of post-partum haemorrhage

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Learning Objectives: to describe the techniques used in emergency uterine artery embolisation in the setting of immediate and post partum haemorrhage and to highlight the increasing role of interventional radiology as a crucial component of the multidisciplinary team decision-making process
Background: selective uterine embolisation (SAE) is a well-established technique in the non- surgical management of severe postpartum haemorrhage (PPH). This minimally invasive technique has reported high success rates of over 95% in arresting both early and late PPH, therefore, sparing surgical arterial ligation and emergency hysterectomy. Early involvement of the vascular interventional radiology service is important to ensure a good outcome.
Clinical findings and procedure details: the technique of selective uterine artery embolisation will be described in the prophylactic management of haemorrhage in conditions such as placenta praevia and acreata and in early and late post-partum haemorrhage. These techniques will be illustrated with recent cases referred by the obstetric department in our institution and a review of the literature.
Conclusion: although the mortality rate from PPH remains low, there is a significant associated morbidity associated with surgery and anaesthesia in the post partum patient. The minimally invasive nature of SAE reduces the early and late complication rate, reduces hospital stay and has been associated with a return to menses and normal fertility. All interventional radiologists providing an obstetric referral service should be aware of the indications for intervention and understand the techniques in SAE.

P-163

Use of amplatzer vascular plug in interventional radiology: technical aspects and limitations

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Learning Objectives: to illustrate various indications of a recently developed endovascular occlusion device, the Amplatzer Vascular Plug (AVP) in interventional radiology and to focus on procedure details and limitations of this device.
Background: although embolization with coils may be considered the first-line therapy in the treatment of numerous pathologic conditions, the impossibility to control the release of coils involves the risk of migration and the great difficulties to occlude large vessels are the main limitations. AVP is composed of a self-expanding cylinder made of nitinol, which is fixed by a microscopic screw and an introduction wire made of stainless steel.
Clinical findings and procedure details: from our experience of 29 patients treated with AVP between October 2005 and January 2009, we aim to explain the technical details for an optimal use of AVP. The breakdown of cases include 3 subclavian arteries, two large renal arteriovenous fistula, 9 internal iliac arteries before EVAR, two ruptured internal iliac artery aneurysms, two pulmonary aneurysms, five patients in the emergency settings, three portal embolization, and one splenic embolization for small-for-size syndrome after liver transplantation and two renal aretery embolizations. Difficulties to deliver the device in tortuous vessels can be ameliorated by using a guiding catheter. A delay of several minutes is sometimes necessary for total vessel occlusion after AVP deployment. Principal causes of non efficacy are post traumatic haemostasis disorders.
Conclusion: amplatzer vascular plug is a new essential device in the arsenal of the interventional radiologist with conditions of knowing to utilize.

P-164

Successful transcatheter arterial embolization for traumatic mesenteric pseudoaneurysm and arteriovenous fistula formed in penetrating wound

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We performed transcatheter arterial embolization(TAE) for mesenteric pseudoaneurysm and arteriovenous fistula formed in a penetrating wound.
The postprocedure course was good without intestinal necrosis. Detailed evaluation of CT before TAE was useful in diagnosis and determination of treatment plan.

P-165

Successful treatment of mesenteric varices after living-donor liver transplantation with retrograde transvenous obliteration via an abdominal wall vein

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[2]Transplantation & Pediatric Surgery, Kumamoto University Graduate School of Medical and Pharmaceutical Sciences, Kumamoto, Japan.

We report the case of a 12-year-old girl with melena due to the rupture of mesenteric varices after living-donor liver transplantation. This report describes the successful management of the mesenteric varices by transvenous obliteration performed via an abdominal-wall collateral vein.

P-166

Unusual case of lower GI bleed

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A 47-year-old lady presented with intermittent bright red lower GI bleeding and discoloured right leg.
CT scan showed tumour eroding into the right external iliac artery, which was embolised with coils .This stopped the GI bleeding, and leg discolouration improved.

P-167

Acute systemic hypertension precipitated by ^{90}Y radioembolization

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Radiology, UCSD Medical Center, San Diego, CA, United States.

Chronic portal hypertension and acute systemic hypertension in patients with neuroendocrine tumors are known complications of TACE and SIRT. We present a case of acute severe intraprocedural systemic hypertension in a patient with colorectal liver metastases undergoing 90Y SIRT.

P-168

Superselective embolization of a life-threatening hematoma in ossificans myositis correlated to persistent vegetative state

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[1]Diagnostic and Interventional Radiology, "SS. Annunziata" Hospital, AUSL TA, Taranto, Italy, [2]Rehabilitative Intensive Care, "San Raffaele" Foundation, Ceglie Messapica, Italy.

A life-threatening thigh hematoma in a 26-year-old patient with ossificans myositis due to persistent vegetative state was successfully treated by superselective embolization with cianoacrylic glue. As far as we are concerned, no similar reports are present in literature.

P-169

Interventional approach to high-flow symptomatic congenital portosystemic shunt with improvement in chronic psychosis

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Radiology, University of Utah, Salt Lake City, UT, United States.

We present a case with improvement in severe psychosis after interventional treatment of a large, congenital, high-flow portosystemic shunt. The phenomenon of altered behavior with congenital shunts is described in the veterinary literature. Surgery is the commonly described therapy.

P-170

Latrogenic femoral artery pseudoaneurysm treated with US-guided thrombin injection that required balloon occlusion of the SFA and additional n-butyl-cyanoacrylate (NBCA) injection: a case report

R. Yoshida, *G. Tsuji, S. Koyama, J. Yoshigi;*
Radiology, Yokosuka Kyosai Hospital, Yokosuka, Japan.

The patient had giant high-flow pseudoaneurysm of SFA caused by wrong insertion of double-lumen catheter. We treated with ultrasound-guided thrombin injection, but required balloon occlusion of the SFA and additional n-butyl-cyanoacrylate (NBCA) injection because of large puncture wound.

P-171

Common hepatic artery pseudo-aneurysm after modified Appleby operation: treatment with coil embolization preserving hepatic arterial flow

M. Tsuda, *K. Seiji, T. Okumoto, T. Yamada, T. Matsuhashi, K. Takase, S. Takahashi;*
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We report a case that underwent embolizaton of common hepatic artery pseudo-aneurysm after modified Appleby operation which consists of combined resection of the stomach, the pancreas, the spleen and the celiac trunk in the treatment of advanced pancreas body cancer.

P-172 withdrawn by authors

P-173

Ultrasound-guided percutaneous thrombosis of post-traumatic large expanding pseudoaneurysms in unusual locations

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Both vertebral artery pseudoaneurysm (9.8x8.5cm) compressing the spinal cord with quadriplegia and Perineal pseudoaneurysm (5.5x6.5cm) with impending rupture following straddle injury with corpus spongiosum laceration were successfully thrombosed using ultrasound-guided percutaneous injection of 500IU and 2000IU bovine thrombin solution.

P-174

Transarterial embolization of rapidly growing focal nodular hyperplasia using PVA microspheres

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[1]Radiology, N.N.Alexandrov National Cancer Centre of Belarus, Minsk, Belarus, [2]Thoracic surgery #[1], N.N.Alexandrov National Cancer Centre of Belarus, Minsk, Belarus.

A female patient with histologically proven focal nodular hyperplasia was observed for 14 months. A noticeable increase in size was revealed. The embolization with PVA microspheres was performed. A considerable shrinkage was detected in the follow-up study after 1 year.

P-175

Stroke complications of ascending pharyngeal artery embolization for hypervascular skull base tumors

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[1]Radiology, N.N.Alexandrov National Cancer Centre of Belarus, Minsk, Belarus, [2]Head and Neck tumors, N.N.Alexandrov National Cancer Centre of Belarus, Minsk, Belarus.

Two patients with glomus jugulare tumor and angiofibroma underwent embolizations of ascending pharyngeal artery with PVA microspheres. Stroke events occurred by the end of procedures. The causes of complications were silent anastomoses between vertebral and ascending pharyngeal arteries.

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P-177

Embolization of post partum AVM

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Mater Adult Hospital, Brisbane, Australia.

Four patients presented with major post partum hemorrhage; ultrasound showed uterine AVM.
First patient embolized with coils, hysterectomy for persistence of AVM.
Last three successfully embolized with 800-micron contour via left antecubital brachial artery.
Two conceived rapidly; third not trying.

P-178

Rotational imaging techniques to minimize contrast utilization in hypogastric embolization

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Baptist Cardiac and Vascular Institute, Miami, FL, United States.

Two patients with chronic renal insufficiency underwent hypogastric artery embolization with minimal contrast media utilizing rotational angiography and 3D roadmap technology. This approach allowed for complete identification, planning, real-time treatment and confirmation of the embolization procedure.

P-179

Endovascular treatment of pulmonary AVM with stop-flow technique: case report and literature review

A. Giordano, *N. Limbucci, G. Lanni, S. Carducci, G. Gismondi, M. Armellani, M. Gallucci;*
Radiology, Ospedale S. Salvatore L'Aquila, L'Aquila, Italy.

A voluminous pulmonary AVM in a 31-year-old woman with Rendu-Osler-Weber disease was successfully embolized with electrolytically detachable coils. To avoid coil migration during the detachment, temporary stop-flow condition was performed by means of a compliant baloon.

P-180

What an interventional radiologist can do in the treatment of tubaric interstitial ectopic pregnancies

R. Vila Miralles, *C. Barber Hueso, E. Lonjedo Vicent, J.J. Martinez Rodrigo, A. Ruiz Guanter;*
Radiology, Hospital Universitario Dr. Peset, Valencia, Spain.

A new approach to the treatment of tubaric interstitial ectopic pregnancies: combined use of uterine arterial embolization and methotrexate injection.

P-181

Post-biopsy axillary lymph-node bleeding treated with embolization

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2nd department of Radiology, Attiko University Hospital of Athens, Athens, Greece.

A routine axillary lymph-node biopsy resulted rapidly in expanding haematoma, causing severe debility, respiratory distress, and haematocrit drop. Only superselective angiography of the branches of axillary artery revealed the active bleeding site, which was treated successfully with coil embolization.

P-182

Endovascular treatment of inadverent injury to the subclavian and internal mammary arteries during central line placement

S.S. Sabri, *U.C. Turba, J.F. Angle;*
University of Virginia, Charlottesville, VA, United States.

A 49-year-old male underwent bedside central line placement, inserted inadverently into right subclavian artery (SCA) and transected the internal mammary(IMA) demonstrated by CTA.
We report on endovascular management with covered stent for the SCA and coil embolization for the IMA.

P-183

Coil embolization of systemic arterial supply to left lower lobe without pulmonary sequestration: a case report

C. Kang;
Radiology, Soon Chun Hyang University Cheon An Hospital, Cheon Ansi, Chuncheongnamdo, Republic of Korea.

We report here on a case of systemic arterial supply to left lower lobe without pulmonary sequestration and also successful coil embolization in a 29-year-old male with a history of hemoptysis during cough.

P-184

Selective internal iliac artery embolisation for treatment of ante-partum haemorrhage

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[1]Radiology, Colchester General Hospital, Colchester, United Kingdom, [2]Obstetrics and Gynaecology, Colchester General Hospital, Colchester, United Kingdom.

The role of iliac artery embolisation for treatment of ante-partum haemorrhage is not well described. We describe a patient with mid-trimester antepartum haemorrhage in coagulopathy, treated with embolisation. The available literature on embolotherapy for this indication is reviewed.

P-185

Arterial embolotherapy for endoscopically uncontrolled upper gastrointestinal bleeding: five cases

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Radiology, SoonChunHyang University CheonAn Hospital, CheonAnsi, Chuncheongnamdo, Republic of Korea.

Transarterial embolization with micro-coil and low-concentration NBCA using coaxial microcatheter technique is a safe and effective treatment for upper gastrointestinal bleeding. We report here on five case of endoscopically uncontrolled, life-threatening upper gastrointestinal bleeding and successful transarterial embolization.

P-186

Traumatic popliteal arteriovenous fistula treated with the Amplatzer vascular plug with a 2-year follow-up

J. Kim;
Radiology, Gachon University, Gil Hospital, Incheon, Republic of Korea.

We present a 34-year-old man with a traumatic popliteal arteriovenous fistula treated with embolization using Amplatzer vascular plug. Patient was uneventful for 2 years as confirmed by 3-dimensional CT images. This case shows a treatment option of using the plug.

P-187

Two cases of percutaneous embolization of an internal iliac artery aneurysm type II endoleak from a transosseous approach

J.J. Gemmete, *W. Cwikiel;*
Radiology, University of Michigan, Ann Arbor, MI, United States.

Access into a type II endoleak from an internal iliac artery aneurysm may not be possible from a standard endovascular approach. We decribe two cases in which a percutaneous transosseous approach was utilized to occlude an endoleak.

P-188

Embolization of hypertrophied aberrant left bronchial artery from circumflex coronary artery in a patient with massive hemoptysis

E.-Y. Jeon, *Y.-A. Bae, H. Lee;*
Hallym University Hospital, Anyang City, Republic of Korea.

A patient with old pulmonary tuberculosis and COPD presented with massive hemoptysis. We embolized both bronchial arteries from descending aorta but hemoptysis recurred. So, we embolized hypertrophied aberrant left bronchial artery from circumflex coronary artery.

P-189

Snare retrieval of left atrial coil fragment during PAVM embolization

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Radiology, Vancouver General Hospital, Vancouver, BC, Canada.

A 65-year-old woman underwent embolization of a PAVM, complicated by a coil fragment embolizing into the left atrium. This was successfully snared in an antegrade fashion by going through the PAVM using coaxial technique and a neurovascular snare.

P-190

Palliative embolotherapy of an ulcerated, bleeding, massive giant-cell variant of malignant fibrous histiocytoma in a 57-year-old male

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[1]Interventional Radiology, Waterford Regional Teaching Hospital, Waterford City, Ireland, [2]Radiology, Waterford Regional Teaching Hospital, Waterford City, Ireland.

Palliative embolotherapy of an ulcerated, bleeding, massive giant-cell variant of malignant fibrous histiocytoma in a 57-year-old male, ceasing haemorrhage, allowing skin healing and discharge from hospital is described.

P-191

Lifesaving embolization of coronary artery perforation

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[1]Interventional Radiology, University Hospital of Patras , Patras, Greece, [2]Interventional Cardiology, Guy's and St. Thomas' Hospitals, London, United Kingdom, [3]Interventional Radiology, Guy's and St. Thomas' Hospitals, London, United Kingdom.

Coronary artery perforation remains one of the most fearsome complications during cardiac catheterization procedures. We describe a case of emergent life-saving micro-coil embolization of the distal right coronary artery in a patient with uncontrollable guidewire perforation resulting in cardiac tamponade.

P-192

CT-guided thrombin injection for treatment of type II endoleak

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Interventional Radiology, Azienda Ospedali Riuniti Ancona, Ancona, Italy.

We report a 91-year-old male case with hypogastric artery type II endoleak maintained by gluteal artery treated with percutaneous embolization.
Under CT-guidance a needle was positioned into aneurysm sac, and then we injected thrombin mixed with contrast to control any reflux.

P-193

Large pelvic AVMs presenting with cardiac failure, treated with endovascular balloon sclerotherapy

R.P. Yadavali, *R. Narlawar, D. Mondal, A. Healey, P. Rowlands;*
Radiology, Royal Liverpool University Hospital, Liverpool, United Kingdom.

A case report on two cases of large pelvic arterio venous malformations with multiple feeders causing high output cardiac failure. They were difficult to treat with transcatheter embolisation with coils. These were managed with endovascular balloon sclerotherapy.

P-194

Spontaneous lumbar artery bleeding in a patient with Von Recklinghausen's disease: endovascular treatment

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We report on a case of a pregnant woman with Von Recklinghausen's disease and bulky retroperitoneal hematoma diagnosed during cesarean delivery secondary to spontaneous lumbar artery rupture. Aortography was performed with successful catheterization and embolization of the bleeding artery.

P-195

Intralobar lung sequestration in a 29-year-old patient: embolization treatment by Amplatzer vascular plug

L. Patrone, **U.G. Rossi**, *G. Bovio, M. Dahmane, S. Seitun, C. Ferro;*
Interventional Radiology, San Martino, University Hospital, Genoa, Italy.

A 29-year-old patient affected by left lung intralobar sequestration with recurrent infections and recent haemoptysis successfully underwent percutaneous treatment by vascular embolization with Amplatzer vascular plug.

P-196

Embolization for life-threatening bleeding due to peliosis hepatis

N. Dasgupta, **B. Arslan**;
Radiology, University of Virginia, Charlottesville, VA, United States.

Peliosis Hepatis patient with major bleeding. She was embolized with gelfoam slurry. Next day she rebled. Repeat embolization was performed with embospheres until complete stagnation. On her 6-month follow-up she had normal liver function and no recurrent problems.

P-197

Uterine artery embolisation in a case of placenta accreta with an associated vascular malformation

S. Hales, **J. Burrill**, *M. Hamady;*
Radiology, St Mary's Hospital, London, United Kingdom.

A patient with post-partum haemorrhage had retained placenta accreta and a vascular malformation, treated successfully with uterine artery embolisation.
We describe the imaging of placenta accreta and uterine vascular malformations. We discuss the literature dealing with treatment of post-partum haemorrhage.

P-198

Preoperative meningioma embolization: evaluation by 3D CT in angiosuite

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Evaluation of vessel occlusion during meningioma embolization by 3D CT acquisition in the angiosuite is described.
The images can be easily evaluated and compaired with the CE CT scan before treatment.

P-199

Challenging radial artery pseudoaneurysm

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A 20-year-old patient with traumatic 4-cm radial artery pseudoaneurysm, failed three treament attempts with percutaneous thrombin injection and glue. Finally embolized with detachable coils in distal radial artery as well as in aneurysm neck. US and angiography images presented.

P-200

Severe peritoneal hemorrhage from adrenal artery injury: successful transcatheter arterial embolization (TAE) following damage control surgery

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[1]Radiology, Nippon Medical School, Tokyo, Japan, [2]Emergency Medicine, Nippon Medical School, Tokyo, Japan.

Severe peritoneal hemorrhage from adrenal artery injury after blunt abdominal trauma is a very rare condition. Here, we report a case which could be controlled with TAE immediately after emergency laparotomy.

P-201

Prostatic artery embolization as a primary treatment for benign prostatic hyperplasia: initial clinical results in two patients

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Prostatic artery embolization was performed in two patients, due to acute urinary retention, as a primary treatment for benign prostatic hyperplasia. Feasibility, safety, clinical outcomes and imaging studies with ultrasound and MRI were evaluated during 6 months of follow-up.

Experimental work in IR

P-202

Method of delivery affects the apoptotic effect of benzamide riboside on N1-S1 transplantable hepatomas in rats

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Purpose: to compare apoptosis in rat hepatomas treated with benzamide riboside via hepatic arterial (IA) or intravenous (IV) routes. BR has been shown to induce apoptosis in cancer cells.
Methods: twelve Sprague-Dawley rats were inoculated with 106 N1-S1 cells in their left hepatic lobes. After 2 weeks, BR (20 mg/kg) was infused into 10 rats by IA (n=5) or IV (n=5) routes. Two rats received saline (n=1 for IA & IV). Animals were sacrificed after 3 weeks. Tumor volumes were measured with weekly MRIs. The percentage of apoptotic cells in tumor and normal liver was assessed via cell counts using 10 fields of TUNEL stained slides at 40x magnification.
Results: mean percent tumor apoptosis was 44.8+5.5% (IA) and 29.4+11.5% (IV) (P=0.1). Normal liver apoptosis was 0.56+2.34% (IA) and 1.32+4.0% (IV) (p=0.017). Saline caused 29.7% (IA) and 0% (IV) tumor apoptosis and 0.8% (IA) and 0.0% (IV) normal liver apoptosis. Mean tumor volume was 0.23+0.21, 0.35+0.29, 0.34+0.38, and 0.11+0.20 cc at 0, 1, 2, and 3 weeks after IA treatment and 0.54+0.60, 1.03+0.85, 1.48+1.34, and 1.06+1.57 cc after IV treatment. P-values for IA vs. IV treatment were 0.31, 0.13, 0.11, and 0.22 at each time. IA saline tumor volume was 0.73, 1.00, 0.55, and 0.33 cc at 0, 1, 2, and 3 weeks; IV saline tumor volume was 0.08, 1.00, 4.77, and 9.00 cc.
Conclusions: there was significantly less apoptosis in normal liver (p=0.017) and greater apoptosis in tumor (p=0.1) with IA treatment. Reduction in tumor volume was greater with IA therapy, though not reaching statistical significance. IA saline caused tumor apoptosis and shrinkage while IV therapy did not.

P-203

Growth and pathological evaluation of Vx2 tumors transplanted to rabbit livers

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[1]Radiology, Shiga University of Medical Science, Otsu, Japan, [2]Radiology, Kohka General Hospital, Kohka, Japan.

Purpose: a time-course analysis was performed regarding Vx2 tumors that were transplanted and observed over a period of 4 weeks. The purpose of this study was to find an appropriate time after transplantation to investigate changes in tumor volumes in order to accurately assess methods of therapy.
Materials/methods: sixteen Japanese white rabbits were used to transplant Vx2 tumors (2 x 2 mm) into the subcapsular hepatic parenchyma after laparotomy under general anesthesia. These rabbits were divided into 4 groups, which were examined by contrast MRI at 1, 2, 3, and 4 weeks after transplantation to evaluate tumor growth rates and tumors that protruded across the hepatic surface. Intrahepatic metastases were examined pathologically.
Results: the rate of tumor implants was 91.67%. Of transplanted tumors that settled within 4 weeks, 41.67% could be visualized by MRI at 1 week, 83.33% at 2 weeks, and 100% at 3 weeks. Tumor protrusion across the hepatic surface was recognized in 0% at 1 week, 9.09% at 2 weeks, 81.82% at 3 weeks, and 100% at 4 weeks. Intrahepatic metastases were not observed until 4 weeks, when they were found in 25% of all rabbits.
Conclusion: implanted tumors were detected in 100% of the rabbits by contrast enhanced MRI. VX2 tumors grew and penetrated the hepatic surface at 3 weeks and intrahepatic metastases occurred at the same time. For optimal therapeutic efficacy on the VX2 liver tumor in rabbit models, a period of 2 weeks after transplantation was considered appropriate.

P-204

A new prototype radiofrequency electrode microcatheter system for artery occlusion

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Purpose: to evaluate the coagulation and occlusion efficacy of a radiofrequency electrode microcatheter system in the egg white and

the rabbit renal artery.
Materials/methods: an electrically conductive ring and an extension lead were placed at a microcatheter tip and at the hub site, and were connected to an inherent coil-mesh, respectively. The rings (cathodes) were 1, 3, 5, 10 and 20 mm in length. In egg white, a coagulation study was performed by changing the length of the guidewire (anodes; 1, 3, 5, 10, 20, 40 mm) in each cathode at 20 watts. The coagulation time and site were analyzed. In rabbits, the renal artery was ablated with the use of a 20-mm cathode and 10-mm anode, and the wall temperature was checked.
Results: in the egg white study, the coagulation time was proportionally increased and was dependent on the length of the cathode and anode ($p<0.05$). Coagula developed at the anode up to the 3-mm protrusion for the 1-mm cathode, and up to the 20-mm protrusion for the 20-mm cathode. In rabbits, the renal artery was successfully occluded. A pathological examination showed occlusion of the renal artery with organization, and the presence of a necrotic arterial wall with fibrosis, inflammation and intact internal elastic lamina. The temperature was 40.6oC on the arterial wall.
Conclusion: the radiofrequency electrode microcatheter system successfully coagulated egg white and occluded the rabbit renal artery.

P-205

Anti-tumor effects of transhepatic arterial embolization (TAE) administered in combination with thalidomide: an experimental study using Vx2 liver tumor rabbit models

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Purpose: thalidomide has been approved in Japan as a therapeutic agent of multiple myeloma. This agent is believed to have suppressive actions to angiogenesis as well as immunoregulatory actions. We examined whether combined use of thalidomide exerted additive effects in TAE using Vx2 liver tumors.
Materials/methods: Vx2 tumors were transplanted to the livers of 15 Japanese white rabbits, which were used for the experiment at 2 weeks after the transplantation. The rabbits were randomly assigned to 3 groups: saline alone, TAE, and TAE plus thalidomide groups. Thalidomide was orally administered at a daily dose of 200 mg/kg for 5 successive days. Gelatin microspheres were used at a dose of 1 mg/kg as an embolic material.TAE was conducted as follows. We chose the celiac arteries using a 4Fr cobra type catheter (Clinical Supply Co.) via the right femoral artery and inserted a microcatheter (Clinical Supply Co.) as far as the proper hepatic artery. Anti-tumor effects were evaluated by the reduction rate of tumor volumes as measured at 2 weeks after transplantation and at 7 days after TAE. Ratios of changes in tumor volumes in each group then were compared using Tukey's HSD test. Tumor volumes were measured using MRI.
Results: the tumor reduction rates were: 344.8±116.7% in the saline group; 279.2±91.8% in the TAE group; and 55.9±29.3% in the TAE plus thalidomide group. There were significant differences between the TAE plus thalidomide and saline groups and between the TAE plus thalidomide and TAE groups ($P<0.05$).
Conclusion: we confirmed that thalidomide enhanced anti-tumor effects in combination with TAE.

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Endovascular creation of aorto- and cava-pulmonary anastomoses in animal study

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Purpose: we present the initial results after the creation of aorto- and cava-pulmonary connections with use of an exclusively endovascular approach.
Material and methods: the procedure was carried out in 7 animals and consisted of bringing together two vascular structures with use of two magnetic navigation catheters. Using a kinematic needle as axis, it performed a puncture from the lumen of one vessel to that of the other, and inserted a prosthesis between the two. Its most outstanding feature is that, when it is dilated with a balloon, it shortens and "rolls up," flattening its ends. This allows good fixation to the vessel wall, avoiding the protrusion of metal into the lumen of the native vessel.
Results: catheterizations of a pulmonary artery and an ascending aorta were made by the right femoral access (4). In addition, access through the right carotid artery was used too (3). The ascending aorta was connected to the trunk of the pulmonary artery (1) and to the right pulmonary artery (2); the descending aorta to the left pulmonary artery (2) and the right pulmonary artery was connected to the superior vena cava (2). The connection of two vessels in the thoracic area was safely performed with passage of a guide wire in all cases.
Conclusion: intervascular anastomoses created by an endovascular approach are feasible in the author's experimental model.

P-207

Telemetric catheter based pressure sensor for hemodynamic monitoring: experimental experience

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Purpose: to evaluate the technical and animal experimental feasibility of an percutaneously implantable pulmonary arterial implant for permanent hemodynamic monitoring.
Materials/methods: two different systems were developed by modifying a commercially available pulmonary artery catheter (PAC). First, a cable bound catheter based system was designed by implementation of a capacitive absolute-pressure sensor in the catheter tip. This system was developed further to a completely implantable telemetric system. The devices were tested in a total of ten sheep. The implant was placed with its tip in the descending pulmonary artery via the right jugular approach. Results were compared with conventional PAC positioned in the contralateral pulmonary artery using Pearson's correlation coefficients and Bland-Altman plots.
Results: implantation of the monitoring systems was uneventful in all animals. In four animals, data from fully functional cable-bound and telemetric pressure monitoring systems were available with a total of 18.506 measurements. There was an excellent correlation between reference data and the data obtained with the implants ($r=0.9944$). Bland-Altman plots indicated a very good agreement between the different techniques.
Conclusion: we report the development and successful initial test of an implantable catheter based device for long-term measurement of PAP and PAOP. Both devices may be applicable for hemodynamic

monitoring. Further long term studies for assessing reliability and durability of the device are warranted.

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Femoral artery thrombus formation after percutaneous catheterization and manual compression hemostasis: An experimental study

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Purpose: To evaluate the femoral artery (FA) shortly after catheterization and manual compression hemostasis in an animal model.
Materials/methods: The evaluation was done in 38 FAs of 19 heparinized (100mg/kg) sheep. After catheterization with an 8 Fr sheath, a 5 minutes compression was applied. Follow-up angiograms were done immediately after compression and then in 2.5 minute intervals until no extravasation was found. Final angiography was performed 30 minutes after hemostasis. After sheep euthanisation, FA specimens were excised for histopathologic evaluation.
Results: Follow up angiographies showed intraluminal clots in 9 FAs. Histology showed clots in 32 FAs consisting predominantly of platelets and fibrin. Their size varied from superficial elevation (8 arteries) to medium size 1-2 mm polyploidy protrusion (15 arteries) to large polyploidy clots 3-4 mm in lengths (9 arteries).
Conclusion: Hemostasis with manual compression is achieved by formation of a predominantly platelet-fibrin thrombus that often extends significantly into the arterial lumen.

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Instrument modelling in virtual interventional radiology training simulations using direct measurement of guide-wire properties

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Purpose: to determine the flexural modulus (FM) of seven guide-wires commonly used during interventional radiology (IR), and to realistically simulate these in an IR virtual training environment.
Materials/methods: seven guide-wires (straight, 3 mm J, Rosen, Bentson, Amplatz stiff, standard and stiff Terumo) were evaluated for FM at a series of points along their length. Two studies applied force, respectively, to the main body component and the 'floppy' end section. In a three-point bending test, two supports 4 cms apart braced the wire, while the mid-point was displaced 5 mms using a force sensitive transducer. A two-point bending test supported the wire at one point (proximally) with the transducer applied to more distal points. In the three-point test, data were obtained at intervals of 1 cm (distal to proximal) for 40 cm, 2 cm for 20 cm, then 5 cm thereafter. Data obtained were incorporated into an IR simulation modelling the guide-wires as particles connected by links of variable FM.
Results: FM values were successfully recorded for all wires studied. Numerical and graphical outcomes data demonstrated differences in stiffness between generic wires of 55MPa (flexible end section) up to 66GPa (main body), correlating well with our clinical expectations. Test results were reproducible and repeatable between identical and generic wires. Depending on the FM assigned to their links, the simulated guide-wires behaved differently and fairly realistically.
Conclusion: studies of deformation of IR instruments can provide data to enhance fidelity of IR simulators. Further work will study torsional behaviour and FM in a wider range of wires and catheters.

P-210

Hemostatic efficacy of chitosan-based bandage for closure of percutaneous arterial access sites in heparinized sheep

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Purpose: to report on comparison of the hemostatic efficacy of the procoagulant-based percutaneous bandage (PPB) and to compare it with standard manual compression (MC) after superficial femoral artery (SFA) catheterization with an 8F sheath in heparinized sheep.
Materials/methods: nine heparinized sheep underwent percutaneous puncture of bilateral SFAs followed by placement of an 8 F sheath for 5 minutes. Upon sheath removal, the puncture sites were randomized to achieve hemostasis between the chitosan-based bandage with manual compression and manual compression alone for 5 minutes. After pressure release, femoral angiography was done to evaluate hemostasis. If bleeding was found, continued pressure and repeat angiography were done at 2.5 minute intervals until successful hemostasis.
Results: the mean hemostasis time in PPB group was 6.1±2.5 minutes, and 10±4.5 in the manual compression group. Hemostasis time in PBB group was significantly shorter than manual compression group in statistics (p=0.043). In the PPB bandage group, hemostasis at 5 minutes post sheath removal was achieved in 7 of 9 SFAs (78%). The other two SFAs revealed hemostasis at 7.5 and 12.5 minutes, respectively. Angiography obtained 30 minutes after stoppage of bleeding showed no extravasation but revealed AVF and intraluminal thrombus (n=3) in PPB group. Pseudoaneurysm and intraluminal thrombus (n=2) were observed in MC group.
Conclusion: the chitosan-based bandage was efficacious and significantly shortened time to hemostasis at the SFA access site following 8 Fr sheath removal. The incidence of intraluminal thrombus formation at the puncture site in both groups needs further exploration.

P-211

N-acetylcysteine for prevention of iodine contrast agent-induced nephropathy in intact and kidney-injured animals: an experimental study in rats

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Purpose: to determine pathophysiological interaction between N-acetylcysteine (NAC) and iodinated contrast agent in terms of contrast-induced nephropathy (CIN).
Materials/methods: all animal studies had institutional animal care and used committee approval. A total number of 139 rats were divided into 3 groups: Group I (n=42) involved intact animals with no insult, Group II (n=55) consisted of animals with subtotal nephrectomy, and in Group III (n=42) were animals with subtotal nephrectomy and further 12 hours lasting water intake restriction. Each of above groups was divided into 6 individual subgroups as follows: control subgroup without any pharmacology intervention, NAC subgroup was given NAC 100 mg/kg b.w., MIO subgroup received meglumine ioxatalamate (Telebrix 350) 6 ml/kg b.w., while IOH subgroup was administered iohexol (Omnipaque 350) 6 ml/kg b.w. In remaining 2 subgroups, combination of contrast agent plus NAC was administered (meglumine ioxatalamate plus NAC in MIO+NAC subgroup, and iohexol plus NAC in IOH+NAC). Plasma

creatinine as well as creatinine clearance was measured before any agent administration, and 1, 3, and 7 days later for further evaluations.
Results: NAC administration improved creatinine-derived parameters (plasma creatinine concentration and clearance as well) on the first day after iodine contrast agent administration ($p < 0.05$) and attenuated negative impact of such contrast agents between day 1 to 7 in comparison to subgroups without NAC administration in various types of kidney injury.
Conclusion: NAC significantly improved creatinine-derived parameters in terms of various types kidney insult and should be regarded as a potent agent for CIN prevention in practice.

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Is doxorubicin the most effective drug for chemoembolization?

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Purpose: lipiodol emulsions of anticancer drugs with faster and higher activity could be more efficient than the classical doxorubicin-lipiodol for chemoembolization. The aim of our study was to evaluate the in vitro cytotoxicity of different anticancer drugs in the presence or not of amiodarone on three digestive human cell lines.
Materials/methods: the three cell lines we used were HepG2 (hepatoma cells), HCT8 and HT29 (colic cells). Tested drugs were cisplatin, daunorubicin, doxorubicin, epirubicin, idarubicin, mitomycin C and mitoxantrone. Confluent cells were washed, resuspended in 100 µl of HAM culture medium and exposed to the chosen concentrations of drugs. Cells were then placed 1 hour in a CO2-incubator at 37°C, washed twice and incubated for 4 additional days at 37°C in 200 µl MNC culture medium. Cytotoxicity was measured by a classical colorimetric assay. Cell survival was expressed as a percent of control untreated cells. Each point was the mean±SD of the three wells.
Results: idarubicin was the most effective drug in inducing cytotoxicity in the three cell lines. The efficacy of idarubicin was already observed at the lowest concentration (31 µg/ml) whereas the activity of doxorubicin, for example, seemed to be dependent on its concentration. On the HepG2 hepatocarcinoma cell line, the three less effective drugs were doxorubicin, cisplatin and mitomycin C. The concentration of three drugs causing a 50% decrease in viability of these cells was around 500 µg/ml.
Conclusion: our results show that idarubicin could be a better choice than doxorubicin for chemoembolization.

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Evaluation of microporous thermoplastic polyurethane as a covering material of a selfexpanding nitinol stent in a porcine iliac artery model

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Purpose: to evaluate a newly designed microporous thermoplastic polyurethane (TPU) as covering material to serve as a mid-size stentgraft in combination with a selfexpanding nitinol stent.
Materials/methods: 14 TPU-covered stent-grafts (TPU-G) and 14 bare metal regular SelfX stents were planned for implantation in both iliac arteries of 14 minipigs with a follow-up of 1, 4 and 12 weeks. Primary study endpoint was late in-stent stenosis assessed by quantitative angiography and microscopy. Secondary endpoints were injury, inflammation and endothelialization.
Results: we found 3/4 occlusions of TPU-G after 4 and in all stent-grafts after 12 weeks. The SelfX showed a significant stenosis in 3/4 both at 4 and 12 weeks. At four weeks follow-up, average percentage luminal loss was 85.2% (40.8-100.0%) in TPU-G and 49.5% (37.9-62.4%) in SelfX ($p=0.003$), respectively. Neointimal height was 1028.7 µm and percentage average stenosis 68.4% in TPU-G. In SelfX it was 1033.6 µm (918.0-1118.4 µm) and 68.1% (60.4-72.0%), respectively. At 12 weeks follow-up, average percentage luminal loss was 100% in TPU-G due to the occlusion of all stent-grafts and 24.9% (8.0-63.9%) in SelfX ($p=0.011$), respectively.
Conclusion: microporous thermoplastic polyurethane (TPU) clearly failed to show a benefit due to even total vessel occlusions and therefore cannot be recommended for human use in peripheral arteries. Surprisingly, the clinical broadly used SelfX stent showed very disappointing angiographic and miscroscopic results in this first published evaluation of the SelfX stent in the porcine animal model.

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Cryo-cooled radiofrequency system with a bipolar probe: application duration and energy absorption in an ex vivo bovine liver study

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Purpose: to evaluate an ablation device combining a bipolar radiofrequency (RF) applicator with cryo-cooling and to test effective application duration and energy absorption with different parameter settings.
Materials/methods: 210 ablations were performed with an internally CO2-cooled cryo-RF applicator at ex-vivo bovine livers. Electric parameters and time to irreversible increase of impedance as assessment parameter for effective application duration were digitally recorded. Gas pressure for constant cryo-cooling (500, 525, 550, 575, 600 psi and without cooling) and electric power (32-50 Watts, 2-Watt-steps) were varied independently. The series was stopped if a preselected impedance of 300 Ω was reached. Cumulative energy absorption was recorded. The short and the long axis of the white coagulation zone were assessed.
Results: induced coagulations were confluent and homogeneous. For all power settings, effective application duration could be increased using higher gas pressure settings (increase 118% at 50 W to 168% at 30 W, if 600 psi series are compared to 500 psi). Without cooling, application time reaches only 30% of the application time at 500 psi and 50 W. Optimal energy absorption was registered at 48 Watts and 600 psi, correspondingly this parameter combination resulted in the largest short axis with 44±1 mm. Energy efficiency ranged between 485 kJ/ccm (at 50 W/ 600 psi) and 1448 kJ/ccm (at 50 W/ 500 psi).
Conclusion: the hybrid technology combining RF with gas-cooling leads to longer energy application duration and correspondingly to higher energy absorption with large coagulation for a single needle procedure.

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Importance of virtual reality simulators in interventional radiology: the ImaGiNe-S CIRSE 2008 experience

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Purpose: to evaluate face and content validity of the Imagine-S simulator model using data collected during the 2008 CIRSE meeting. Image-guided needle puncture procedures are commonly performed in interventional radiology (IR) and use hand-eye coordination to direct needles to perform biopsy, nephrostomy and abscess drainage. Currently, the perceptual-motor skills required are learnt in a traditional apprenticeship model, with drawbacks such as involvement of patients, limited case mix and reducing in-hospital work hours of trainees. While animal and fixed models can reproduce many training objectives, they are an imperfect substitute for the 'real patient' experience. ImaGiNe-S is a computer-based VR training simulator, using virtual environments with stereo 3D visual representation and devices to convey feel, realistically mimicking a percutaneous nephrostomy procedure. Use of such simulator to train IR requires evidence of correct development before studies of efficacy.
Materials and methods: with ethical approval, a prospective pilot study was conducted to assess simulator validity. 53 subjects used the simulation to perform a simulated percutaneous nephrostomy task. Subjects then completed a 5-point Likert scale questionnaire covering 6 key procedure steps.
Results: outcomes showed that 41/53 (78%) participants thought that the design of Imagine-S was moderately realistic with content validity being rated average (3.2/5) for all critical task steps. 44/53 (83%) participants considered Imagine-S to be a useful model for training skills for nephrostomy.
Conclusion: objective review of simulators can identify valid content and steps requiring modifications. Further evaluation of face and content validity is planned in 2009.

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Liver proliferation after portal vein embolization: comparison of the efficacy of two different embolization materials in a swine model

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Purpose: portal vein embolization (PVE) is used clinically to achieve liver hypertrophy in patients with primary or secondary liver tumor before major hepatectomy. The ideal embolic material is not yet determined. Our purpose was to compare two different embolic materials (histoacrylic glue versus hepaspheres) using a swine model.
Materials and methods: twelve male pigs underwent PVE. Six pigs (group I) were embolized with glue (3 underwent left and median and 3 right portal branch embolisation) and 6 (group II) were embolized with hepaspheres 50-100 and 100-150 µm (4 underwent left and median and 2 right portal branch embolisation). Liver function laboratory tests were performed before, 1, 7 and 14 days after PVE. Volumentric CT-study of the embolized (EL) and non-embolized lobe (FLR) was performed before, 14 and 28 days (sacrifice) after embolization. Tissue samples from both lobes were taken 14 and 28 days after PVE.
Results: one animal (group II) died after PVE from pneumothorax and was excluded from the study. No other major complications were observed. FLR and FLR-ratio increase was significantly higher in group I at 14 days (75.7 and 49.3%, respectively) and 28 days after PVE (86.7 and 62.7%, respectively) than in group II (31.7, 12.3 and 28.3, 9.7%, respectively), ($p<0.05$ in all cases). No statistical significant elevation of liver enzymes was noted in both groups.
Conclusion: PVE using glue as embolic material seems to be more efficient, causing more FLR hypertrophy than hepaspheres.

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Automated quantification of tissular changes in Vx2 liver tumor for chemoembolization

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Purpose: the liver Vx2 tumor is a standard model for the evaluation of chemoembolization techniques and products. Our general objective is to apply infrared spectral imaging (IRSI) to quantify in Vx2: (1) the drug released in tissue by drug eluting beads, as previously evidenced (Namur et al. CIRSE 2007) and (2) the tissular changes induced by the released drug. In this study, we validated IRSI for automatic characterization and quantification of the areas of tumor, necrosis and intact liver in rabbit liver Vx2 carcinoma model.
Materials/methods: Vx2 carcinoma cell preparation was injected into 9 rabbit livers. Sampling at D14. Formalin fixation, paraffin embedding. Two adjacent sections (10 µm) were cut from each sample: one analyzed with IRSI and one stained with H&E. Spectral data were processed by multivariate analysis, associated to K-means classification in 5 clusters. Spectral images were then correlated with classical H&E histology for validation of clusters assignment.
Results: mean tumour size was 2 cm. IRSI and H&E images correlated strongly for normal liver parenchyma (93.5%), viable tumor (93.2%) and intratumoral necrosis (98.5%). The automated quantification of each type of tissues showed that carcinoma cells represent 60.2±18% of the tumor area, and necrotic tissue 23.5±8%.
Conclusion: IRSI allows automatic characterization and quantification of tissular lesions in Vx2 liver tumor. A coupling to drug tissular quantification will permit to assess the effect of chemoembolization agents in tumor and surrounding liver.

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Mechanical follow-up of resorbable embolic microspheres degradation

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Purpose: most resorbable embolisation microspheres, which are being developed are based on materials that undergo spontaneous hydrolysis when put in contact water. Their in vivo degradation rate can be predicted from their in vitro hydrolysis rate. Since they become progressively more fragile with time, mechanical testing of

individual microsphere become progressively impossible. To follow up in vitro resorption of resorbable microspheres, we developed a testing method, which is applicable at any stage of their degradation, to measure their resistance to rupture (i.e., limit between elastic and plastic deformation: Re).
Materials/methods: microspheres based on PLGA (250±150 µm) were incubated in PBS in a special syringe at 37°C (group 1) during 1, 2, 3, 7, 13, 20 and 35 days or at 70°C (group 2) during 4, 20, 28, 44, 52, 68, 76, 92 and 100 hours, pH was then measured, and microspheres were compressed (0.1 mL) with a TA-XT2.
Results: Re decreased in two phases - an initial decrease of about 50% after 24 H in group 1 and after 4 H in group 2 - followed by a slower decrease with a 90% decrease after 35 D in group 1 and after 3 D in group 2. Re decrease correlated negatively to time for group 1 (Rho>-0.699; p<0.0001) and group 2 (Rho>-0.526; p<0.0001). pH decrease correlated negatively with time for group 1 (Rho>-0.928; p<0.0001) and group 2 (Rho>-0.909; p<0.0001).
Conclusion: this method is easily applicable to resorbable microspheres and could be useful to control their performances before in vivo evaluation.

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Evaluation of modes of irinotecan administration in a rabbit Vx-2 tumour model: early pharmacokinetics and tumour response

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Purpose: to evaluate the pharmacokinetics and tumour reponse to irinotecan administration by chemoembolisation using irinotecan drug eluting beads (DEB-IRI), intra-arterial (IA) and intra-venous (IV) infusion in a rabbit Vx-2 model.
Materials/methods: 47 rabbits implanted with Vx-2 tumours in the liver were divided into 3 groups and treated after 2.5 wks by either DEB-IRI (100-300 µm, mean dose 9.4 mg, n=17), IA or IV infusion (12 mg over 1 h; n=17 and 13, respectively). Plasma and tumour tissue levels of irinotecan and SN-38 metabolite were measured at 1, 6 and 24 h. The presence of drug remaining in the beads was assessed using FTIR microspectroscopy (FTIR-MS) on histological sections. Tumour necrosis was determined by histopathology.
Results: peak irinotecan serum concentrations were significantly lower for DEB-IRI (1746±756 ng/mL) compared to IA (4194±805 ng/mL) and IV (4088±1171 ng/mL) (p=0.005). Both irinotecan and SN-38 levels were significantly higher in the tumour tissue for DEBIRI versus IA and IV at 6 and 24 h. FTIR-MS analysis suggested drug was still present in the beads at 24 h. Tumour necrosis was the same for all groups at 1 h (29±13%) but significantly greater at 24 h (p=0.018 between groups) for DEB-IRI (83±19%) and IA (57±26%) compared to IV (22±11%).
Conclusion: administration of irinotecan using DEB-IRI results in lower systemic exposure compared to IA and IV, higher levels of drug and metabolite in the tumour and greater levels of tumour necrosis at 24.

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Evaluation of modes of irinotecan administration in a rabbit Vx-2 tumour model: drug quantification in DEB

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Purpose: irinotecan (IRI) can be quantified in drug eluting beads (DEB) using Fourier transform infrared microspectroscopy (FTIR-MS) (Namur et al. 2008). Moreover, modifications of the FTIR-MS signal of DEBIRI can evidence an interaction between the drug and the bead (Namur et al. 2008). We applied FTIR-MS to determine if IRI was still retained inside DEB at short term (6 hours and 24 hours) after DEBIRI embolization in a Vx-2 model.
Materials/methods: rabbits implanted with Vx-2 tumor in the liver were embolized with DEBIRI (100-300 µm, 50 mg drug /mL bead, n=5 animals). Liver samples were taken 6 hours (H6) and 24 hours (H24) post-embolization and snap-frozen. Thin tissue sections were cut and analyzed with FTIR-MS. The amount of IRI retained inside the DEB was assessed using standard FTIR signal-IRI concentration curves (lowest limit of quantification LLOQ = 5 mg/mL, R^2=0.977). The infrared signal of DEB sulfonate group responsible for drug binding was examined to confirm any interaction between IRI and DEB.
Results: IRI signal was below the LLOQ 5 mg/mL in all beads at both H6 and H24. However, the infrared peak characteristic for the sulfonate group of DEB was shifted in 25% beads (3/12) at H6 and 12.5% (2/16) at H24, showing that IRI was still present in these DEB.
Conclusion: DEBIRI releases rapidly a major amount of drug and retains less than 10% of initial load 6 hours after embolisation.

P-222 withdrawn by authors

P-223

Development of gemcitabine eluting membrane for biliary stent

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Purpose: the purpose of this study was to evaluate the efficiency of local chemotherapy using stent membrane containing Gemcitibine in animal models.
Materials/methods: the membrane of stent covering was consisted of combination of polyurethane with Gemcitabine and Silicon with thickness of 45 micron. The concentration of Gemcitabine was 2, 3, 4, and 5 wt% for polyurethane. For evaluation of anticancer effects, mouse tumor model for 4 weeks was used. The mice received 1×106 cells of CT-26 into the dorsal skin of mice prior to insertion of control and Gemcitabine containing membrane in each of mice. The tumor size was measured using calipers, and the body weight of the tumor model was monitored until 4 weeks after insertion of each membrane. The tumor mass was harvested on day 28 of the membrane treatment.
Results: the tumor mass was measured when the mice harvested on day 28 after the insertion of each membrane. The tumor mess was decreased in the group of 2, 3, 4 wt% Gemcitabine comparing with control. But 5 wt% of Gemcitabine membrane group of mice died within a week. For the results, it was assumed that the lethal dosage of Gemcitabine local delivery as well as significant antitumor activity dosage in mouse tumor model. And it was founded that there was no exert systemic toxicity under the 4 wt% Gemcitabine groups.
Conclusion: our data suggest that the Gemcitabine releasing

membrane would be applied for the drug-eluting stent as local therapy of biliary cancer.

P-224

Transcatheter ablation of the liver: experimental study of balloon catheter assisted transarterial high pressure injection of a nonadhesive liquid embolic agent

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Purpose: to evaluate the feasibility of a new technique for transcatheter ablation of the liver with balloon catheter assisted transarterial high pressure injection of a nonadhesive liquid embolic agent composed of ethylene vinyl alcohol copolymer (EVAL) and ethanol mixture, in swine model.
Materials/methods: embolization was performed at the subsegmental hepatic artery until the complete blockage of blood flow was obtained. For the high pressure injection, a microcatheter with a silicone balloon was advanced into the subsegmental hepatic artery, and the balloon was inflated during the injection of EVAL/ethanol mixture through the microcatheter (pressure injection group, n=3). In the other three swine, the mixture was injected under the natural blood flow (flow injection group). In the other two swine, embolization with microparticles (Bead Block, 100-300 µm) was carried out (particles group). 28 days after embolization, necrosis and the vessels reached by embolic materials were assessed angiographically and microscopically.
Results: in all of the pressure injection group and one of the flow injection groups, the portal veins in the embolized segment were not visualized on arterial portography. Parenchymal necrosis was observed in all of the pressure injection group and one of the flow injection groups, but no in the particles group. In the pressure injection group, embolic materials were observed at the hepatic arteries, portal veins and sinusoids. In the particle group, particles were seen at the hepatic arteries only.
Conclusion: with balloon assisted injection, EVAL/ethanol mixture passed the arterial-to-portal pathway, and arrived to the portal veins and sinusoids. It induced complete embolization and necrosis in the swine liver.

P-225

Ethanol embolization under closed renal circuit: a preliminary experimental study and clinical trial

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Purpose: to assess the safety and efficacy of closed renal circuit for renal embolization with absolute ethanol (TAE-CRC) in preliminary examination and clinical trials.
Materials and methods: (1) Preliminary examination; fourteen pigs were used. In group A (n=7), we occluded renal artery and vein with balloon catheters, and embolized renal artery with absolute ethanol (0.5 ml/kg) under aspirating renal venous flow (TAE-CRC). In group B (n=7), we performed standard embolization with absolute ethanol (0.5 ml/kg). Serum ethanol concentrations in the systemic circulation were monitored (student t-test). Nephrectomy was performed in 5 pigs of each group 4 days after the procedures and histological studies were examined. (2) Clinical trials; 25 patients with renal cell carcinoma (RCC) were treated by TAE-CRC. The dosage of ethanol ranged from 0.2 to 0.5 ml/kg increased in a stepwise manner. Serum ethanol concentrations in the systemic venous circulation were monitored in 14 patients. The survival rate was calculated by the Kaplan-Meier Method.
Results: (1) Preliminary examination; the mean ethanol concentration in group A (<0.1 mg/ml) is significantly ($p<0.05$) lower than in group B (0.28 mg/ml). There were no histological differences except the venous thrombus formations and endothelial damages were decreased in group A. (2) Clinical trials; the serum ethanol concentration was less than 0.1 mg/ml in 12 cases and 0.2 mg/ml in 2 cases. The overall 1-, 3- and 5-year survival rates were 71, 35 and 35%.
Conclusion: TAE-CRC is a safe and effective treatment for large RCCs due to decreasing ethanol leakage and increasing ethanol dosage.

P-226

MRI guided robotic assisted procedures for pain treatment

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Purpose: a fully MR-compatible assistance system INNOMOTION (Innomedic, Germany) was developed to provide instrument positioning inside the magnet. The objective was to determine targeting precision during MRI guided bilateral facet joint injection of steroids at spine segment L5 S1.
Materials/methods: the pneumatic robotic assistance system is fully MR-compatible and consists of a robot arm with 6 degrees of freedom. The MRI procedures were performed a 1.5 T Intera Philips, Eindhoven, NL. The evaluation of target precision and safety has been conducted during MRI guided interventions on 16 patients 4 female and 12 male with informed consent. All patients had previous MRI scan of the spine and have been treated via CT guidance at the same segment. 22G Titanium grade 4 cannulae (In Vivo, Germany) were then manually inserted and 5 ml Mepivacain and 40 mg triamcinolone or ethanol injected under MR imaging.
Results: position and orientation of all cannula insertions were appropriately visualized on axial MRI images. Precision of insertion site in axial plane was ±1 mm (min of 0.5 mm and max of 3 mm). Angular deviation in the transverse plane of the cannulae shows ±1° with min of 0.5 and max of 3°. Despite minor side effects of increased sweating in two patients and prolonged menstruation in one patient no major adverse events have been noted.
Conclusion: MRI guided pain treatment assisted by MRI safe robotic systems is feasible and the initial clinical experience indicate a safe and effective use of the robot.

P-227

MRI guided delivery and retrieval of a resonant vena cava filter in a porcine animal model

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Purpose: stainless steel or nitinol vena cava filter (VCF) are causing susceptibility and radio frequency (RF) artifacts in magnetic resonance imaging (MRI). This compromises MRI guided delivery, retrieval and evaluation of intra filter thrombi.
Materials/methods: a resonant circuit consisting of inductivity and capacity tuned to the frequency of the MRI (64 Mhz at 1.5 Tesla), was integrated in a nitinol detachable and retrievable VCF. This resonant filter inductively couples with the MRI RF system, resulting in an increased flip angle. The VCF was mounted into a 9 F catheter and

delivered via a trans femoral route through a 16F sheath in six female pigs (30-40 kg) under general anesthesia. MRI was performed in a 1.5 Tesla MRI (Achieva, Philips Medical Systems) using a 5 element surface coil. Balanced MRI sequences (SSFP, 6 mm, FA=90, 40, 25, 15°) were applied, before and after filter deployment. Subsequent to MRI guided deploying and retrieval of the aVCF an extra-corporally produced thrombus was washed into ICV via the venous sheath and MRI monitored. All filters were recovered by autopsy to correlate the intra-filter thrombi with the MRI findings.
Results: MRI guided filter placement was successfully performed in all cases. Intravenous thrombi were successfully filtered by the aVCF and visualized by MRI. Autopsy confirmed the positive correlation of the thrombi with the MRI findings.
Conclusion: active VCF tuned to the resonance frequency of the MRI and that this VCF can be delivered, retrieved and monitored during therapy solely using MRI.

P-228

Microwave ablation for treatment of recurrent bleeding adrenal adenoma in a dog: a treatment potentially translational in human

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We report a case of 12-year-old dog with a 4-cm left adrenal adenoma presented to our attention for recurrent bleeding, successfully treated with Microwave ablation to obtain hemostasis. Three months of follow up showed no recurrence of bleeding.

P-229

Palliative treatment with covered, self-expandable nitinol stent of transitional cell carcinoma (TCC) of urethra: a treatment potentially applicable to human

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We report a case of palliative treatment with covered, self-expandable nitinol stent of TCC of urethra in an 8-year-old female dog.
Stent placement was technically successful. No recurrence of symptoms were observed at 2 months' follow up.

P-230

RF ablation in the angioroom: 3DA - 3DCT - ultrasound, complementary utilities

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Needle position, placed under ultrasound guidance, can be controlled by 3DA and/or 3DCT.
The angiosuite has several advantages for RFA: easy access to the patient, combination of imaging modalities (US,3DA,3DCT) and therapies (RFA,chemoembolization).

Fibroids intervention

P-231

Long-term quality of life assessment in patients undergoing uterine fibroid embolization

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Purpose: assessment of long-term outcomes of fibroid-associated quality of life in patients treated by uterine fibroid embolization.
Materials and methods: this retrospective follow-up cohort study was performed including all patients from a 2006 publication. Analysis was performed by a questionnaire consisting of 49 questions about six topics. Assessment focus was put on comparing symptoms, follow-up, and quality of life in long-term.
Results: the analysis was performed based on questionnaires from 39 patients. The median follow-up was 7.0 years (IQR: 1.5 years). Uterine fibroid embolization led to a reduction of bleeding symptoms in 89.7% of patients, pain in 78.9%, bulk-related symptoms in 89.5%, fatigue in 76.9%, limitations in social life in 92.9%, and depression in 78.6%. The median impairment score for bleeding and pain decreased significantly from 7 to 0 and from 5 to 0, respectively (both $p<0.001$). The general quality of life index increased significantly from 4.5 to 9 ($p<0.001$). In the long-term, there was no significant difference in parameters assessed as compared to mid-term follow-up (for all, $p<0.05$). Six (15.4%) patients had hysterectomies after an average of 32.1 months post intervention. Twenty-eight (71.8%) patients were still very satisfied with their intervention and thirty-two (82.1%) patients would recommend uterine fibroid embolization to other patients.
Conclusion: uterine fibroid embolization seems to lead to a notable long-term improvement of fibroid-associated symptoms and women's quality of life. In comparison to the mid-term results, the long-term outcomes show a clear continuance of general quality of life improvement.

P-232

Does choice of embolic agent influence fibroid volume reduction, extent of infarction or clinical outcome following uterine fibroid embolization (UFE)?

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Purpose: to compare the clinical and radiological outcomes of UFE performed with beadblock, embospheres, embozenes or gelfoam.
Materials/methods: a prospective non-randomised single-centre study was carried out between May 2006 and February 2009. Patients presenting to Southampton General Hospital for UFE for symptomatic fibroids were included. Patients were then divided on a sequential basis into 4 groups of 20. UFE was carried out with gelfoam (group 1), embospheres (group 2), beadblock (group 3) or embozenes (group 4). Contrast MRI was carried out prior to embolization and at 3 to 6 months post embolization. All patients completed quality of life questionnaires at the time of follow up.
Results: in groups 1, 2 and 4, comparable rates of dominant fibroid complete infarction (85, 90, and 93%) and overall complete fibroid infarction (70, 80, and 71%) were seen. Lower rates of dominant fibroid complete infarction (53%) and overall complete fibroid infarction (47%) were seen in group 3. Clinical outcomes correlated with the degree of fibroid infarction. Dominant fibroid volume reduction was comparable between the groups. (Final data is only available for 75% of group 4 patients. Full data will be available for presentation at the meeting.)

Conclusion: the choice of embolic agent in UFE not only has an impact on radiological and clinical outcomes, but also has significant cost implications. Our small study has demonstrated similar outcomes for embolic agents of notably different cost.

P-233

Fertility after uterine artery embolization: investigation using a sheep model

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Purpose: to investigate the influence of uterine artery embolization (UAE) on fertility after bilateral UAE with either tris-acryl gelatin microspheres or gelatin particles.
Materials and methods: six ewes that underwent UAE with tris-acryl gelatin microspheres, 6 ewes that underwent UAE with gelatin particles and 6 control ewes were compared. After hormonal synchronization of the menstrual cycle, artificial insemination was performed. When pregnancy did not result, ewes were naturally inseminated. Ovarian function and pregnancy was evaluated in each ewe.
Results: after artificial insemination, progesterone concentrations in blood increased and were maintained at > 1.0 ng/ml in 9 ewes (3 per group). Three ewes became pregnant after artificial insemination (2, control group; 1, UAE group). Thus, the abortion rate was higher in the UAE group. The remaining 15 sheep were naturally inseminated, with 14 delivering 15 lambs. Lambs' body weight, body length after birth did not differ between those from UAE group ewes and control group ewes. Lambs from ewes embolized with gelatin particles tended to be smaller and have lower body weight than those from other groups.
Conclusion: UAE influenced reproductive ability in sheep and UAE with gelatin particles might lead to intrauterine growth retardation.

P-234

Comparison of ultrasound versus MRI prior to uterine artery embolization in symptomatic patients with presumed uterine fibroids

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Purpose: to compare the utility of pelvic ultrasound (US) and magnetic resonance imaging (MRI) on the decision to proceed with uterine artery embolization (UAE).
Materials/methods: institutional REB approval was obtained. Over 2 years, 180 consecutive women sought consultation for UAE, 116 underwent US and MRI exams before possible embolization. Data was collected prospectively; imaging was analyzed for leiomyoma quantity, size and location, uterine volume, and the presence of potential contraindications to UAE. Discrepancies between imaging modalities that could have altered management were recorded.
Results: for the 116 patients who completed imaging, average uterine volume was 701 cc by MRI vs 658 cc by US (p=0.48), average dominant leiomyoma volume was 292 cc by MRI vs 253 cc by US (p=0.16). In 14 (12.1%), US did not correctly quantify or localize leiomyomas compared to MRI (p=0.0005). Thirteen patients did not undergo UAE (patient preference n=9, pre-procedural imaging findings n=4). In four cases, UAE was not performed due to imaging findings, all were diagnosed by MRI vs two by US (p=0.5). Of the two cases missed by US, one had adenomyosis and the other had a pedunculated subserosal leiomyoma. Of the 103 patients who underwent UAE, 14 of these women were treated (without complication) despite the presence of a relative contraindication; all 14 were identified by MRI vs 13 by US (p=1.0).
Conclusion: MRI is more accurate than US for characterizing uterine leiomyomas. In a small but statistically insignificant number of cases, MRI identified findings that were missed by the US, which changed management.

P-235

Outpatient uterine fibroid embolization: 400 patients in a single center

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Purpose: to evaluate the safety of uterine fibroid embolization (UFE) as an outpatient procedure.
Materials/methods: non-randomized retrospective study in 410 patients (age range 24-58 years; mean 40.5 years). Uterine fibroid embolization (UFE) was performed under local anesthesia with polivynil alcohol particles (PVA) between March 2006 and March 2008. Patients were given acid suppressing drugs, nonsteroidal anti-inflammatories, anti-histaminic drugs and laxatives twice on the day before and once in the morning of UFE. The same type of drugs was given just before, during and after embolization. Pain score, rated from 0 to 10, was evaluated, using a numeric pain scale. Four to eight hours after the embolization all patients received tramadol 100 mg i.v. and metoclopramide 25 mg i.v. The outcome of UAE was evaluated at 6 months by pelvic magnetic resonance, clinical observation and questionnaires.
Results: the mean pain score during embolization was 0.8, after embolization 2.6, at discharge 0.7, at first night after discharge 1.2 and next morning 0.9. Four hundred patients were discharged from the hospital 4 to 8 hours after the procedure. There were no readmissions. At 6 months, there was a clinical improvement of menorrhagia in 91.8% of the patients, of bulk symptoms in 83.5% and of the pain in 78.2%. The uterus and the dominant fibroid volumes reduced 36.8 and 45.3%, respectively.
Conclusion: with acid suppressing, anti-inflammatory and anti-histaminic drugs started on the day before the UFE procedure can be performed, safely, as an outpatient procedure.

P-236

Uterine fibroid expulsion after embolization in outpatient setting

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Purpose: to report our experience with uterine fibroid expulsion following uterine artery embolization (UAE) in an outpatient setting and its management.
Materials/methods: between January 2006 and April 2008, 226 women (mean age 42 years) with symptomatic fibroids underwent UAE as an outpatient procedure. All patients had telephone follow-up in the first 2-3 weeks post UA and MR imaging and a clinic visit 3 months post UAE. Patients with symptoms of vaginal discharge and pain were monitored more closely. If there was any clinical suspicion of expulsion MRI was performed. Gynecology was consulted for all cases.
Results: six patients (2.6 %) experienced vaginal discharge and cramping abdominal pain followed by fibroid expulsion. All expulsed fibroids were solitary. On pre-UAE MRI, the location was submucosal (2), intramural (3) or transmural (1); mean diameter was 10.9 cm. The time interval from UAE to expulsion was 20-60 days. Cervical dilatation

and endocavitary location of the fibroid were demonstrated on MRI prior to expulsion in three patients. Spontaneous fibroid expulsion in bulk was seen in 2 patients and tissue fragment passage in 1 patient. Two patients underwent hysteroscopic resection of the fibroid and were admitted to hospital for 2 nights. One patient underwent hysterectomy.
Conclusion: although fibroid expulsion after UAE is uncommon, patients should be informed about it. It can be managed easily. However, unattended, it may lead to serious complications. Correlating clinical findings with MR imaging can help to predict the risk of expulsion and assess the need for an intervention.

P-237

A measure of ovarian reserve following fibroid uterine artery embolization with two different embolic materials: early six month results

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Purpose: to assess the difference between Embozene™ and PVA particles for uterine artery embolization (UAE) on ovarian reserve.
Materials/methods: a prospective randomized trial of 100 patients beginning September 2008 who present for UAE as treatment for symptomatic fibroids. There are two groups, one treated with PVA particles and the other with Embozene™. Hormone levels and quality of life (QOL) will be evaluated pre-procedure and at each follow-up. Mean patient age to date is 38 (range, 30-45 yrs). The mean maximum uterine length was 13.8 cm (range, 9.4-17.5 cm). All fibroids were either subserosal, intra-mural without pedunculation or submucosal. UAE was performed by unilateral femoral approach utilizing microcatheters for uterine artery selection.
Results: estradiol levels prior to UAE were normal for all patients. A single patient had a slightly raised FSH and LH, 13.5 and 13.7 respectively. AMH and QOL results are pending. One patient (in PVA arm) had an absent left uterine artery and was treated with unilateral embolization. This patient had an elevated FSH of 46 at 6 weeks follow-up. Otherwise, FSH, LH and estradiol levels were normal for all patients at 6 weeks. All but one of the patients had restarted menstruation by 6 weeks. Six month results will be presented at CIRSE 2009.
Conclusion: initial results suggest that both types of particles are effective in achieving the end point of flow for successful UAE. There is no significant difference between hormone levels at 6 weeks.

P-238

Web based cross-sectional vascular anatomy atlas of the pelvis and lower extremity

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Learning Objectives: knowledge of the normal, abnormal and variant pelvic vascular anatomy is paramount for understanding vascular interventional procedures, particularly with regard to uterine fibroid embolization. Numerous vascular anatomy texts exist today. However, a text based atlas cannot substitute for a web based interactive anatomy atlas. The purpose of the web based cross-sectional atlas of pelvic and lower limb anatomy is to provide a quick and accessible online reference of normal and variant vascular anatomy.
Background: the web based atlas will contain many categories consisting of a series of CT, MR, ultrasound and angiographic images of normal, abnormal and variant anatomy, navigated in a scrollable fashion. Cross referencing of images between different imaging planes will allow for better correlation and understanding of anatomy. Embedded web links will also direct users to electronic literature and references. Various imaging modalities will be incorporated into the presentation, to help better elucidate the anatomical relationship of vessels to muscles and internal gynecological structures in the pelvis. The atlas will consist of a text based database, implemented using common programming languages including javascript, perl and XML. The atlas will run on a personal PC based Apache server.
Conclusion: users will have an image rich interactive program to gain a better understanding of major pelvic vessels, including branches of the internal, external, hypogastric, and femoral arteries and their tributaries. Three dimensional anatomy images will be presented where applicable.

P-239

Anatomical variation in uterine vascular supply and its implication in effective fibroid treatment by embolisation

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Learning Objectives: to understand the anatomical variations in the uterine vascular supply in the context of uterine artery embolisation.
Background: uterine arteries usually arise from the anterior division of the internal iliac artery. However, anatomical variations occur in 10-15% of the population. UAE is an established treatment for symptomatic fibroids. However, treatment failures and/or fibroid recurrence do occur and are attributed to inadequate fibroid devascularisation. It is thought that alternative uterine supply may account for up to 10% of treatment failures following UAE. Effective treatment includes vigilant identification and embolisation of non-uterine collateral supply.
Clinical findings: we present a patient undergoing renal angiography in whom selective catheterization of the right suprarenal artery demonstrated a branch supplying the ovary and the uterus. This is a recognized source of collateral supply to the uterus according to the anatomical texts. The ovarian artery is the most well-recognized source of alternative supply to the uterus but other unusual sources of uterine supply also exist. It is, therefore, important to search for alternative uterine supply when embolisation results in inadequate fibroid infarction.
Conclusion: we will illustrate the different anatomical variants of uterine supply in order to help interventionists recognise and address the potential causes of treatment failure.

P-240

Uterine fibroid embolization of the ovarian artery

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A 47-year-old woman presented with recurrent dysmenorrhea and menorrhagia after repeated myomectomies. MR revealed multiple fibroids (maximum diameter 8cm). Percutaneous treatment was successfully performed by selective embolization of the left uterine artery and the right ovarian artery with Embosphere.

Genitourinary intervention

P-241

Selective salpingography and uterine tube recanalization in the treatment of infertility

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Purpose: to study diagnostic and therapeutic modalities of selective salpingography (SSG) and uterine tube recanalization (UTR) in infertile women.
Materials/methods: between 1993 and 2008, we examined 200 women aged 20-44 years with uterine tubes occlusion (diagnosed by GSG or laparoscopy) and infertility of mean duration of 4.5 yrs. The procedure was performed on an outpatient basis and included step-by-step repeated GSG, SSG, and UTR.
Results: repeated GSG showed patent UT in 38 (19%) patients; of them 25 (66%) became pregnant within 1 year. SSG visualized UT in 56 (28%) women and 20 (36%) of them conceived. UTR was successful in 96 (91%) of 106 women; the pregnancy rate averaged 28% (n=27) and depended on patients' age and presence or absence pathological changes of UT distal segments. In total, after GSG+SSG+UTR, pregnancy occurred in 72 (36%) of 200 women and ended with normal delivery in 69 (35%).
Conclusion: SSG and UTR are important additions to GSG in infertile women due to both the accurate diagnosis of UT occlusion and possibility of simultaneous therapeutic intervention giving real chance of pregnancy.

P-242

Prophylactic temporary balloon occlusion of the internal iliac arteries in patients submitted to cesarean hysterectomy due to placenta accreta

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Placenta accreta is the leading cause of third trimester hemorrhage and postpartum maternal death. Cesarean hysterectomy is the current treatment but can be complicated by large volume blood loss.
Purpose: to describe the preliminary results of prophylatic temporary balloon occlusion of the internal iliac arteries for bleeding control in patients with placenta accreta during cesarean hysterectomy.
Materials/methods: from May 2006 to December 2008, seventeen patients with diagnosis of placenta accreta by ultrasound and/or magnetic resonance imaging were submitted to prophylactic balloon occlusion. Fluoroscopy, balloon occlusion time, surgical duration, intraoperative blood loss, transfusion volumes and procedure complications were analyzed.
Results: the mean age was 32.2 years with a mean of 3.2 previous gestations. All patients had findings of placenta accreta by imaging studies. Fifteen patients were submitted to cesarean hysterectomy, one to hysterectomy due to previous diagnosis of fetal death and another to cesarean with uterine curettage. Mean fluoroscopy time was 7.5 minutes, balloon occlusion time was 155 minutes and surgery duration was 250 minutes. Estimated blood loss was 1468 mL with mean reposition fluids of 3468 mL of crystalloids, 593 mL of colloids and 1.6 blood units. Two patients were submitted to thromboembolectomy due to prolonged surgical time. There was no maternal or fetal mortality related to the procedure.
Conclusion: prophylactic balloon occlusion of internal iliac artery is a safe method and appears to reduce blood loss and transfusion requirements in patients with placenta accrete undergoing to cesarean hysterectomy. Antenatal imaging diagnosis of placenta accreta enables preoperative planning.

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Multidisciplinary approach in the management of abnormal adherent placenta (AAP): 10 years experience

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Purpose: to report the experience of a multidisciplinary approach in the management of AAP, regarding the impact on maternal bleeding.
Materials/methods: from 1998 to 2008, 59 patients were included. Pregnancies were allowed to progress until term, unless complications appeared. Preoperative selective bilateral uterine artery catheterization was done from femoral approach. Delivery was performed after ureterical stent placement. Uterine arteries were occluded with gelfoam and total hysterectomy was performed when AAP was confirmed (sequential regional and general anesthesia was used).
Results: delivery was performed as planned in 49 patients; in 10, delivery was advanced because of active bleeding. Diagnosis was suspected during prenatal screening by ultrasound in 55 (93%); of those 48 (87%) were true AAP and 7 (13%) were false positive. 46 women underwent MRI that predicted AAP in 37 of 40 (sensitivity 0.92). 6 showed false positive results. Agreement between methods was 93.4%. Preoperative selective bilateral uterine artery catheterization was performed in 55 (93%). 52 (88%) underwent embolization, 45 (76%) underwent hysterectomy and 14 (24%) a conservative approach. No case of maternal death occurred. 37 (45%) (23 true positive, 3 false negative, and 1 false positive) received blood transfusion. 10 (17%) were admitted to the intensive care unit. No patient suffered from endovascular procedure complication. Mean hospital stay: 4.9 days (range 2-13).
Conclusion: prophylactic arterial catheterization and embolization showed to be a safe and effective, controlling massive intraoperative bleeding (comparing with literature and false negative results) in patient with AAP.

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Ureteric stenting in a large DGH: which is the most effective approach?

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Purpose: to assess the technical success of antegrade and retrograde approach for ureteric stenting with subset analysis into the indications for stent insertion.
Materials/methods: this was a retrospective data collection of 122 consecutive patients for both antegrade and retrograde stenting procedures between January 2005 and January 2008.
Results: the technical success rate for antegrade stenting was 92%. 10 procedures failed. Reasons for failure included false passage, contrast leak, obstruction distal to PUJ, stent in posterior pararenal space and poor patient tolerance. 106 procedures were performed for pelvic malignancy, which accounted for the 10 failed procedures giving an indication specific success rate of 91%. 7 cases were performed for ureteric calculi for which there were no failures. The technical

success rate for retrograde stenting was 94% including 6 failures of stent placement and 1 death. Delayed complications included 3 stent migrations, 5 blocked stents and a case of perforated ureter. The major indication was stone disease (67 procedures, 1 technical failure), which gave an indication specific success rate of 98.5%. 41 procedures were performed for pelvic malignancy with a success rate of 87%.
Conclusion: pelvic malignancy and renal stone disease were the main indications for antegrade and retrograde stenting, respectively. A high technical success rate was achieved for both antegrade stenting and retrograde stenting. However, treatment of pelvic malignancy using the retrograde approach gave a comparatively lower success rate. Clinical discussion prior to stenting ensures selection of the optimal procedure.

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Finding the origin of the gonadal vein for embolization: helpful anatomical guidelines derived from multidetector CT

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Purpose: inability of venous cannulation accounts for many failed cases, especially on the right, reported up to 25-45%. Knowledge about the common insertions into the IVC/renal veins should help.
Materials/methods: routine enhanced fine section MPR CT scans of abdomen/pelvis were analysed (age range 32-80 yrs). Studies where a vein could be clearly followed down to the gonads were evaluated (2 independent readers) for the range of gonadal/renal vein insertions.
Results: in 60 cases so far, an opacified gonadal vein was clearly seen. The right gonadal vein inserted directly into the IVC in 95% (n=57). In all cases, insertion was inferior to the renal vein (mean 19.9mm, range 1-67 mm); but majority (73%, n= 44) being within 25 mm of the right renal vein. 58% (n=35) inserted anterolaterally into the IVC (range 270-360 degrees). In the rest (5%), the gonadal vein inserted directly into right renal vein. The left gonadal vein inserted into the left renal vein in all cases (mean distance from the IVC 37.4 mm, range 15-48 mm). The mean distance from the ipsilateral vertebral body edge was 4.9 mm, with 90% inserting within 10 mm. Collaterals and multiple veins were identified in 15%.
Conclusion: on the right side, the anterolateral IVC, within 25 mm of the renal vein should be first explored. On the left side, most insert into the left renal vein within 10 mm of the left edge of the vertebral body. Further useful tips will be discussed.

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Minimally invasive interventional radiologic management of urinary tract fistulae (outcome study)

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Purpose: evaluation of minimally invasive radiologic techniques(IR) such as percutaneous nephrostomy (PCN), drainage (DR), antigrade stenting (A St) percutaneous ureteroneocystostomies (PUNC) in management of urinary tract fistulae.
Material and methods: a retrospective analysis of treatment results is carried out in 522 patients with urinary tract fistulae (347 male, 171 female 4 children, ages 11-88 years). Material from the files of 4 University Medical Centers 1985-2007. Selection criteria: urinary tract dehiscences due to trauma, inflammatory or neoplastic disease.
Results: four of 13 fistulae from bowel or pancreas to the renal collecting system closed managed by PCN, ASt and DR, as did 145 of 197 traumatic fistulae of ureter and bladder with viable margins while 53 of 104 fistulae but with compromised vascular supply to parenchymalf margins failed to respond to PN, ASt, DR mandating PUNC. 59 of 132 fistulae attributable to underlying neoplastic disease responded satisfactorily to IR management, as did 37 of 80 inflammatory fistulae. In 12 patients IR failed, in 197 PCN, DR successfully temporized conditions until definitive urologic intervention could be instituted.
Conclusions: IR definitively treated 60% (317 of 522) of urinary tract fistulae, stabilizing conditions in 197 patients awaiting definitive intervention. The minimally invasive nature, attendant lower cost and reconvalescence period recommend this modality.

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The role of interventional radiology in the management of iatrogenic ureteral lesions

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Purpose: to assess the role of interventional radiology in the management of iatrogenic ureteral lesions.
Materials/methods: during 4 years, we observed 17 patients (10 males and 7 woman; mean age: 59.8 years) with 8 ureteral stenosis and 9 ureteral leakage in native kidney (resulting from gynaecologic surgery in 5/17 patients, urologic surgery in 3/17, RF procedure in 2/17, colonic surgery in 5/17 and aortic surgery in 2/17). Pre-procedural diagnosis was performed in all patients by MR or CT-urography. Stenosis was treated with percutaneous nephrostomy, balloon dilatation and stent. In patients with ureteral leakage, we first performed a nephrostomy; then an ureteral stent was positioned through nephrostomic approach; in 5/21 patients with complete ureteral disruption, we use a "rendez-vous" technique (performed by a combined nephrostomic and cystoscopic approach). Technical success was evaluated with pyelography performed after the procedure, after 1 week and then monthly. CT and MR urography were performed in selected cases.
Results: the procedure was successful in 16/17 patients; in 1 complete ureteral disruption it was not possible to re-establish ureteral continuity. No major complication occurred. We observed 4 cases of slight haematuria spontaneously resolved. Ureteral stents were removed in 8/17 patients after a mean time of 6.2 months.
Conclusion: intervention radiology can be considered the first choice treatment of iatrogenic ureteral lesions; complete ureteral disruption frequently requires a combined treatment (radiologic and urologic); surgery should be reserved for failures of interventional procedures.

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CT-guided percutaneous nephrostomy in patients with non-obstructive uropathy

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Purpose: to report our experience with CT-guided percutaneous nephrostomy (CTPN) after ineffective sonography-guided percutaneous nephrostomy in patients with non-obstructive uropathy.
Patients and methods: 43 CTPN in 38 patients after ineffective sonography-guided percutaneous nephrostomy were analysed retrospectively. Group 1 (I) included kidneys with non-obstructive (n=30) and group 2 (II) kidneys with obstructive uropathy (n=13). CT-guided punctures and guidewire placements and correct fluoroscopy-guided nphrostomy tube positionings were evaluated. Duration of CT-guided

punctures, fluoroscopy-guided procedure and complete procedure was analyzed. Procedural complications and 30-day mortality was surveyed. Laboratory follow-up was carried out.
Results: in I, 10.7±7.1 and in II, 8.2±5.1 CT-guided punctures were performed. Overall procedural success was 97% in I and 89% in II. Duration of CT-guided punctures, fluoroscopy-guided NT positionings and complete procedure was 34±21, 26±19 and 74±32 min in I and 29±15, 26±22 and 69±17 min in II. Procedural complications included 1 perirenal and 1 subcapsular renal hematoma and 2 urinomas in I and 1 urinoma in II. 30-day mortality was 0%. Creatinine and urea significantly decreased 10 days after CTPN in NOU (n=0.003, n=0.015) and OU (n=0.015, n=0.012). Leucocytes significantly decreased 4 days after CTPN in NOU (n=0.047) and OU (n=0.024).
Conclusion: CTPN after ineffective sonography-guided percutaneous nephrostomy is a reliable, quick and safe method with excellent success and low complications.

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Post abortion late genital bleeding due to retained products of conception mimicking arteriovenous malformation (AVM): imaging findings; the place of the arterial embolisation - our experience with 13 cases

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Learning Objectives: to illustrate the different angiographic aspects in patients with late genital bleeding after abortion. To illustrate the possible evolution from trophoblastic retention to uterine AVM. To show the place of arterial embolisation.
Background: retained products of conception, mostly trophoblastic residues, produce arteriovenous shunting that can be difficult to distinguish from uterine AVMs. Doppler sonography shows persistent hypervascularity and turbulent flow in the myometrium evoking AVM. Arteriography is crucial to differential diagnosis with real AVM in which curettage is contra indicated because heavy bleeding risk. Arterial embolisation is simple and has a key place in management of late post abortion genital bleeding in cases of retained products of conception.
Clinical findings and procedure details: in our experience of 13 cases of post abortion bleeding, arteriography shows variable aspects from false aneurysm or vascular tangle evocating trophoblastic tissue, to true AVM in advanced cases, suggesting an evolving relationship. Selective embolisation of the uterine arteries occludes arteriovenous lesions, allowing safe further curettage. The literature and our experience show that embolisation can be sufficient for a complete resolution of trophoblastic retention.
Conclusion: retained products of conception appear as uterine AVM on Doppler sonography.
In cases of low flow arteriovenous shunts, safe and simple embolisation with microparticules is possible. In advanced cases, these lesions can evolve to real AVM with a complicated therapeutic approach with a high risk of hysterectomy.

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Management by percutaneous means of an iliopsoas abscess containing multiple calculi which had eroded through the pyeloureteric junction in a duplex system with focal xanthogranulomatous pyelonephritis in one moiety

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The complete percutaneous management of a 64-year-old woman with a very large iliopsoas abscess containing calculi which had eroded through the ureter of an upper pole moiety affected by focal xanthogranulomatous pyelonephritis is described.

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An unusual case of recurrent haematuria secondary to right ovarian vein syndrome in non symptomatic pelvic varicocele

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A 32-year-old woman with right recurrent ureteral haematuria.
CT showed pelvic varicocele and right light hydronephrosis.
Patient diagnosed with right ovarian vein syndrome.
Therapy: percutaneous sclerosis of ovarian veins. 6-12 months of follow-up showed disappeared haematuria and decreased right hydronephrosis.

P-252

Removal of double-J ureteral stents using a braided and curved sheath in patients with reconstructed neobladder after cystectomy

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The authors demonstrate techniques for transurethral removal of the double-J stents using braided and curved sheath in a patient with an orthotopic neobladder after radical cystectomy to treat urinary bladder cancer. This exhibition includes images and movies obtained during procedures.

Haemodialysis shunts and venous access

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Polarcath™ balloon dilatation (cryoplasty) in haemodialysis radio cephalic fistulas

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Purpose: to communicate our preliminary experience with the PolarCath™ balloon in radio cephalic fistulas.
Materials/methods: we used PolarCath™, isolated or in conjunction with the high pressure balloon (HPB), in 37 radio cephalic fistulas. Clinical indications were: poor flow (n=25), high pressure (n=2), punction difficulties (n=3) and immature fistulas (n=7).
Results: there were 35 post anastomotic lesions and 2 distal stenoses. In two cases, we did manual thromboaspiration. There were three cases with post angioplasty rupture, two of which needed graft-stent implants. We used the PolarCath alone in 20 cases (54.1%) and in conjunction with the high pressure balloon in 17 cases (45.9%). The clinical success rate was 97%. The primary patency rate when we used the PolarCath in isolation was 63±11% at 3 months, 42±11% at 6 months and 15±8% at 12 months. The primary patency rate when we used the PolarCath in conjunction with HPB was 82±9% at 3 months, 64±11% at 6 months and 58±11% at 12 months.
Conclusion: at the moment, our experience suggests that the use of the PolarCath in conjunction with HPB may improve haemodialysis vascular access survival. However, it is an expensive device.

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Usefulness of Gore Viabahn endoprostheses in management of PTFE haemodialysis graft problems

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Purpose: the Gore Viabahn endoprosthesis (GVE) is made of an expanded polytetrafluoroethylene (ePTFE) lining with an external nitinol stent.

Materials/methods: thirteen prosthetic grafts underwent insertion of a GVE (in eleven patients; mean age 58 years; range 33-77 years). The grafts were: prosthetic brachial-axillary access (n=11), prosthetic radial-median cubital forearm straight access (n=1) and prosthetic femoral-femoral looped inguinal access (n=1). Indications for GVE placement were: pseudoaneurysm (4), wall damage due to punction (7) and rupture of previously implanted GVE (2).
Results: the GVE was successfully inserted in all 13 prosthetic grafts. Manual aspiration thrombectomy was performed in three grafts before the endoprosthesis implantation. Percutaneous transluminal angioplasty was carried out in 10 cases (7 in venous anastomotic stenoses, one in a central venous segment, one in a previously implanted GVE and one in another endoprosthesis type). In two cases, a new GVE was superposed over an existing one because of punction rupture. The follow-up was from 0 to 39 months. The primary patency rate was 77% at 6 months and 22% at a year. The secondary patency rate was was 81±11% at 6 months, 45±15% at a year, and 27±13% at two years. At the end of follow-up, seven of the eleven patients had functioning grafts.
Conclusion: in our experience, the Gore Viabahn endoprosthesis is useful for improving the patency of deteriorated PTFE haemodialysis grafts.

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Angioplasty with the Gore Hemobahn and Viabahn stent-grafts in arteriovenous access for hemodialysis

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Purpose: despite significantly improved short term restenosis rates and long term patency for fluency (Bard) stent-grafts in angioplasty for recurrent cephalic arch stenosis compared with bare stents, stent inflexibility causes kinking at the transition zone and in-segment stenosis in the bare segments at the ends of the stent-graft also causes restenosis. We compared outcomes with newer, more flexible, fully covered stent grafts.
Materials/methods: sixty-six consecutive procedures using Hemobahn and Viabahn stent-grafts (Gore) were carried out from October 2007 to December 2008, 23 in cephalic arch restenoses. Indications for stent insertion were cephalic arch restenosis within three months of successful balloon angioplasty, poor outcome for angioplasty alone and extravasation or occlusion during angioplasty. Results were compared with 44 historical controls using Bard stent-grafts. Restenosis was defined as >50% narrowing of the lumen. Primary patency was time until first intervention for >50% stenosis. Secondary patency was time until occlusion of the access or insertion of an additional stent-graft into the stent in the study.
Results: six month primary and secondary patency for Gore stent-grafts was 100%, with no in segment restenoses. Six month primary and secondary patency for Bard stent-grafts was 54% (p=0.001) and 94% (p=0.32), respectively.
Conclusion: use of Gore stent-grafts in angioplasty for recurrent cephalic arch stenosis resulted in significantly improved primary patency rates compared with Bard stent-grafts. They are flexible and completely covered with graft, mandatory features for dealing with access stenoses. The weak radial force and complicated delivery system are drawbacks.

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Percutaneous embolization of hemodialysis fistulas by amplatzer vascular plug

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Purpose: to demonstrate the safety and efficacy of amplatzer vascular plug in the embolization of hemodialysis fistulas.
Materials/methods: six women and three men with chronic renal failure with an average age of 61.7 years were referred to our unit for embolization of their native hemodialysis arteriovenous fistula. The mean age of fistulas was 4.7 years. In three patients, surgical ligation attempts failed and the patients were referred for endovascular occlusion. The underlying disease was hyperdynamic heart failure in four patients and venous aneurysm with skin ulceration and nipple and high risk for sudden rupture in five patients. All fistulas were embolized by using amplatzer vascular plug.
Results: all procedures were successfully performed. No periprocedural complication was observed. The mean follow-up time was 7 months. In a patient after achieving a subtotal occlusion, recanalization in the first week control was detected and re-embolization by radial artery approach was performed. Total occlusion in the second session was obtained. No recanalization was detected at the six month control.
Conclusion: the endovascular treatment is a well-known procedure in the occlusion of hemodialysis fistulas. Amplatzer vascular plug is a safe and effective device that should be considered in the percutaneous occlusion of hemodialysis fistulas. Our results with mid-term follow-up are encouraging but further studies with long-term follow-up are necessary.

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Percutaneous translumbar tesio catheters for long-term haemodialysis: combining adequacy with low infection rates

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Purpose: to assess the efficacy of the translumbar approach to inferior vena caval (IVC) central venous catheter (CVC) insertion for long-term haemodialysis using Tesio lines.
Methods and materials: 26 patients at our centre who required an IVC CVC for haemodialysis (Tesio twin catheter) were followed up over a 91/2 year period (39 CVCs over a total of 15,864 catheter days). Written and electronic records capturing dialysis adequacy and complications, hospital admissions and laboratory data were analysed.
Results: cumulative survival was 81% at 6 months and 73% at 1 year (median survival 18.5 months). Good dialysis adequacy was achieved throughout (mean spKt/V 1.5±0.4). The incidence of access-related infections was low (exit site infection rate of 2.02/1000 catheter days; catheter-related bacteraemia rate of 0.82/1000 catheter days) and comparable to that of tunnelled jugular lines at our centre. The rate of all-cause hospital admission was 3.97/1000 catheter days. Catheter dysfunction (i.e. need for thrombolytic infusion or catheter change) led to 0.88 admissions per 1000 catheter days.
Conclusion: translumbar inferior vena caval central venous catheters offer a safe and effective mode of long-term haemodialysis access in patients who have limited venous access options.

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Pain control with local injections for percutaneous transluminal angioplasty in the treatment of stenosis of arteriovenous fistula for hemodialysis

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Purpose: to evaluate the safety and effectiveness of anesthesia with percutaneous xylocaine injections at stenosis regions of hemodialysis vessels during percutaneous transluminal angioplasty (PTA).
Material and methods: twenty adult patients with stenosis of autogenous arteriovenous access for hemodialysis underwent 22 PTAs. The stenosis areas were marked by sonography and angiography at first. Then percutaneous injections with 2~4 cc xylocaine (2%) under sonographic guiding were performed at every marked region before the procedure of balloon dilatation. Patients' responses to pain were recorded by using a visual analog scale (0 to 10).
Results: a total of 30 stenosis regions were collected. The average pain score was 2.1, medium number was 1.5; pain scores in 25 (83.33%) points were 5 or less and in 20 (66.67%) were less than 2. No major complication was noted during or after the interventional procedures. Only subcutaneous swelling and temporary oozing over injected sites happened.
Conclusion: this way allows safe and effective pain control during the procedure of PTA. Most patients were satisfied and without worries to receive the same treatment again if restenosis occured.

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Endovascular treatment of immature, dysfunctional and thrombosed forearm autogenous ulnar-basilic and radial-basilic fistulas for hemodialysis

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Purpose: there is no information in the literature to date about the outcome of direct ulnar-basilic or transposed radial-basilic forearm autogenous fistulas after endovascular treatment of stenosis or thrombosis.
Materials/methods: this retrospective study included 78 consecutive patients who were referred to a single interventional radiology centre for endovascular treatment of delayed maturation (n=30), dysfunction (n=35) or thrombosis (n=13) of their autogenous forearm ulnar-basilic (n=62) or radial-basilic fistulas (n=16). The mean age was 64.7 years, 26% had diabetes, 83% were treated for hypertension. Immature and dysfunctional fistulas were treated by dilation, and thrombosed fistulas by aspiration thrombectomy. Clinical success was defined as the perception of a continuous thrill and the ability to perform dialysis. Fistula patency rates were calculated with the Kaplan-Meier method.
Results: immediate overall clinical success was 97%. The 2 failures occurred with an immature and a thrombosed fistula. Immediate complications included 2 transient dilation-induced ruptures treated by prolonged balloon inflation. One case of subsequent hand ischemia was successfully treated by distal artery ligation. Overall primary patency rates were 51% at 1 year. These rates were significantly lower for immature and thrombosed fistulas (35-37%) compared to dysfunctional mature fistulas (71%). Secondary patency rates were 96 and 91% at 1 and 4 years, respectively.
Conclusion: endovascular treatment plays a major role in the maturation process, maintenance and salvage of radial and ulnar-basilic fistulas. It might encourage nephrologists and surgeons to consider forearm basilic fistulas systematically in their strategy of vascular access creation.

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Central venous occlusions with thrombus in hemodialysis patients: efficacy of primary percutaneous stent deployment

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Purpose: the efficacy of primary stenting of central venous occlusions with thrombus in hemodialysis fistula was retrospectively analysed.
Materials/methods: primary percutaneous stent deployment was attempted in 34 central venous occlusions with thrombus for 9 years. There were 22 (64.7%) male and 12 (35.3%) female patients (mean age, 57.2 and range, 23-77 years). The type of fistula was an autologous arteriovenous fistula in 26 cases and a PTFE implant graft in 8 cases. The occlusive lesion involved subclavian vein in 11 cases, innominate vein in 19 cases, and both veins in 4 cases. The mean length of the occlusion was 3.6 ±1.5 cm with a range from 1 to 7 cm. Seventeen patients had history of central venous catheter on the same side. Additional balloon dilation was performed after stent deployment. Technical success, procedure related complications and long-term patency were calculated with the Kaplan-Meier method.
Results: percutaneous angioplasty with stent in central venous thrombus was successful in all procedures. There were no procedure related complications. Mean primary patency period was 14.8±4.78 months. Primary patency rates at 6, 12, and 24 months were 60.8, 36, and 7.7%, respectively. Cumulative patency rates at 6, 12, and 24 months were 86.5, 81.7 and 53.3%, respectively. Repeat intervention was required 2.18 times per year during follow up period.
Conclusion: in patients undergoing hemodialysis, primary stenting is safe and effective for treatment of central venous occlusion with thrombus. Frequent re-interventions are necessary to maintain vascular patency to achieve long-term success.

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Percutaneous transluminal angioplasty for dysfunctional transposed brachiobasilic arteriovenous fistula

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Purpose: to evaluate character of dysfunctional transposed brachiobasilic arteriovenous fistula (TBB AVF) and outcome after percutaneous transluminal angioplasty (PTA).
Materials/methods: in total 101 patients who underwent TBB AVF operation, twenty-nine patients underwent PTA for dysfunction from January 2006 to February 2008. Retrospective image analysis was also performed for evaluation of stenotic site, length and degree. The stenotic site was grouped as follows: 1) junction of basilic and axillary veins, 2) initial 3 cm to anastomosis, 3) mid-fistula, and 4) central vein. Primary and secondary patency rates were determined using Kaplan-Meier methods.
Results: in 29 patients with TBB AVF, total 45 lesions were detected (group 1, n=15; group 2, n=10; group 3, n=15; group 4, n=5). The length and degree of stenosis was as follows: group 1, 2.3 cm and 71%; group 2, 3.7 cm and 75%; group 3, 2.2 cm and 61%; group 4,

4.8 cm and 88%). Technical success was 100%. Vascular ruptures after PTA were developed 8 lesions (17%) (group 1, n=5/15, 33%; group 2, n=3/15, 20%). All vascular ruptures were successfully treated with balloon tamponade. Primary patency at 3, 6, 12 months were 92, 59, 27% and secondary patency at 12, 18, 24 months were 89, 58, 31%. Mean primary patency was 9.8 (overall), 7.8 (group 1), 11.8 (group 2), 13.2 (group 3), 5.7 months (group 4).
Conclusion: PTA for dysfunctional TBB AVF is safe and effective. PTA for junction of basilic and axillary veins is higher rupture rate and shorter patency than other sites.

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Role of interventional radiology in management of dialysis fistulas

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Learning Objectives: 1. To appreciate the anatomy and physiology of an arterio-venous dialysis fistula. 2.To demonstrate common presentations of fistula complications. 3.To illustrate the technique of performing percutaneous diagnostic evaluation. 4.To familiarise with the interpretation of imaging findings. 5.To appreciate the growing role of interventional radiology in dealing with these complications.
Background: dialysis access fistulas remain the lifeline of haemodialysis dependent end stage renal failure patients. Stenosis and thrombosis of dialysis fistulae are common problems in these patients. Haemodialysis catheter related venous scarring and thrombosis can further result in loss of fistula. Timely recognition and treatment of fistula related complications are vital to maintain access function. Minimally invasive percutaneous radiological interventions are of increasing importance in diagnosis and management of such problems.
Clinical findings and procedure details: maintenance of vascular access is an ongoing challenge in haemodialysis patients. The radiologist needs to have an understanding of the anatomy and physiology of the fistula and be adept at performing and interpreting various diagnostic modalities such as fistulagram, Doppler ultrasound, flow volumes and pressure measurement. Percutaneous investigations define pathology such as stenosis, which may be peripheral or central, thrombosis, aneurysm of the fistula, steal syndrome, etc. Increasingly these complications are treated by percutaneous radiological interventions, e.g. thrombolysis, angioplasty, cutting balloons and stents. The role of these techniques will be outlined.
Conclusion: interventional radiology plays an important role in early diagnosis and treatment of dialysis fistula complications, thus, maintaining long term access function.

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Percutaneous closure of a 13 french inadvertent arteriotomy using two angio-seal devices simultaneously

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Successful percutaneous closure, using occlusion balloon and simultaneous deployment of two Angio-Seal devices to post close an inadvertent 13 French dialysis catheter placement in the subclavian artery, close to the vertebral artery origin, in an obese, high surgical risk patient.

P-265

The use of stent grafts in complicated arteriovenos access false aneurysms

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Endovascular stent-graft deployment was used to treat nine patients with infected access aneurysms. It was a simple, safe and rapid ambulatory procedure that simultaneously treated both the aneurysms and their cause (percutaneous transluminal angioplasty of severe draining vein stenosis).

Hepato-biliary intervention

P-266

MR ONCO-TREAT: a new tool for the assessment of hepatic tumors treated with trans-arterial therapy and monitored with multi-modal MRI

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Purpose: for hepatic tumors, the RECIST criteria are a poor indicator of response to intra-arterial therapy. Multi-parametric MRI, including diffusion-weighted imaging (DWI) and dynamic contrast-enhancement (DCE) is a more sensitive indicator of response. MR ONCO-TREAT is a semi-automated software package for three-dimensional intra- and inter-study image registration, segmentation, volumetric and functional analysis of hepatic tumors.
Materials/methods: a non-rigid registration algorithm is used for aligning all images from pre- and post study within the same coordinate system. A semi-automated 3D segmentation technique is then used to define tumor borders. MR ONCO-TREAT can automatically evaluate: volumetric data, DWI values, DCE in multiple vascular phases, and can automatically compare two studies either using percent volume or on a voxel-by-voxel basis. Data presentation with this tool is highly flexible with various graphical displays, color maps, 3D visualization and measurement tools provided.
Results: MR studies from 6 patients with hepatocellular carcinoma were evaluated before and 4-6 weeks after trans-arterial chemoembolization. The software was able to accurately register the studies, to segment the tumors from the surrounding liver, to analyze functional data on a voxel-by-voxel basis where possible. On average, tumor size increased by 24%, the apparent diffusion coefficient increased by 9.5%, and percent enhancement decreased by 35.7 (arterial) and 14.5 (venous).
Conclusion: MR-ONCO-TREAT can provide comprehensive, 3D volumetric and functional analyses of hepatic tumors within and between serial studies. Future work will focus on testing this software package in the clinical setting, and to correlate data acquired from this software package with clinical outcomes.

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Transarterial chemoembolization in down-staging program for hepatocellular carcinoma prior to liver transplantation: the Bologna work-in-progress experience

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Purpose: to assess the efficacy and the safety of trans-arterial chemoembolization (TACE) in inducing complete tumor necrosis in HCC-patients, confirmed by the histology after liver transplantation (LT). To analyze the overall survival and the tumor recurrence rate of patients both within and exceeding the Milan criteria (MC).
Materials/methods: we prospectively analyzed from 2003 to 2007 the outcome of 173 patients listed for LT divided in 3 groups: single nodule <3 cm (T1, 37 pts); single nodule ≤5 cm or multiple nodules ≤3 with a diameter ≤3 cm (T2, 93 pts) meeting the MC and the down-stage group (T3, 43 pts): single HCC ≤6 cm or multiple nodules ≤6 with a total diameter ≤12 cm. Eighty-two patients (68.3%) underwent TACE: 7 in T1 (18.9%), 46 in T2 (49.5%), 29 in T3 (67.4%).
Results: histology after LT demonstrated a complete tumor necrosis in 61 patients (74.4%) and partial necrosis in 21 patients (25.6%). The degree of necrosis directly correlated with the selectivity of TACE: 80.6% of cases were treated with superselective TACE vs 46.7% with a lobar TACE. After a median follow-up of 28.3 months, the overall tumor recurrence rate was 14.6% and the overall survival was 82%. The recurrence rate was comparable among the groups and it did not affect significantly the patients' survival.
Conclusion: TACE is safe and effective in obtaining a complete tumor necrosis when performed in a superselective way compared to lobar procedures. The pre-operative tumor stage did not affect patient survival and the down-stage group had comparable outcome than the others.

P-268

Dual catheter placement technique for treatment of biliary strictures after liver transplantation

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Purpose: to evaluate the results of percutaneous transhepatic management of anastomotic biliary strictures using a dual catheter placement technique.
Materials/methods: among 1201 liver transplant recipients, percutaneous transhepatic biliary drainage and subsequent balloon dilation of the anastomotic stricture were performed on 84 patients. Serial exchanges of drainage catheter with larger diameters up to 14 Fr were performed at 1-month interval and then three exchanges of the dual catheters were performed at 2-months interval. Drainage catheters were removed if follow-up cholangiography revealed improvement the stricture without recurrence of symptoms or elevation of biochemical findings.
Results: the clinical success was achieved in all 80 patients after percutaneous transhepatic treatment. The drainage catheters removed 25.4±9 months (range, 12-51 months) after the initial percutaneous transhepatic biliary drainage (PTBD) in 79 (98.75%) of these 80 patients and the mean period of the dual catheter placement was 7.5±1.7 months (range, 6-17 months). The patency rate at a mean follow-up of 18.9±3 months (range, 0.1-22.5 months) following the drainage catheter removal was 98.7%.
Conclusion: dual catheter placement technique is an effective method for treatment of anastomotic strictures following liver transplantation.

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Interventional radiology of Mirizzy syndrome

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Purpose: to determine the safety and efficacy of Mirizzy syndrome treatment by techniques of interventional radiology.
Materials/methods: between 2006 and 2008, we have studied 9 patients with Mirizzy syndrome. Acute form (without bile fistula) was in 2 cases; in 7 cases of chronic form common bile duct occlusion was by stones, which have migrated from gall bladder through bile-bile fistula. Every patient has been evaluated by US and percutaneous transhepatic cholangiogram through the transhepatic biliary drainage catheter (PTD) that was inserted by US and X-ray control for the relief of obstructive jaundice. We combined PTD with transcutaneous extrahepatic microcholecystostomy. Transhepatic and extrahepatic approach has created by sequential telescopic dilatation of primary bile drainage channel from 8 Fr to 28 Fr in 6-7 days after cholangyo- cholecystostomystomy. Lithotripsy was used by pneumatic lithotripter through the working channel of rigid 26 Fr nephroscope. Antegrade lithotripsy was added by antegrade balloon papilloplastic or retrograde papillotomy and temporary external-internal bile drainage.
Results: the treatment was successful in all 9 patients. In 4 patients, lithotripsy was by two sessions, in 5 -tree once. There were no hemorrhage or bile leakage during large size access formation and litotripsy.
Conclusion: our experience confirms that even large size (28 Fr) transhepatic approach into bile tree and extrahepatic once into gallbladder can be free from complications due to severe execution of technique procedure. Mirizzy syndrome can be treated successfully by antegrade percutaneous trans- and extrahepatic pneumatic lithotripsy.

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Tumor response criteria to transarterial chemoembolization (TACE) for hepatocellular carcinoma (HCC): inter- and intra-observer reproducibility of modified EASL (European Association for the Study of the Liver) and RECIST (response evaluation criteria in solid tumors) ver 1.1 from the dataset of JIVROSG (Japan Interventional Radiology in Oncology Study Group) 0401

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Purpose: to compare two standard criteria (RECIST ver 1.1 and modified EASL) for tumor response evaluation of HCC treated by TACE. Tumor size is evaluated by measurement of the entire lesion including necrotic part using RECIST (EJC 2009;45:228), whereas the only contrast-enhanced part on arterial phase using EASL (JNCI 2008;100:698). Both criteria adopt the unidimensional measurement.
Materials/methods: this is a study of the radiological findings of patients who underwent TACE for multiple HCCs in the JIVORSG 0401 study. The subjects were 65 lesions in 21 patients treated by pan-hepatic TACE using cisplatin and gelatin particles without mixing iodized-oil. Five radiologists measured independently each lesion twice according to RECIST and EASL. To evaluate the inter- and intra-observer reproducibility, CR rate, response rate, kappa statistics, and proportion of agreement (PA) for response categories were calculated.
Results: CR rate and response rate obtained by EASL (56.9 and 79.5%) were higher than those by RECIST (9.6 and 43.7%). The inter-observer reproducibility of EASL indicated "almost perfect agreement" (Kappa= 0.829 (95%CI:0.792-0.866), PA= 90.0%), while that of RECIST

indicated "substantial agreement" (Kappa= 0.628 (95%CI: 0.571-0.684), PA= 78.8%). The intra-observer reproducibility of EASL indicated "almost perfect agreement" (Kappa= 0.900 (95%CI:0.858-0.942), PA=94.2%), while that of RECIST indicated "substantial agreement" (Kappa= 0.643 (95%CI:0.565-0.722), PA= 79.4%).
Conclusion: for the tumor response criteria in clinical trials of TACE for HCC, modified EASL was more encouraged comparing with RECIST ver 1.1 from a viewpoint of the high inter- and intra-observer reproducibility.

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Superior efficacy of doxorubicin eluting beads in hepatocellular cancer: results of multi-institutional registry

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Purpose: to evaluate the use of the DC Bead in the intermediate HCC and compare efficacy and doxorubicin related toxicity to the recent prospective randomized control trial of the DC Bead.
Materials/methods: 125 intermediate/advanced HCC patients were enrolled in a prospective open-label, multi-center, multi-national single arm study receiving doxorubicin loaded DC Bead (max 150 mg per infusion). Complications were graded by the CTCAE for adverse events version 3.0. Response rates were graded by the modified RECIST criteria.
Results: patients received a total of 172 DC Bead(range 1- 4) treatments. Eighty-two were Childs A, 38 Childs B, and 5 Childs C, median number of lesions was 1 (range 1-25), median size of largest was 4 cm (range 1-20 cm), with 93 having <25% liver involvement.
Treatment: a median dose of 150 mg (range 50-150 mg) was used for 172 treatments, with 83% of patients receiving full planned dose, with the most common reason for incomplete dosing being patients undergoing their 2 or 3 treatment. A lobar infusion was used in 57% and segmental in 34%. Twenty-four patients suffered adverse events at 30 day follow up (median grade 2, range 1-5), with the most common being post-embolic syndrome. After a median follow up of 12 months, we have seen an overall response of 82% (24%CR, 58%PR) at 3 months, 82% at 6 months, and 70% at 12 months with median overall survival of 11 months.
Conclusion: doxorubicin DC Bead provides superior safety profile and effective treatment of intermediate/advanced HCC as demonstrated by a minimal complication rate and maximum tumor response and overall survival.

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Transcatheter arterial chemoembolization for hepatocellular carcinoma via the intercostal arteries

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Purpose: to clarify the factors of hepatocellular carcinoma (HCC) fed by intercostal arteries (ICA) and to evaluate the efficacy of transcatheter arterial chemoembolization (TACE) for HCC fed by ICAs.
Materials and methods: eighteen patients with HCC fed by ICAs were studied by clinical records retrospectively. The times of TACE until the development of ICAs, tumor size, and the tumor location were analyzed. TACE was performed with anticancer agent mixed with lipiodol (Lp) and gelatine sponge particles (GS) via the peripheral portion of ICAs in 39% (7/18) and via the middle or proximal portion of ICAs in 61% (11/18). Complications were also analyzed after TACE via ICAs of HCC.
Results: except only one patient, TACE was performed repeatedly, and the mean time of previous TACE is 4.3 times. And surgical resection was previously received in 28% (5/18). The tumor size was less than 3 cm in 17% (3/18), ranged from 3 to 5 cm in 44% (8/18) and over 5 cm in 39% (7/18), respectively. All tumors were located in the posterior segment of the right hepatic lobe. Lp accumulation was seen in all cases on CT after TACE. Severe complications such as skin ulceration and paralysis were found in 17% (3/18), all of who were performed TACE via the middle or proximal portion of ICAs.
Conclusion: the development of ICAs in HCC is correlated with multiple TACE, tumor size, and tumor location. TACE for HCC fed by ICAs should be performed super-selectively via the peripheral portion of ICAs to prevent severe complications.

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Risk factors of hepatic segmental or lobar misperfusion on CT hepatic arteriography after embolization of replaced or accessory hepatic arteries for efficient performance of repeated hepatic arterial infusion chemotherapy

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Purpose: to investigate the risk factors of hepatic segmental or lobar misperfusion on CT hepatic arteriography after embolization of replaced or accessory hepatic arteries performed to elucidate the distribution of contrast material in the entire liver.
Materials/methods: forty-four patients with replaced or accessory hepatic arteries, with unresectable advanced liver cancer were the subject of this study. These patients underwent placement of a percutaneous implantable port-catheter system after embolization of replaced or accessory hepatic arteries during hepatic arterial port placement to insert a single indwelling catheter. The correlation between hepatic arterial perfusion of contrast material on CT hepatic arteriography after implantation and various factors was retrospectively reviewed.
Results: in 40 patients, contrast material perfused through the entire liver, however, in the remaining 4 patients, contrast material was misperfused in some areas of the liver on CT hepatic arteriography. Significant difference was noted only in the incidence of the appearance of misperfusion areas between cases in which embolization was limited to the proximal part of the bifurcation of the replaced or accessory hepatic arteries and those in which some of the coils migrated to the distal part (1/34 versus 3/10, p value=0.032, Fisher's exact probability test).
Conclusion: to prevent hepatic arterial misperfusion after embolizing replaced or accessory hepatic arteries during hepatic arterial port placement, coil embolization should be positioned at the proximal site of the first bifurcation of the intrahepatic segment of the hepatic artery. Additionally, embolization with n-butyl-cyanoacrylate is useful when embolization is insufficient with coils alone.

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Liver bland embolization with 40 µm Embozene™ micro-particles associated with radiofrequency thermal ablation in a single session to increase the area of coagulation necrosis in liver lesions: preliminary results

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Purpose: tumor size, site and morphology may affect the local results of liver radiofrequency ablation (RFA). We are evaluating feasibility, safety and local effectiveness of a single session combined approach for treating difficult liver lesions with bland embolization (TAE) immediately prior to RFA.
Materials/methods: nine patients (7 males; mean age 67.3 years) with liver lesions (6 metastases from CRC, 2 HCC and 1 CCC) underwent the combined approach (TAE and RFA) in the same session. TAE was performed with 40 µm Embozene™ injected within segmental or sub-segmental arteries supplying the lesion, until cessation of blood flow. RFA was then performed under US/CT guidance with 3.5 to 5 cm Lee-Veen needle, according to the lesion size (mean diameter 36.7 mm; range 25-47 mm).
Results: technical success was 100%. We obtained an area of coagulation necrosis larger than needle size (mean diameter 65.2 mm; range 44-80 mm). All lesions were completely ablated with a safe margin; no recurrences have been detected to date (median F/U 3 months; range 1-28 months) at the site of ablation. No patient required retreatment and no major complications occurred.
Conclusion: combined approach for treating difficult liver lesions seems to be feasible and safe. TAE with micro-particles performed immediately before RFA allows for a larger area of coagulation necrosis, improving the volume of ablation. Even if long-term clinical results are needed, this technique could be a useful therapeutic option for patient with large or difficult liver lesions appropriate for localized treatment.

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First report of a pilot study of trans arterial chemo-embolization (TACE) with drug eluting beads irinotecan (IRI) preloaded (DEBI) for liver metastases (LM) from uveal melanoma (UM)

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Purpose: exclusive LM occurs in up to 40% of patients with UM associated with a median survival of 2-5 months; surgery and chemotherapy have poor results. TACE seems effective in palliation of LM from different tumours.
Materials/methods: between February 2006 and February 2009, 16 patients with LM from UM (F/M=12/6 median age 48 yrs, liver replacement (LR) 25%=8 cases, 50%=3 cases, 75%=5), treated with surgery (3 cases) and chemo-immunotherapy (16) were enrolled into a pilot trial of TACE with DEBI. One patient had early death and five had early progression during staging and were not treated. TACE with DEBI preloaded with 100-200 mg of IRI was delivered every 4 weeks for 2 folds. Computed tomography was performed before, after treatment and every three months till progression. Before treatment intra-arterial lidocaine and from day 0 to 4 analgesic medications, antibiotics and intravenously hydration were administered.
Results: 13 patients received 26 cycles (2 each patient). Right upper quadrant pain (RUQP) grade 2 short lasting, fever grade 2 lasting 3 days (range 2-7) and increases of liver enzymes grade 2-3 were reported by all patients. After 30 days, a reduction of 75% of the lesional contrast enhancement was observed in 8 patients. A complete disappearance of enhancement was observed in 8 patients.
Conclusion: TACE with DEBI is feasible and safe in patients with LM from UM. Fever, RUQP, and increases of liver enzymes are the side effects. Responses seem related to beads diameter. Survival is related to liver substitution.

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A "must" procedure for hemodialysis patients with acute cholecystitis: percutaneous cholecystostomy in chronic hemodialysis patients as definitive treatment or as a first step procedure for interval laparoscopic cholecystectomy

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Purpose: the aim of this article is to document the safety and efficacy of percutaneous cholecystostomy (PC) in chronic hemodialysis patients with acute cholecystitis as definitive treatment with no need of cholecystectomy or as a first step procedure for interval cholecystectomy.
Materials/methods: twelve patients on maintenance hemodialysis with acute cholecystitis underwent PC. The mean hemodialysis time was 11.2 years for the patients. All the patients were classified as ASA score IV by the anesthesiology team. All procedures were carried out by transhepatic route in ten and transperitoneal route in two patients.
Results: no procedure-related complication was observed. The mean catheterization time was 25.3 days. In eight patients, the catheter was withdrawn after the detection of clinical and radiological improvement. In three patients, no clinical improvement was observed and urgent surgery was performed. All of these patients died because of surgical complications and multiorgan failure. In one patient, during the follow-up period a new cholecystitis attack was detected and urgent surgery was performed. Gangraneous cholecystitis was detected.
Conclusion: PC is an urgent procedure that should be performed in patients on maintenance hemodialysis with acute cholecystitis as a 'must' step for definitive treatment or as a beginner to make the patients fit for surgery. These patients are generally ASA score IV patients with multisystemic diseases. Elective or urgent surgery has high risk of morbidity and mortality depending on the time of hemodialysis. PC can be a life saving procedure with no need of interval surgery in a hemodialysis patient with acute cholecystitis.

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Expanding selection criteria for liver transplantation: the role of tumour response after TACE in patients exceeding Milan criteria

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Purpose: to retrospectively evaluate long-term clinical results of patients with hepatocellular carcinoma (HCC) exceeding Milan selection criteria who received transarterial chemoembolization (TACE) before orthotopic liver transplantation (OLT).
Materials/methods: the study included 33 HCC patients beyond Milan criteria who underwent OLT after TACE. Tumor response to TACE was evaluated at 1 month by Computed Tomography (CT) according to the amended RECIST criteria. On the explanted liver, tumor necrosis was graded as greater than 90%, between 50 and 89%, or less than 50%; residual tumor stage and grade and microvascular invasion were assessed.
Results: after TACE, 1-month CT control showed complete tumor response (CR) in 18 patients (54.6%) with a mean percentage of viable tumor volume reduction of 80.1%. CT results correlated well with histological data that demonstrated a mean degree of tumor necrosis of 72.1%, with 20 (60.6%) patients with > 90% necrosis. In 9

(27.3%) patients, microvascular invasion was observed; none of them were considered as CR at CT after TACE. Post-OLT 5-year cumulative survival and recurrence rates were 71.2 and 26.7%, respectively. Recurrence rate at 5 years was significantly (P=0.003) lower in patients with CR (5.6 versus 53.3% and 50% in stable disease and partial response), and with residual tumor grade G1-G2 (P=0.002), residual tumor stage T1-T2 (P=0.0006) and absence of microvascular invasion (P<0.0001).
Conclusion: in HCC patients beyond Milan criteria, CR after TACE is associated with high post-OLT recurrence-free survival and can offer a valid preoperative selection criterion for OLT.

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TACE of unresectable HCC with doxorubicin pre-loaded DC beads: results of six months of follow up

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Purpose: to present the results in terms of efficacy and safety of precision TACE with doxorubicin pre-loaded DC beads in unresectable hepatocellular carcinoma (HCC).
Materials/methods: thirty-five patients with multiple (from 1 to 4 lesions) documented unresectable HCC were included. The mean tumour diameter was 4.89±4.39 cm. Doxorubicin dose was 50-100 mg loaded in DC beads of 100-700 µm. Objective response was defined on the base of volumetric reduction of vital area of the lesion based on EASL criteria. Each patient was evaluated with CT control at 1 and at 6 months after the procedure.
Results: efficacy at 1 month: 85% of the patients showed complete response, 15% partial response and no cases of stable disease. Efficacy at 6 months: 62.5% of the patients showed complete response, 37.5% partial response, and progression of disease in 75% of patients. Peri-procedural compilcations were: minimum temperature increase (means 38 C°) in 20% of patients, abdominal pain in 10% of patients and a minimum increase of hepatic enzymes in 15% of patients. In 85% of patients, a single treatment was enough to induce complete tumoral necrosis at 1 month control.
Conclusion: the precision TACE with doxorubicin pre-loaded DC beads represents a safe and effective treatment of unresectable HCC.

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Doxorubicin eluting beads in 6 patients with HCC: tissue concentration and modifications

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Purpose: a preclinical study in a non-tumorous pig liver model previously showed that doxorubicin embolization beads (DOXO-DEB) give high tissular levels of drug over several months, inducing necrosis of liver parenchyma (Namur et al. CIRSE 2008). The present study used the same method to correlate the tissular concentration and modifications induced by DOXO-DEB in HCC tumors.
Materials/methods: six patients with HCC underwent chemoembolization with DOXO-DEB (LC/DC Bead™ Biocompatibles UK Ltd, size: 100-300 µm, mean dose of drug injected: 98.3±24.4 mg, 75-150 mg) prior to liver transplantation (mean time of explantation: 17.5±11 days, 6 hours-36 days). On sections of explanted liver, the tissular concentration of DOXO was determined radially around the vessels occluded by DEB with microspectrofluorimetry (M51, Dilor). The modifications of the tissue surrounding the DEB were determined as: necrotic/fibrotic/tumor/non tumorous liver.
Results: DOXO was detected in the tissue around DEB for all times of explantation. DEB distribution assessment in patient transplanted at H6 showed that DEB could penetrate inside the tumor (43% of vessels) up to a distance of 1.1 cm. The concentration of DOXO around occluded vessels was higher in tumor (6.40 µM) than in non-tumorous liver (3.35 µM). Between D9 and D36, no viable tumor was seen around DEB and the beads were surrounded with necrosis (41% occluded vessels) or fibrotic tissue (52%). The necrotic tissue was associated with higher concentration and deeper penetration of the drug than non necrotized liver.
Conclusion: DOXO-DEB give high drug concentration in HCC over at least 36 days post-embolization associated with tumor necrosis.

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Selective internal radiation therapy (SIRT): technical remarks and first clinical results

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Purpose: to report our first clinical results.
Materials/methods: 26 patients with progressive liver tumors were indicated for SIRT after interdisciplinary consensus conference (10 HCC, 7 colorectal, 3 CCC, 2 RCC, 2 neuroendocrine, 1 angiosarcoma, and 1 leiomyosarcoma). Work-up included MRI of the liver, PET-CT for screening, liver function tests, and 99mTc-MAA-scan for assessment of arterio-venous shunting after embolization of the gastroduodenal and right gastric artery. 90Y-microspheres were administered under fluoroscopy to avoid reflux. Follow-up included clinical visits, liver function tests, and MRI at one and three months and every three months thereafter.
Results: in 26 patients (16 male, 10 female, age 62.5±13.2 years), 34 procedures were performed, 22 single procedures, 4 split primary treatments, and 3 repeated SIRT because of progressive disease. There were no peri-interventional procedural complications. 30 day mortality was 3.8% (one case with cardiac insufficiency at 10 d). Follow-up is 6.1±4.6 months (range 10 days to 15.5 months) with an overall mortality of 34.6% (9 of 26). One patient with single SIRT treatment died from progressive intrahepatic tumor spread and liver insufficiency at 39 d, possibly RILD as co-factor. Seven died because of local and/or systemic tumor progress. Of the remaining patients, 7 presented with progressive disease, 6 with stable disease, and 4 with partial response. One patient developed a duodenal ulcer 12 months after the first SIRT procedure.
Conclusion: SIRT has been successfully introduced into our armamentarium for local tumor treatment. Indication for SIRT should be based on an interdisciplinary consensus conference.

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TACE with HepaSphere™ in treatment of unresectable HCC: preliminary results of a monocentric study and comparison with historical personal series of standard TACE

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Purpose: to present the preliminary results of TACE using HepaSphere™ microspheres (Biosphere Medical) loaded with

Doxorubicin in patients with unresectable hepatocellular carcinoma and to compare this series with our precedent series of traditional TACE: TACE with Lipiodol and Gelfoam 340 pts treated between December 1991 and April 1996, TACE with Lipiodol and Embosphere 46 pts treated between February 2000 and November 2005.
Materials/methods: from December 2005 to October 2008, 50 patients (39 male and 11 female, mean age 71.5 years) were treated by TACE using HepaSphere™ loaded with Doxorubicin. The diameter of the lesions ranged from 25 to 176 mm, with a mean diameter of 66.3 mm and a maximum of 4 lesions for patient (91 lesions treated).
Results: technical success rate was 100%; one month CT follow up shows complete necrosis in 38.6%, partial necrosis in 43.2%, and progression disease in 6.8%. 6 month follow-up shows complete necrosis in 25.9%, partial necrosis in 44.4% and progression disease in 18.5%. 6 patients underwent other treatments, 5 were lost at follow up. Survival at 6 months was 90.9% in HepaSphere™, 91.3% in Embosphere and 77% Gelfoam group; at 12 months it was 77.2% to HepaSphere™, 73.9% in Embosphere and 59,1% in Gelfoam group.
Conclusion: our initial experience demonstrates that TACE using HepaSphere™ is a feasible, with low complication rate and promising efficacy: the results seem to be better than standard TACE with Gelfoam. Larger series and randomized studies are mandatory to confirm these preliminary results.

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"Pooling phenomenon" during embolization with microspheres of hepatocellular carcinoma

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Purpose: to describe the outcome of patients with HCC nodules, showing pooling phenomenon on angiographic sequences undergone with transarterial embolization (TAE) with microspheres.
Materials and methods: among 145 patients with HCC consecutively treated with TAE, 16 patients (11%; 13 HCV, 3 HBV; 13 Child A and 3 Child B; 8 monofocal, 6 bifocal and 2 trifocal; medium nodes diameter 32.7 mm) showed angiographic "pooling phenomenon". It was defined as thick, patchy, concentrated spots of contrast medium that persisted during venous phase.
In all cases, TAE was performed throught injection of microspheres (100-300 or 300-500 micron), but Gelfoam was always needed to obtain complete devascularization.
Results: complete response was achieved in 9/16 patients (14/26 nodes) after a medium of 2.6 treatment per patient (range 1-7), but all presented disease recurrence after 4.2 months (range 1-12 months). Partial response was obtained after 1 treatment in 6 patients and after 2 treatments in the last one. After a medium follow-up of 14 months (range 3-38), 6/16 patients died (4 hepatic failure, 1 other primitive cancer, 1 haematemesis). Five patients were shifted to other therapies because of disease progression (3 conventional chemoembolization, 2 supportive care); 4 patients are still in follow-up for chemoembolization with drug-eluting beads, 1 refused treatment.
Conclusion: in our experience, according to anatomopathologic literature, HCC presenting this peculiar feature, corresponding to histologic changes, seems to have more vascular invasivity and even in patients with complete necrosis recurrence rate is high.

P-283

Efficacy of percutaneous intervention for biliary stricture in pediatric liver transplant patients

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Purpose: to investigate the efficacy of percutaneous interventions for biliary stricture in pediatric liver transplant patients.
Materials/methods: 265 transplants were performed in 236 patients over 12 years. A prospective transplant database was utilized. Inclusion criteria were the presence of biliary stricture as a complication after transplantation. Transplants with biliary leak were excluded from the controls. Graft revision, graft loss and survival were evaluated following percutaneous intervention.
Results: 9.8% (26/265) of transplants demonstrated biliary stricture after transplant. 85.3% (226/265) had no biliary complications. Two patients with stricture had HAT. All strictures were treated with percutaneous intervention. Graft revision was performed in 12.5% (3/24) of cases with stricture, compared to 10.2% (23/226) of transplantations without biliary complications (p=0.73). 29.2% (7/24) of biliary stricture cases proceeded to graft loss compared to 8.9% (20/226) in the control group (p=0.008). Biliary complications were the reason for graft loss in 20.8% (5/24) of cases with biliary stricture. Overall survival at 1 year and 3 years in patients with biliary stricture was 91 and 86% compared to 92 and 89% of patients in the control group (p=0.91).
Conclusion: biliary stricture in pediatric patients after liver transplant can cause graft loss. Strictures can be successfully treated by percutaneous intervention without the need for surgical revision in 70.8% of transplants. With appropriate treatment, pediatric patients with biliary stricture after transplant can expect similar survival compared to patients without biliary complications.

P-284

Accession of cytostatic drugs in the transcatheter arterial embolization treatment of "giant" cavernous hemangiomas of the liver

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Purpose: the treatment of "giant" cavernous hepatic hemangiomas (GHH) with transcatheter arterial embolization (TAE) is often not effective. We studied the role of cytostatic drug (bleomycin) addition into the embolic material of TAE for interaction with the endothelium of hemandiomas.
Materials/methods: eleven (11) consecutive patients (all females, age range 39-63 y) with GHH (diameter 7-18 cm, mean 12.5 cm) enrolled in this study. The arterial supply of the tumors was initially assessed by a superselective catheterization and a lipiodol 20 ml with bleomycin 4-6 ml emulsion was injected, followed by particles Spongostan® and PVA (500-1200 μm). The treatment response was measured by volumetry on CT (n=4) or MRI (n=7) studies, along with clinical and laboratory evaluation, at the 1st, 3rd, 6th and 12th months.
Results: in 10/11 (91%) patients, the mean reduction in size of the tumors

was 39% on the 1st, 54% on the 3rd, 62% on the 6th and 64.5% on the 12th month post treatment, respectively. In 1/11 (9%) patient, there was a dramatic decrease of the tumor's size (91% on the 6th month post treatment). No major complications were observed in short and longterm follow-up. Minor symptoms including nausea/vomiting (n=4), pain (n=5) and fever (n=3) were observed during the first 24-72 hours.
Conclusion: addition of cytostatic drug emulsion in the TAE of GHH ameliorates the final therapeutic result, without obvious complications related to the use of the drug.

P-285

From confusion to clarity: evaluating abnormal liver function tests, a systematic approach

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Learning Objectives: 1. Understand the pattern of abnormalities among liver function tests that are consistent with specific diseases/conditions. 2. Distinguish hepatocellular injury from biliary tract dysfunction or obstruction. 3. Determine progression of liver disease using liver function tests.
Background: liver function testes (LFTs) reflect the condition of the liver and biliary system. Analysis of LFTs may be helpful in making the distinction between hepatocellular injury versus biliary tract dysfunction or obstruction. A systematic approach to LFT interpretation is useful in determining the primary hepatic disorder.
Clinical findings and procedure details: discussion of the liver function tests commonly used will ensue, with emphasis on differentiating types of liver disease based on LFT interpretation.
Conclusion: correct interpretation of liver function tests is vital for the understanding of underlying pathology, effect of interventions, prognosis, and subsequent treatment plan of liver disease.

P-286

Segmental and extrahepatic biliary duct anatomy: what every interventionalist needs to know

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Learning Objectives: 1. To understand normal and variant segmental biliary anatomy. 2. To review clinical scenarios in which anatomical considerations may alter therapy. 3. To understand biliary anastomoses commonly used during liver transplantation.
Background: percutaneous biliary procedures remain an important tool for interventional radiologists. Oftentimes used in combination with endoscopic treatments, percutaneous biliary procedures become especially important for patients in whom endoscopic treatments fail, or in patients who cannot undergo endoscopic therapy due to prior surgical interventions. Understanding biliary ductal anatomy is a vital first step in performing these procedures.
Clinical findings and procedure details: developmental anatomy of the biliary system will be reviewed, as will normal and variant ductal anatomy. Post-surgical appearances of the biliary tree will also be discussed. Finally, technical pearls regarding percutaneous interventions in difficult ductal systems (e.g., non-dilated ducts, patients with primary sclerosing cholangitis, etc.) will also be presented.
Conclusion: an in-depth understanding of biliary ductal anatomy is fundamental for any interventionalist performing percutaneous biliary procedures.

P-287

The strategy of partial splenic embolization using angio-CT system equipped with 16-channel MDCT

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Learning Objectives: to demonstrate our strategy of partial splenic embolization (PSE) and mention the usefulness of 16-channel angio-CT system for PSE procedure. 1) Evaluation of the vascular anatomies of splenic artery with 3D-CTA. 2) How to choose the target artery to embolize. 3) Evaluation of volume of infarcted splenic parenchyma with CT splenic arteriography during the procedure. 4) Efficacy of PSE in improving thrombocytopenia.
Background: in the patients with liver cirrhosis, with or without hepatocellular carcinoma, thrombocytopenia is a limiting factor of interferon therapy and/or chemotherapy. PSE is a beneficial procedure to control hypersplenism. In this procedure, it is important to avoid excessive embolization, which induces complications such as abscess, rupture, septicemia and portal vein thrombosis. However, on two-dimensional DSA alone, it is sometimes difficult to recognize three-dimensional vascular anatomies and relation between splenic artery and the volume of corresponding splenic parenchyma. And it is also difficult to assess the volume of infarcted splenic parenchyma accurately during procedure.
Procedure details: during PSE procedure, we refer to the volume rendering movie of 3D-CTA generated from CT data set acquired with direct opacification of splenic artery. This informs us the detail of the vascular anatomies, and enables us to choose the target artery to embolize. Immediately after PSE, we can accurately evaluate the infarcted volume of splenic parenchyma with CT splenic arteriography. Average platelet counts were elevated within two weeks in all patients from 65000 to 173000/mm3.
Conclusion: angio-CT system equipped with MDCT is a useful tool to make strategy of PSE procedure.

P-288

Successful recanalization of bile duct occlusion with radiofrequency (RF) puncture wire technique

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Learning Objectives: describe the use of RF wire puncture technique for biliary obstructions recanalization in patients with previous failed attempts using conventional techniques.
Background: between May/07 and June/08, 5 patients (4 males/1 female), age ranging from 48 to 70 years, with biliary occlusions were treated with RF wire. Four patients had extra-hepatic anastomotic biliary occlusions and one at the bile ducts confluence. All patients had previous failed attempts at recanalization using mechanical catheter/wire techniques. Causes of biliary occlusions were: 2 patients underwent hepatico-jejunostomy anastomosis, 1 had cholangiocarcinoma resection and 2 patients developed the occlusion after liver transplantation.
Procedure details: percutaneous cholangiogram showed the occlusion site. A straight PowerWire was advanced within a 5-Fr KMP catheter. A straight wire tip combined with a semi-curved catheter provides higher tissue puncture precision. Once in contact with the occlusion site, the RF energy was delivered while the wire was gently advanced for a few millimeters. The catheter was advanced and a gentle test injection was performed to confirm its position. If inadequate, a new location was pursued. Once the bowel was catheterized, the RF wire was exchanged for a stiffer wire followed by 6-8 mm balloon cholangioplasty and internal-external biliary

drain placement. Biliary dilation and catheter upsizing every 4 weeks were performed until the recanalized tract was adequately patent. 5 out of the 4 patients are catheter free with an average follow-up of 5 months, without immediate/delayed clinical complications.
Conclusion: RF wire offers a promising alternative to open surgery for the recanalization of biliary occlusions when conventional techniques fail.

P-289

Massive air embolism through an entero-biliary-venous fistula during rendezvous duodenoscopy/percutaneous drainage

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Rendezvous duodenoscopy/percutaneous biliary drainage to treat a stenosis of the bilio-digestive anastomosis after Whipple's operation. During the intervention, air embolism from the duodenum through the hepatic duct and a bilio-venous fistula caused by the percutaneous access led to cardiac failure.

P-290

Fatal acute tumor lysis syndrome associated with transcatheter chemoembolization in a patient with large hepatocellular carcinomas

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A 62-year-old HCV-cirrhosis patient with multiple large hepatomas experienced fatal ATLS following a repeat TACE (first was uneventful), including metabolic derangements, renal failure, MI and respiratory failure. Autopsy confirmed extensive tumor necrosis. This paper highlights management and risk-mitigation of this rare complication.

P-291

Percutaneal low-invasive management of recurrent multilocular echinococcal cyst

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A 10-cm multilocular recurrent echinococcal cyst of right liver lobe was drained percutaneally under CT guidance and ethanol was used as a scolicidal agent. Subsequently, a bigger-diameter catheter was used as replacement and proteolythic enzymes used. Parasitic cyst contents were evacuated completely

P-292

Percutaneal transhepatic biliary stenting (PTBS) using cholecystostomy fistula

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PTBS was performed in two cases following cholecystostomy, which was performed because of insufficient intrahepatic biliary dilatation due to liver fibrosis in one case and failure in the other. Guidewire and stent was conducted in CBD using the guiding catheter.

P-293

Thrombocytopenia following transcatheter arterial embolization for hepatic tumors

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We report four cases of acute severe thrombocytopenia occurring 1--5 days after TACE. Thrombocytopenia recovered after steroid and azatioprine therapy. This is the first report of acute thrombocytopenia in this clinical setting.

P-294

Biliary cast syndrome in nonliver transplant patients

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Bilary cast syndrome is an uncommon condition associated with liver transplantation. We describe a patient with biliary cast syndrome after perutaneous ethanol infusion therapy for treatment of hepatoma. The cast was removed endoscopically.

P-295

Transcolecystic placement of an ePTFE/FEP-covered stent due to diffuse hepatic metastasis

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An ePTFE/FEP-covered biliary stent was placed transcolecystically in the distal common bile duct of a patient with obstructive jaundice due to pancreatic cancer and diffuse liver metastases without any complications. No stent dysfunction appeared in the 8-month follow-up

P-296

Stent placement via the PTBD tract for treatment of afferent loop syndrome in patients with recurred stomach cancer after gastrectomy

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The authors demonstrate a case of successful treatment by placing the stent through the percutaneous transhepatic biliary drainage tract in an afferent loop syndrome patient suffering a recurred stomach cancer after receiving subtotal gastrectomy and Billoth-II operation.

P-297

Fibrous stenosis in bilio-digestive anastomoses solved through the use of a cutting balloon

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We are presenting examples of fibrous stenosis on bilio-digestive anastomoses solved through the use of a cutting balloon.Three

patients with stenosis in bilio-digestive junction which was solved by means of a cutting balloon.The follow-up period was 15-41 months.

P-298

Intrahepatic biliary strictures: retrograde traversal using a loop snare

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When traversal of a stricture from the duct distal to the stricture is unsuccessful, a retrograde loop-snare technique from a larger duct proximal to the stricture can occasionally be successful. A step-by-step description of this procedure will be presented

P-299

Isolated biliary segmental ablation with GLUBRAN® in a pediatric liver transplant

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Successful treatment by GLUBRAN® ablation of isolated biliary segmental for persistent leak after transhepatic drainage of bilio-digestive stenosis in a pediatric liver transplant.

Neuro intervention

P-300

Lumbar spinal stenosis: efficacy of percutaneous interspinous spacer in the treatment of neurogenic intermittent claudication, a preliminary experience

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Purpose: lumbar spinal stenosis (LSS) is a narrowing of the spinal canal: LSS degenerative type usually affects people aged over 50 years and causes several symptoms, in particular, neurogenic intermittent claudication (NIC). The aim of this study is to provide the efficacy of percutaneous interspinous spacer.
Materials and methods: eleven patients (mean age 60.5±11.4, range 48-77) with NIC due to LSS were selected for implantation of percutaneous interspinous spacer. Diagnosis was confirmed by conventional X-Ray, CT and MRI. Each procedure was performed using an Aperius PercLID system (Kyphon Medtronic). All devices were implanted under fluoroscopic guidance and with local anesthesia. Clinical evaluation and assessment of pain by mean of Oswestry disability index (ODI, 0-100) test was performed before and one month after the procedure. We also carried out CT and MRI scans at one and six months.
Results: a total of 11 intervertebral spaces were treated in the 11 patients enrolled in the study. Baseline mean ODI index was 51.6±26.1 while one month after procedure was 19.3±17.4 ($p<0.01$, t-test). The 45.4% of patients reported no improvement one month after implantation (ODI score variation <20), while 36.3% of patients were still on analgesic drugs (compared with 90.9% before treatment). No intraprocedural side effects or dislocation were reported.
Conclusions: implant of percutaneous interspinous spacer is an effective and safe procedure in reducing neurogenic intermittent claudication in patients with lumbar spinal stenosis.

P-301

Painful disc herniation treatment: comparison between three percutaneous techniques

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Purpose: herniated discs sometimes cause pain that is incapacitating and the condition accounts for a major cause of work disability and health case expense in the Western world. The aim of this work was to compare three percoutaneous techniques for the treatment of painful disk herniations in order to evaluate their efficacy.
Materials and methods: one thousand eight hundred thirty-five patients with painful disc herniations were treated by using coablation (Disc Nucleoplasty) (956), laser (PLDD) (249) and mechanical decompression (Dekompressor) (620). The degenerative grade of each lumbar disc was assessed from conventional T2-weighted images according to the Pfirmann classification system and grade 1-3 were treated. Each procedure was performed by one experienced interventional radiologist. Visual analog pain scale (VAS) was used to evaluate pain relief and success was defined as a minimum 2-point reduction in VAS. Reduction of analgesic treatment and the patient's satisfaction were also recorded. Statistical analysis was performed to compare the three methods.
Results: success rate in pain reduction was 92.1, 82.9 and 84.5%, respectively, for Nucleoplasty, PLDD and Dekompressor. Average VAS pain reduction was 3.4, 2.4 and 2.7, respectively, for Nucleoplasty, PLDD and Dekompressor. A significant statistical difference was observed between Nucleoplasty compared with PLDD and Dekompressor for success rate in pain reduction ($p<0.001$). Non significant different was observed between PLDD and Dekompressor ($p=0.32$).
Conclusions: our data indicate that Nucleoplasty is an optimal method in the treatment of painful disc herniations compared to PLDD and Dekompressor.

P-302

Intravascular haemodynamic changes during cerebral three-dimensional rotational angiography

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Purpose: three-dimensional rotational angiography (3DRA) is useful for detecting, classifying and planning treatment for intracranial aneurysms. Prolonged contrast material (CM) injection, required for 3DRA, might cause blood pressure changes in the selectively catheterized artery. The purpose of this study was to assess the extent and clinical relevance of haemodynamic changes in the selected artery during 3DRA.
Materials/methods: twenty-five consecutive patients with intracranial aneurysms were prospectively examined with 3DRA (18 ml, 3 ml/s power injector) for planning treatment. Intra-arterial pressure was measured in the internal carotid or vertebral artery by using a pressure guidewire. Mean and systolic blood pressure acquired by the guidewire (Pd) and fractional flow reserve (FFR) were measured before, during and after CM injection. The extent of Pd and FFR changes was evaluated by Student's t-test and linear regression analysis and their clinical relevance with the limits-of-agreement analysis.
Results: mean systolic Pd and FFR increased significantly ($P<0.001$) from 105.2± 22 mmHg and 0.98±0.04, respectively, at the baseline to 118.1± 23 mmHg and 1.09±0.12, respectively, during injection and

decreased thereafter to baseline. The correlation between mean and systolic Pd during injection and at baseline was moderate (r2=0.47 and 0.63, respectively) but remained significant (P=0.001 and <0.001, respectively). Moderate bias and range of agreement were found for systolic Pd (12.8±29.2 mmHg) and FFR (0.1±0.24).
Conclusion: selective CM injection during 3DRA causes a temporary but clinically tolerable increase in blood pressure and pressure gradient.

P-303

Transvenous embolization of the transverse sigmoid sinus dural arteriovenous fistulas through occluded sinus

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Purpose: transverse sigmoid sinus dural arteriovenous fistulas (TSSDAVFs) with occlusion of the sigmoid sinus frequently drain via cortical veins, which have high risk of aggressive symptoms and required complete occlusion of the AVFs and/or cortical reflux. We demonstrate the efficacy of transvenous embolization (TVE) technique through the occluded sinus for such cases.
Materials/methods: we reviewed consecutive 7 patients with TSSDAVFs with sigmoid sinus occlusion treated by TVE through the occluded sinus for the last 3 years. There are 7 males with age ranging from 52 to 71 years. Symptoms included cerebral hemorrhage (n=2), conscious disturbance (n=3), visual disturbance (n=2), and tinnitus (n=1). All cases showed marked cortical reflux with ipsilateral sigmoid sinus occlusion, and 4 cases showed disconnection to the contralateral transverse sinus.
Results: TVE was performed through the occluded sinuses with ipsilateral approach in 6 and contralateral approach in one. A 5F/7F coaxial guiding catheter was placed at the distal end of the internal juglar vein. A 1.7-2.0F microcatheter could be navigated following a microguidewire through the occluded sinus into the affected sinus in all cases, and the sinus was packed with coils. The DAVFs disappeared in 6 patients, and markedly regressed with disappearance of cortical reflux in one. No complication was observed during and after the procedures. All symptoms disappeared or improved within one month, and no recurrence was observed during 3-37 months follow-up.
Conclusion: TVE through the occluded sinus is a safe and highly effective technique for the TSSDAVFs with occluded sinus.

P-304

Endovascular management and long term follow up vein of galen malformations

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Purpose: present study is aimed to evaluate the varied clinical manifestations, treatment strategy and the long term follow up in our case series of vein of Galen malformations.
Materials/methods: between October 1983 and August 2008, 31 patients with VOGMs were referred to our institution for evaluation and management. Thirteen children younger than 2 years of age presented with rapidly increasing head size. Among 14 children with age above 2 years, the most common presentation was chronic headache. Four patients who presented during adulthood had chronic headache for many years before presentation. Angiographic evaluation of the lesion was performed in 21 patients. Twenty-one patients were treated using endovascular techniques. Coils and glue was used in all cases and the embolisation procedure was done under general anesthesia with induced systemic hypotension.
Results: complete obliteration was achieved in 8 out of 9 cases of mural type and 5 out of 7 cases of choroidal type of vein of Galen malformation. In rest patients, near complete obliteration was achieved and these patients were followed up clinically. Occlusion of the arteriovenous shunts and resolution of vein of Galen aneurysmal dilation could be achieved in two patients. All the patients were regularly followed up after the procedure.
Conclusion: VOGMs usually present with varied clinical manifestations in different age group and endovascular management provides an excellent and an effective way to treat such malformations.

P-305

Endovascular treatment of intracranial DAVF: SCTIMST experience

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Purpose: to study the efficacy of the endovascular embolisation of intracranial DAVFs.
Materials/methods: forty-two patients were included in this retrospective study during the interval between July 2001 and August 2008. Clinically patients presented with tinnitus, headache, dementia and blurring of vision. Endovascular embolisation was attempted in all the forty-two patients with symptomatic DAVF. They were treated with transarterial particles, glue, alcohol, and onyx. Transvenous coil embolization was performed in majority of patients. Transvenous stenting was done in one patient.
Results: angiographic total occlusion was achieved in thirty patients. These patients had complete resolution of their symptoms and total endovascular obliteration of their DAVF noted on follow-up angiogram obtained between 6 months and 5 years. Nine patients had partial embolization (>85%) with clinical improvement. Three patients developed complications, out of which two died due to subdural and intraventricular hemorrhage and one patient was in vegetative state due to intraventricular and parenchyma hemorrhage. In one case, catheter could not be retrieved following onyx embolization.
Conclusion: transarterial and transvenous embolization can achieve total angiographic obliteration of these difficult intracranial DAVFs with good clinical outcome and low complication rate.

P-306

Onyx embolisation of cerebral AVMs

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Purpose: to study the efficacy of Onyx embolization in cerebral AVMs.
Materials/methods: between March 2006 and Aug 2008, 45 patients with brain AVMs were embolized with Onyx. Patients included 24 males and 21 females with mean age of 28 yrs (range 10-52 yrs). Clinical presentation included intractable seizures in 30 patients, parenchymal and intraventricular hemorrhage in 8, SAH from concomitant aneurysm in 1, motor aphasia in 1 and intractable headache in 5 patients. Average Spetzler-Martin grade and AVM volume at presentation was 3 and 18 cm3, respectively.
Results: fifty-nine Onyx embolisation procedures were performed in these patients. A total of 138 feeding pedicles were embolized, averaging 2-3 pedicles per patient. Intranidal fistulas were embolized

with varying concentration of NBCA. Average estimated size reduction was 75% (range 10-100%). Total angiographic obliteration was achieved in 8, partial embolisation followed by radiosurgery in 25 (90-95% obliteration in 10 and 80-90% obliteration in 15 patients), partial embolisation followed by surgery in 1, and 11 patients have been advised additional sittings of embolization. Complications occurred in 10 patients, 4 had transient neurological deficits, one each had intraventricular and small parenchymal haematoma, cortical vein thrombosis and 3 had post embolisation parenchymal haematoma that was surgically evacuated. No mortality was documented.
Conclusion: onyx is a safe new liquid embolic agent for the embolisation of brain AVMs. Complete obliteration can be achieved in small AVMs. Large AVMs can be adequately reduced in size for additional surgical/radiosurgical treatment.

P-307

Percutaneous disc decompression (nucleoplasty) utilizing cool ablation plasma technology (coblation)

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Learning Objectives: to determine effectiveness of nucleoplasty with Coblation Technology in patients with discogenic back pain.
Background: coblation utilizes the PercD SpineWand, a 1 mm diameter bipolar instrument utilizing both energy and heat. It generates approximately 120 volts at the tip of the wand, with a unique millimicron thick field of highly energized particles, resulting in molecular dissociation of the nuclear material with significant reduction of heat generation (45°C), with no risk of thermal injury.
Clinical findings and procedure details: in our study, 11 patients presenting with discogenic back pain and with contained lumbar disc herniation undergo the treatment. 2 patients had suffered re-injury within 6 months of the procedure, undergoing additional treatment. Follow-up was at 1, 3, and 6 months. The disc space was localized under fluoroscopic guidance. A 17G needle was introduced from the side of predominant pain to the junction nucleus-annulus. A channel was created within the nucleus by advancing the spine wand (2 mm/sec) in ablation mode to a pre-determined depth, for 8 sec. Decompression was accomplished by creating 6 channels. The success was achieved if all of the following criteria were met: 2 point reduction on VAS, patient satisfaction, absence of narcotic use. 11/11 patients reported 50% or more pain relief; all patients reported functional improvement for sitting, standing and walking ability. No complications were observed.
Conclusion: the degree of annular disruption can have a significant impact on the long-term outcome; Nucleoplasty minimizes annular damage. These preliminary results confirm nucleoplasty as a safe, minimally invasive and efficacious procedure.

P-308

Rare case of vertebral artery pseudoaneurysm following epidural abscess in the neck

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A rare case of wide-necked vertebral artery pseudoaneurysm in a 55-year-old female is presented, which occurred following an epidural abscess at C 4-6 level, and sepsis. Detailed account of endovascular therapy (using stents and coils) is given.

P-309

Rupture of a needle inside the intervertebral disc due to malfunction of laser fibre

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During a procedure of PLDD, a rupture of the Chiba needle and the laser fibre occured; consequently, a 3-cm fragment remained in the disc. Rupture was due to heating of the entire length of the fibre which burned the needle.

P-310

Efficacy of intra-arterial tPA administration for acute stroke in therapeutically anti-coagulated patients

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Efficacy of intra-arterial tPA administration for patients presenting with acute ischemic stroke, who are already therapeutically anti-coagulated, is feasible.This approach may provide a better option with less systemic risks to patients suffering from an acute ischemic event.

P-311

Transfemoral venous embolization for ruptured arteriovenous malformation with craniofacial arteriovenous metameric syndrome type 3

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Transfemoral venous embolization using glue and microcoils stopped finally the fatal intractable bleeding of arteriovenous malformation of the mandible that occurred after biopsy , under flow contral technic. Diagnosis of craniofacial arteriovenous metameric syndrome type 3 was made.

P-312

Asymptomatic leakage of cement in right ventricle after percutaneous vertebroplasty

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During a vertebroplasty multilevel procedure in a 57-year-old female, a venous leak with asymptomathic pulmonary microembolism occurred. Two years later, in the asymptomatic patient a routine echocardiography examination showed a 5-cm-long stick of PMMA in the right ventricula.

P-313

Intravascular ultrasound thrombolysis of the dural sinus

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A comatose patient with total dural sinus thrombosis, subarachnoid hemorrhage, and basal ganglia hemorrhage underwent successful EKOS intravascular ultrasound thrombolysis. The patient awoke the next day, followed commands, and was discharged two weeks later with only mild unilateral weakness.

P-314

Combined treatment of the vertebro-basilar artery AVMs

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On the basis of result VBT (vertebro-basilar territory) AVM (132 patients) surgical treatment analysis the transcranial malformation extraction at disease clinical manifestation and possibility of complex microsurgical and endovascular technologies application were proved.

Other oncologic intervention

P-315

Oxaliplatin eluting microspheres transarterial chemoembolization: a new therapeutic approach in unresectable intrahepatic cholangiocarcinoma

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Purpose: intrahepatic cholangiocarcinoma (ICC) is a deadly disease, whose only treatment with potential for cure is surgical resection. However, only 27% of patients at diagnosis are suitable for surgery. For patients with unresectable disease, therapeutic options are chemotherapy (ChT) or chemoradiation. New treatment options have been proposed in the ICC, including transarterial chemoembolization. We evaluated the safety and feasibilty of oxaliplatin eluting microspheres transarterial chemoembolization (OEM-TACE) associated with ChT in patients affected by unresectable ICC.
Materials/methods: between December 2005 and May 2008, we treated nine patients with unresectable ICC. All patients had undergone chemotherapy (ChT) with oxaliplatin and gemcitabine, associated with OEM-TACE. A retrospective comparison was carried out with an historical group of 11 patients treated with ChT only, estimating the incidence of adverse effects and the median survival of the two groups.
Results: a total of 30 TACE were performed during the observational time (ranging from one to seven procedures). OEM-TACE was followed by a few adverse effects (AE), without G4 AE. According with RECIST criteria, 44% (4/9) of patients achieved partial responses and 56% (5/9) disease stabilization. Overall survival analysis in the two groups has shown a significantly increased survival in patients treated with ChT and OEM-TACE, with respect to those treated with only ChT (30 vs 12.7 months, p-value=0.00376).
Conclusion: in our experience, OEM-TACE associated with ChT in unresectable ICC is a safe and feasible treatment that is able to improve the survival.

P-316

CAM/oil/PVA chemoembolization of liver metastases from colorectal carcinoma: overall survival in 120 patients and correlation to prior systemic therapy

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Purpose: unresectable colorectal liver metastases have a 18-20 month median survival with sequential triple-drug systemic therapies. We evaluated response and survival after CAM/Ethiodol/PVA chemoembolization.
Materials/methods: chemoembolization with cisplatinum, doxorubicin, mitomycin-C, Ethiodol, and PVA was performed at monthly intervals for 1-4 sessions. Imaging, clinical and laboratory evaluation was performed before treatment, 1 month after and then every 3 months. A second cycle of treatment was performed for intrahepatic recurrence. Response was evaluated using RECIST, and survival estimated with Kaplan-Meier analysis.
Results: 243 procedures (mean 2.0 per subject) were performed over 141 treatment cycles on 120 patients. There were 16 major complications. 30-day mortality was 3.9%. 95 of the 141 treatment cycles were evaluable for morphologic response: 2 (2%) PR, 39 (41%) stable, and 54 (57%) progression. Median survival was 33 months from diagnosis of the primary colon cancer, 27 months from development of liver metastases, and 9 months from chemoembolization. Survival was significantly better when chemoembolization was performed following first- or second-line systemic therapy (12 and 11 months, respectively) than after 3-5th line therapies (6 months) (p=0.03). There was no difference in survival between patients with or without extrahepatic metastases at the time of chemoembolization (p=0.48).
Conclusion: local disease control was achieved in 43%. Median survival was 27 months overall, and 11 months when initiated for salvage after failure of second-line systemic therapy. Presence of extrahepatic disease did not adversely impact survival after liver-directed therapy.

P-317

Multicenter phase II trial of chemoembolization of intrahepatic cholangiocarcinoma

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Purpose: unresectable intrahepatic cholangiocarcinoma has a poor prognosis with 1- and 2-year survival in the U.S. of 24.5 and 13%. We evaluated response and survival after chemoembolization.
Materials/methods: chemoembolization with cisplatinum, doxorubicin, mitomycin-C, Ethiodol, and PVA particles was performed at monthly intervals for 1-4 sessions. Cross-sectional imaging, clinical and laboratory evaluations were performed before treatment, one month after and then every 3 months. A second cycle of treatment was performed for intrahepatic recurrence. Toxicity was assessed using NCI CTC v.3.0. Response was evaluated using RECIST criteria, and survival estimated with Kaplan-Meier analysis.
Results: 62 patients were treated. 36 had pathologically proven cholangiocarcinoma and 26 had poorly differentiated adenocarcinoma of unknown primary, likely cholangiocarcinoma. 161 chemoembolizations (mean 2.7 per subject) were performed over 81 treatment cycles. There were 5 major complications. 30 day disease-specific mortality was 0%. 66/81 treatment cycles were evaluable for morphologic response: 6% (n=4) PR, 71% (n=47) stable, and 23% (n=15) progressed. Median TTP in the treated liver was 8 months, with 30% freedom from local progression at 12 months. Median TTP of disease anywhere was 8 months, with 27% freedom from progression at 1 year. Median survival was 22 months from diagnosis and 16 months post chemoembolization. 1-, 2-, 3-, and 4-year survival from diagnosis was 73, 40, 20, and 10%. There was no difference in survival between patients with cholangiocarcinoma and those with poorly-differentiated adenocarcinoma.
Conclusion: chemoembolization provided local disease control of intrahepatic cholangiocarcinoma in 77%. Overall survival was superior to prior reports of other non-surgical therapies.

P-318

Combined transarterial chemoembolization with Irinotecan-loaded microspheres plus percutaneous RFA for the treatment of liver metastases: preliminary results

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Purpose: recent studies reported the efficacy and safety of transarterial chemoembolization (TACE) with Irinotecan-eluting beads for liver metastases from colorectal cancer in pretreated chemorefractory patients. Percutaneous radiofrequency thermal ablation (RFA) is a minimally invasive therapy for unresectable liver metastases. The present study investigated the feasibility and safety of the combination of these two procedures, performed during the same session, in order to improve the clinical outcome of these patients.
Materials/methods: from March 2007 to November 2008, 9 patients (5 male, 4 female; median age 59) with liver metastases from colorectal (7 patients) and pancreatic cancer (2 patients) underwent 12 sessions of TACE with Irinotecan-loaded microspheres (DC-Bead Biocompatibles; Biosphere) combined with percutaneous RFA. Twenty-one nodules (median diameter 2.6 cm, range 1.0-7.0) were treated. Percutaneous RFA was performed with monopolar cooled-tip electrode-needle in 9 sessions, while bipolar multiprobe device was used in 3 cases. TACE was performed with embolic microspheres preloaded with Irinotecan (100 mg) and delivered selectively into hepatic arteries by transfemoral approach. Post-operative management and response assessment included: contrast-enhanced CT scan and CEUS 48 hours after the procedure, 1 month after and every 3 months thereafter.
Results: no major complication occurred. Two patients underwent two and three sessions of treatment, respectively, due to late distant hepatic relapse. Toxicity was mild and manageable, mostly represented by nausea and abdominal pain. Technical success was obtained in all sessions.
Conclusion: the combined procedure (single-step therapy) was safe and feasible. These preliminary data, also regarding technical success, deserve further investigation.

P-319

Combination treatment of HCC with simultaneous embolization and radiofrequency

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Purpose: to show our experience in percutaneous treatment of HCC with a synchronic combination of radiofrequency and hepatic embolization.
Methods and materials: 119 nodular, low or intermediate stage HCC were treated in 88 child A and B cirrhotic patients. 30 women and 58 men had a mean age of 67.3 years (43-84). Average tumors size was of 33.2 mm (10-150). Embolizations and RF were all done in the same day. If tumor was <3 cm, we performed TAE with lipiodol. For the recurrences or tumors >3 cm, we did TACE. A combination of fluoroscopy and ultrasound guidance was used for tumoral puncture. Treatment response evaluation follows EASL and RECIST criteria.
Results: mean follow up is of 35.1 months (1-91). Complete response was100% in tumors < 3 cm, 94% in tumors >3<5 cm and 23% in tumors >5 cm. There is 0% of local recurrence during the FU in tumors <3 cm. Recurrence as a distant nodule occurred in 47% during FU. One patient died of colon perforation. There were 6.6% of readmissions because of severe pain or fever. Specific HCC survival was 91, 70, and 46% at 12, 24 and 36 months, respectively. Logrank test shows non significative differences in survival between tumors of <3 cm and tumors of >3<5 cm.
Conclusion: there is a synergy effect between RF and embolization. A very good local control of HCC is achieved by this combined treatment.

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P-321

A simplified technique of percutaneous hepatic artery port-catheter insertion for the treatment of advanced hepatocellular carcinoma with portal vein invasion

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Purpose: percutaneous placement of hepatic arterial port-catheter system can be performed for continuous hepatic arterial infusion of chemotherapeutic agents or concurrent chemo-radiation therapy for locally advanced hepatocellular carcinoma with portal vein thrombosis. The purpose was to assess the technical outcome of the simplified technique of the hepatic artery port-catheter system.
Materials/methods: from February 2003 to February 2008, percutaneous hepatic artery port-catheter insertion was performed in 137 patients with hepatocellular carcinoma with portal vein invasion. Access route was common femoral artery in all patients. The tip of the catheter was wedged into either proximal right gastroepiploic artery or distal gastroduodenal artery without additional fixation device such as coil or n-butyl cyanoacrylate. Two handmade side holes were positioned at the distal common hepatic artery, which allows flow directed delivery of chemotherapeutic agents through these side holes into the hepatic arteries. Coil embolization was performed only for the redistribution of hepatic arteries or preventing mis-delivery of agents into extra-hepatic arteries. Port-chamber was created either at the supra-inguinal or infra-inguinal region.
Results: technical success was achieved in all patients. Maintenance of proper positioning of side holes was checked before every scheduled chemotherapy by port-angiography. Malfunctioning was detected in 24 (17.5%) patients (20 catheter migration, 4 catheter obstruction), but revision was feasible in all of those patients. Serious port-site skin complications occurred in five (3.6%) patients.
Conclusion: this method showed excellent technical feasibility and acceptable range of problems, and it can be worthwhile for management of patients with advanced hepatocellular carcinoma with portal vein thrombosis.

P-322

Imaging-guided core biopsy of pancreatic masses: results and complications

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Purpose: the objective of this study was to evaluate the accuracy and complication rate of imaging-guided percutaneous core biopsies of the pancreas in patients with a suspected pancreatic neoplasm.
Materials/methods: from January 1999 to January 2009, 144 patients underwent percutaneous ultrasonography (US)-guided biopsy or computed tomographic (CT)-guided biopsy of the pancreas in a single center. Biopsies were performed with an 18 or

20 gauge cutting-type needle, automatic or semi automatic, using coaxial technic and local anesthesia. Histological reports and medical records of all patients were retrospectively reviewed.
Results: 83 biopsies (58%) were performed under CT fluroscopy guidance and 61 (42%) under US guidance. A definitive benign or malignant diagnosis was obtained with a sensitivity of 94.4% and a specifity of 100%. No false positive cancer diagnosis was found. One major complication (0.7%) was observed under CT-guidance, with an acute hemorrhage and had necessitated an embolization with a good clinical issue.
Conclusion: imaging-guided core needle biopsy with an automated or semi automated biopsy gun is a simple, safe and accurate tool in the management of suspected pancreatic malignancies. Benign biopsy findings cannot definitely exclude presence of malignant disease.

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P-324

Phase II trial of bevacizumab combined with transarterial chemoembolization (TACE) for hepatocellular carcinoma: initial experience at two institutions

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Purpose: this phase II pilot study evaluates tumor response and safety of concurrent bevacizumab and TACE in patients with advanced HCC.
Materials/methods: patients with unresectable advanced HCC, ECOG 0-1, received bevacizumab 10 mg/kg every two weeks, in addition to TACE, in a 6-week cycle. Primary endpoint was tumor response, assessed by contrast-enhanced MR imaging at baseline, and 3 weeks following TACE, using size (RECIST), and contrast-enhancement (EASL). Secondary endpoints included safety and progression free survival (PFS).
Results: nineteen patients (16 males, 3 females; mean age 59 yrs) were enrolled in this prospective study. At time of analysis, median follow-up was 9 months (range 3-27). Patients received 1-3 cycles. On follow-up imaging (n=17), index lesions had a mean decrease in size of 14%. Using RECIST, three (18%) achieved partial response, fourteen (82%) had stable disease. Targeted tumors demonstrated mean decrease in venous enhancement of 53%. By EASL criteria, ten (59%) patients had complete or partial response, and seven (41%) had stable disease. No patient had progression of targeted liver lesions while undergoing treatment. Median PFS was 16 months. Fourteen (74%) patients experienced grade 3/4 toxicities. Eight were expected, transient postembolization and resolved in one month, three were lost to follow-up, and three died of end-stage disease.
Conclusion: combination therapy with TACE and bevacizumab is reasonably well tolerated in advanced HCC patients, with no progression of disease by imaging criteria during the study period and relatively long PFS of 16 months. These results may guide development of novel antiangiogenic liver cancer regimens.

P-325

Efficacy of single drug hepatic chemoembolization on tumor necrosis: cisplatin vs. doxorubicin

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Purpose: transarterial chemoembolization (TACE) is used to treat hepatocellular cancer (HCC). To date, there is no consensus on the optimal drug regimen. The purpose of the current study was to evaluate the therapeutic efficacy of cisplatin vs doxorubicin for TACE using a single drug regimen. Tumors in explanted livers were examined for degree of necrosis.
Materials and methods: TACE was performed in 22 patients with unresectable HCC. 15 patients received cisplatin, 7 patients received doxorubicin. In the cisplatin group, mean tumor size radiographically was 2.7 cm and patients were treated with a mean of 2.3 TACE procedures. In the doxorubicin group, mean tumor size radiographically was 2.2 cm and patients were treated with a mean of 3.0 TACE procedures. TACE was performed in a selective or super-selective manner within the right or left hepatic artery and consisted of a mixture of the chemotherapeutic agent and ethiodol followed by gelfoam pledgets. All patients subsequently underwent liver transplantation. A single expert hepatology pathologist blinded to the drug regimen performed the histological evaluation of explanted livers and tumors were evaluated for size, and percent necrosis.
Results: for all tumors, percent necrosis after cisplatin chemoembolization was 43.3% compared to 30.8% for doxorubicin. For tumors one centimeter or larger necrosis after cisplatin chemoembolization was 54.6% compared to 31.9% for doxorubicin.
Conclusion: hepatic chemoembolization of HCC with cisplatin results in greater tumor necrosis than chemoembolization with doxorubicin.

P-326

Prospective study of Bio-Seal plug implantation after percutaneous lung biopsy

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Purpose: to evaluate the efficiency of the Bio-Seal plug to prevent pneumothorax after percutaneaous lung biopsy under CT guidance, especially in fragile patients.
Material and methods: twenty consecutive patients, referred for percutaneous lung biopsy under CT guidance, entered the study, prospectively. Inclusion criteria for Bio-Seal plug implantation was high risk of pneumothorax, such as presence of a nodule surrounded by more than 1 cm of lung parenchyma, no pleural contact, emphysematous lung) or suspected poor tolerance to pneumothorax (elderly patients, poor clinical status, unique lung, respiratory failure). Pneumothorax was evaluated quantitatively by CT after biopsy samplings and after coaxial introducer withdrawal (i.e. after Bio-Seal implantation). In case of pneumothorax, control CT scan was performed at day 2 for quantitative evaluation. Evaluation criteria involved procedure time and ease in using the device.
Results: a pneumothorax >50 ml at needle placement was found in 4 patients, with a mean volume of 121.3 ml. A pneumothorax <50 ml was found in 7 patients with a mean volume of 3.2 ml. In both groups,

no significant volume increase was found after needle withdrawal or at day 2. In 9 patients, no pneumothorax was found at needle placement, after needle withdrawal or at chest X-ray control. The plug delivery mean time was 2.4 minutes.
Conclusion: the Bio-Seal plug was found easy to use without lengthening the procedure. These results show the efficiency of the device in preventing pneumothorax development after needle withdrawal. Bio-Seal plug was useful in fragile patients or at high-risk of procedural pneumothorax.

P-327

Treatment of neoplasms with cyberknife radiosurgery: placement of fiducials under CT-guidance, our experience during a period of almost 2 years

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Purpose: to present our experience in delivering fiducials in patients who are candidates for stereotactic radiosurgery with Cyberkinife.
Materials/methods: during the last 22 months, we have placed a total of 256 fiducials (range 1-5) in 77 patients with primary or metastatic lesions in the lungs, liver, pancreas, nodes, adrenals and bones. The delivery was performed under local anaesthesia with xylocaine 2% through a Chiba 18 G needle, which was advanced under CT guidance. Fiducials were placed inside/around the tumor.
Results: 254/256 fiducials were placed successfully. Only 2/256 fiducials migrated. We had 1 case of pneumothorax and 1 case of perifocal hemorrhage that were treated conservatively.
Conclusion: the delivery of fiducials under CT guidance is imperative in order to perform Cyberknife radiosurgery in malignant lesions in the lung and the abdominal organs. When performed by experienced interventionalists in percutaneous biopsy, it is a safe and efficient technique.

P-328

Selective intra-arterial chemoembolization of bone metastases: a 12-year experience

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Purpose: our purpose was to evaluate effect of interventional palliative therapy by using chemoembolization on metastatic bone pain and tumour bulk in inoperable metastases where conventional treatment had failed.
Materials/methods: from 1996 to 2008, 138 patients with 148 symptomatic bone metastases underwent chemoembolization in our department. Their medical files were reviewed retrospectively and features of the metastasis, clinical and tumour response were assessed according to RECIST criteria. All patients had at least two procedures based on selective chemoembolization using at each session 300 mg of carboplatin and 10 mg pirarubicin mixed with polyvynil alcohol particles. Fifty-four patients had additional cementoplasty.
Results: data were available for 91 patients. The procedures were well tolerated in spite of a transitory (2-10 days) increase of pain in 40% of patients. At one month, 67 of 91 had significant pain relieve as shown by decrease of analgesic drug use. Mean clinical response duration was 9 months (4-36). Radiologically, 50 of 64 patients had non-progressive disease at 3 months. Favourable outcome was related to tumor type (breast cancer) and solitary leasions but no correlation was found with hypervascularization or initial metastasis size.
Conclusion: selective intra-arterial chemoembolization is efficient in pain relief and local control of refractory bone metastases. This technique seems promising in solitary bone metastases from breast cancer and might be worth further evaluation.

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Chemotherapy and biologic agents used in cancer patients: a primer for the interventionalist

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Learning Objectives: 1. To understand the biological basis of cancer therapeutic agents used in interventional radiology cases. 2. To recognize the clinical indications for the use of different drug classes. 3. To review the common and major complications associated with chemotherapeutic agents commonly used in interventional radiologic procedures.
Background: as interventionalists become more involved with the care of cancer patients, an understanding of the agents commonly used in minimally-invasive procedures becomes vital. This understanding is important both to protect our patients and to allow open communication with colleagues in the oncologic specialties.
Clinical findings and procedure details: the clinical indications for different drug classes will be reviewed, as will their mode of action, complication profile, and relative costs.
Conclusion: familiarity with antineoplastic agents is vital for any practitioner using such drugs in the treatment of patients. Understanding the effects of the drugs, their indications, and their safety profiles is a necessary component to delivering safe and effective care for this patient population.

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Percutaneous stenting of pulmonary artery stenosis secondary to malignancy: a comprehensive review

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Learning Objectives: • Review the clinical indications for the procedure. • Understanding the principles of the technique including choice of stent device. • Awareness of the potential pitfalls and complications.
Background: stenting of the pulmonary artery is an uncommonly performed procedure used to provide palliative relief of dyspnoea in patients with mediastinal malignancy and pulmonary artery stenosis. Careful case selection is mandatory as the patient's symptoms may not be secondary to pulmonary artery stenosis and may be explained by other causes such as pleural effusion or lung metastases.
Procedure details: vascular access, choice of equipment and procedural details will be discussed with an emphasis on optimal practice. The different types of stents are reviewed. As the choice of stent and device placement depends on the location of the stenosis, for example, balloon expandable stents are recommended for proximal pulmonary artery lesions whereas self-expandable stents are more useful in more distal vessels (due to calibre change).
Conclusion: stenting of the pulmonary artery for malignancy is a seldom performed procedure but can provide significant symptomatic relief for patients with advanced mediastinal malignancy. Knowledge of the indications and awareness of potential complications is important to avoid unnecessary morbidity.

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Core biopsy in a series of 22 patients under angiogenic inhibitors: no indication for an increase in hemorrhagic complications

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Learning Objectives: to evaluate potential complications, namely hemorrhagic, following percutaneous core biopsy of deep organs in patients treated with angiogenic inhibitors (AIs).
Background: AIs have been found to have a significant activity against neoplasm by blocking VEGF (vascular endothelial growth factor) signaling pathway, either by targeting the intracellular tyrosine kinase of VEGF-R (sorafenib and sunitinib) or by binding to the circulating VEGF (bevacizumab and VEGF-Trap). Poor wound healing caused by inhibition of angiogenesis during tissue repair and hemorrhagic complications related to poor maintenance of vascular integrity are classic complications of both types of AIs. Minor surgical procedures, such as core biopsy, within 7 days prior to study enrollment are thus a classic exclusion criteria in phase1 studies.
Clinical findings and procedure details: during the last 4 years, 1324 biopsies were performed in our department. Among these, we identified 22 patients receiving 18 G cutting needles core biopsy before and 15 to 21 days after initiation of sorafenib or anti VEGF-R in 19 patients. 3 patients received biopsy, 8 days, 42 days and 146 days after. Biopsy targeted liver (n=14), lung (n=1), lymph node (n=1), pleural (n=2), costal (n=2), peritoneal (n=1), and sinus biopsy (n=1). Overall, we observed one minor alveolar hemorrhage in patients under AIs and one 6 mm hepatic subcapsular hematoma before AIs.
Conclusion: even if small, this series of core biopsies under AIs is the first reported and does not seem to indicate an increase in hemorrhagic complications.

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Delayed onset of isolated pulmonary oil embolism after transarterial chemoembolization

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We report a case of delayed onset pulmonary oil embolism following transcatheter chemoembolization(TACE) for hepatocellular carcinoma(HCC). A 84-year-old man with a large unresectable HCC underwent TACE. Pulmonary function deteriorated 2 weeks after procedure, and HRCT revealed a pulmonary oil embolism.

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Percutaneal management of giant mediastinal metastasis of osteosarcoma: an emergency case

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Giant necrotic mediastinal metastasis of osteosarcoma, causing severe heart dislocation, was drained three times (once under combined ultrasound-fluoroscopy and two times under CT guidance). Pericardium was drained because of restrictive fluid. Stable heart and pulmonary function was restored.

P-334

Direct intratumoral chemotherapy with carboplatin and epinephrine in a recurrent cervical chordoma

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A 46-year-old man presented with recurrent cervical chordoma manifesting as C4-C5 spinal cord compression. A carboplatin solution combined with epinephrine and an iodinated contrast agent was injected into the tumor under CT guidance. A marked clinical response was obtained.

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Gastro-dorsal-bronchial fistula: treatment with a covered tracheobronchial stents and an integrated inverted Y-shaped metallic stent

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A Y-shaped metallic stent was implanted into the bronchi to close a fistula communication between the right posterior wall of the upper residual stomach and the dorsal segment of the left lower lobe bronchus.

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Inferior vena cava leiomyosarcoma: diagnostic imaging and percutaneous core needle biopsy

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A rare case of primary inferior vena cava leiomyosarcoma involving the renal veins and infiltrating the liver and the right atrium was evaluated with MDCT. A needle core biopsy via right femoral access was performed.

Others

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Silverhawk directional atherectomy alone in the treatment of de novo femoropopliteal aterosclerotic obstructive disease: single center experience

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Purpose: directional atherectomy could represent an alternative to the established PTA and stenting in lower limbs revascularization strategies and a useful tool especially in popliteal arteries district attempting to achieve long-term patency without stenting.
Materials and methods: fifteen patients (10 male, mean age 69) affected by PAD have been treated in our unit for 15 femoropopliteal chronic total obstructions. Indications for intervention were: severe lifestyle limiting intermittent claudication in 9 cases and rest pain in 6. All patients underwent preprocedural CD-ultrasound and in selected cases CT-angiography to better characterize the lesions. All lesions were low calcified. In all cases, atherectomy was performed only after intraluminal guide wire crossing the obstruction. Average angiographic lesion length was 52 mm (range 32-83 mm).
Results: recanalization of obstructed vessel was possible in all cases without complications.

The proper vessel diameter reestablishment was assessed with different orthogonal angiographic views. Average ABI increased from 0.51±7 to 0.85±8. Balloon angioplasty or stenting were never performed as adjunctive treatment. Mean follow-up was 10 months (range 6-15 months) that showed patency of the treated vessels with improvement of at least one Fontaine stage.
Conclusion: percutaneous directional atherectomy is a safe and effective technique in lower limb revascularization. These preliminary results supported by short- and mid-term data strongly encourage use of directional atherectomy as an alternative to PTA and stenting in the femoropopliteal obstructive lesions treatment. Long term data are missing.

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A haptically enhanced interventional radiology vascular simulator for training the Seldinger technique

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Purpose: to date, there are no interventional radiology (IR) vascular simulators for the Seldinger technique, an integral part of achieving initial access to the vascular tree. This work presents a novel virtual environment for teaching this core skill.
Materials/methods: our current simulator consists of two haptic ('touch') devices linked to the software framework. First is a needle insertion haptic device, whereby a trainee can perform a simulated vessel puncture and manipulate the needle tip to correctly position it within the virtual vessel lumen. This then allows an entering guidewire to be aligned along the virtual vessel in preparation for catheter introduction. Both the guidewire and catheter are passed through the first haptic device to a second, catheterisation haptic device: this tracks the trainee's manipulations of a guidewire and catheter simultaneously in a coaxial system. Instruments are simulated using a mass-spring model consisting of a set of particles connected by rigid springs. Simulation software then displays interactions of these virtual instruments with virtual vessels in real time.
Results: this prototype simulator has been evaluated by experienced interventional radiologists and feedback on realism is positive. The vessel puncture haptic device introduces sufficient functionality to perform a simulation of the Seldinger technique. An evaluation on a vascular phantom showed a close match between virtual instrument behaviour and real behaviour.
Conclusion: this work presents the first simulator to train the Seldinger technique in a virtual environment. The preliminary results confirm utility for IR training with great potential for expansion to other specialties.

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Comparison of automated biopsy needles for lung biopsy under CT fluoroscopic guidance

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Purpose: the aim of this study is to compare two different automated biopsy needles, a fully automated biopsy needle (Monopty) and a semiautomated biopsy needle (Temno) for lung biopsy.
Materials/methods: consecutive 50 percutaneous lung biopsies with the Monopty needle between June 2006 and January 2007, and consecutive 74 lung biopsies with the Temno needle between February 2007 and August 2008 were performed under CT fluoroscopic guidance, and the specimens obtained underwent histopathologic evaluation. In 42 lung biopsies with the Monopty needle and 62 lung biopsies with the Temno needle, a final diagnosis was confirmed independent surgical pathologic findings or clinical follow-up.
Results: the rate of success for diagnosis for specimens that were adequate for histopathologic analysis and of precise diagnosis in usage of the Monopty needle was 100 and 95.2%, whereas those rates were 85.1 and 86.8% in usage of the Temno needle. In the 11 cases in which specimens were inadequate for diagnosis in usage of the Temno needle, additional biopsies were performed using the Momopty needle and all these cases were successful in obtaining of adequate specimens for diagnosis. The biopsy-induced complications encountered were pneumothorax, hemoptysis and hemothorax in 42.0, 10.0 and 6.0%, respectively, in usage of the Monopty needle and in 48.3, 8.3 and 3.3%, respectively, in usage of the Temno needle.
Conclusion: the fully automated biopsy needle provides higher degree of diagnostic accuracy than the semiautomated biopsy needle for percutaneous lung biopsy.

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Fine needle aspiration cytology of thyroid nodules under sonographic guidance

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Aim: to analyse the diagnostic efficacy of ultrasound guided fine needle aspiration cytology (FNAC) of thyroid nodules.
Methods: this is a retrospective study involving 487 patients (408 female and 79 male patients) with a mean age of 52.2 years (range 16-88 years). FNAC of the thyroid nodules was performed on an outpatient basis under real time ultrasound guidance with 21G hypodermic needles under local anaesthesia. There was no cytopathologist on site. Eighty seven patients (17.9%) had prior non diagnostic non-imaging guided FNAC. In total, 625 lesions were biopsied over 511 sessions for cytological analysis. Sixty-six patients subsequently had surgical excision of their lesions. Mean follow up period was 13.07 months (range 1-65 mths).
Results: diagnostic yield was 82.7% (517/625 biopsies). Mean number of needle passes was 2.19 (range 1-4 passes). Seventy of the 87 patients (80.5%) with prior non diagnostic non-imaging guided FNAC had diagnostic yield by ultrasound guided FNAC. Twenty of 66 (30.3%) surgically excised nodules were malignant. Ultrasound guided FNAC accurately diagnosed 14 out of the 20 surgically proven malignant nodules. The sensitivity, specificity, positive predictive value and negative predictive values for malignancy were 99.8, 70.0, 93.3 and 98.8%, respectively. All the 486 benign biopsies remained stable on clinical follow up and subsequent imaging.
Conclusion: ultrasound guided FNAC is safe and has high diagnostic yield despite not having a cytopathologist on site.

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Percutaneous CT-guided interventional procedures [biopsies and radiofrequency ablation (RFA)] of pulmonary hilum lesions

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Purpose: to report our experience in CT-guided percutaneous procedures (biopsies and RFA) of pulmonary hilum lesions.

Materials/methods: during the last 12 months, we performed: a. Percutaneous biopsies in the lung hilum in 42 patients after negative endoscopy. All biopsies were performed under local anesthesia (lydocaine 2%) using 22F fine needles or 18G automatic cutting needles. b.18 percutaneous RFA sessions of pulmonary malignancies in 12 patients with nonresectable tumors (7/12 in the left hilum and 5/12 in the right hilum). All procedures were performed under local anesthesia (lydocaine 2%). Lexotanil 3 mg per os and zideron 75 mg IM were administered 45 min before the session. We used spiral (Miras) or hooked electrodes (RITA Starburst Electrosurgical Device). RFA energy was applied for 10-15 min.
Results: concerning biopsy our results regarded: Successful biopsy: 36/42 (85.7%) cases. Nondiagnostic material: 6/42 (14.3%) cases. Diagnosis or suspicion of malignancy: 28/42 (67%) cases. Benign histological findings: 8/42 (19%) cases. Concerning RFA, our results regarded: Total necrosis of the lesion in 8/12 patients (66 %). Partial necrosis of the lesion in 4/12 patients (33.4%) and second session was performed. Complications: 2/12 patients (16.7%) had pneumothorax, 3/12 patients (25%) had hemoptysis and 1/12 patient had perifocal hemorrhage. 1 patient died one year later because of multiple metastatic disease (head and bones).
Conclusion: CT-guided percutaneous procedures (biopsies and RFA) of pulmonary hilar lesions are cost effective, minimally invasive and may be safely applied.

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Ten-year experience with catheter-directed thrombolysis for acute arterial limb ischemia

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Purpose: the aim of this study was to review our experience with catheter-directed thrombolysis (CDT) for acute arterial limb ischemia.
Materials/methods: in this retrospective study (1999-2008), all episodes of CDT were reviewed. A catheter was placed, mostly using a contralateral femoral access, into the clot. Urokinase (Actosolv®) was administered at a rate of 120 000 units per hour (initial four hours double dose). Heparine was administered intravenously.
Results: a total of 152 episodes of thrombolysis were initiated (343 limb ischemias). The majority of patients (113) had antecedents of open or endovascular treatments. Thrombolysis was successful in 113 patients; 39 patients were converted to open surgery (urokinase not successful; deterioration of ischemia; bleeding). In 61 patients, thrombolysis was the only treatment of the ischemia; an underlying problem was treated by endovascular means or by open surgery in 38 and 11 patients, respectively. Thrombolysis was complicated by bleeding in 42 episodes (puncture site: 26; retroperitoneal:8; other: 12). Only in 16 cases, the bleeding could not be managed conservatively. Three patients died as a result of bleeding complications (one puncture side bleeding, two intracranial haemorrhages). Eleven patients needed to be amputated as a result of persisting ischemia. Follow up was 24 months (1-106 months); 43 cases developed a recurrent episode of ischemia at the same place.
Conclusion: acute arterial ischemia is a sign of severe arterial insufficiency. Many patients can be helped with CDT. The risk of this therapy is bleeding, in this case series in about 25% of the thrombolytic episodes.

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Image quality and doses in digital flat panel cardiovascular imaging

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Purpose: to compare image quality and doses on three different digital flat panel X-ray laboratories in cardiovascular imaging.
Materials/methods: fluoroscopy and cine imaging of a contrast-detail phantom with 15 cm polymethyl methacrylate (PMMA) were performed. Flat panel detectors from three different vendors were used. Dose modus, zooming and frame rates were varied. Entrance doses to the phantom were measured in ten seconds with fluoroscopy and five seconds with cine. Image quality was examined in four fluoroscopy and three cine images. Two radiologists and two physicists evaluated the 21 images for visible dots. The image quality factor (IQF) was used for calculation.
Results: entrance doses in fluoroscopy varied from 221 to 458 µGy with low framerate and from 716 to 1987 µGy with high framerate. In the cine imaging, the entrance doses varied from 1147 to 3214 µGy with low framerate and 956 to 9610 µGy with high framerate. In the cine images the IQF was lower with higher entrance doses but in the fluoroscopy images this relation was not seen.
Conclusion: large differences in both entrance doses and image quality were found between the three vendors. The machines with the highest doses did not always have the best image quality.

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A prospective study of the Cook Celect™ vena cava filter

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Purpose: to collect data regarding the safety and performance of the Cook Celect™ Filter when used as a permanent or retrievable device in a multi-center registry.
Materials/methods: registry A included 34 patients who received filters as permanent devices, and Registry B included 95 patients who received filters for temporary indications. Registry A patients were followed for 1 year, and Registry B patients were followed through 3 months post-retrieval. Primary indications for filter placement in each group included: evidence of PE or DVT and contraindication to, or failure of, anticoagulation (53% of Registry A; 43% of Registry B), massive PE with residual DVT in patients at further risk for PE (35% of Registry A), high risk of PE (30.8% of Registry B), and severe trauma without documented PE or DVT (23.1% of Registry B). Registry B patients underwent filter retrieval when clinically indicated.
Results: the type and rate of complications reported were similar in both registries; the major adverse event rate (including recurrent PE, procedure-related death, significant migration, etc.) was 3% in both registries. All Registry A patients kept their filters as permanent devices; no long-term complications were associated with permanent placement. Filter retrieval was attempted in 57 Registry B patients, with 55 successful retrievals (96.5%; mean filter indwell time of 175.3 days). Retrieval procedures were not associated with serious complications.
Conclusion: the Celect™ Registry data indicate that the Celect™ filter can be used safely in patients with either a permanent or temporary need for preventive PE therapy.

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Can diffusion imaging sequences (DWI) MRI help in pulmonary nodule biopsy side choice?

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Purpose: evaluate diagnostic efficacy of diffusion-weighted imaging (DWI) sequences in tissue characterization of pulmonary nodules and identification of the biopsy side.
Materials/methods: thirty patients with pulmonary nodules (>5 mm in diameter) (18 men, 12 women; mean age 65 years) with neoplastic disease were consecutive enrolled. All the patients underwent 16 or 64-MSCT (Somaton Sensation Siemens) staging exam and an MRI (Synphony or Advanto, Siemens) evaluation using DWI sequences. A CT-guided biopsy was performed for all the nodules analysed in order to realize a histological and/or cytological diagnosis. The signal intensity of nodules on DWI, calculated as ADC, was compared with intensity, morpho-dimensional and hysto-patologycal results, using a Spearman test.
Results: all the biopsy performed using the diffusion imaging sequences MRI led to diagnostic results (18 squamocellular carcinoma and 12 adenocarcinoma). We found a statistic correlation between grading and volume, number of mitosis and vascularization degree on the Spearman test. The signal intensity of pulmonary nodules on DWI, expressed as ADC, resulted very omogeneus in all the study population. Two patients with pleural nodular thickening and with apical granuloma showed high intensity signal on DWI.
Conclusion: diffusion-weighted imaging can be used in the assessment of pulmonary nodules; the signal intensity can provide a tissue characterization, giving information about the cellular density. The evaluation of signal intensity distribution can help in the choice of the biopsy site avoiding MSCT and X-ray administration and false positive results correlated with inflammatory nodules.

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Surgical intervention for complications after femoral artery puncture closure using the Angio-Seal device

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Introduction: arterial puncture closure devices are frequently used after cardiac catheterisation and radiological interventions. We report the femoral artery closure complications using the Angio-Seal device requiring surgical interventions.
Methods: over a 3 year period (2006-2008), the Angio Seal device was deployed in 4200 patients undergoing transfemoral angiography and/or endovascular interventions. In this period, the complications requiring surgical intervention were analysed retrospectively. Diagnosis was made after duplex ultrasonography, CT-scanning or angiography.
Results: in 18 of 4200 cases (0.43%), serious vascular complications occurred following Angio-Seal deployment. Intraoperative findings consisted mainly of destruction of the vessel wall and subsequent thrombosis followed by vascular dissection, embolisation of the anchor to popliteal artery and serious infection with abscess formation. After the appropriate surgical interventions 17 patients fully recovered, 1 patient died as a result of Angio-Seal related sepsis. Discussion: purely based on the results, a 0.43% complication rate might be acceptable. Bearing in mind the limitations of this retrospective analysis the complication rate is probably higher. Only the serious complications requiring surgical consultation and intervention were included. We believe milder complications like partial arterial obstruction resulting in mild to severe claudication are underreported. Angio-Seal infection is a potentially life threatening complication for which surgical treatment seems mandatory. Complications may also arise after arterial puncture closure by manual compression, especially in an atherosclerotic population. The impression is, however, that routine use of this closure device leads to a number of serious complications that can be avoided by using the manual compression technique.

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The role of interventional radiology in venous blood sampling revisited

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Learning Objectives: venous blood sampling (VBS) was a "routine" procedure to localize endocrine tumors before the advent of noninvasive imaging. Lately with noninvasive imaging, the need of VBS decreased significantly. With newer CT scanners (64 MDCT), smaller tumors (<5mm) can be found. VBS was no longer included in the armamentarium of new interventional radiologists (IRs). Most young IRs do not learn or get exposure. There is a serious gap of knowledge in the inability of making or suggesting appropriate diagnoses in special circumstances.
Background: there are IRs with little experience in VBS. We encountered instances of colleagues unaware of "obsolete" studies and, therefore, VBS must be "resuscitated." Some of these studies are: • Inferior petrosal sinus VBS and sinography • VBS and venography of neck and mediastinal veins in hyperparathyroidism • Portal vein and tributaries VBS • VBS from hepatic veins • Adrenal VBS and venography in aldosteronomas and hyperaldosteronism • Adrenal, retroperitoneal (IVC and tributary veins), thoracic (mediastinal veins) and • Gonadal VBS and venography. **Conclusion:** IRs and clinicians must know the role of VBS and venography in the work up of patients with clinical and laboratory evidence suggesting an endocrine tumor and a full workup, including noninvasive imaging nondiagnostic. VBS are important procedures to diagnose endocrine tumors when "conventional" diagnostic studies fail to localize the tumor(s). VBS is rapid, simple, safe and easy to perform. VBS must be learned and included in the training of IRs.

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Simulators in interventional radiology: training or computer games?

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Purpose: targeted needle placement is a core skill for percutaneous interventional procedures. The aim of this study is to determine construct validity for an augmented reality simulator for ultrasound guided liver biopsy.
Materials and methods: 8 experts, 8 intermediates and 8 novices performed 3 guided and 3 freehand targeted "liver" biopsies on the simulator. The novices had a preliminary teaching session introducing them to the principles of ultrasound guided needle intervention. Metrics assessing accuracy of the procedure were recorded and statistically analysed, using the unpaired one-tail t-test.
Results: use of needle guide: experts performed statistically significantly better than novices (p=0.005) at choosing the optimal needle path and at keeping the target central in the scan plane

(p=0.02). Freehand biopsy: the novices were significantly better than expert and intermediate groups at keeping: the needle tip along the optimal pathway to the target (p=0.007), target in the scan plane during needle insertion (P=0.02) and at getting the needle tip closest to the centre of the target (p=0.03).
Conclusion: construct validity was shown for the guided procedures, but surprisingly novices outperformed experts on freehand procedures. This apparent paradox may be explained by the preliminary training session given to the novices or that the chosen metrics do not truly reflect the skills necessary to perform the procedure. These results suggest the importance of combining a high quality educational framework with simulator experience early in training and the need for properly validated assessment tools to assess competence rather than unproven metrics.

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Endovascular material selection and fluoroscopy preferences for carotid artery stenting are influenced by patient specific rehearsal on a virtual reality simulator

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Purpose: the ability to perform patient-specific simulated rehearsal of complex endovascular interventions is a technological advance with potential benefits to patient outcomes. This study aimed to evaluate whether patient-specific rehearsal of a carotid artery stent (CAS) procedure has an influence on tool selection and the use of fluoroscopy.
Materials/methods: following case note and CT angiographic review of a real patient case, subjects performed the CAS procedure on a virtual reality simulator. Endovascular tool requirements and fluoroscopic angles were evaluated with a pre- and post-case questionnaire.
Results: thirty-three endovascular physicians with varying degrees of CAS experience were recruited: inexperienced (5-20 CAS) n=11, moderately experienced (21-50 CAS) n=7 or highly experienced (>50 CAS procedures) n=15. For all participants, 98 of a possible 363 changes (27%) were observed from pre- to post-case questionnaires. This was most notable for optimal fluoroscopy C-arm position 17/33 (52%), guide wire chosen to exchange a sheath 15/33 (46%), choice of selective catheter 13/33 (39%), choice of sheath or guiding catheter 12/33 (36%) and balloon dilatation strategy 10/33 (30%). Experience with the CAS procedure did not influence the degree of change significantly (p>0.05) and all groups exhibited a considerable modification in tool and fluoroscopy preference.
Conclusion: patient-specific simulated rehearsal of a complex endovascular procedure strongly influences tool selection and fluoroscopy preferences for the real case. This technology requires further investigation with respect to a potential reduction in the use of endovascular material and X-ray exposition and with respect to improved outcomes in the clinical setting.

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Large-scale clinical evaluation of contrast-induced nephropathy in patients with chronic kidney disease undergoing ct imaging: incidence and risk factors

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Purpose: to evaluate the incidence of contrast-induced nephropathy (CIN) in patients with chronic kidney disease (CKD) undergoing MDCT and to evaluate risk factors for CIN, including choice of contrast medium (CM).
Materials/methods: 401 patients with SCr ≥1.5 mg/dL and/or CrCl ≤60 mL/min were randomized to either iopamidol-370 (IOP=202 patients) or iodixanol-320 (IODIX=199 patients). CM was injected at 4 mL/sec with a 20 mL saline flush. 153 patients received 40 g iodine (gI); the remaining patients received at least 65 mL CM. CIN was defined as a SCr rise ≥25% from baseline at 48-72 h.
Results: no significant differences were seen in the two populations, except that total gI was higher patients receiving IOP-370. Baseline SCr level were similar (IOP 1.52±0.36 mg/dL vs. IODIX 1.49±0.38; p=0.48). No case of acute renal was observed, and CIN rates were similar in the two groups (IOP=10 patients; IODIX=9 patients; p=1.0). Mean postdose SCr changes were comparable (IOP 0.03±0.22 mg/dL vs. IODIX 0.04±0.25 mg/dL, p=0.619). Similar findings were seen in patients with both CKD and diabetes (IOP 7/140, IOD 7/144, p=1.0) or patients with baseline SCr ≥2.0 mg/dL and/or baseline CrCl ≤40 mL/min (IOP 2/53, IODIX 2/40, p=1.0). In a multivariate logistic regression analysis no single risk factor predicted CIN, but hydration proved marginally beneficial (p=0.042).
Conclusion: in a large population with CKD undergoing MDCT, the rate of CIN was approximately 5%. Both CM tested were safe for use in patients with CKD and other risk factors undergoing CT imaging.

P-352

Endovascular management of limb vascular malformations

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Purpose: (1) To analyze the clinical presentations of peripheral vascular malformations. (2) To analyze the type of treatment used for various vascular malformations. (3) To analyze the outcome of treatment in various malformations.
Materials/methods: we studied 52 patients with mean age 32.4 years, who were diagnosed to have vascular malformations of limbs. Most of the patients underwent pre procedural Doppler and cross sectional imaging to know the extent and nature of the lesion. All the malformations were typed and angiographically analyzed. Depending on the type it was managed by different materials and routes.
Results: of these, lower limb involved in 72% cases and upper limb involved in 28% cases. High flow AVM consisted around 35%, low flow AVM/hemangiomas were around 45% and rest were venous malformations. Transarterial embolization was done in 68% cases and percutaneous injectin of bleomycin done in 32% cases. High flow Fistulae and AVMs were obliterated with various embolic materials like PVA and Gelfoam; either single or in combination. Out of 52 cases, 33 cases underwent plastic surgery and rest on follow up. Follow up was done at 3 mth, 6 mth and at every 1 year.
Conclusion: high flow AVMs can be managed by endovascular

technique, which is beneficial in decreasing the blood loss in post procedure surgery of lesion. Percuatneous bleomycin is an effective way of managing low flow malformations and venous malformations.

P-353

Effectiveness for transcatheter coil embolization using coil anchor

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Learning objective: we describe the efficacy and safety of transcatheter coil embolization using a coil anchor.
Background: for treatment arteriovenous fistulas, arterial aneurysms, and traumatic or postoperative hemorrhage, transcatheter coil embolization has been replacing surgical intervention. However, in patients with markedly fast blood blow, transcatheter coil embolization carries the risk of coil migration, which may result in severe complication. We will show several cases in which we could reduce the risk of coil migration by using coil anchors.
Clinical findings: we reviewed 9 patients (8 men and 1 woman, age range 56-69 years; mean 61 years) who underwent transcatheter coil embolization using coil anchors between 2001 and 2008. We used coil anchors in patients who had a risk of coil migration due to rapid blood flow. The embolic coils were inserted after the introduction of the coil anchors. Of the 9 patients, 5 underwent the procedure for hemodynamic modification of the replaced right hepatic artery before port-catheter implantation for hepatic arterial infusion chemotherapy, and one each for hepatic arteriovenous fistulas or renal arteriovenous fistulas; two patients were treated by splenic artery embolization for hypersplenism or by percutaneous transhepatic splenic vein embolization with portosystemic shunt encephalopathy. Transcatheter coil embolization using coil anchors was technically successful in all 9 patients; success was defined as good angiographic results. We encountered no instances of coil migration or procedural complications.
Conclusion: although transcatheter coil embolization is difficult in patients with markedly fast blood flow, coil anchors may prevent coil migration in some cases.

P-354

Angiographic evaluation and treatment of frostbite injury using catheter directed thrombolysis

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Learning Objectives: to review and compare the results of the traditional management of frostbite injury with that of catheter directed thrombolysis.
Background: severe frostbite injury to the extremities may ultimately lead to vascular damage and thrombosis, with potentially devastating complications such as progressive gangrene and eventual amputation of limbs and digits.
Findings and procedure details: the tissue injury that occurs in severe frostbite injury results from initial tissue freezing and crystal formation followed by an intense local inflammatory reaction that leads to vascular thrombosis. The resultant lack of tissue perfusion ultimately leads to irreversible ischemia and tissue necrosis. Traditional management with resuscitation, tissue rewarming and watchful waiting, and other strategies to improve perfusion and prevent or reverse thrombosis, such as administration of heparin or low molecular-weight dextran have failed to alter outcomes. More recently, both systemic and catheter directed thrombolysis have been used, with encouraging results. Patients who present with frostbite injury to the extremities are resuscitated and undergo rapid tissue rewarming. If there is clinical and Doppler evidence of impaired perfusion to the affected extremity, the patient undergoes angiographic evaluation, followed by intra-arterial catheter-directed thrombolysis with tissue plasminogen activator (tPA) and systemic heparinization. Thrombolytic therapy is continued for up to 24 hours followed by 5-7 days of heparinization and conversion to warfarin therapy. This exhibit illustrates, with clinical and imaging examples, the angiographic diagnosis and treatment of severe frostbite injury with intra-arterial catheter directed thrombolysis.
Conclusion: intra-arterial catheter-directed thrombolysis may improve outcomes in severe frostbite injury.

P-355

A guide to troubleshooting using guidewires

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Learning Objectives: to understand the different types, sizes and features of available guidewires, their typical uses in interventional radiology and, in particular, how they may be used to overcome difficult clinical scenarios.
Background: guidewires are part of the core equipment utilised in numerous interventional radiology procedures. Their varied usage extends from basic vascular access to complex vascular and endoluminal intervention. Knowledge of the different guidewires available is crucial for their correct use but also to assist in overcoming difficulties during procedures.
Clinical findings and procedure details: 1) Introduction of different types, sizes and features of guidewires. 2) Presentation of typical applications of different guidewires. 3) Discussion of how to overcome difficult clinical scenarios with guidewires.
Conclusion: guidewires are a core item of equipment in interventional radiology. Knowledge of their features will enable maximum utilisation of their functionality in both routine and complex interventional radiological procedures in addition to enabling a solution to certain difficult clinical scenarios.

P-356

A guide to troubleshooting using interventional catheters

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Learning Objectives: to understand the different types, sizes and configurations of available catheters, their typical uses in interventional radiology and, in particular, how they may be used in certain difficult clinical scenarios.
Background: catheters are part of the core equipment utilised in numerous interventional radiology procedures. They are flexible hollow tubes that allow external access into the body with varied usage, encompassing being a delivery conduit for therapeutic substrates and assisting access in complex vascular and endoluminal intervention. Knowledge of the different catheters available is crucial for their correct use and correct selection in trying to assist in overcoming certain difficulties during procedures.
Clinical findings and procedure details: 1) Introduction of different types, sizes and configurations of catheters. 2) Presentation of typical applications of different catheters. 3) Discussion of how to overcome difficult clinical scenarios with catheters.
Conclusion: catheters are a core item of equipment in interventional radiology. Knowledge of their features will enable maximum utilisation of their functionality in both routine and complex interventional radiological procedures in addition to enabling a solution to certain difficult clinical scenarios.

P-357

How to buy your new digital angiography X-ray system: tailoring the choice to the real needs of interventional radiologist

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Learning Objectives: to provide an insight and detailed explanation of the needs and useful technical features in the selection of New Digital Angiography X-Ray System in order to enhance its quality, as well as "buying force" of Interventional Radiologist (IR).
Background: most of the IRs have limited knowledge in advanced technical features of angiography systems. Better understanding of technological progress will improve decision making when buying new systems. The terminology is vendor oriented, and understanding key aspects, priorities, usefulness of optional items and their link with clinical tasks is invaluable. IR should gain full understanding of the main technical features, in order to lead the decision making process.
Clinical findings and procedure details: basic safety is insured by the CE mark obligation in Europe. Key aspects to be considered during the selection of angiography system are: X-ray generation (including high beam filtration), detector technology (image intensifier or flat panel detector and its size), ability to select a range of dose levels and pulse sequences as well as image quality, ergonomics, geometrical movements, image processing, fluoroscopy storage, DICOM conformance, and patient dosimetric information (including reporting and in-room display). Typical optional items are: application specifics (bolus chasing, rotational angiography with 3D and CT reconstructions, image guidance), image quantification tools, image archiving, emergency power supply, and in-room display of CTA/MRA images.
Conclusion: a comprehensive approach with simple take home messages in selection of the New Digital Angiography X-Ray system was described. Acquired knowledge and cooperation with manufacturers is a key to successful purchase.

P-358

IR to the rescue: minimally invasive management of iatrogenic complications

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Learning Objectives: to showcase the utility of minimally invasive management of iatrogenic complications in a broad range of both surgical and interventional radiology procedures.
Background: iatrogenic complications, severe as well as non life threatening, are not uncommonly encountered in the setting of both invasive surgical procedures in addition to minimally invasive interventions. As a 903 bed tertiary care hospital, we have encountered a broad range of complications successfully managed through minimally invasive management.
Clinical findings and procedure details: cases ranging from a renal transplant biopsy with development of a pseudoaneurysm, lumbar bleed after robotic nephrectomy, vertebral body bone biopsy causing a lumbar hemorrhage, hepatocellular carcinoma embolization causing a tumor "explosion", genicular pseudoaneurysm after total knee replacement, and peroneal pseudoaneurysm after removal of orthopaedic hardware all demonstrate the role of the interventional radiologist in the successful management of "sticky situations". Even commonly encountered procedures such as paracentesis, liver biopsy, biliary drainage, and nephrostomies all present complications managed successfully by minimally invasive techniques.
Conclusion: interventional radiology plays a vital role in the minimally invasive management of iatrogenic complications, whether encountered in the operating suite or the fluoroscopy table.

P-359

Leash your guiding catheter: or how to obtain a stable catheter position for cross-over iliac embolization procedures

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Learning Objectives: supported by detailed image documentation readers will learn -step-by-step- how to leash a guiding catheter with a cross-over attached snare after a pull-through maneuver to perform safe and quick cross-over embolization of the internal iliac artery (IIA).
Background: for cross-over embolization of the IIA it is essential to provide a stable catheter position. Especially, large profile guiding catheters of 6-8F for embolization with e.g., an amplatzer vascular plug (AVP) may cause problems by recoiling and dislocating.
Procedure details: 1) Via both groins insert 8F/10 cm sheaths. Introduce a 0.035 inch/150 cm hydrophilic guide-wire contralaterally; advance a 5F/80 cm multipurpose-catheter containing a snare to the aortic bifurcation. 2) Catch and pull through the guide-wire with the snare establishing a cross-over wire-loop. 3) Exchange the guide-wire for a 0.035 inch/180 cm stiff guide-wire. Gently advance an 8F/100 cm guiding-catheter from contralaterally to the IIA's origin. 4) Introduce the multipurpose-catheter with the snare coaxially over the pulled-through wire from ipsilaterally; attach it at the distal end of the guiding-catheter. 5) Introduce a second 0.035 inch/180 cm stiff guide-wire parallel to the first in the guiding-catheter; direct it into the IIA. 6) Remove the first pulled-through wire; keep the snare attached to the guiding-catheter.
7) Direct the guiding-catheter gently into the IIA over the remaining wire supported by the attached snare. 8) Once in place, hold the guiding-catheter in position by the attached snare; remove the wire; embolize the IIA by deploying an AVP.
Conclusion: after a pull-through maneuver, a cross-over attached snare stabilizes the guiding catheter, thus enabling embolization procedures in the IIA in even acute-angled iliac axis.

P-360

An evidenced based users' guide to the use of prophylactic antibiotics in interventional radiology

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Learning Objectives: to evaluate the evidence for prophylactic antibiotics use in interventional radiology (IR) and to provide a guide for their appropriate administration.
Background: the use of antibiotic prophylaxis in IR has become widespread. Despite this, the rate of infectious complications from many interventional procedures has increased. This is partly due to the use of more invasive and complex procedures but may also be as a result of inappropriate antibiotic use. Antibiotic resistance has placed increased emphasis on the use of antibiotics only when definite benefit is demonstrated.
Clinical findings and procedure details: antibiotic choice should be directed towards a specific organism, the use of broad spectrum coverage is inappropriate. Antibiotics should be administered 2

hours, or less, before the procedure. Specific guidelines for individual procedures will be discussed in detail under the headings: hepatobiliary, endovascular, genitourinary, musculoskeletal and central venous access. Hepatobiliary interventional procedures require gram negative cover. Third generation cephalosporins reach high levels in excreted bile and are thus ideal. Genitourinary procedures again require predominantly gram negative cover and when given, third generation cephalosporins or ampicillin + gentamycin are appropriate. For angiography, antibiotics should not be used. For endovascular graft insertion, high risk patients such as those with immunosuppression or undergoing multiple procedures need prophylaxis with cefazolin. There is no evidence using systemic antibiotics to prevent central catheter infection; however, catheters impregnated with minocycline and rifampin show reduced infection rates.
Conclusion: the judicious use of antibiotics is important to avoid unnecessary infectious complications in IR.

P-361

Percutaneous intra-arterial thrombolytic treatment in a 26-year-old man with accidental intra-arterial injection of cocaine

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The case shows thrombolysis of the interdigital arteries successfully performed in the 1st and 2nd ischemic fingers in a 26-year-old man with accidental intra-arterial injection of cocaine.

P-362

Spontaneous recovery of severe cerebral air embolism after lung biopsy

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A 72-year-old patient undergoing CT-guided lung biopsy for suspected bronchial cancer suffered severe cerebral air embolism. Due to pronounced COPD, hyperbaric oxygen therapy was not possible. We report a nearly complete restitution ad integrum without any specific therapy.

P-363

Percutaneal treatment of splenic abscess

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Patient developed fever 3 weeks after aorto-coronary shunting. Cystic mass in spleen (abscess) was revealed and percutaneal drainage under combined Ultrasound-Fluoroscopy control was performed. Symptoms were gone immediately and catheter was withdrawn in 2 weeks.

P-364

Successful transcatheter occlusion of pulmonary artero-venous malformation (AVM) using the Amplatzer vascular plug

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Poorly symptomatic pulmonary AVM incidentally discovered pre-surgically by chest-X ray and CT-angiopraphy in a 67-year-old female. The high-grade fistula was successfully embolized using the Amplatzer plug, sparing pulmonary arterial vascularization. Clinical success was complete.

P-365

Treatment of massive haemoptysis secondary to pulmonary artery pseudoaneurysm following necrotizing pneumonia with pneumatocele formation

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We present a case of life-threatening haemoptysis secondary to pulmonary artery pseudoaneurysms in a 35-year-old man with necrotizing pneumonia with pneumatocele formation. The pseudoaneurysms were diagnosed by CT angiography. Treatment was achieved with coil embolisation without necessitating surgical intervention.

P-366

A new approach to the treatment of aortic endoleaks: echo-guided percutaneous injection of human thrombin in the aneurysm sac, case review

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Two cases of aortic endoleaks are reported. We describe treatment using ultrasound-guided percutaneous injection of human thrombin in the aneurysm sac.

P-367

OK-432 sclerotherapy of parotid lymphoepithelial cysts in an HIV patient

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A 44-year-old male presented with mildly tender, cosmetically deforming, bilateral parotid lymphoepithelial cysts. Sessional treatment with percutaneous injection of OK-432 has resulted in good clinical success.

P-368

Temporary intraoperative balloon occlusion of common internal iliac arteries for prophylactic control of postpartum bleeding in abdominal pregnancy

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A woman carried live intraabdominal pregnancy until 32 weeks and was submitted to temporary intraoperative balloon occlusion of common internal iliac arteries for prophylactic control of postpartum bleeding because of placental implantation. The fetus and patient survived without complications.

P-369

Latrogenic pulmonary artery aneurysm: embolisation with Amplatzer vascular plug

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Interventional tratment of iatrogenic pulmonary pseudoaneurysms can be performed using coils. We describe a case of left pulmonary pseudoaneurysm after wedge pressure measuring which was treated successfully using the Amplatzer vascular plug.

Pediatric IR

P-370

Central venous access in children: a comprehensive review

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Purpose: traditionally, central venous catheter (CVC) and port placement in children has been performed by pediatric surgeons or operators with little or no experience in catheterization techniques. During the last few years, transition from surgical placement in the OR, to IR placement in the IR suite, is occurring in children, as has occurred, in the past, in adults.
Materials/methods: we have considerable experience in CVC and port placement in children. We review methods, techniques; catheter types, selection; patient preparation, sedation, techniques for insertion of tunneled and non-tunneled catheters; hemodialysis catheters; ports; "power" ports; and peripherally inserted central catheters (PICCs).
Results: we present many examples of poorly inserted, nonfunctioning, complicated CVC and ports, and ways to correct, fix, replace or remove nonfunctioning devices.
Conclusion: CVC and port placement in children is much easier and simpler than in adults. However, some IRs are hesitant to insert CVC and ports in children and allow other operators (pediatric surgeons, nephrologists, or personnel with little or no experience in catheterization) to insert these devices with significant problems, complications, and a high rate of failure.

P-371

Biliary complications in pediatric liver transplant patients: a 12 year, single institution experience

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Purpose: to compare overall survival, graft survival and surgical revision of the pediatric patients who received percutaneous interventions for biliary complications after liver transplant.
Materials/methods: 265 transplants were performed in 236 patients over 12 years. A prospective transplant database was utilized. Graft revision, graft loss and survival following percutaneous intervention were compared in cases of biliary leak and biliary stricture. One patient with stricture and leak was excluded from analysis.
Results: 13.9% (37/265) of transplants developed biliary complications; 9.1% (24/265) of transplants had biliary strictures and 5.3% (14/265) of transplants demonstrated anastomotic leaks. 94.6% (35/37) of these patients were treated by percutaneous interventions. Surgical revision was necessary in 27.2% (3/11) of the transplants with leak as compared to 13.0% (3/23) of the transplants with stricture following percutaneous intervention [p=0.36]. 9.1% (1/11) of transplants proceeded to graft loss in cases with biliary leak compared to 30.4% (7/23) of transplants with biliary stricture after undergoing percutaneous intervention [p=0.23]. Biliary complications were the reason for graft loss in 21.7% (5/23) of cases with biliary stricture compared to 0% cases with biliary leak after percutaneous intervention. Overall survival rates at 1 year and 3 years in cases with biliary leak were 100% compared to 90 and 84% in cases of biliary stricture [p=0.94].
Conclusion: percutaneous interventions are similarly effective in managing biliary leak and biliary stricture complications in pediatric liver transplant patients. Our data demonstrate biliary leak to be an uncommon cause of graft loss.

P-372

Pediatric interventional procedures: when and how we do it

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Learning Objectives: to describe the main indications and the technical steps to perform angiographic and percutaneous image-guided procedures in children. To access procedure safety, accuracy and effectiveness.
Background: with expertise several image-guided techniques and the ability to adjust them to the special needs of children can be made. In our children reference hospital, the most clinical problem related with the need of doing such techniques was chronic liver failure and transplantation. Metastatic disease was the second related condition. This exhibit reviews the indications and contraindications of the described techniques. All techniques were made under sedation (with or without general anesthesia) and with appropriate materials (needles, catheters, guide-wires) sometimes different from the adult.
Clinical findings and procedure details: different procedures are described: US-guided liver biopsies, CT-guided catheter drainages, RF-ablation of lung metastases, PTC with biliary endoprosthesis placement, transjugular liver biopsies, stenting and balloon angioplasty in cases of vessel stenosis after liver transplantation, arteriovenous malformations (AVMs) embolizations and transjugular intrahepatic portosystemic shunt placement (TIPS). We illustrate the specific needs of pediatric patients during the procedures, catheter insertion techniques and the use of different imaging modalities for guidance.
Conclusion: successful adaptation of interventional techniques for pediatric use requires attention to the specific needs of children in the different procedures but with respect to sedation and monitoring equipment, avoidance of body heat loss, minimization of radiation doses and greater involvement of family compared with that in adult practice. Adult techniques are applicable to infants and children but may require some technical modifications to succeed.

P-373

Pediatric sedation for painful procedures: tested approaches and emerging concepts

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Learning Objectives: this presentation will familiarize practitioners with safe and effective approaches to provide analgesia and anesthesia during painful procedures in children. It will also discuss emerging medications and practices, and provide guidelines and recommendations for specific challenging situations.
Background: sedation in children presents diverse and uncommon challenges compared to sedation in adults, including a large spectrum of weight and size requirements, weight-based dosing, fluid and temperature control, and a small physiologic reserve. Additional difficulties arise in patients with compromised cardiac or respiratory status, altered metabolism of common sedative medications, difficult

venous access, and reduced ability to communicate and cooperate.
Clinical findings and procedure details: we discuss 20 years' experience in the sedation of children for painful procedures, and review outcomes compared to alternative strategies, including endotracheal anesthesia. We also report emerging strategies and infrastructural requirements necessary to support them.
Conclusion: with thorough understanding of pediatric physiology and pharmacology, and experience with successful strategies, sedation can be provided for even prolonged or extensive procedures in children. Appropriate credentialing, control mechanisms, infrastructural resources, continuing education and quality assurance programs are important elements for safe and satisfactory outcomes.

P-374

Transesophageal catheter-directed sclerotherapy of postoperative tracheoesophageal fistula with histoacryl glue: a case report

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Results of transtracheal endoscopic closure of recurrent postoperative tracheoesophageal fistula (TEF) are disppointing. We present a new technique of successful transesophageal catheter-directed sclerotherapy of TEF with histoacryl glue under fluroscopy, which resulted in non-recurrence of TEF for a year.

P-375

Transnodal lymphangiography and percutaneous translumbar thoracic duct ligation in an infant

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A 2-month-old male child was referred to IR with high-volume chylothorax after repair of tetralogy of Fallot. Rotational lymphangiography after US-guided transnodal ethiodol was used to guide biplane fluoroscopic translumbar thoracic duct ligation with Onyx. Chylous output was significantly reduced.

Peripheral PTA and vascular stents

P-376

Infrapopliteal stent placement in patients with critical limb ischemia is a reliable treatment option

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Purpose: to evaluate the effectiveness of primary nitinol stent placement in patients with chronic critical limb ischemia.
Materials/methods: between January 2005 and May 2008, 42 high-risk patients (18 female; mean age 75.8±4.1) with peripheral arterial disease underwent infragenicular stenting. They had serious cardiovascular comorbidities (>3, such as COPD, congestive heart failure, coronary artery occlusive disease), American Society of Anaesthesiologists score=3 or more, previous myocardial infarction, coronary stent or bypass. The mean stenosis length was 7.5±0.9 cm (range 2.2-8 cm), and the mean occlusion length was 8.5±2.9 cm (range 3-10.6 cm). All patients suffered from critical limb ischemia based on the Rutherford categories.
Results: the primary cumulative patency rate was 85.1% during a follow up period of 14.4±4.3 months. Two patients underwent successful repeat angioplasty due to in-stent restenosis (>70%) with relevant limitation of the pain-free walking distance, after tibioperoneal (n=2) interventions. Two patients presented with rest pain underwent extraanatomic bypass due to occlusion of the infragenicular stents at 6 and 12 months postinterventionally. The mean ankle-brachial index increased significantly following intervention (0.32±0.25 to 0.82±0.13, p<0.001). Two patients suffered from false aneurysms at the puncture site in the groin after antegrade access and a surgical revision was necessary. No mortality was recorded.
Conclusion: in high-risk patients for crural bypass and unlimited supragenicular inflow, stent-supported angioplasty should be considered as treatment of first choice.

P-377

Alternative to the ‚classic' kissing stents for endovascular reconstruction of the aorto-iliac bifurcation: aorto-uniliac stenting with controlateral fenestration

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Purpose: the aim is to propose an alternative technique for the reconstruction of the aorto-iliac bifurcation in case of small infrarenal aortic diameter that can influence the outcomes of the usually adopted kissing stents.
Materials/methods: from January 2005 to November 2008, 8 patients (5 males, 3 females; mean age 50.5, range 41-61) at different stages of the Lafontaine classification were treated with the aorto-uniliac stenting and controlateral fenestration technique. 13 iliac lesions were treated with placement of a self-expandable stent (diameter range 14-10 mm) in the lower aorta and one iliac axis followed by a ballon-expandable stenting (diameter range 7-8 mm) of the controlateral axis. Clinical, US Doppler and CT or MR follow up were scheduled for each patient (follow up range 3-36 months).
Results: all the patients improved their symptoms and ABI. The 8 procedures showed an immediate technical success (100%) with good delivery of the stents and satisfying control angiographies. At the follow up, all the stents were patent (patency rate: 100%); in 2 patients (22%), findings of intimal hyperplasia were detected at the proximal and distal end of the aorto-uniliac stent.
Conclusion: the aorto-uniliac stenting with controlateral fenestration technique appears a feasible alternative for aorto-iliac reconstruction in those patients presenting a small diameter of the lower aorta. Longer term follow up and randomized trials are necessary for consensual validation.

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Endovascular stent-graft placement for isolated iliac artery aneurysms repair

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Purpose: to evaluate the safety, efficacy and midterm result of endovascular stent-graft (SG) placement for isolated iliac artery aneurysms (IAAs) repair.
Materials/methods: SG placement for repair of 18 IAAs was performed in 16 patients (12 male, mean age 75.0±6.0 years) from September 2002 to January 2009. Six patients (38%) had previous open abdominal aortic aneurysm repair. In three symptomatic cases (19%), procedures were carried out under emergency. The mean

aneurismal diameter was 40.2±10.3 mm. After embolization of the proximal portion of internal iliac artery (IIA), SGs were placed in seven aneurysms, located in common iliac artery (CIA). However, in one case there was no proximal landing zone; therefore, bifurcated aorto-iliac SG was placed. Eleven SGs were placed (seven in IIA and three in IIA and CIA aneurysm) after embolization of IIA distal branches. The mean SG diameter was 13.8±3.1 mm and the mean length was 83.2±21.2 mm.
Results: the technical success was 93% (17/18 procedures). In one case, insertion of SG delivery system was unsuccessful because of tortuous iliac artery. No procedural related complications occurred. The mean post operative stay was 13.4 days (range 7-32 days). At a mean follow-up of 597 days (range 8-2309 days), no late rapture and SG-related complications occurred. The aneurismal diameter was decreased in eleven cases (65%), had no change in five cases (29%) and was increased in one case (6%).
Conclusion: endovascular SG placement for isolated IAAs repair is a safe and effective treatment.

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Endovascular treatment for isolated lower limb ischemia complicating aortic dissection

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Purpose: to evaluate the endovascular treatment for isolated lower limb ischemia complicating aortic dissection.
Materials/methods: from March 2003 to January 2009, we retrospectively reviewed our database identifying 12 patients with an aortic dissection (11 male, 1 female; mean age 54.1 years; 8 acute, 4 chronic; 10 Stanford type B, and, 2 post operative type A) who underwent endovascular procedures to attempt revascularization of 15 isolated ischemic limbs. Interventions included abdominal aortic, and iliac, true lumen stent placement (9 patients), balloon fenestration (7 patients) and stent-graft placement for closure of distal arch entry (1 patient). Balloon fenestration (12-18 mm) was performed via dilatation of a natural fenestration, or puncture of the flap using the hard edge of a guidewire assisted by a fixation device and puncture needle.
Results: all ischemic limbs were initially successfully reperfused. No mortality or procedural complications were noted. In 1 patient, after an iliac true lumen stent was placed, a further stent-graft was necessitated for entry closure at the distal arch to address the potential of branch vessel malperfusion. During follow-up period (median 727 days, 394-1772 days), no patients presented late recurrent ischemia. We collected 9 patients' data regarding aortic diameter. Although aortic diameter has no significance at celiac (P=0.17), renal (P=0.12) and bifurcation (P=0.23) levels, it tends to increase compared with pre-procedure.
Conclusion: entry closure with stent-graft should be considered as the endovascular procedure of choice for aortic dissection with malperfusion; however, in the case of isolated limb ischemia, aortic percutaneous fenestration and stent placement is feasible as an alternative.

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Directional atherectomy for in-stent restenosis of the femoropopliteal artery: mid-term results of a prospective study

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Purpose: safety and efficacy of directional atherectomy for femoro-popliteal instent restenosis.
Materials/methods: 17 patients, mean age 70.5 (±8.2) years, with restenosis following femoropopliteal stenting were treated primarily with excisional atherectomy using the Silver Hawk™ device (EV3, USA). Primary objective is anatomical treatment success in the absence of complications. Secondary objective is TVP at 3, 6 and 12 months.
Results: 15/17 patients (88.2%) were claudicants. Stents were in-situ for 10.9 (±11.5) months. Grade of restenosis was 93.1% (±7.7), lesion length was 13.2 cm (±10.4). Length of stented vessel segment was 15 cm (±8.0) with 2 cases of stent fracture. On intention-to-treat basis treatment success of atherectomy alone was 76% (13/17). In 47% (8/17) of cases, additional balloon angioplasty was performed for residual stenosis and/or proximal and distal de-novo lesions. Stents were implanted in 3/17 cases (17.6%). Overall success of the procedure was 100%. Doppler index improved from 0.46 (±0.3) to 0.78 (±0.3). There were three cases of distal embolization, managed with aspiration (3/17; 17.6%). One patient experienced reocclusion before 30 days. So far 14/17 patients reached 3-months follow-up (mean F/U: 4.4 ±1.9 months). TVP at 3 months is 13/14 (92.9%±SE). 6 and 9 months patency rates are pending and will be presented.
Conclusion: directional atherectomy as a primary treatment modality for instent restenosis of the femoropopliteal artery yields high initial success with promising 3-months patency rates. Longer follow-up is needed to determine if the avoidance of repeated barotrauma with actual removal of neointimal tissue also translates into a continuous clinical benefit.

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Superficial femoral and popliteal artery disease treated with nitinol stents: review of a 100 cases

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Purpose: to review our experience of stenting the femoropopliteal segment in a population with advanced peripheral arterial disease, ascertaining patency and clinical outcome and to relate outcome to patterns of disease.
Materials/methods: a retrospective review of data from clinical notes, procedural databases and ultrasound surveillance was carried out for 100 consecutive cases of native superficial femoral or popliteal artery stenting for obstructive disease from 2004 to 2007.
Results: 100 limbs in 98 patients (64 males; age 47-93 years; mean 74 years) were reviewed. 64 of the patients were clinical Rutherford grade 3 (ulceration), another 19 were grade 2. The majority of lesions (58) were occlusive. The mean length of the diseased segment was 15 cm. The TASC 2007 categorisation of the lesions was: A=14, B=32, C=33 and D=21. A mean of 1.5 stents were deployed per limb. There was only 1 technical failure where thrombosis of the stents occurred. The cumulative patency rates at 6, 12 and 18 months were 77.6/50.4/40.2% (primary), 80.8/57.9/48.7% (primary assisted) and 91.8/80.5/66.8% (secondary). Patency was significantly related to the TASC category (p=0.021). The ABPI improved by a mean of 0.30 (p<0.001). Complications included 6 stent fractures and 4 patients subsequently needed major amputations.
Conclusion: our patency rates are higher than those published

for angioplasty alone. In our series, which included a much higher proportion of patients with advanced disease (critically ischaemics and long occlusions) than in major published series of femoral stenting, the results suggest femoropopliteal stenting may achieve better results than angioplasty on its own.

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Atherectomy of heavily calcified stenotic lesions at the lower limb

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Purpose: to investigate the long-term outcome of patients with peripheral occlusive disease (POD) of the lower limb with heavily calcified stenotic lesions after atherectomy.
Materials/methods: patients suffering from POD (Rutherford 3 to 6) were treated with the Silverhawk atherectomy device (ev3 Endovascular, MN, USA) if heavily calcified lesions in the superficial femoral artery or the popliteal artery were present. Overall 38 patients (mean age: 70±8 (standard deviation); 15 female, 23 male) were included in this prospective study. 13 patients were not available for follow-up examination Patients were followed up after 6 and 12 months for clinical re-evaluation including the measurement of the maximum walking distance (MWD) and the ankle brachial index (ABI) and to perform duplex sonography.
Results: the primary success rate of the treated 44 lesions was 100%. The mean Rutherford score decreased from 3.63 to 0.81 and 0.45 after 6 and 12 months, respectively. The mean MWD increased from 98.78±79.0 to 192.3±27.7 m and 183.33± 40.8 m and the ABI from 0.69±0.42 to 0.98±0.33 and 0.84±0.24 after 6 and 12 months, respectively. 5 patients with open wounds demonstrated complete healing. Vessel patency was 71% after one year. Procedure-related embolization was easily treated by aspiration in 2 of 44 cases (4.5%).
Conclusion: using the Silverhawk atherectomy device in patients suffering from POD with heavily calcified femoro-popliteal lesions leads to a decrease of the Rutherford score and an increase of the MWD and ABI.

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Below-the-knee endovascular treatment in diabetic patients with critical limb ischemia in a single-center experience

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Purpose: to evaluate the midterm clinical results of below the knee (BTK) percutaneous revascularization in a series of diabetic patients with critical limb ischemia in a single center experience.
Materials/methods: between 2004 and 2008, 146 diabetic patients with foot rest pain (17%) and/or tissue loss (83%) underwent percutaneous revascularization for BTK obstructions. According to Texas university classification, 86 were III-D stage. All patients underwent preoperative evaluation with CD-ultrasound and TCPO2. Antegrade groin access was mainly used (>95%). In 9 pt, retrograde tibial/pedal access was associated. Btk target vessel was treated with PTA using very low-profile balloons. In 43 pts, SFA subintimal/intraluminal recanalization was performed and associated with stenting in 50%. Clinical evaluation in "diabetic foot" unit and US was obtained every 6 months.
Results: technical success was 97%. One-or-2-vessel straight distal run off was obtained. Three complications occurred. At mean follow-up of 28 mt (range 6-49) patient clinical condition was: improved (87%), stable (9%) and worst (4%). Patients with ulcers presented a complete (69%) and partial (18%) healing. Limb salvage was 95%. Reintervention rate was 11%. Kaplan-Meier analysis showed minor amputation-free rate of 79% at 6 months remaining stable at 2 and 3 years. Major amputation-free rate was 98 and 82% at 1 and 4-years, respectively.
Conclusion: BTK revascularization in diabetic CLI and foot ulcers is safe and effective. It can be successfully repeated. Minor amputations were observed within 6 months mainly related to advanced stage disease at time of procedure.

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Preliminary experience using Reekross PTA catheter in the treatment of long calcified lesions

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Purpose: the aim of the study was to investigate safety and efficacy of the Reekross PTA catheter in the treatment of obstructed high calcified lesions, in patients with critical limb ischemia (CLI).
Materials/methods: from January 2007 to December 2008, 231 diabetic patients (mean age 72.5 years), candidates to amputation or with critical limb ischemia (CLI), with multivessel disease of SFA and infrapopliteal arteries, were treated by PTA. In 28 of these patients, presenting long obstruction of SFA (16 pts) or at least two infragenicular arteries occluded (12 pts), it was not possible to cross the lesions using diagnostic or conventional baloon catheters, due to the presence of very stiff calcifications. In all cases, then, Reekross PTA catheters of diameter between 5 and 3 mm and length of 120 mm were used.
Results: all patients were treated successfully using Reekross PTA catheter that allows us to pass and to perform angioplasty of very high calcified long lesions. Angiographic and procedural success was achieved in all the patients (28 pts). Only in 2 patients after the procedure occurred a distal trombo-embolic event that was solved by aspiration and by urokinasi infusion.
Conclusion: in our experience, the use of Reekross PTA catheter allows to pass very high calcified long lesions, thanks to its excellent trackability and pushability, and to perform several angioplasty thanks to the durability of the balloon. Moreover, Reekross PTA catheter gives an additional control to the wire even using 0.014" guidewires.

P-387

Nitinol stent deformations in femoropopliteal arteries during physiological movements

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Purpose: local biomechanical forces in stented peripheral arteries can play a crucial role in nitinol stent fatigue life. The aim of the study was to evaluate the range of nitinol stent deformations in stented femoropopliteal arteries.
Materials/methods: computerized tomography (CT) and X-ray images were obtained from standard clinical cases of angioplasty with nitinol self-expanding stents in the femoropopliteal artery

(n=23) during hip/knee movement. Images were analyzed for stent axial deformation (compression, elongation) and bending (deflection angle). For measurements on stents, three-dimensional (3-D) analysis was utilized with CT images, and Sigma-Pro software was used with X-ray images.
Results: during knee/hip 90°/90° flexion, it was found that there were on average 3% axial compression and 5° deflection angle for stents in the superficial femoral artery (SFA), 5% and 7°, respectively, in distal SFA/proximal popliteal artery, and 9% and 58°, respectively, in the popliteal artery. 3-D CT allows more accurate evaluation of three-dimensional deformations of stents in the popliteal fossa and the adductor hiatus during ambulation and muscle contraction.
Conclusion: nitinol self-expanding stents are subjected to biomechanical forces, and deformation modes are specific for the different parts of the femoropopliteal artery. The ranges of stent axial compression and deflection angle can be applied as parameters for stent fatigue tests and stent design.

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Evaluation of cost and fluoroscopy's time in subintimal recanalization of chronic occluded SFAs using true lumen re-entry device or "double approach" technique

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Purpose: assessment of difference of cost and fluoroscopy's time in the treatment of long obstruction of superficial femoral artery in unsuccessful true lumen re-entry after subintimal revascularization, using two different techniques: "double approach" (femoral and popliteal puncture) and re-entry device ("Outback catheter").
Materials/methods: from June 2006 to December 2008, 159 patients with CLI and long obstruction of SFA were treated with intentional subintimal angioplasty. In 50 patients, after 15 minutes, it was not possible to re-enter the true lumen with standard technique, and so we randomized the patients in two different groups: 25 of them were treated with "double approach" technique, others with Outback catheter re-entry device. The "Outback" group had mean time fluoroscopy of 14±8 min, and the "double approach" technique group of 26±12 min. The mean cost of procedure was 4025€ for the "Outback" group and 2025€ for the other group.
Results: technical success was 100% in the "double approach" group and in the other group was 95% due to high calcification. In the "Outback" group, it was necessary to place a stent in the site of re-entry in 60% of the patients, whereas in "double approach" group stenting was necessary only in 20%. Three complications were detected in the "double approach" group: one arteriovenous fistulae and two haematoma in site of puncture.
Conclusion: both techniques are safe and effective; despite the shorter time of fluoroscopy in the Outback group, the "double approach" technique group had lower costs and was much more uncomfortable for the patients.

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Internal iliac arteries occlusion with the amplatzer vascular plug during endovascular repair of abdominal aortic aneurysms: single center initial report

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Purpose: to report initial experience using the Amplatzer-Vascular-Plug (AVP) in internal iliac arteries (IIA) exclusion performed during endovascular repair of aorto-iliac aneurysms (EVAR).
Materials/methods: between May 2006 and October 2008, 16 patients with abdominal aneurysms involving the common iliac artery underwent EVAR using a bifurcated stent-graft. Before endograft deployment, IIA was excluded, in the same session, using AVP device deployed in the proximal portion of the IIA avoiding distal branches embolization. AVP size was selected on the basis of IIA diameter with an oversize of 30-40%. CTA was performed during the follow-up evaluating IIA flow exclusion in the proximal portion and distal branches patency.
Results: technical success was achieved in all 16 cases. Flow exclusion from the proximal portion of the IIA occurred in 15/16 cases. In one patient (6.25%), 9 minutes after AVP deployment an antegrade flow was still present and coils were added. In the other 15 cases (93.7%), IIA occlusion occurred spontaneously after a mean period of 8 minutes (range 6.30-12 minutes). In all cases, only one AVP was sufficient to exclude the IIA. After a mean follow-up of 13.7 months, all patients are alive with complete exclusion of the IIA. One patient (6.25%) developed mild buttock claudication that disappeared spontaneously after 3 months. No other ischemic complications were reported. No type II endoleaks or retrograde perfusion of the aneurysmatic sac occurred.
Conclusion: IIA embolization using AVP seems to be a valid alternative to coils embolization with low rate of ischemic complications, reducing the procedure time and costs.

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Below-the-ankle angioplasty and provisional stenting for critical limb ischemia treatment

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Purpose: to present the long-term angiographic and clinical outcome of percutaneous angioplasty and optional bail-out stenting of the arteries below the level of the ankle for critical limb ischemia (CLI) treatment.
Materials/methods: the digital archives of 17 patients (15 males, mean age 73±8 years), who underwent infrapopliteal revascularization procedures including angioplasty and optional bail-out stenting of the dorsalis pedis and/or the plantar arteries (20 lesions in 19 limbs), were retrospectively analyzed. Technical success was defined as residual stenosis <30% and absence of flow-limiting dissection. Clinical and angiographic follow-up was scheduled at 6 and 12 months and annually thereafter. Stent integrity was evaluated with plain X-Ray imaging at two different angulations (>45% difference) during regular follow-up.
Results: the majority of patients were diabetics (82%) and mostly suffered from ischemic ulcers and tissue loss (median Rutherford stage: 5). 75% of the lesions were calcified (15/20) and 40% were initial total occlusions (8/20). In 55% of the lesions (11/20), adjunctive bail-out stenting with balloon expandable drug-eluting stents was performed. Technical success rate was 95% (19/20 lesions). No immediate site-related major complications were noted. Mean follow-up period was 26±13 months. Cumulative limb salvage was 88% with 2 major amputations. Repeat angioplasty because of recurrent symptoms was necessary in 5 cases (29%). X-Ray follow-up revealed 4 deformed and/or collapsed stents and 1 severe stent fracture, all of which were associated with significant vessel restenosis and/or occlusion.
Conclusion: below-the-ankle angioplasty for CLI treatment is safe and feasible. Balloon-expandable stents should be reserved for bail-out in exceptional cases because of a high risk of external compression.

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Femoral artery closure with the StarClose device: experience in more than 600 angioplasty procedures

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Purpose: to report the results of a prospective registry investigating the StarClose device for femoral artery closure after percutaneous angioplasty of the peripheral arteries.
Materials/methods: the registry was approved by the Hospital's Scientific and Ethical Committee and all patients gave their informed consent. The StarClose device was applied for retrograde or antegrade femoral artery closure after elective peripheral angioplasty procedures (single antiplatelet therapy and 5,000 IU of heparin during the procedure). Baseline demographics and technical procedural variables were recorded. Major and minor complications, time-to-hemostasis and time-to-ambulation were recorded.
Results: during a 5-year period (2004-2008), a total of 656 devices were used in 413 patients (316 males and 97 females, mean age 65 years) for 309 antegrade and 347 retrograde femoral artery punctures. Bilateral femoral artery puncture was performed in 57 patients. The device was applied more than once in the same artery in 66 patients during different sessions. In almost all cases, a 6F sheath was used apart from 17 cases with a 7F and 1 case with an 8F sheath. Successful device deployment reached 97% with 21 failures requiring prolonged manual compression (10-20 minutes). Immediate hemostasis was achieved in 78% of the cases, while the remaining 19% required manual compression <5 minutes due to minor oozing. There were 2 (0.3%) major retroperitoneal hematomas and 22 (3.5%) minor local hematomas. There was no other device-related major complication or death. Mean time-to-ambulation was 3.5±0.5 h after successful device deployment.
Conclusion: Starclose is a safe and effective artery closure device achieving satisfactory rates of immediate hemostasis, early patient ambulation and low local complications.

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Transfemoral arterial access sites: results of using a suture-mediated percutaneous closure device to achieve hemostasis

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Purpose: vascular closure devices are designed to obtain a fast hemostasis of the vascular access site after diagnostic and interventional procedures. The feasibility and clinical outcome of suture-mediated closure after transfemoral puncture of arterial access are examined.
Materials/methods: 1500 patients (873 men, 627 women; mean age±SD, 67.4 years±12.3) who had undergone femoral angioplasty by a transfemoral access underwent suture-mediated percutaneous closure with 6-F devices (Perclse, Abbott). Patients received 5000IE heparin intraarterial and were immobilized for 6 hours after the intervention. All patients underwent a physical examination the day after the procedure. Color-coded Duplex ultrasonography was performed in all 1500 patients. After 6 weeks, an identical clinical examination was performed in every patient.
Results: hemostasis was achieved in 1487 (99.2%) patients. The closure devices could not be deployed in 13 patients; these patients needed compression because of a steep angulation of the puncture track and suture entrapment. In three patients, a groin infection occurred and had to be treated by vascular surgery. Minor complications: Only 45 small hematomas occurred. Three pseudoaneurysms, no a-v-fistulas and no lymphatic fistulas occurred.
Conclusion: suture-mediated percutaneous closure of transfemoral puncture site is very safe and effective. Compared with manual compression, the time of hemostasis, the time of imobilisation and the complication rate is significant lower. Problems may arise in punctures owing to steep device angulation, calcification of punctured artery and preinterventional operations.

P-393

Subintimal angioplasty (SIA): review of technique, tips and tricks

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Learning Objectives: The objectives of this exhibit are as follows: 1. To learn the indications for and contraindications to SIA. 2. To discuss the expanded indications in crural vessel disease and the diabetic foot. 3. To learn the technique of SIA and how to overcome difficulties. 4. To learn how to deal with complications.
Background: a subintimal approach to angioplasty offers an alternative to invasive surgical treatment when conventional intraluminal angioplasty is not technically possible. The procedure was first described by Bolia in 1989 as a treatment for patients with intermittent claudication due to femoropopliteal occlusive disease. SIA has since evolved to include management of iliac and crural vessel disease in patients with critical ischaemia.
Procedure details: with the use of diagrams, we illustrate the technique including accessing the subintimal space, re-entry into the vessel lumen and balloon angioplasty of the occluded segment. Options regarding catheter choices including ReeKross(TM) and Outback(TM) catheters are detailed. Management of challenging cases is discussed including difficult re-entry and stent placement for bail-out procedures.
Conclusion: SIA is an effective technique for management of patients with critical ischaemia and/or those unsuitable for surgery. With the advent of newer catheters the applications of this technique are evolving and expanding.

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Noninvasive imaging and endovascular interventions for critical limb ischemia in diabetics: are we there yet? an evidence based review

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Learning Objectives: 1. Highlight epidemiological significance of Diabetes Mellitus (DM) and Infrainguinal Peripheral Arterial Disease (PAD) with specific reference to critical limb ischemia. 2. Evaluate noninvasive imaging techniques - US, CTA and MRA techniques for PAD evaluation in the typical diabetic distribution. 3. Review the shifting paradigms of management for PAD in DM for critical limb ischemia especially ulceration and/or gangrene.
Background: peripheral arterial disease (PAD) affects 12 million Americans, approximately 7% of these suffering from critical limb ischemia; diabetes mellitus (DM) being a major contributing factor. With the increasing prevalence of diabetes and coexistent risk factors, risk of critical limb ischemia increases considerably. Understanding the nature of the disease, the imaging evaluation techniques and knowing our armamentarium to manage it are essential in decreasing the associated morbidity and mortality.
Clinical findings and procedure details: 1. Epidemiological significance of DM and PAD. 2. Evidence based review - compare and contrast US, CTA and MRA techniques for PAD evaluation in the typical diabetic vascular distribution. 3. Review evolving patterns of treatment for PAD (surgical vs endovascular) over the last 10 years for critical limb ischemia.

Conclusion: the aim of this exhibit is to highlight our better understanding of epidemiology of DM and PAD, evaluate the evolution of imaging techniques for PAD evaluation and assess the shifting paradigms of management for PAD in DM for critical limb ischemia. Management of critical limb ischemia is a monumental task requiring a cohesive multidisciplinary approach rather than a turf issue.

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Visceral vascular stent fractures: evidence based review of the biophysiological interactions and clinical significance

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Learning Objectives: 1. Highlight awareness of mesenteric/renal arterial stent fractures and understand their clinical significance. 2. Understand possible etiopathogenesis of stent fractures in the visceral location with our local and evidence based review. 3. Review possible IR technique or stent modifications to decrease chances of stent fractures.
Clinical findings and procedure details: 1. Incidence, prevalence and clinical significance of visceral arterial stent fractures. 2. Pictorial essay angiographic and MDCT imaging of stent fractures and in-vitro imaging of corrosion and disruption of stent integrity. 3. Evidence based review of physiological, chemical and inflammatory etiologies of stent fractures causing deformability in the visceral circulation.
Conclusion: stents have revolutionized endovascular management of vascular disease; however, recent trials (SIROCCO I) and other recent studies have again highlighted the importance of stent fractures, though their clinical significance is unclear. This exhibit aims to present an evidence based review of the clinical significance of visceral stent fractures related to a complex interplay of respiration induced vessel deformation and chemical/ inflammatory factors.

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Insertion of three covered stents in sequence for treatment of femoropopliteal artery aneurysm followed by knee arthroplasty

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We report the insertion of three viabahn endoprosthesis by overlapping, in total of 26 cm, for treatment of atherosclerotic aneurysm of distal femoral and popliteal artery in a patient with indication for posterior knee arthroplasty.

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Endovascular repair of post traumatic multiple femoral-femoral and popliteal-popliteal arteriovenous fistula with viabahn and excluder stent graft: case report

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This case report describes an endovascular repair of post-traumatic multiple femoral-femoral and popliteal-popliteal arteriovenous fistula using the viabahn and excluder stent graft

P-398

Stent-graft migration after deployment in a patient with femoral AV fistula

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A 23-year-old patient with a history of drug abuse was diagnosed with femoral AV fistula. Stent graft was deployed to cover the fistula, which migrated to femoral vein where it was subcutaneously pinched with needles and patient sent for surgery.

P-399

Bilateral renal artery stenting by right axillary artery in leriche syndrome

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A 55-year-old woman with leriche syndrome-hypertension refractory to medical treatment. Bilateral renal artery stenting by right axillary route. Remained normotensive during 6 months of follow-up with no residual stenosis. The second case reported in the literature.

P-400

Cutting balloon angioplasty in the management of renal artery stenosis resistant to conventional balloon angioplasty in Takayasu arteritis

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Cutting balloon performed in four renal artery stenosis of three patients with Takayasu arteritis. The stenoses were resistant to conventional angioplasty. No complication observed. Mean follow-up period 16 months. First year MRA or CTA detected no residual stenosis.

P-401

Treatment of an abdominal blowout aneurysm using the Amplatzer plug II, detachable coils, and an open cell stent

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We describe the treatment of thoracoabdominal blowout aneurysm by means of embolization. Using an open cell stent as protection device, the aneurysm was embolized with an Amplatzer plug II and detachable coils until 95% of the volume was filled up.

P-402

Endovascular repair of a subtotal transected subclavian artery

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A traumatic, subtotal transected subclavian artery is traditionally cited as a contraindication to endovascular repair and usually requires surgical intervention. This case details successful endovascular repair of such an injury with a Wallstent graft using simultaneous femoral and brachial approaches.

P-403

Combined approach in treatment of femoral pseuadoaneurysm in a high-risk patient with difficult anatomy: case report and literature review

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We describe the case of a combined endovascular-surgical approach in a patient treated for femoral pseudoaneurysm. The poor clinical conditions and the difficult vascular anatomy needed both the placement of an Amplazer vascular plug and a crossed fermoro-femoral bypass.

P-404

Percutaneous transluminal angioplasty for treatment of critical hand ischemia with a novel endovascular approach: "the radial to ulnar artery loop technique"

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We describe a novel endovascular technique (The radial to ulnar artery loop technique ◊ retrograde ulnar artery recanalization after unsuccessful antegrade approach) that was successfully performed on a patient with critical upper limb ischemia (CTO of the ulnar artery).

P-405

Vascular closure devices: not without risks; a case in point

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A dislodged vascular closure device, following a technically successful ante grade angioplasty, resulted in critical limb ischemia due to extensive thrombosis of the SFA, and required emergency arteriotomy and thrombectomy for retrieval of VCD and subsequent PTFE Iliac popliteal bypass.

P-406

The management of occlusive thrombosis secondary to the deployment of an angioseal device in the common femoral artery after antegrade puncture and angioplasty

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The management of early occlusive thrombosis secondary to the deployment of an Angioseal device in the common femoral artery after antegrade puncture and angioplasty in a 68-year-old female is described.

P-407

Usefulness of transpedal approach in patients of SFA occlusion

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SFA occlusion with severe calcification is frequently seen. We experienced a case of failed SFA recanalization with ipsilateral femoral approach at the first time. We were successful with combined contra lateral femoral approach and transpedal approach at the next time.

P-408

Lower limb complications after the use of arterial puncture closure devices

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We report two cases in which the use of percutaneous suture-mediated closure resulted in lower-limb ischemic complications: an acute occlusion of common femoral artery near the bifurcation and a severe stenosis treated with endovascular angioplasty performed with cutting-balloon.

P-409

Endovascular treatment of superior mesenteric pseudoaneurysm developing from a pancreatic pseudocyst

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We report a case of endovascular treatement to control active hemorrhage by coil embolization and management of persistent bleeding by artery's stent-graft in a 59-year-old man with a pancreatic pseudocyst converted to mesenteric pseudoaneurysm.

P-410

Transbrachial treatment of a large aneurysm of the hypogastric artery

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AAA patient with bifurcated graft and large aneurysm of left hypogastric artery. Implantation of two self-expanding stents via F6 left brachial access. Control CT: after 1 month, patent stent, aneurysm thrombosed, size unchanged. After 14 months status idem.

P-411

Endovascular management of popliteal artery aneurysm in a patient with sickle cell disease: a case report

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Popliteal artery pseudoaneurysms are usually associated with atherosclerosis or trauma. We report a case of pseudoaneurysm of the popliteal artery in a patient with sickle cell anemia treated successfully by endovascular occlusion of popliteal artery.

Radiation safety

P-412

Evaluation of effective dose during three-dimensional imaging for three flat-panel-detector angiography systems using Monte Carlo technique

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Purpose: the purpose is to evaluate the effective dose during abdominal 3D imaging on a phantom using Monte Carlo technique (MCT), and determine the DAP to effective dose conversion factors (CFs) for three types of angiographic unit.
Materials/methods: 3D imaging was performed for 3 sizes of human-shaped phantom with 3 types of angiographic unit. We calculated 25 organ doses and effective doses using MCT for the three phantoms with a program for personal computer. We determined a CF for each angiographic unit, based on the effective dose to DAP ratios. We compared the estimated effective dose (DAP × CF) with the dose by MCT.
Results: the DAP value increased as the phantom size increased. The doses of organs in the exposure field were larger than the doses of the other organs. The organ doses and the effective doses during the 3D-imaging increased as the phantom size increased. The effective doses to DAP ratios were 0.37-0.45, 0.26-0.32, and 0.13-0.15 (mSv Gy-1cm-2) for Allura Xper FD20/10, INNOVA 4100, and AXIOM Artis dTA, respectively. Based on these ratios, we determined CFs for each angiographic unit (Allura Xper FD20/10, CF=0.40; INNOVA 4100, CF=0.29; AXIOM Artis dTA, CF=0.14). The differences between the estimated effective doses and the doses by MCT were within 11%.
Conclusion: the effective dose during 3D imaging can be estimated with a CF for each angiographic unit, although the CF differs among angiographic units.

P-413

Patients' skin doses during neurointerventions and cardiac interventions evaluated by multiple-point measurement using radiosensitive indicators

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Purpose: radiation skin injuries due to extended fluoroscopy and/or repeated angiography have been reported in neurointerventions and cardiac interventions. We evaluated patients' entrance skin doses (ESDs) during such procedures.
Materials/methods: consecutive procedures of 103 neuroembolizations, 72 percutaneous coronary interventions (PCIs) for chronic total occlusion (CTO), 84 PCIs for coronary diseases other than CTO, 104 radiofrequency arrhythmia ablations, and 16 cardiac resynchronization therapy (CRT) system implantations performed in single or multiple institutions were studied. Institutional review board approval and patient consent were obtained. Patients' ESDs during the procedures were evaluated using a cap or jacket with 44 or 100 radiosensitive indicators adherent to the surface. The ESDs were calculated from the color difference of the indicators.
Results: total fluoroscopic time was 67.1±41.6, 45.0±24.5, 18.0±9.5, 48.4±28.7, and 56.7±28.0 minutes for neuroembolization, PCI for CTO, PCI for non-CTO, ablation, and CRT implantation, respectively. The total number of digital subtraction angiography frames in neuroembolization and of cine frames in PCI for CTO, and PCI for non-CTO were 883±626, 4558±3440, and 2224±919, respectively. The maximum ESD for each procedure was 1.9±1.1 (range: 0.4-5.6), 3.2±2.1 (range: 0.5-10.2), 1.0±0.6 (range: 0.3-3.0), 0.5±0.5 (range: 0.0-2.7), 1.0±0.6 (range: 0.3-2.5) Gy for neuroembolization, PCI for CTO, PCI for non-CTO, ablation, and CRT implantation, respectively. Clinical follow-up showed temporary epilation and main erythema reaction in 6 and 2 patients, respectively.
Conclusion: the maximum ESD in PCI for CTO or neuroembolization often exceeds the thresholds for radiation skin injuries, indicating that distribution of ESDs should preferably be recorded for each procedure.

P-414

Staff radiation doses in a real time display inside the angio room

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Purpose: to present the functionality and advantages of a real time display of the staff radiation doses inside the angio room.
Material/methods: a new occupational dose aware system allowing showing in real time the staff radiation dose rates (during fluoroscopy or DSA acquisitions) and the cumulative dose during the pauses of the interventional procedures has been evaluated in an angio room. The system uses electronic solid state detectors with a high capacity memory to archive dose and dose rate values measured every second and linked wireless with a base station (screen) mounted on the diagnostic monitors in the room, allowing staff to see in real time the doses they are receiving during the procedure. An easy transfer to a data sheet allows performing an ulterior analysis to show the scatter dose profile received during the procedure and to look for the most effective actions to reduce occupational doses.
Results: measured cumulative occupational doses per procedure (over the lead apron) ranged from 10 to 140 microSv when ceiling suspended screen (CSS) is used and personnel acquire the DSA series from outside the angio room. If the CSS is not used and radiologists remains inside the angio room during DSA acquisitions, registered doses arrived to be up to 1-5 mSv/h during fluoroscopy and 50-250 mSv/h during DSA acquisitions.
Conclusion: the real time, display of staff doses allows interventionists to be alerted when the CSS is not used properly, giving a tool to potentially improve the personal protection and reduce occupational doses.

P-415

Influence of the X-ray system on patient doses in vascular radiology: results of a bicentric European study

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Purpose: to evaluate the influence on patient doses of the X-ray systems during a bicentric European study and to derive recommendations for improvement.
Methods and materials: two laboratories from two different European countries agreed to compare their practice performing fluoroscopy guided procedures in carotid stenting (CI) and lower limb arteriography (LLA). X-ray systems (one with image intensifier and the second with flat detector) were less than 6 years old. Dose

measurements were made in both centers using phantoms. A random sample of procedures was collected, comparing fluoroscopy time, number of series and kerma area product. Clinical images were scored by radiologists of both centres to confirm that the obtained diagnostic information was acceptable.
Results: dose setting in fluoroscopy (for 20 cm of tissue phantom) was 5 times and dose per DSA image was 2.7 higher in Centre M than in centre B. Results (median values) for patients were, for CI in centre B (35 procedures): 7.2 minutes, 11 series and 17.4 Gy.cm2. In centre M (33 procedures) 11.3 minutes, 6 series and 47.0 Gy.cm2. For LLA, in centre B (66 procedures) 1.6 minutes, 7 series and 23.6 Gy.cm2. In centre M (119 procedures) 2.5 minutes, 6 series and 56.7 Gy.cm2.
Conclusion: dose setting of the X-ray system has a dramatic influence on patient dose results (2.4 and 2.7 higher in centre M) being image quality and diagnostic information similar in both laboratories. Evaluation of dose setting in the X-ray systems should be included as a part of the clinical audit.

Renal artery intervention

P-416

Percutaneous embolization of arterial kidney injuries: effects on renal function and arterial blood pressure

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Purpose: To determine the effects of percutaneous embolization of arterial kidney injuries on arterial blood pressure and renal function.
Materiel and methods: Over a 12 year period, 48 consecutive patients with severe haemorrhage following renal artery injuries underwent supraselective embolization. Renal function was assessed by CGFR (MDRD method). Renal function was stratified according to the National Kidney Foundation scale. AHA high blood pressure classification was used to stratify patients. Apparition of high blood pressure was defined as anti-hypertensive medication or 2 blood pressure measurements over 140/90 during follow-up.
Results: Renal artery embolization was successful in all except one patient. Forty patients had a mean available follow-up of 4 months after embolization: 22 patients were in stage 1 and 2 and 18 were in stage 3-5 before renal injury. Seven (17,5%) patients demonstrated a fall of renal function of at least one stage: Four (10%) patients changed from stage 1 to stage 2, another (2,5%) patient changed from stage 3 to 4, and 2 others (5%), changed respectively from stage 3 and 4 to haemodialysis after embolization. Twenty-six (81%) of 32 patients with available blood pressure follow-up demonstrated no change in blood pressure stage, including all 6 normotensive patients. Five (16%) hypertensive patients worsen their stage by one level, one (3%) patient changed from optimal stage to stage 2.
Conclusion: Embolization of hemorrhagic renal artery injuries is associated with a significant raise in blood pressure and decline of renal function in a small proportion of patients with prior renal comorbidity.

P-417

Are there negative predictive factors affecting the outcome of renal stenting in chronic renal failure?

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Purpose: a significant subset of patients with chronic renal failure (CFR) undergoing a stenting for renal artery stenosis (RAS) shows no benefit on renal function (RF). The purpose of the study was to show which factors were predictive of this negative outcome.
Materials/methods: 112 patients with CFR (creatinine ≥1.5 mg/dl) were treated with renal stenting for RAS greater than 70%. The primary end points were to demostrate significant change of RF after stenting and to evidence predictive factors affecting this outcome, during a median follow-up of 29 months. To assess changes of RF, we compared the slopes of the regression lines derived from the reciprocal of creatinine versus time.
Results: the patients were divided into 2 groups, according to post-stent slopes of creatinine. Group 1 was composed by 82 (73%) patients with significant positive or not different from zero slopes. Group 2, composed by 30 (27%) patients with significant negative slopes, showed progression to end stage renal disease. Logistic regression analysis showed that independent predictors for a negative outcome were a higher baseline creatinine levels (odds ratio: 1.91, p: 0.01), a baseline high resistive index (OR: 1.89, p: 0.01) and younger age (OR: 0.81, p: 0.02). Gender, diabetes, prestent renal size, bilateral stenosis or hypertension was not predictive of the outcome.
Conclusion: the management of renal artery stenosis with renal stenting may provide fewer benefits on RF in patients with high baseline creatinine, high resistive index or young age.

P-418

Transplant renal artery stenosis: radiological and clinical results in 68 patients treated with percutaneous intervention

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Purpose: to evaluate procedural success, complications, rate of re-intervention and clinical effectiveness of percutaneous balloon angioplasty and balloon angioplasty with stent insertion over a 9 year period of follow up.
Materials and methods: data was collected retrospectively from the radiological management system for all patients who underwent percutaneous renal angiography and intervention for transplant renal artery stenosis between February 2000 and August 2008. Clinical and biochemical data were documented prospectively during follow up in the clinical records. These have been analysed retrospectively and matched to the radiological data.
Results and **Conclusion:** technical success for primary interventional procedure was 97% with a low complication rate. The rate of re-stenosis and re-intervention approached 20%. Details of complications and clinical outcome will be presented. We conclude that percutaneous intervention for treating transplant renal artery stenosis is a safe and effective procedure.

P-419

A review of renal artery intervention

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Learning Objectives: 1) to review the clinical pathologies requiring percutaneous radiological intervention of renal artery 2) to describe the technique and materials used in angioplasty, stenting, embolization, management of surgical and percutaneous complications.
Background: renal artery interventional is a growing field due to earlier and more accurate diagnosis and resultant percutaneous interventions improved patient clinical outcome and symptom relief.
Clinical findings and procedure details: different technique and materials are described and their characteristics are listed. We suggest a guide-line to choose the appropriate technique and materials in the treatment of renal disease (arteriosclerotic and

non-arteriosclerotic renal artery stenosis, tumor embolization, arteriovenous malformations embolizations, and management of surgical and percutaneous complications).
Conclusion: understanding the different pathologies of renal artery may help interventional radiologists in the utilization of the appropriate techniques and materials.

P-420

Acquired high-flow renal arteriovenous fistula treated with transcatheter embolization: the utility of Amplatzer plug device

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We present an interesting case in which simultaneous bilateral, arterial and venous femoral access greatly facilitated the deployment of an Amplatzer Vascular Plug device to achieve safe and complete embolization of a large symptomatic high-flow renal arteriovenous fistula

P-421

Surprising resolution of two intraparenchymal renal aneurysms in a one-kidney patient despite embolization of only one of them

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We report the endovascular treatment of a one-kidney patient with two intraparenchymal renal aneurysms. Only the biggest one was embolized with successful thrombosis. After 2 months, control angiography surprisingly showed resolution of both lesions. Hemodynamic causes?

P-422

Rescue from hemodialysis by late recanalization of renal artery occlusion

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We report on a patient with terminal renal insufficiency (hemodialysis since 4 months). Renal artery of a single kidney with collateral perfusion was completely occluded. Interventional recanalization was succesful with a drop of serum creatinin from 1138 to 163 µmol/l.

P-423

Stent-assisted coil-embolization of wide-necked bifurcation aneurysm using kissing stenting technique

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Stent-assisted coil-embolization is a widely used technique for the treatment of wide-necked intracranial aneurysm, recently applied to renal artery bifurcation aneurysms.We report a case of kissing-stenting and embolization of a large wide-necked renal artery bifurcation.

TIPS and portal vein intervention

P-424

Covered stents vs uncovered stents for TIPS: results in a 46 patient series

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Purpose: TIPS is useful to treat portal hypertension complications with high technical and initial clinical success, but due to its tendency to dysfunction (stenosis-occlusion) has not become in all patients the first choice when portal decompression is needed. The goal of this presentation is to compare the dysfunction rate of TIPS created using e-PTFE covered stents with TIPS created using uncovered stents.
Material and method: TIPS were performed in 46 patients, 23 using covered stents (group I) and 23 using uncovered stents (group II). Both groups were clinically and demographically similar. Follow up included Doppler ultrasound at day 1, 7 and 30 and one every 3 months. Angiography with pressure measurements was performed when shunt dysfunction were seen at US Doppler or with symptom recurrence. Angiographic dysfunction was defined as stent stenosis of more than 50% or portosystemic gradient higher than 12 mmHg.
Results: after follow up of a median of 414 days, 3 patients (13%) in group I and 10 (43%) in group II showed TIPS dysfunction ($p<0.05$). Symptoms recurrence occurred in 2 patients in group I and 7 in group II ($p<0.05$). The actuarial probability to present encephalopathy was 20% in group I and 35% in group II (NS). There was no statistical significant difference of survival in either group.
Conclusions: TIPS performed with covered stents improve shunt patency and decreases the number of clinical relapses without increasing the risk of encephalopathy.

P-425

Portal vein embolization: comparison of two different techniques

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Purpose: the purpose of this study was to compare initial results of coil embolization versus the Amplatzer Vascular Plug II (AVP-II) for portal vein embolization (PVE). We therefore measured the variables "procedure time" and "costs" for both devices.
Materials/methods: we included 24 patients (9 female, age 64±9 years) who underwent transhepatic PVE prior intended liver resection of metastases (N=21) or a Klatskin tumor (N=3). First, the liver parenchyma was embolized in all patients with microparticles (polyvinyl alcohol, 200-1100 µm). The portal vein was occluded in 12 patients using the AVP-II (group 1) and in 12 patients with microcoils (group 2). Procedure time was defined as the period from the deployment of the coils/AVP-II until complete vessel occlusion on angiography.
Results: all PVE procedures were successful without acute complications. Procedure time of the AVP-II and coils was 25±12 min and 60±10 min, respectively ($p<0.05$). We applied 13 AVP-II for the 12 patients in group 1 and 11±2 microcoils for each patient in group 2. Therefore, calculated costs for the AVP-II and coils were 580±154€ and 1120±179€, respectively ($p< 0.02$).
Conclusion: transhepatic PVE can be effectively achieved by using either microcoils or the AVP-II. In our study, the AVP-II showed a significantly reduced procedure time and better cost-effectiveness compared to microcoils.

P-426

A new TIPS reduction method in patients with refractory encephalopathy

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Learning Objectives: to describe a new, simple TIPS reduction method based on a balloon in balloon (BIB) device.
Background: TIPS is an effective therapy in patients with uncontrollable portal-hypertension related complications (such as refractory ascite or uncontrollable variceal bleeding). Hepatic encephalopathy (HE) is a common post TIPS complication that is usually manageable through medical treatment or dietary measures. In 4-8% of patients, however, further invasive treatment is required to increase the portosystemic gradient through stent diameter reduction. Key issues in TIPS reduction technique are simplicity, ability to finely adjust the shunt diameter and reversibility in case of recurrent life threatening portal-hypertension related complications.
Clinical findings and procedure details: a central ligature is adjusted after the inflation of the inner balloon of a BIB. A PTFE-covered Advanta V12 stent-graft is mounted on the deflated BIB and advanced into the TIPS. After inflation of the BIB inner and outer balloons, the stent-graft adopts an hourglass shape. We treated 7 patients with this new TIPS reduction method. Technical success was observed in 100% of cases with no per or immediate post procedural complication. Good clinical response on HE was obtained in all cases and no serious complication related to portal hypertension recurred in any of the patients. Pressure measurements made showed an increase of portosystemic gradient between 4 and 10 mmHg.
Conclusion: a new and efficient method for TIPS reduction has been successfully implemented in 7 patients. The main advantages are simplicity, precise calibration of shunt diameter and easy reversibility through stent reexpansion.

P-427

B-flow imaging of transjugular intrahepatic portosystemic shunts (TIPS): a pictorial essay

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Objective: the purpose of this article is to illustrate a spectrum of findings encountered during the noninvasive evaluation of transjugular intrahepatic portosystemic shunt (TIPS) function and correlating the Doppler sonography and B-flow imaging findings.
Background: Doppler sonography is the primary technique for noninvasive vascular flow mapping despite being prone to various artifacts and limitations. B-flow imaging is a non-Doppler technology that directly displays flowing intravascular echoes during real-time gray-scale sonography. The real-time B-flow imaging appearance of blood flow consists of mobile intravascular echoes that simulate a conventional contrast angiogram, similar to the appearance seen during infusion of a sonographic IV contrast agent. The images are particularly impressive when viewed during real-time sonography or on recorded movie clips.
Clinical findings and procedure details: 30 cases illustrating a spectrum of findings encountered during evaluation of transjugular intrahepatic portosystemic shunt (TIPS) function and correlating the Doppler sonography, B-flow and CT imaging findings.
Conclusion: color and spectral Doppler sonography are invaluable for noninvasive evaluation of the transjugular intrahepatic portosystemic shunt (TIPS) function. However, a number of pitfalls and artifacts have been described that can cause important pathologic findings to be overlooked or can suggest incorrect diagnoses. In our experience, B-flow imaging is very helpful in supplementing the Doppler sonography TIPS evaluation.

P-428

Embolization of extrahepatic collaterals through paraumbilical vein approach

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We embolized the paraumbilical and inferior mesenteric veins via percutaneous trans-paraumbilical approach in two patients with hepatic encephalopathy owing to markedly developed paraumbilical vein. Here, we would like to demonstrate our techniques and clinical outcomes of trans-paraumbilical variceal embolization.

P-429

Transjugular intrahepatic portosystemic shunt (TIPS) in a child with hepatic veins and inferior vena cava thrombosis: a case report

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A child with thrombosis of the inferior vena cava and hepatic veins was submitted to TIPS. After anticoagulants' withdrawal, he presented with thrombosis of the TIPS, portal, splenic and superior mesenteric veins treated successfully by percutaneous thrombolysis and balloon angioplasty.

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Bleeding duodenal varices after balloon-occluded retrograde transverse obliteration: treated with TIPS and transcatheter embolization

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There is no report that BRTO leads to worsening of preexisting duodenal varices. We describe our clinical experience of bleeding duodenal varices patient successfully treated with TIPS and transcatheter variceal embolization.

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Downgrading method for treatment of gastric varix in balloon-occluded retrograde transvenous obliteration via the left inferior phrenic vein

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We report a case of high-grade gastric varix without gastrorenal shunt, which was not oppcified by the retrograde venography, successfully treated by B-RTO via the left inferior phrenic vein with practical use of several downgrading methods.

P-432

Reversed TIPS: a step-by-step approach

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Reversed TIPS involves a minilaparatomy and is useful when standard TIPS is not feasible. A step-by-step description of this procedure including intraoperative photographs, spot films and diagrams will be presented enabling the reader to successfully perform a reversed TIPS.

P-433

Embolotherapy of the liver capsula laceration and extravasation during catheter wedging in TIPS procedure

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The authors report the case of extravazation in to the peritoneal cavity during wedging catheter in the hepatic vein. The complication was treated with embolization using torpedo from gelatine sponge and TIPS was successfully created without any clinical sequelae.

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The liver capsula laceration due to wedged carbondioxide portography: successful embolization with acrylic glue

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The authors present the case of liver capsula laceration due to wedged CO2 portography. The embolization was done with acrylic glue which penetrated on the liver surface and TIPS procedure was successfully finished.

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TIPS in a patient with thrombosed hepatic artery and known arterial collaterals as a bridge to retransplantation

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Thrombosis of the hepatic artery in transplanted liver means devascularization post TIPS. We present a case in which known chronic arterial collaterals allowed for TIPS formation in the setting of variceal bleeding with successful bridging to retransplantation.

Tumour ablation

P-436

Utility of combined RFA and cementoplasty in treatment of painful neoplastic bone lesions

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Purpose: we report the safety and efficacy of combined radiofrequency ablation and cementoplasty in treating painful neoplastic bone lesions.
Materials and methods: fifty-three combined radiofrequency ablation and cementoplasty procedures were completed in 35 patients. Thirty-six vertebrae (20 lumbar, 16 thoracic), 12 acetabulae, 3 sacra, 1 pubic symphysis and 1 humerus were treated. Patient age ranged from 34-81 years (mean 57.5 years). Primary malignancies included: 11 breast, 5 lung, 6 multiple myeloma, 2 prostate, 2 renal cell carcinoma, 1 synovial sarcoma, 1 endometrial, 1 oral squamous cell carcinoma, 1 lymphoma, 1 colon, 1 transitional cell carcinoma, 1 rectal, 1 cholangiocarcinoma and 1 pheochromocytoma. Primary neoplasm location, lesion size, pain levels pre and post procedure (as assessed using the visual analog scale), number of RF treatments, procedural temperature, RF time, cement volume and any extravasation were documented.
Results: combined RFA and cementoplasty procedures were performed with 100% technical success (53/53). The mean pre-procedure and post-procedure pain, as measured by the visual analog scale (VAS), was 7.2/10 and 3.5/10, respectively. Symptomatic complications included one case of self-resolving transient thermal sciatic neurapraxia following RFA and acetabuloplasty. Two cases of transient pain following epidural leaks during treatment of thoracic vertebrae breast metastases also occurred. Non-symptomatic complications, from a variety of cases, included cement emboli to the lung, trivial leaks into the needle track, spinal canal, draining veins, disc spaces and a hip intra-articular leak.
Conclusion: combined radiofrequency ablation and cementoplasty appears to be a safe, practical and effective in the treatment of painful neoplastic lesions.

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CT-guided radiofrequency ablation of colo-rectal liver metastasis: mid-term results

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Purpose: over the last decade, percutaneous radiofrequency ablation (RFA) was established for the treatment of liver tumors with a particular focus on the treatment hepatocellular carcinoma. Data on RFA of liver metastasis are inhomogeneous with respect to indication, treatment and image guidance. The goal of this study was to assess mid-term success of CT-guided RFA of liver metastases from colo-rectal cancer.
Materials/methods: 44 consecutive patients (28 men; 67±10 years) with 91 liver metastasis from colo-rectal cancer were included into this retrospective analysis. All patients underwent percutaneous RFA after first- or second-line chemotherapy. Survival was analyzed using Kaplan-Meier curves and multivariate Cox`s regression analysis.
Results: mean follow-up was 27.8±22.2 (4-85) months. Local recurrence was observed in 9.4% of lesions. Estimated median survival was 46 months with estimated 1-, 3- and 5-year survival rates of 89.1, 65.8 and 39.4%. Median interval to hepatic tumor progression was 13 months after RFA. Survival was determined by primary treatment success, number of lesions and total lesion diameter. Multivariate analysis proved the number of lesions to have a significant impact on overall survival (p=0.0290).
Conclusion: CT-guided RFA is an effective treatment for liver metastases from colo-rectal cancer. In thoroughly selected patients, overall survival rate matches resection. Local recurrence rate, however, is higher when compared with surgery.

P-438

Radiofrequency ablation of peripherally located liver tumors: protection with 5% dextrose solution injection

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Purpose: the aim of this study was to determine the effectiveness of 5% dextrose solution injection to protect neighboring structures from thermal injury during radiofrequency (RF) ablation of peripherally located liver tumors.
Materials and methods: twelve patients (nine men and three women; age range, 48-84 years; mean, 60 years) with primary or metastatic hepatic tumors were involved in this study. Twenty-four lesions were treated with ultrasound (US) guided percutaneous RF ablation. Before the treatment of peripherally located lesions (n=15), an amount of 100-1000 mL (average, 366 mL) of 5% dextrose solution was injected into the peritoneal cavity with 18 gauge Chiba needle to isolate the liver. The mean diameter of the peripheral lesions were between 2 and 5 cm (mean diameter, 3.1 cm). All of the RF procedures were performed with "RITA Talon Starburst" electrode. Patients were followed-up with CT examinations for 1-20 months after RF ablations.
Results: in one of the patients, skin burn was developed after tract ablation. No other serious complications were observed. Follow-up CT examinations revealed recurrences in 3/12 of the patients. These new lesions were retreated under US and CT guidance. One of the patients was lost after six months from procedure due to widespread lung metastases.
Conlusion: radiofrequency ablation of peripherally located liver tumors carries the risk of thermal injury to neighboring structures like diaphragm, gall bladder, colon and kidney. The intraperitoneal injection of 5% dextrose solution before the procedure isolates the liver from adjacent structures, provides safe ablation of more lesions and reduces the rate of possible complications.

P-439

Radiofrequency ablation as a palliative tool for patients with large lung tumors: our experience

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Purpose: utility of RFA in treating patient with tumors <5 cm in size in combination with other forms of cancer treatment (radiotherapy and chemotherapy) is well known and documented. We have performed RFA for tumors well over 5 cm in size to debulk the tumor and to alleviate symptoms like pain, retractable cough and cachexia.
Materials/methods: thirty patients underwent radiofrequency ablation of lung tumors more than five cm in size. This was performed under CT guidance with a RF RITA 1500 generator and a five cm RF electrode. In five patients, the tumor was addressed in two stages. Out of the 37 patients, fourteen had adenocarcinoma, twenty one had secondaries and another two were malignant histiocytoma and giant cell tumor. Six patients had tumors larger than 10 cm and presented with dyspnoea, three had chest pain. All patients underwent chemotherapy after the procedure. The patients were followed up at 1, 3, 8 and 14 months after the procedure. The longest follow up we have is 30 months.
Results: all six patients who had dyspnoea were relieved of their symptoms. Pain subsided in all three patients who presented with pain. Twenty-nine patients showed significant gradual reduction in tumor size with time. We did not encounter any major complications due to the procedures. Two patients developed pulmonary oedema during radiofrequency ablation procedure, which was well identified in time.
Conclusion: RFA is an excellent tool to palliate patients with inoperable large tumors of lung.

P-440

Does the presence of residual tumor after thermoablation influence survival of patients with liver metastases?

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Purpose: thermotherapy is a common palliative interventional method for patients with liver metastases. The aim of this study was to investigate if the presence or absence of residual tumor after thermoablation has an impact on patient survival.
Material and methods: 93 patients with liver metastases treated from Jan. 2000 to Dec. 2003 were analysed. Extrahepatic disease was excluded by CT of the thorax and the abdomen. All patients had up to five liver lesions with a size < 5 cm; diagnoses was confirmed by contrast enhanced MRI. MRI was done immediately after intervention (24-72 h) and at least once after more than six months. Only patients without signs of residual tumor on both control MRI were defined as complete ablation (CA). Patients were classified into three groups: (1) complete ablation obtained after first thermotherapy; (2) complete ablation obtained after multiple sessions of thermotherapy; and (3) partial ablation (PA).
Results: persisting complete ablation (CA) over a period of 6 months was obtained in 72 patients (n=54 group 1; n=28 group 2). Mean survival (MS) did not differ significantly in group 1 (47 months) and group 2 (45 months), while MS was 32 months in PA (n=21); both $p < 0.05$.
Conclusion: in this retrospective study, patients with CA after thermotherapy had a better outcome than patients with PA. Immediate MRI after intervention may detect residual tumor, which should be treated in a following session.

P-441

Percutaneous image-guided ablation of renal tumors: results of an 8-year experience

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Purpose: to review our 8-year series of percutaneous image-guided ablation of renal tumors, in order to highlight our main results.
Materials/methods: we analyzed 121 treated tumors (diameter 13-75 mm; mean 29) in 94 patients (68/26 M/F; mean age 64.6 y; 84/10 sporadic/hereditary; 30 single-kidney, including 3 transplants). Ninety patients underwent RFA, 4 cryoablation. Hundred and sixteen procedures were US-guided, 3 CT-guided, 2 both US and CT-guided. Complications (recently prevented by adjunctive techniques, namely hydrodissection in 5 cases and pyeloperfusion during uretheroscopy in 2) and complete versus partial ablation (after 1 or 2 sessions) were recorded. For RFA, we performed a univariate analysis of several predictors for complications and technique effectiveness. Cancer-specific survival was calculated in patients with malignant tumors.
Results: in our RFA experience (follow-up 1-80 months; mean 34), 4 major complications occurred (3.4%), all before using adjunctive techniques; only exophytic extension ($p=0.0465$) was protective against complications. Technique effectiveness was 91% overall, 93% in tumors up to 3 cm; non-central extension ($p=0.0052$) and diameter up to 3 cm ($p=0.0558$) resulted as positive predictors, being the mean size of completely versus partially ablated tumors 28 and 38 mm, respectively ($p=0.0315$). Two-year cancer-specific survival rate was 92%. Cryoablation did not obtain complete ablation in two tumors larger than 3.5 cm.

Conclusion: percutaneous image-guided ablation of non-central renal tumors up to 3 cm is safe (especially using adjunctive techniques) and effective. It can be considered as a reliable option also in patients without surgical contraindications.

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Percutaneous cryoablation for renal cell carcinoma: safety profile over a 3-year follow up

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Purpose: our objective was to describe and quantify complications related to percutaneous cryoablation of renal tumors and discuss mitigating interventions.
Materials/methods: our prospective study included 116 consecutive, CT-guided, percutaneous cryoablations for Bosniak III-IV renal tumors. Baseline H&P, laboratory values and enhanced CT/MRI were obtained. All patients had biopsy at or prior to cryoablation, performed under moderate sedation. We utilized a total of 244 cryoablation probes, 91 biopsy guns, 18 needles for thermo-protection and 3 thermocouples. Immediate pre- and post-operative CTs were obtained in all patients. Follow up consisted of H&P, laboratory values and contrast-enhanced CT/MRI at 3-, 6- and 12-months and then annually. All peri-procedural and long-term complications were categorized according to the Common Terminology Criteria for Adverse Events version 3.0 (CTCAE).
Results: median follow-up was 52+4 weeks (0-141 weeks). M/F:57/47 (Median age 69+10 years). Technical success was 100%. Air- or hydro-dissection was necessary in 15 patients (13%) to prevent non-target ablation. Lesion size was 2.6+1.7 cm (1-10 cm). 17/116 lesions (15%) were benign. There were a total of 7 (6%) CTCAE category >2 complications and another 29 (25%) self-limiting CTCAE 1 events. No procedure related deaths were noted. 59 procedures were performed on an outpatient basis, 56 with one night's stay and one patient (cryoshock) required 7 day hospital treatment.
Conclusion: CT-guided percutaneous cryoablation for solid renal masses has an excellent safety profile with a CTCAE >2 complication rate of 6%. There were no treatment related deaths and most patients can be discharged on day of procedure.

P-443

Irreversible electroporation with the NanoKnife in humans

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Purpose: to determine the clinical safety of the Nanoknife in tumours of the lung, liver, and kidney.
Materials/methods: patients with tumours not responsive to conventional therapy were treated with irreversible electroporation under general anaesthetic. The NanoKnife procedure employs high voltages and current (typically 2700 V and 30 amps) with 70 µs pulses to kill cells without significant damage to supporting connective tissue, nerves, blood vessels and bile ducts. Electrodes were placed percutaneously in the target tumour under CT and ultrasound guidance.
Results: 12 liver, 3 lung and 3 renal tumours have been treated. Four patients have received more than one procedure. There have been three adverse events, one minor pneumothorax, partial collapse of the right upper lobe related to bronchial compression by tumour and one ventricular tachycardia associated with fall in blood pressure. ECG synchronisation was not used in this latter patient. 17 of the 18 procedures were associated with a remarkable lack of symptoms post procedure. The average length of stay was 24 hours. One patient continued a rapid decline as a result of their tumour.
Conclusion: Nanoknife appears to have a high safety profile and a low incidence of after-effects. ECG synchronisation appears to be necessary to avoid arrhythmia. 30 day CT follow-up is not yet complete in all patients but there has been significant tumour reduction in most patients. Patient acceptance of this method is extremely high because of the low incidence of postoperative discomfort.

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Thawing until temperature reaches a plateau is required for maximum frozen volume in lung cryoablation

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Purpose: in the previous study, we have shown satisfactory local control rate of percutaneous cryoablation for lung tumors smaller than 2 cm. However, it is necessary to expand the ice ball to improve local control rate for larger tumors. Our previous experiments revealed it could not be accomplished by extending freezing time alone. In this study, we verified the significance of thawing on the ice ball size using pigs.
Materials/methods: under general anesthesia, right thoracotomy was performed to expose the right lung. Cryprobes were punctured at 3 points into the posterior lung lobe of each pig. Thermocouples were put at a distance of 4, 6, 8, and 10 mm from the center of the cryoprobe. Freezing was continued until all temperatures reach a plateau. During freeze-thaw cycles, two thawing protocols were compared: 1) thawing ceased when all temperatures reached 0°C. 2) thawing continued until all temperatures reached a plateau near body temperature. In both protocols, corresponding temperature points and radius of the ice ball were measured during 3 freeze-thaw cycles.
Results: repetition of freeze-thaw cycles expanded the size of ice ball in both protocols. Protocol 2 resulted in larger ice ball formation in comparison to protocol 1.
Conclusion: the ice ball size continued to increase at least up to 3 freeze-thaw cycles. To achieve maximum ice ball size within 3 freeze-thaw cycles, thawing until temperatures reach a plateau was important. We speculate this to be due to increased hemorrhage by protocol 2, which improved the lung thermal conductivity.

P-445

Comparison of cone-beam CT and CT for the detection of pulmonary nodules using a lung phantom

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Purpose: cone-beam CT (CBCT) guided targeting system has been applied to visceral interventional procedures, but not yet for lung tumor. The purpose of this study was to compare CBCT with CT for the detection of pulmonary nodules using a lung phantom.
Materials and methods: a lung phantom 'N-1' (Kyoto Kagaku Corporation) contained with twelve phantom nodules of different four sizes (5, 8, 10, and 12 mm) with each of three opacities (+100,

-630 and -800HU) was scanned by CBCT (matrix: 1024×1024, rotational angle: 240°, acquired images: 312, slice thickness: 4.5 mm) and CT (60 mA, 140 KV, 0.8 sec/rotation, slice thickness: 5 mm, Helical Pitch: 1.0). A total of six scans were performed, and the locations of nodules were arbitrarily changed every time. Three radiologists (#1-3) were separately assigned to detect any lung nodule on the CBCT and CT images. The nodule detectability was statistically compared between CBCT and CT by McNemar test (P<0.05).
Results: detectability was not significantly different between CBCT vs. CT by each reader: #1; 81.9 vs. 87.5% (p=0.22), #2; 81.9 vs. 77.8% (p=0.37), and #3; 79.2 vs. 83.3% (p=0.48). If limited to nodules equal to or larger than 8 mm, the detectability increased substantially in both modalities: #1; 98.1 vs. 100%, #2; 98.1 vs. 96.3%, and #3; 96.3 vs. 100%.
Conclusion: detection of pulmonary nodules by CBCT was comparable to that of CT regardless of the tested opacities, especially for nodules equal to or larger than 8 mm. In the future, CBCT can be applied as a guiding image for targeting lung tumors.

P-446

A cone-beam CT guided interventions by XperGuide: accuracy and feasibility in a phantom model with respiratory like motion

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Purpose: cone-beam (CBCT) guided targeting system (XperGuide, Philips Medical Systems) has still limitations for visceral lesions of the chest or upper abdomen because of the respiratory displacement. The purpose of this study was to evaluate the accuracy and feasibility of needle insertion under XperGuide in a phantom model with respiratory like motion.
Materials and methods: the clay phantom contained multiple 2 cm targets made of kneaded erasers and the phantom shuttled by a ventilator in the craniocaudal direction. Three radiologists randomly aimed at four targets in different set angles (RAO30, LAO30, CRA25, and CAU25). On 3D-workstation, the needle path to each target was planned on CBCT images taken under the expiratory phase. A 19G 20 cm needle was positioned in the target circle and aligned with the planned path under the entry-point view to look down the needle axis. Then, the needle was advanced only during the expiratory phase until it reached the target under the progress view to look perpendicular to the needle to monitor the needle depth. To verify the accuracy of the puncture, the gap between the needle tip and the center of the target was measured on CBCT images after each puncture. Fluoroscopy time was also measured.
Results: all radiologists successfully hit the 12 of 12 targets (100%). Mean distance from the surface entry point to the target was 58±11 mm. Mean gap was 5.6±1.5 mm. Mean fluoroscopy time was 47±15 s.
Conclusion: XperGuide allows accurate needle insertion into lesions with respiratory like motion in the phantom model.

P-447

Irreversible electroporation: a novel non-thermal tumor ablation technique (investigation in VX2 liver tumor model)

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Purpose: 1.To determine the effectiveness and safety of irreversible electroporation (IRE) in VX2 liver tumor ablation. 2.To present radio-pathologic correlation of IRE-induced liver tumor ablation.
Materials/methods: upon ARC approval, 10 New Zealand white rabbits underwent IRE treatment of liver VX2 tumors and 10 others served as control. Size comparison between ultrasound (US) and pathology, and histologic analysis of ablated vs. non-ablated tumors were investigated.
Results: in 2 weeks post-treatment, IRE decreased the size of tumor by 73-100% (p<0.001) with no metastatic disease. Numerous lung and liver metastases were found in the control group. All 10 rabbits treated with IRE survived throughout the experiment without tumor burden. No complications were noted. H and E staining of IRE-treated tumors demonstrated a sharp demarcation between ablated and non-ablated areas. Positive CD30 immunostaining demonstrated stem cell involvement of the healing process in IRE-treated area. Ki-67 immunostaining demonstrated complete destruction of cellular proliferating activity in IRE-treated tumors. VEGFR immunostaining showed complete preservation of blood vessels and bile ducts in all treated livers. Positive TUNEL assay indicated involvement of apoptosis in the cell death process.
Conclusion: 1. IRE is a novel non-thermal hepatic tumor ablation technique that can eradicate hepatic tumor without damaging adjacent healthy tissue or critical structures. 2. IRE can create focused complete cell death, which results in hepatic regeneration with stem cell involvement.

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Evaluation of the microwaves ablation system in pig pulmonary tumours starting from a mimic model

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Purpose: the microwave ablation (MWA) system allows tumor ablation with shorter electromagnetic wave that are not transmitted by the electric current. Consequently, MWA has many theoretical advantages over radiofrequency. There are no histopathologic series reported in pulmonary tumor. The aim of this study is to evaluate MWA in a VX2 rabbit tumor model and a tumor mimic model in pigs using either single or multiple antennas.
Materials/methods: a MWA generator working at a frequency of 915 Mhz (Covidien) delivered a power of 45 watts during 10 minutes, through antenna placed under imaging guidance. We performed an evaluation of tumor properties in a dielectric probe kit before each procedure. VX2 model was evaluated with single antenna placed within the tumor in contact with the periphery of the tumor or a few millimeters apart. The pig tumor mimic models were made of crushed thigh muscle mixed with barium. Single antenna MWA was performed in 2 and 4 cm tumor mimic. Multiple antennas were applied in 4 cm tumor mimic. After the procedure, each animal is sacrificed for macroscopic study and NADH diaphorase staining.
Results: the electric biopsies validate the mimic mode to have the same parameters as VX2 tumor (80 Ohms). The macroscopic analysis shows a statistically (independent-sample T test p<0.05) significant difference in size of tumoral ablation between single and multiple needles (maximum diameter: 32 vs 53 mm).
Conclusion: these preliminary results seem to confirm the theoretical advantages of microwaves ablation for large pulmonary lung tumor due to synergistic effect when using multiple antennas.

P-449

Precision pulmonary trans-arterial chemoembolization (PPTACE) plus RFA for lung neoplasms: initial experience in twelve patients

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Purpose: to evaluate the feasibility and safety of precision pulmonary arterial chemoembolization (PPTACE) followed by percutaneous RFA in patients with unresectable lung neoplasms.
Materials/methods: from November 2007 to October 2008, twelve patients (5 male, 7 female, median age 57) and 20 nodules (median diameter 2 cm) were treated in 14 sessions. Patients had lung metastases from uterine (2), colorectal (7) and breast carcinoma (1) while two patients had primary unresectable NSCLC. Both techniques were performed under general anesthesia. After subclavian vein puncture and mapping of arterial vascularization of the segment including the tumor, drug-loaded microspheres (Biosphere; 50-100 micron in diameter) were perfused in a subsegmental sector. Doxorubicin and Mitomycin C were used in 3 sessions, Irinotecan in six sessions and Cisplatin in one case. Lung RFA was performed 2-7 days after PPTACE. Pretreatment work-up included: contrast-enhanced CT-scan, (18-F) fluorodeoxyglucose positron emission tomography/computed tomography (18F-FDG PET/CT) and ventilation lung single photon emission tomography (VL-SPET).
Results: pneumothorax, requiring drainage, occurred in two sessions (14%). Technical success was achieved in all cases; the impedance during RFA decreased from 30 to 50%, with increase of the delivered energy (expressed by Watts). Post-treatment CT scan showed a necrotic non-enhanced area, including the neoplasm plus a large safety zone. VL-SPET showed a wide area without ventilation in parenchyma submitted to PPTACE and extending over it; changes of alveolar ventilation detected by VL-SPET after PPTACE could explain the better heat conduction during RFA.
Conclusion: lung RFA after pulmonary TACE is feasible and safe. These preliminary data deserve further investigation.

P-450

Reduction of α-FP values after radiofrequency ablations (RFA) of diafragmatic metastatic lymph nodes in patients with HCC

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Purpose: to show the effectiveness of RFA when applied in diafragmatic metastatic lymph nodes in HCC patients.
Materials/methods: during the last year, we treated the metastatic diafragmatic lymph nodes of 8 patients with HCC who had a long term survival with RFA . All patients had undergone one or multiple RFA sessions, and during their follow up, laboratory exams showed an increase in α-FP values; CT imaging revealed the presence of a metastatic diaphragmatic lymph node (in 1 case at 3 years follow up, in 2 cases at 4 years, in 3 cases at 5 years and in 2 cases at 6 years), whereas, the already RFA treated lesions did not show local recurrence nor were there any other new metastases. Lymph nodes measured 2.5-4 cm. RFA was performed under local anaesthesia post lexotanil and zideron administration. RFA electrode was advanced under CT guidance inside the lesions and RFA energy was applied for 12-16 min.
Results: in all cases, there was a reduction of α-FP post RFA of the metastatic lymph nodes. No complications occurred.
Conclusion: the presence of a diaphragmatic lymph node in HCC patients suggests a poor prognosis; however, RFA seems to be an effective treatment.

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Radiofrequency ablation (RFA) and microwave ablation as treatment of metastatic lesions of the thoracic wall

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Purpose: to show the efficacy of ablation techniques in treating painful metastatic lesions of the thoracic wall.
Materials/methods: during the last 3 years, we treated 21 patients with thoracic wall metastases originating from lung carcinoma (12), HCC (4), and breast carcinoma (6). In all cases, patients suffered with pain since the lesion seemed to involve the pleura and the ribs. Some of them (12) were already on analgesic treatment. We used expandable RFA electrodes and in 2 sessions we used microwave energy. Lesions ranged between 3 and10 cm. Time of ablation was 6-16 minutes. The procedure was performed under local anaesthesia after administration of lexotanil 3 mg and zideron 75 mg IM, 45 minutes before starting.
Results: elimination of pain was achieved in 74.2% of the cases (15/21) and in the cases there was a significant reduction of pain. No major complications occurred.
Conclusion: RFA as a safe and efficient procedure in the management of patients with painful metastases on the thoracic wall.

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Survival after radiofrequency ablation (RFA): treatment of postoperative recurrence of HCC and metastatic liver disease

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Purpose: to evaluate the efficacy, safety and survival rates after RFA for the treatment of postoperative recurrence of hepatocellular carcinoma and liver metastases.
Materials/methods: from April 2003 to December 2007, we performed CT guided RFA in 74 recurrences or new metastases in 50 patients (male 80%, female 20%, age range 52-83 years), who had previously undergone partial hepatectomy due to solitary HCC or metastatic lesions, mainly arising from colorectal cancer. They had 1-4 lesions. Internally cooled or multitined electrodes were used. Mean diameter of lesions was 3 cm. Contrast-enhanced CT follow-up was performed at 1, 3, and 6 months. Ablation success rate, local recurrence rate, distant recurrence rate, and survival were obtained for analysis and comparison.
Results: technique effectiveness was 90.5% (67/74) defined as "complete ablation" of macroscopic liver tumor evidenced in follow-up imaging. Local recurrence rate was 16% (8/50 patients) and distant recurrence rate was 28% (14/50 patients). Major complications did not occur. We had a case of subcapsular hematoma that was treated conservatively. 14/50 (28%) patients have died during follow up (median survival 41 months).
Conclusion: hepatic resection is the treatment of choice for solitary liver metastatic or primary disease. In case of recurrence, chemotherapy and palliative therapy are considered. Repeated hepatectomy is most of the times impossible. However, percutaneous

ablation therapy for intrahepatic recurrence is considered to be a major contributory factor for improving survival after recurrence, as well as for overall survival.

P-453

Noninvasive temperature mapping by CT during liver ablation: feasibility in vitro

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Purpose: The purpose of this study was to assess the feasibility of a clinical CT scanner for temperature mapping. The objectives were to: i) analyze and illustrate the relationships between the CT value and temperature, and ii) use the CT value-temperature relationship to characterize lesion dimensions with a color overlay on CT images.
Materials/methods: Samples of liver were heated and image acquisition was performed with a multi-slice CT scanner before, during and after ablation. CT image data were evaluated using dedicated software. Real time temperature was measured and stored using calibrated thermal sensors.
Results: Spatial and temporal temperature growth were validated during heating using Hounsfield values (HU-value). Thermal necrosis was shown as hyperdense area after cooling down the sample as a result of tissue desiccation. The change in HU-value for water and liver tissue was -0.48±0.13 and -0.54±0.10 HU/ oC, respectively. Color coded thermal maps were used to image the ablated region.
Conclusion: CT can be used to monitor in real time the spatial and temporal distribution of heat during ablation. The method presented can be used to predict the heat distribution using CT during ablation. The developed program can be used to assess non-invasive thermal CT mapping.

P-454

Feasibility study of MRI with impaired clearance of ferucarbotran to demonstrate ablative margin after radiofrequency ablation of the liver

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Purpose: to evaluate the feasibility of MRI with impaired clearance of ferucarbotran to visualize ablative margin (AM) after radiofrequency ablation (RFA) of the liver.
Materials/methods: the study comprised 21 patients with hepatocellular carcinomas (6 women and 15 men; mean age, 67 years; range 50-80 years). They first underwent ferucarbotran-enhanced MRI, followed by RFA within 8 h and unenhanced MRI after 3-5 d. On post-RFA T2*-weighted images obtained at a 1.5-T MRI unit, 2 radiologists independently classified the ability to separate AMs from tumors as easy or difficult and the AM status as "AM-plus," AM completely surrounding the tumor; "AM-zero," partly discontinuous AM without tumor protrusion; and "AM-minus," partly discontinuous AM with tumor protrusion. The incidence of local recurrence was compared among the 3 AM statuses using Fisher's exact probability test. The signal-to-muscle signal ratios (SMRs) of tumors, AMs, and non-ablated livers were compared using Tukey's multiple comparison tests.
Results: AMs were easily differentiated from tumors and non-ablated livers as hypointense rims due to impaired clearance of ferucarbotran in 17 patients (81%). Local recurrence occurred in none of 12 AM-plus, in 1 of 6 AM-zero and in all 3 AM-minus patients. The incidence of local recurrence was significantly different among the 3 AM statuses (P=0.001). The SMR of AMs was significantly lower than those of tumors and non-ablated livers (P<0.01).
Conclusion: MRI with impaired clearance of ferucarbotran was feasible to determine the AM status and predict local recurrence after RFA of the liver.

P-455

Multipolar radiofrequency ablation for the treatment of HCC using no touch technique: initial experience

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Purpose: to assess feasibility and effectiveness of extranodular no touch multipolar radiofrequency ablation of hepatocellular carcinoma (HCC).
Materials/methods: 26 patients (56-82 years, mean: 68±7 years) with cirrhosis (Child-Pugh A/B: 21/5) and one or two (22/4) HCC (1.5-5.5 cm, mean: 3±0.9 cm) were treated with no touch multipolar radiofrequency ablation consisting of simultaneous activation of two to four bipolar coaxial electrodes inserted just outside the tumors. Safety and effectiveness of the no touch technique were assessed. Treatment response was evaluated with CT scan.
Results: to achieve complete ablation of all tumors (100%) one to two sessions (mean: 1±0.3) including one to two applications (mean: 1±0.2) of 16 min to 45 minutes were required. The mean number of electrodes used per tumor ablation was 3.1±0.6. 40 to 220 kJ were delivered per session into the tumors (mean: 119±43 kJ). Two deaths occurred within three months after the procedure: one at 82 days in a patient who experienced uncontrolled pneumonia and the other at 54 days in patient who had infected ascites. Two other patient experienced minor complications: transient jaundice in one and pleural effusion in other. After a mean follow up of 6.6±5 months, no local tumor progression was detected. Distant multinodular recurrence occurred in one patient 2 months after the treatment.
Conclusion: multipolar radiofrequency ablation of HCC using no touch technique seems to be a very effective method in term of tumor control. However, owing to the large volume of non tumorous liver tissue ablated, a careful selection of patients is mandatory.

P-456

Characterization of thermal tissue damage in radiofrequency and microwave ablations using multiple staining techniques

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Purpose: H&E alone cannot provide acceptable evidence of ablation-specific tissue damage due to the 'thermal fixation' phenomenon described in literature. This study characterizes tissue damage in healthy porcine liver with H&E and two complementary stains.
Methods: thermal ablations were created with radiofrequency (RF) and microwave (MW) energy. H&E was validated with NBT staining for NADH diaphorase and gross staining with a modified protocol for Trypan Blue. All ablations were sliced and partitioned after sacrifice into five distinct regions (0-4) based on color where '0' is closest to the electrode shaft and '4' is farthest.

Results: after preliminary pilot investigations concluded that region 0 was dead, samples were obtained from the other four regions for damage assessment with the stains mentioned above. The staining protocols were fine-tuned for tissue staining during pilot investigations. NBT refuted H&E's false positive within the 'thermally fixed' region 1. No noticeable NADH diaphorase enzyme activity was seen in cells within regions 1 and 2. Trypan blue followed the pattern set by NADH diaphorase activity. TTC which is another common gross stain used in literature showed similar results. No qualitative differences were seen between morphologies of tissue ablated by RF and MW devices. The detail provided by this stain array may lend validity to our method as an acceptable benchmark for future tissue effect studies.
Conclusion: these data provide fundamental characterization of RF and MW ablation regions. Tissue staining yields variable results; a problem best addressed with multiple stains that target unrelated essential cell functions.

P-457

Measurement and full-wave electromagnetic simulation of 915 MHz microwave ablation probe scattering parameters over the course of an ablation cycle

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Purpose: microwave ablation (MWA) is emerging as an effective method to ablate soft tissue. Electromagnetic simulation tools have the potential to reduce prototyping time of MWA antennas. This study outlines the approach and verifies the accuracy of electromagnetic simulation of MWA antennas at the onset of energy delivery to tissue and at the end of an ablation cycle.
Materials/methods: microwave ablation was performed in ex-vivo bovine liver utilizing a surgical antenna from Covidien EbD's Evident MWA system. Scattering parameter measurements of the antenna were recorded at one minute intervals throughout the ablation cycle. Measurements at the onset and at the conclusion of the ablation cycle are compared to corresponding simulation results from electromagnetic full-wave antenna models. The MWA models utilize dispersion fit data sets from complex permittivity measurements of unablated and ablated ex-vivo bovine liver tissue.
Results: scattering parameters of the surgical MWA antenna vary over the course of an ablation cycle due to tissue electrical property shift as a result of thermal coagulation. Scattering parameter measurement and simulation results agree well across a bandwidth from DC to 3 GHz for the MWA antenna in both unablated and ablated tissue.
Conclusion: this study introduces the utility of measurement verified simulation of MWA antenna scattering parameter performance over the course of an ablation cycle. While Evident surgical antennas have demonstrated performance experimentally and clinically, it is clear that utilizing the methods discussed in this work will aid in the future design and manufacture of more efficient MWA antennas.

P-458

Software-assisted monitoring of MR guided radiofrequency ablation of large liver malignancies: initial clinical results

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Purpose: to evaluate feasibility and effectiveness of software-assisted monitoring of MR-guided RF ablation of large liver malignancies.
Materials/methods: N= 20 patients with primary (n=10) or secondary (n=18) liver tumors (mean diameter: 35 mm; range: 10-60 mm) were treated with one session of MR-guided RF ablation. The ablation procedure was entirely performed at an interventional MR unit (Magnetom Espree 1.5 T, Siemens Medical Solutions, Forchheim) using MR-compatible internally cooled electrodes. MeVisSafir software (MeVis research, Bremen) was used as an application tool for computer-aided 3D planning and assessment of the safety margin (1.0 cm). All MR data were transferred immediately during RF ablation to the MeVis workstation to evaluate the technical success by comparison of 3D shape analysis of pre-tumor volume and induced coagulation necrosis volume with a traffic color scheme. T2- and T1 weighted sequences with dynamic MR imaging (TR/TE: 3500/110 ms and TR/TE: 500/50 ms) were used to monitor the extent of induced coagulation.
Results: complete coagulation was intended in 27/28 tumors by using the software-assistant. To achieve complete coagulation 1/28 tumors required a second session. MeVisSafir was able to monitor the extent of coagulation necrosis and to determine the safety margin. Furthermore, it was supportive in guiding overlapping ablations for complete tumor coagulation for larger liver tumors (> 30 mm).
Conclusion: software-assisted monitoring of tumor ablation is feasible and effective during MR-guided RF ablation. In our opinion, the clinical benefit may be to improve the complete tumor destruction for larger liver tumors in a single session.

P-459

Evaluation of major complications after image-guided radiofrequency ablation of liver tumors: a pictorial review

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Learning Objectives: describe and illustrate the major procedure-related complications after liver tumor radiofrequency (RF) ablation, demonstrated by conventional radiography, ultrasound and MDCT.
Background: image-guided RF ablation has been used increasingly during the past decade to treat hepatic tumors. After the procedure, a close radiologic follow-up is mandatory in order to exclude both immediate and delayed complications, usually related to thermal or mechanic damage. Ultrasonography, multidetector computed tomography (MDCT) and magnetic resonance imaging (MRI) all can be useful for this assessment. At most institutions, follow-up contrast-enhanced CT is indicated both to recognize tumour recurrence and identify major thoracic and abdominal complications after the procedure.
Clinical findings: the overall complication rate for RF is low and ranges from minor complications (pleural effusion, self-limited hemobilia, thermal skin injury and minimal perihepatic fluid), to major complications (intraperitoneal hemorrhage, hepatic infarction, hepatic abscess formation, intestinal perforation, bile peritonitis and delayed tumor seeding). Most complications can be managed with conservative measures, percutaneous or endoscopic drainage, or surgical repair. Because an early and accurate diagnosis is necessary for proper management, radiologists should be familiar with the imaging features of each type of complication.
Conclusion: RF of liver tumours has many advantages over surgery, including low complication rate, reduced cost and increased patient compliance. However, radiologists should be aware of both the typical and the atypical imaging findings in the RF ablation zone and their clinical significance.

P-460

Extrahepatic complications after radiofrequency thermal ablation

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Learning Objectives: the aim of this study is to evaluate the occurrence of major and minor extra-hepatic complications after radiofrequency ablation (RFA).
Background: radiofrequency ablation has become a feasible treatment option for the inoperable neoplasm or metastatic disease in the kidney, adrenal gland, lung, bone, parathyroid, pancreas, lymph node and for uterine myomas. Like all other imaging-guided interventional procedures, RFA involves some element of risk. The most common clinical application has been for liver tumors and the hepatic complications are also well recognised. Less known are extra hepatic complications after RFA. The literature describes several cases of hepatic complications, while only case reports have been published about extra-hepatic complications after RFA.
Clinical findings and procedure details: we carried out an internal review of the extra-hepatic complications that occurred after 96 RFA sessions in 92 patients (37 women and 55 men); 25 kidney RFA (6 minor and 2 major complications), 6 adrenal RFA (1 major complication), 14 pulmonary RFA (7 minor and 1 major complications), 15 bone RFA (1 major complication), 3 parathyroid RFA (2 minor complications), 2 pancreatic RFA (1 minor complication), 3 lymph node RFA (1 minor and 1 major complication), and 12 uterus RFA (2 minor complications).
Conclusion: we can affirm that extra-hepatic RFA is a safe and minimally invasive treatment but sometimes complications can occur. RFA should be performed in institutions with well-trained interventional radiologist in a multidisciplinary team and with right equipment to treat the complications. This allows the radiologist to be relatively independent in patient management.

P-461

Microwave liver tumors ablation: principles, technique and patients selection

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Learning Objectives: to learn principles, technique and patients selection for the treatment of liver tumors with microwave ablation.
Background: microwave technology is a relative new thermal ablation technique for different types of tumors including liver. Microwave radiation lies between radiowaves and infrared radiation with frequencies from 900 to 2450 MHz. Heating of the tissue is based on agitation of water molecules; electrical charge on the water molecule flips 2-5 billion times. Microwave ablation offers many of the benefits of other ablation techniques, and has several other advantages including: higher intra-tumoral temperatures, larger tumor ablation volumes, faster ablation times, ability to use simultaneously multiple applicators, optimal heating of cystic masses and tumors close to the vessels.
Clinical findings and procedure details: the procedure is done in conscious sedation under imaging guidance (CT, US and CEUS). Patients with tumors up to 8 cm can be treated (liver tumors measuring less than 3 cm with single antenna and lesions larger than 3 cm with multiple antennas up to 3). The pain of the procedure is lower than the radiofrequency because the patient is not included in the circuit; in fact this procedure do not necessitate of grounding pads. Also, lesions near to vessel with diameter larger of 3 mm can be treated more safely because MW are not influenced by heat sink effect.
Conclusion: the procedure of microwave ablation for liver tumors is safe and can be used as an alternative to radiofrequency where it exceeds the limits of this technique.

P-462

Radiofrequency ablation (RFA) of adrenal metastases: presentation of the technique

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Learning Objectives: to show the way of applying RFA in case of adrenal metastases.
Background: in some patients, adrenal metastases can be treated surgically, prolonging their survival; however, not all patients are surgical candidates. Chemotherapy and radiotherapy have provided poor results. RFA of these lesions is an alternative treatment
Clinical findings and procedure details: 1. To present the criteria based on which type and size of electrode (expandable spiral, expandable hooked, perfusion saline) is selected. 2. To show which access is preferred according to the lesion and the projection of adjacent structures. 3. To refer upon the duration of the ablation, in proportion to the lesion size and the equipment used. 4. To discuss possible complications due to the procedure as well as their management.
Conclusion: RFA of adrenal malignant lesions is a safe and efficient alternative treatment.

P-463

Radiofrequency ablation (RFA) of liver malignant lesions: what type of electrode is indicated each time?

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Learning Objectives: to discuss criteria for the selection of the RFA electrode that should be used in case of liver lesions.
Background: RFA of liver malignant lesions is being used the last years with promising results in treatment of inoperable primary, recurrent or metastatic malignant liver lesions. RFA can cause destruction of the tumors especially when they measure no more than 3 cm, with a low complication rate when performed by experienced interventionalists. There are many types of electrodes that may be used; expandable spiral or hooked with multiple tines and perfusion saline electrodes. The type of the device used depends on the tumor size and location, and the right choice of the electrode influences the result of the RFA.
Clinical findings and procedure details: 1. To present the available RFA electrodes. 2. To discuss the selection criteria for the type (spiral, hooked, perfusion saline) and size of electrode based on the location, the size and the morphology of the lesion. 3. Presentation of possible complications.
Conclusion: proper selection of the RFA electrode is crucial for optimal post-treatment results.

P-464

Radiofrequency ablation of lung malignancies: complications and side effects

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Learning Objectives: to became familiar with complications and side effects of percutaneous radiofrequency ablation (RFA) of lung malignancies.
Background: RFA is being increasingly used for the treatment of lung malignancies in selected patients. The exhibit will present our large experience on RFA for lung cancer specifically focusing on complications and side effects and technical hints to reduce such complications.
Clinical findings and procedure details: one hundred and sixty RFA procedures were performed in 114 patients with 137 malignant lung tumors. Tumor size ranged 0.7-7 cm (mean 2.3 cm ±1.0). CT-guided RFA was performed under conscious sedation by using 150-200 W generators and multitined expandable electrodes. One procedure-related death occurred. Major complications were observed in 13/160 procedures: eleven occurred during or immediately after the procedure (pneumothorax requiring drainage, n=8, and hemothorax treated conservatively, n=3) and two occurred during the periprocedural time (a pneumomediastinum associated with subcutaneous emphysema and a pneumothorax requiring surgery). Minor complications were observed in 29/160 procedures (pneumothorax and pleural effusion not requiring drainage). Side effects were encountered in 51/160 procedures (pain, limited intraparenchymal hemorrhage, lesion cavitation with bronchial drainage). Data are presented regarding the incidence of complications in relation to nature, size and site of the lesion, patient clinical conditions, and procedure-related factors (patient position, RF device, ablation time).
Conclusion: percutaneous RFA of lung malignancies is a safe procedure. Indeed, in experienced hands, the procedure-specific major complication rate is below 10%. A deep knowledge of technical tips and tricks is required to reduce the incidence of complications.

P-465

Challenging percutaneous cryoablation of renal and adrenal tumors

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Learning Objectives: to familiarize with the principles of cryotherapy. To outline the advantages and the drawbacks of the cryotherapy, compared to other ablation techniques. To describe the tips and tricks for successful treatment of renal and adrenal tumors in complex locations, insisting on thermal protection techniques.
Background: cryotherapy achieves tumor ablation with lethal freezing temperatures ranging from -20 to -40°C. This technique has been successfully used in liver, kidney, lung and bone. Miniaturization of the cryo-probes allows their percutaneous use in CT and MR tunnel.
Procedure details: compared to the other thermal ablation techniques, the ice ball created during the cryotherapy procedures can be clearly visualized under CT or MR guidance. This allows a precise tumoral coverage. Multiple electrodes (up to 30) can be activated simultaneously to treat large lesions (thermal synergy) or several non adjacent lesions in the same time. Pain induced by freezing is low, thus, majority of the procedures can be performed under local anaesthesia or conscious sedation. For adrenal tumor ablation, specific sedation technique is required. When the tumor is in contact with vulnerable structures (e.g., bowel, ureter, pancreas or vessels), thermal protection techniques are required. Percutaneous CO2 injection using dedicated injection set achieves organs displacement and thermal insulation; insertion of thermocouples achieves continuous thermal monitoring of the vulnerable structure.
Conclusion: based on our experience including 31 renal cancers and 5 adrenal metastases, we present the interest of percutaneous cryoablation for renal and adrenal tumors and tips and tricks for successful treatment in challenging locations.

P-466

The thread and streak sign

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Thread and streak sign is an angiographic finding representing neovascularity in the tumor mass within the hepatic vein and IVC. This case illustrates this sign and its significance, which was missed during transarterial embolisation of hepatoma, making the procedure futile.

P-467

Pancreatic unresectable tumour RF ablation: preliminary cases

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We report two cases of unresectable, non metastatic pancreatic cancer treated with intraoperative RF-ablation associated with bilio-digestive diversion.Pain palliation Ganglia RF-ablation was also performed. Postoperative CT showed complete tumour necrosis. No complications occurred. Clinical pain reduction was achieved.Work in progress.

P-468

Uretheroscopy during pyeloperfusion for percutaneous RFA of central renal tumors

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In two patients (female, 78 years, previous contralateral partial resection; male, 62 years, single-kidney with multiple tumors) with central tumor (31 and 39 mm), uretheroscopy during pyeloperfusion was successfully used to monitor percutaneous RFA, prevent urinary tract mechanical or thermal injuries.

P-469

Transcatheter intra-arterial bland embolization of intra-parenchymal renal cell carcinoma prior to cryoablative therapy allows percutaneous treatment of larger tumors

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Successful trans-catheter intra-arterial bland embolization of intraparenchymal renal cell carcinoma, rather than exophylic tumors, prior to cryoablation, enables larger lesions to be treated entirely percutaneously, while preserving renal function and reducing post procedural complications.

P-470

PET versus CT for follow-up of recurrent hepatocellular carcinoma after embolization and RF ablation

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To present the superiority of PET/CT over contrast-enhanced CT in surveillance of hepatic tumors following Embolization and RFA, we present images obtained for 2 years demonstrating residual disease in a lesion on PET/CT, not evident on contrast-enhanced CT.

P-471

Rendezvous technique for repair of ureter following thermal injury after radiofrequency ablation in a renal tumor

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We report a successful management by the interventional radiologist of the rendezvous procedure of a patient who underwent radiofrequency thermal ablation of a renal tumor complicated by a nontarget thermal injury of proximal ureter, with urinary leaks and an abscess.

P-472

A novel radiofrequency ablation technique

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We report a novel bipolar radiofrequency ablation apparatus using two monopolar levine needles to treat a hepatic metastasis. We discuss the apparatus set up as well as the nature and shape of the ablation obtained.

Vascular imaging and diagnosis

P-473

Detection of hepatocellular carcinoma: the value of C-arm angiographic CT and multidetector CT

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Purpose: to compare the diagnostic accuracy of C-arm CT with that of contrast-enhanced multidetector CT (MDCT) in detection of hepatocellular carcinoma (HCC).
Materials/methods: fifty patients (29 men, 21 women; mean age, 68.1 years) with 119 HCC nodules (mean size, 12.8 mm) who underwent C-arm CT during transarterial chemoembolization (TACE) and preoperative biphasic MDCT were enrolled. C-arm CT images were obtained at 7-10 seconds after the initiation of intraarterial administration of contrast medium. Focal iodized oil accumulation observed on plain CT after TACE was considered the reference standard. Three blinded observers independently viewed all images and rated them using the confidence scale for detection. Alternative free-response receiver operating characteristic analysis was used to compare the diagnostic accuracy.
Results: for lesions < 1 cm in diameter, the accuracy of C-arm CT (0.830) was significantly greater than that of MDCT (0.618). For lesions > 1 cm, the accuracy of C-arm CT and MDCT (0.968 and 0.937 for lesions 1-2 cm, and perfect decision performances for lesions > 2 cm, respectively) were not significantly different. Sensitivity of C-arm CT was significantly greater than that of MDCT for lesions < 2 cm (74.1 and 34.0% for lesions < 1 cm, and 94.7 and 77.1% for lesions 1-2 cm, respectively). For lesions >2 cm, sensitivity of C-arm CT (92.9%) and MDCT (92.9%) were not significantly different.
Conclusion: C-arm CT is more accurate than MDCT in detecting small HCC less than 1 cm in diameter, while both imaging modalities had same accuracy in detecting HCC larger than 1 cm.

P-474

The role of sampling in pancreatic insulinomas: our ten year experience

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Purpose: to describe our results with a very accurate and specific technique in identifying pancreatic insulinomas in patients with hyperinsulinemic hypoglycemia.
Materials/methods: eight consecutive adult patients (7 women, 1 man aged 21-47 years) with documented hyperinsulinemic hypoglycemia underwent selective intraarterial calcium stimulation in conjunction with hepatic venous sampling (ASVS test). We catheterized the proximal and distal splenic artery, the gastroduodenal and the proper hepatic arteries. We used a small dose of calcium gluconate (0.30 mg/ kg) and collected venous blood from the right hepatic vein at 0, 30, 60, 90 and 120 seconds after each injection. We considered a sample positive when the insulin secretion was tripled. The results were compared with the postoperative findings.
Results: the calcium injection into the splenic artery provoked a 10-fold rise in insulin release at 90 seconds in three patients. At subsequent surgery, solitary insulinomas were removed from the tail of the pancreas in these three patients. One patient had a 3-fold rise in insulin secretion in samples when the splenic and gastroduodenal arteries were stimulated, interpreted as generalised nesidioblastosis. Finally, one patient had a 12-fold rise in insulin secretion at 90 seconds after calcium injection into the gastroduodenal artery, a finding confirmed postoperatively as insulinoma of the head of pancreas. In three patients, we did not notice any increase in the insulin secretion.
Conclusion: ASVS test is a very specific and extremely safe, minimally invasive technique for identifying preoperatively insulinomas. We recommend it in all patients with this clinical scenario.

P-475

Virtual angio-endoscopy of the thoracic aorta with 64-slice MDCT

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Purpose: virtual endoscopy (VE) emulates optic fibre endoscopic view through computation of data acquired during computed tomography (CT) scan or magnetic resonance imaging (MRI). Our aim is to determine the role of vascular VE in the assessment of the thoracic aorta disease.
Materials/methods: during the last 7 months, we performed VE reconstructions from acquisition data of 88 patients who underwent an angio-MDCT scan of the thoracic aorta. CT examination was executed for evaluation of native aorta in 66/88 pts and during the follow up of previous treatments in 22/88 pts (12/22 endovascular treatments, 5/22 hybrid treatments and 5/22 surgical treatments). Virtual endoscopic view was achieved by dedicated software.
Results: VE showed a normal vascular wall in 12/66 cases (18.2%), an aneurysm in 23/66 cases (7 of the ascending aorta, 12 of the aortic arch), an aortic dissection in 19/66 cases (28.8%) (5 Stanford type A) and a penetrating aortic ulcer in 12/66 cases (18.2%). During the

follow up of 17 patients after endovascular or hybrid treatment, we assessed 2 type I endoleaks (11.8%) and 1 type III endoleak (5.9%). Among the 5 patients surgically treated for type A aortic dissection, one showed a worsening with type B dissection and one was diagnosed with an anastomotic pseudo-aneurysm; the remaining 3 patients showed normal post-surgical findings.
Conclusion: VE is a complementary non-invasive diagnostic tool that allows a correct topograghic assessment of the thoracic aorta disease.

P-476

Imaging and percutaneous treatment of pelvic varicocele

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Purpose: our aim is to evaluate diagnostic imaging of pelvic varicocele by different techniques and the outcome of endovascular treatment in a cohort of patients.
Materials/methods: we considered 98 patients (mean age: 37.5 y/o) with pelvic varicocele evaluated at least with two imaging techniques: eco-color-Doppler, angioCT, magnetic resonance and planning angiography. 36 patients referred chronic pelvic pain. We analyzed grade, anatomic variants and ovaric vein flux inversion. 9 symptomatic patients with grade II or III of ovaric vein flux inversion underwent scleroterapic and/or embolization treatment.
Results: all patients had ovaric vein flux inversion: grade I was in 6 (6%) patients, grade II in 48 (49%) patients and grade III in 44 (45%) patients. Anatomic variants were observed in 7 (7%) women: nutcracker type I syndrome (left renal vein compression between abdominal aorta and mesenteric artery) in 3 (3%) patients and left renal vein retro-aortic course in 4 (4%) patients. The 9 (10%) patients who underwent scleroterapic and/or embolization treatment had complete resolution on eco-color-Doppler at 1, 6, and 12 months follow-up and were symptoms free.
Conclusion: imaging techniques permit simple and accurate diagnosis of ovaric vein flux inversion and allow evaluating anatomic variants. Symptomatic patients with grade II or III ovaric vein flux inversion can benefit by scleroterapic and/or embolization treatment.

P-477

Spontaneous renal artery dissection as a cause of acute renal infarct: MDCT evaluation

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Purpose: to evaluate the incidence, clinical and CT angiographic findings of spontaneous renal artery dissection (SRAD) as a cause of acute renal infarct.
Materials/methods: during one year period, 22 patients (mean age, 56 year-old; M:F=12:10) were diagnosed as acute renal infarct on MDCT. We retrospectively analyzed their MDCT data set and medical records. We evaluated their causes and MDCT findings of SRAD. We compared clinical features of SRAD with embolic in cause.
Results: among 22 patients, the causes of acute renal infarct were embolic in ten patients (45.5%), SRAD in five (22.7%), traumatic renal artery dissection in two (9.1%), aortic dissection in one (4.5%), and undetermined in five (22.7%). All cases, except for two cases of embolic infarct, were unilateral involvement. The involved artery in cases of SRAD was main renal to divisional artery in two patients, divisional to segmental artery in two, and segmental artery in one. There were stenoses of true lumen due to compression by thrombosed false lumen in all cases. Underlying arterial disease was of SRAD cases were presumed fibromuscular disease in one and remaining were none. Compared with SRAD and embolic infarct was as follows; the age, 42 year-old (31-52) vs 63 (24-95); M:F=4:1 vs 6:4 and incidence of hypertension, 80% (4/5) vs 30% (3/10). Only statistically significant factor was age (p=0.04).
Conclusion: SRAD was not a rare cause of acute renal infarct, particularly in young aged patients. It frequently caused renovascular hypertension.

P-478

Volume intra-venous injection DSA (VIVID) for detection of ophthalmic artery

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Purpose: for safety operation, it is important to analyze the anatomy of vessels prior to maxillofacial intervensions. We analyzed a detectability of branches of ophthalmic artery on volume intra-venous injection DSA (VIVID) by flat-panel detector angiographic CT system (FACT).
Materials/methods: we retrospectively analyzed 35 consecutive patients (70 sides) who underwent VIVID for neuronavigation from May 2006 to September 2007. For VIVID, 100 ml of nonionic iodine contrast (350 mg/ml) was injected via the antecubital vein. The rotational digital subtraction angiographies were performed on FACT. Data were transferred to a workstation and image post-processing was performed by software called DynaCT. We analyzed by three experienced radiologists with regard to the detection of the branches of ophthalmic artery.
Results: we can depict 80% (56/70) of central retinal artery, 97% (68/70) of posterior ciliary artery, 57% (40/70) of lacrimal artery, 91% (64/70) of anterior ethmoidal artery, 59% (41/70) of posterior ethmoidal artery, 93% (65/70) of branch to superior rectus muscle, 91% (64/70) of branch to lateral rectus muscle, 94% (66/70) of branch to medial rectus muscle, 91% (64/70) of branch to inferior rectus muscle, 94% (66/70) of branch to superior oblique muscle, and 50% (35/70) of branch to inferior oblique muscle. In one case, we found the ophthalmic artery originating from the middle meningeal artery and no pedicle of the ophthalmic artery at C3 portion of the ICA.
Conclusion: VIVID can depict about 90% of branches of ophthalmic artery. VIVID is useful to analyze the anatomy of vessels prior to maxillofacial intervensions. VIVID can depict a narrow vessels such as branches of ophthalmic artery more than MDCT.

P-479

CTAP using C-arm angiography system: is it worth performing?

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Purpose: first, to compare CTAP using C-arm angiography system (CCTAP) with DSA portogram in terms of visualization of portal vein (PV). Second, to evaluate the performance of CCTAP in comparison with contrast-enhanced MRI to detect the following aspects: hepatic tumors, tumor thrombus, and decreasing PV flow (PVF) in normal hepatic tissue.
Materials/methods: we evaluated the visibility of PV of 15 patients who had both CCTAP and DSA portography using a 5-point grade scale: PV trunk (grade-0), right or left branch (grade-1), segmental branch (grade-2), subsegmental branch (grade-3), and sub-subsegmental branch (grade-4). We retrospectively analyzed CCTAP and MRI of 16 patients with 62 nodules for tumor detectability using a 3-point grade scale: tumor was clearly observed (grade-1); tumor was faintly observed (grade-2); and tumor was not detectable (grade-3).

Moreover, we evaluated for tumor thrombus and decreased PVF in normal hepatic tissue in 23 patients.
Results: the visualization of PV on CCTAP was superior to that on DSA (3.9±0.4 versus 2.8±1.0; p<0.001). Eleven, four, and four nodules were classified as grade-1, 2, and 3, respectively. Grade-1 or 2 tumors comprised 87.1% of all tumors. Regarding tumor thrombus, 4 lesions in 3 cases were detectable on CCTAP, while 3 lesions in 3 cases on MRI. Regarding decreasing PVF in normal hepatic tissue, 10 cases were detectable on CCTAP compared to 2 on MRI.
Conclusion: MRI was more sensitive to detect tumors than CCTAP; however, CCTAP outperformed both DSA and MRI in identifying PV and its damage.

P-480

ECG-triggered 64-row CT angiography of the thoracic aorta: less motion artifacts and higher diagnostic confidence

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Purpose: to compare ECG-triggered to non-triggered CT angiography of the thoracic aorta with regard to motion artifacts and diagnostic confidence.
Materials/methods: sixty consecutive patients were prospectively randomized into two groups and underwent 64-row CT angiography of the thoracic aorta with or without the use of ECG-triggering for the following indications: aneurysm of the ascending aorta, Type A dissection, aortic coarctation or previous surgery of ascending aorta. The diagnostic confidence was assessed on a 4 point scale, from 0 (no anatomical structures assessable) up to 3 (all details visible and assessable). Motion artifacts were categorized into 4 groups, from 0 (no artifacts) up to 3 (severe artifacts).
Results: ECG-triggered CT angiography showed statistically significant advantages over non-triggered CT angiography with regard to motion artifacts (p<0.001) and diagnostic confidence (p<0.001) at the aortic valve, at the branch of the coronary arteries and at the membrane of dissection with a significant correlation (p<0.001) between motion artifacts and diagnostic confidence. However, ECG-triggered CT angiography showed statistically significant less motion artifacts (p<0.001), but not a statistically significant higher diagnostic confidence (p=0.137) at the aortic wall in comparison to non-triggered CT angiography. At the supra-aortic vessels and the descending aorta, the ECG-triggering showed no statistically significant differences with regard to motion artifacts (p= 0.861 and 0.526, respectively) and diagnostic confidence (p=1.88 and 0.728, respectively).
Conclusion: ECG-triggered CT angiography offers images with less motion artifacts and results in a higher diagnostic confidence for the evaluation of the thoracic aorta.

P-481

Novel computational flow dynamics (CFD) imaging tool for hemodynamic evaluation of aortic pathologies

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Purpose: vascular imaging modality capable of providing functional information with computational flow dynamics (CFD) becomes crucial for therapeutic decisions. In this work, we present 10 patients with variable thoracic aortic pathologies in order to demonstrate the capabilities of a novel CFD imaging tool developed in our laboratory.
Methods: a numerical method based on MR dedicated protocols (angio MR, cine-BTFE, Q-flow sequences) has been developed. Geometry surface extraction as well as inlet and outlet flow profiles provided the boundary conditions for the numerical computation. 4D patient-specific virtual models were obtained to analyze different parameters related to the blood flow and the parietal status. 10 patients with variable thoracic aortic pathologies (1 coarctation, 3 aneurysms, 1 acute and 5 chronic dissections) were analyzed.
Results: this novel realistic and patient specific CFD technique accurately calculated biomechanical conditions: Velocity (210±30; 50±30 cm/sec) and vorticity (38±4; 30±6 s-1, ranges were measured at systole and diastole revealing hot spots (maximal values) of turbulence. Abnormal patterns of compliance (mean distensibility coefficient at proximal and distal landing zones: 5.22; 5.82 10-3 mmHg-1) and wall shear stress were identified at the landing zones (WSS: +12% at systole; +35% at diastole).
Conclusions: CFD technology is able to demonstrate quantitative and qualitative hemodynamic status. They have variable clinical applications (studying natural courses of aortic pathologies, evaluation of the aorta before and after stent-grafting, prediction of long term therapeutic outcomes/ complications and improving stent-grafts design).

P-482

A biomechanical diagnostic software for aortic aneurysms

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Purpose: according to the current clinical practice, the rupture risk of an abdominal aortic aneurysm is (mainly) estimated from its maximum diameter and/or expansion rate; an approach motivated from statistics but known to fail often in individuals. In contrast, recent research demonstrated that patient specific biomechanical simulations can provide more reliable diagnostic parameters; however, biomechanical model development is time consuming and current approaches suffer from sever inter-operator variability.
Materials/methods: to overcome current shortcomings of biomechanical simulations our software uses especially developed active contour (deformable) models, which support an artifact-insensitive segmentation of computer tomography angiography data. A hexahedral-dominated computational grid is derived from the 3D reconstruction of the aneurysm, which allows an accurate finite element analysis and in turn provides detailed information about its mechanical stress state.
Results: in cooperation with the Department of Vascular Surgery at Karolinska Institute, Sweden, the proposed software tool was used to investigate the reliability of the biomechanical rupture risk hypothesis by comparing ruptured (n=10) and diameter-matched non-ruptured (n=10) aneurysms. The study revealed that peak wall rupture risk (stress related to strength) was 1.73 times (p=0.022) higher in ruptured than non-ruptured aneurysms.
Conclusion: the developed computer program is entirely feasible to analyze realistic patient specific aneurysms on standard personal computers. It can easily be integrated in the routinely clinical dataflow and first validations emphasize its clinical value in assessing the rupture risk of abdominal aortic aneurysms.

P-483

Is there still a role for venous sampling in the diagnosis of endocrine abnormalities?

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Learning Objectives: review the current role and techniques of venous sampling in managing various endocrine diseases.
Background: certain endocrine tumors may not be apparent on imaging studies, despite clinical and/or biochemical abnormalities. Alternately, functionality of an identified endocrine lesion may be uncertain. Venous sampling has been used to clarify a lesion's functional status, or aid in localization and potentially impact management. We review the current role and techniques of venous sampling in the inferior petrosal sinuses, adrenal, parathyroid and pancreatic venous drainage and examine its efficacy in managing endocrine diseases such as Cushing's disease, Conn's syndrome, hyperparathyoidism, diabetes mellitus and other pancreatic islet-cell abnormalities such as Zollinger-Ellison syndrome.
Clinical findings and procedure details: representative examples of problematic endocrine disorders where venous sampling significantly changed management are presented, with imaging, laboratory data and appropriate sampling techniques. A systematic approach to venous sampling including indications, patient preparation, technique, appropriate catheters, potential intraprocedural difficulties and pitfalls is presented. Potential complications, diagnostic failures, causes of false positive or negative results, post-procedural patient management and correlations between imaging and sampling are discussed.
Conclusion: various endocrine abnormalities often are diagnostic dilemmas in which clinical evaluation, laboratory data and imaging findings may be ambiguous or inconclusive. Venous sampling may clarify, localize or diagnose the abnormality in selected cases. Successful results depend upon proper patient selection and preparation, catheter choice, angiographic technique, attention to intraprocedural details and meticulous sample labeling and handling. Familiarity with potential complications that may occur with venous sampling aids in avoiding or managing adverse outcomes.

P-484

Persistent sciatic artery: a review of the clinical and multimodality imaging findings, natural history, management options and outcomes

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Learning Objectives: to review the clinical presentation, natural history and management of persistent sciatic artery and to illustrate, with multimodality imaging, the characteristics of this rare congenital anomaly.
Background: the sciatic artery is an important embryologic vessel connecting the internal iliac and popliteal arteries as the major blood supply to the lower limb. Persistence of this vessel represents a rare congenital vascular anomaly, with an incidence of 0.02-0.04%. In the complete form, the persistent artery remains the dominant lower extremity blood supply, while the iliofemoral system remains underdeveloped. In the incomplete type, the persistent sciatic artery is hypoplastic, and the superficial femoral artery is the major blood supply to the leg. A persistent sciatic artery is prone to early atherosclerosis, aneurysm formation, and distal embolization; rarely there is atypical sciatica or claudication. Aneurysmal degeneration is increased if the ipsilateral SFA is inadequate. Because of the high risk of limb loss, aneurysms should be corrected when encountered. Familiarity with the aberrant anatomy and appropriate imaging are important for determining management.
Clinical findings and procedure details: we present characteristic CT, MR and angiographic imaging findings of both the complete and incomplete forms of persistent sciatic artery, including 3-D reformatted CTA images of both forms. A clinical case of aneurysmal degeneration is used to review various treatment options including ligation, embolization, surgical bypass or endovascular treatment, and to examine their reported outcomes.
Conclusion: knowledge of the anatomy and natural history of persistent sciatic artery allows for appropriate management of this rare congenital anomaly.

P-485

64-Multidetector CT angiography prior to bronchial artery embolization for haemoptysis in patients with cystic fibrosis

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Learning Objectives: 1. To learn the normal anatomy and anatomical variants of bronchial and nonbronchial systemic arteries. 2. To understand the pathophysiology of haemoptysis in patients with cystic fibrosis (CF). 3. To appreciate the value of multidetector CT angiography in planning endovascular embolization for haemoptysis in patients with CF.
Background: cystic fibrosis is the commonest hereditary disease in the Western world. Major haemoptysis occurs in approximately 1% of all patients with CF. Percutaneous bronchial artery embolization is an effective method of controlling haemoptysis. Recent advances in multidetector CT allow high-resolution angiographic studies, which are useful prior to anticipated bronchial artery embolization.
Procedure details: using examples from our tertiary referral centre, we will: 1. Describe our technique for thoracic CT angiography. 2. Demonstrate how CT angiography can provide a detailed "road map" of the thoracic vasculature by means of multi-planar reconstructions, maximum intensity projections and volume rendering. 3. Correlate CT angiography with conventional angiography.
Conclusion: in this exhibit, we describe and illustrate the practical role of multidetector CT angiography in the planning of endovascular treatment of haemoptysis in patients with CF.

P-486

Multi-modality imaging findings of segmental arterial mediolysis: radiologic contributions to diagnosis and follow-up

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Learning Objectives: the purpose of this exhibit is: 1) to explain the patho-physiology of segmental arterial mediolysis (SAM) 2) to describe the imaging findings of SAM on angiography, CT and MRI 3) to discuss radiologic contributions to the diagnosis and the follow-up of patients with SAM.
Background: SAM is a rare non-inflammatory, non-arteriosclerotic vascular disease characterized pathologically by arterial media weakening. Early recognition of SAM may facilitate prompt appropriate treatment.
Clinical findings and procedure details: three visceral SAM patients (three men, 47-70 years old) were proved pathologically in our hospital. Primary symptom was abdominal distress and spontaneous intra-abdominal hemorrhage. Vertebral arterial dissection also occurred in one patient. CT findings and clinical presentations prompted catheter angiography (pre-operative and post-operative

angiography). CT showed ascites and extra-vasation, mesenteric hematoma, aneurysm of the SMA and aneurysm of the celiac trunk. multi-planar format of CT showed a string-of-beads appearance of the middle colic artery and a dissection of the superior mesenteric artery. Angiographic findings of visceral arteries include alternating stenosis and aneurysmal dissection, wall thickening, dissection, elongation and kinked vessels may be diagnostic when corroborated by clinical and laboratory exclusion of other differential diagnoses. Abdominal MR imaging showed mesenteric hematoma and brain MR angiography showed MCA aneurysm.
Conclusion: SAM is an important diagnosis made in patients with abdominal hematoma or spontaneous intra-abdominal hemorrhage. Angiography and CT follow-up images indicated that SAM lesions may resolve or remain unchanged. Multi-modality imaging appears to be a useful tool for a prompt diagnosis and follow-up of patients with SAM.

P-487

Angiographic appearance and management of pancreatic transplant complication

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Learning Objectives: 1. To describe the vascular anatomy of pancreatic transplant with angiographic correlation. 2. To demonstrate vascular complications of pancreatic tranplants, their angiographic appearance and management.
Background: since the first pancreatic transplant was undertaken in 1966, there has been a steady rise in their numbers. Improved surgical technique and the advent of immunosuppressive drugs have improved surgical results and graft longevity. Pancreatic transplant is most often undertaken simultaneously with renal transplantation in patients with Type I diabetes. Like renal transplants, pancreatic grafts are subject to both immunological and non-immunological complications. Venous and arterial thromboses are the most common non-immunological reasons for graft loss. Early intervention may be required to salvage the graft. Symptoms associated with pancreatic transplant dysfunction are non-specific. High clinical suspicion is required and thorough investigation should be undertaken to identify potential complications. Radiologists need to be able to identify normal and abnormal appearances in pancreatic transplant which may be incidental findings on investigation for non-specific symptoms.
Clinical findings and procedure details: 1. The surgical anatomy of pancreatic transplantation practiced at our centre will be detailed. 2. We present cases detailing the angiographic appearance of normal pancreatic transplant anatomy. 3. Cases will illustrate various vascular complications of pancreatic transplants which will include haemorrhage, vascular occlusion, aneurysm and stenosis. 4. Correlation between angiographic and CT appearances will be illustrated.
Conclusion: we will emphasize the role of CT and angiography in the prompt diagnosis and management of pancreatic transplant dysfunction.

P-488

CO_2 DSA: why, when and how

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Learning Objectives: correct indication and implementation of CO2 digital subtraction angiography in visceral and peripheral vessels for diagnostic or therapeutic interventions. Information about side effects, limitations and possible contraindications of the method.
Background: PAOD is often accompanied by severe renal insufficiency. However, Iodine containing contrast media are known to deteriorate renal function and may induce renal failure. Gadolinium enhanced MRA has, therefore, been used for some time to replace DSA with certain patients. With the discovery of nephrogenic sclerosis as a potentially fatal side effect, MRA had to be abandoned as a diagnostic tool for patients with severe renal insufficiency or terminal renal failure. CO2 angiography, as described by Hawkins I.F. could fill the gap.
Clinical findings and procedure details: overview of current imaging techniques. Differential indication depending on renal status, iodine allergy or hyperthyreoidism. Description of a closed hand delivery system for CO2 angiography. Injection and imaging technique, tips and tricks. Restrictions, side effects and contraindications.
Conclusion: CO2 DSA is a safe, cheap and reliable method to depict visceral and peripheral blood vessels or to guide peripheral interventions. It can easily be trained and should be available in every peripheral cath lab to avoid severe side effects from Iodine dye or Gadolinium in selected patients.

P-489

MDCT imaging of the vessels of the anterior abdominal wall

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Learning Objectives: 1. Identify CT angiographic imaging techniques of the anterior abdominal wall. 2. Discuss variations in anatomy. 3. Describe the various abdominal flaps. 4. Explain how variations in anatomy can effect the formation of these flaps.
Background: abdominal donor site flaps, including the transverse rectus abdominis musculocutaneous and deep inferior epigastric artery (DIEA) perforator flaps, are the standard in autologous breast reconstruction. Refinements in tissue transfer, from pedicled to free flaps and musculocutaneous to perforator flaps, have required increasing understanding of finer levels of abdominal wall vascular anatomy. Preoperative mapping of the perforators with abdominal wall CTA may improve patient care by providing the surgeon with additional information that will lead to optimization of the surgical technique, shorter procedure time, and reduction in the frequency of surgical complications.
Clinical findings: this review presents the anatomy and the branching patterns of the DIEA, the segmental anatomy of the anterior adipocutaneous perforating branches of the DIEA, and the importance of these features in pre- and intraoperative surgical planning. This requires a different approach to abdominal wall CT angiography than that used with other abdominal CT angiographic techniques. The anatomic accuracy of abdominal wall CT angiography has been investigated in cadaveric and surgical studies, with sensitivity of 96-100% and specificity of 95-100%.
Conclusion: correct imaging and reporting of the variations in anterior abdominal wall anatomy in patients undergoing breast reconstruction is essential for preoperative planning and reduces the risk of intraoperative error.

P-490

Imaging of aortic diseases: a pictorial review

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Learning Objectives: to describe the spectrum of aortic pathology and outline the state-of-the-art in the imaging evaluation of aortic disease, assessing key points in pre and post-therapy studies as

well as in the follow-up of patients. To present an iconographic selection of representative cases of aortic pathology, including acute aortic syndromes, aneurysms, obstructive aorto-arteriopathies and inflammatory (Takayasu) and neoplastic disease (sarcoma).
Background: aortic diseases are common and apparently increasing in western populations, most likely due to aging but also because of higher clinical awareness and more frequent use of non-invasive imaging modalities.
Clinical findings and procedure details: aortic pathology includes a wide spectrum of diseases, which can present as diverse clinical scenarios and are associated with high morbidity and mortality. Aortic dissection is the most common cause of aortic emergency, frequently with a fatal outcome. Recent refinements in surgical and endovascular techniques for aortic pathology have increased the need for accurate, easily feasible diagnostic examinations, which provide critical information for patient selection, especially in the acute setting. During the past decade, computed tomographic angiography has become a standard non-invasive modality for depiction of vascular anatomy and pathology, with the benefits of high speed of examination and low cost. Tailoring the acquisition parameters and protocols, with special attention to contrast injection, is essential for consistent acquisition of diagnostic images.
Conclusion: knowledge of the spectrum of aortic pathology and awareness of optimal technical acquisition parameters improves diagnostic accuracy and favors optimal therapeutic management.

P-491

Technical and diagnostic pitfalls of multidetector CT angiography (MDCTA) in interventional procedure planning: a review for interventionalists

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Learning Objectives: review basic technical aspects of peripheral CTAs and common diagnostic pitafalls for peripheral interventional procedural planning.
Background: multidetector CT angiography (MDCTA) is emerging as the diagnostic test of choice for peripheral vascular disease treatment planning. All interventional radiologists need to be familiar with this technology beyond its basic concepts. We will review important technical factors to improve imaging diagnostic quality, examination time and patient safety. Diagnostic pitfalls with potential significant clinical consequences will be discussed.
Clinical findings and procedure details: the choice of an appropriate treatment strategy requires accurate characterization of vascular pathology and anatomy. MDCTA is a promising non-invasive imaging technique with three-dimensional visualization capability, shorter acquisition time, and simultaneous visualization of vascular, muscular, and bony structures. In many centers, interventional radiologists have been asked to take full responsibility for performing and interpreting these studies or at least they use CTA for treatment planning. This presentation discusses several technical factors and diagnostic pitfalls pertinent to the correct interpretation of these studies. Many diagnostic and management mistakes can be avoided through a better understanding of scanning techniques, contrast timing and clinical pitfalls. In this presentation, we will share our experience and provide literature review.
Conclusion: all interventional radiologists should educate themselves about the technical aspects of peripheral CTAs and be familiar with the common diagnostic mistakes with potentially vital clinical consequences.

P-492

The role of multi-detector computed tomography (MDCT) in evaluating acute gastrointestinal bleeding: what the interventional trainees need to know

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Learning Objectives: an interventional trainee should be able to establish the role of MDCT in evaluating acute gastrointestinal bleed, be aware of what protocols to use and to know when it is appropriate to perform a radiological intervention.
Background: the evaluation and treatment of acute gastrointestinal bleeding is complex and often requires a multidisciplinary approach. In the majority of patients, the source of the bleeding can be localised and managed by endoscopy/colonoscopy. In a small percentage, the bleeding site remains elusive. Traditionally, surgery or invasive angiography is the next course of action. We concentrate on the use of MDCT angiography and aim to illustrate its increasingly central role. Information from MDCT angiography can be helpful in guiding appropriate management (e.g., conservative, surgery, embolisation).
Clinical findings and procedure details: criteria for selecting patients will be discussed. A specific protocol should be established for each institution taking into account availability of equipment and expertise. Factors affecting further management will be reviewed as well as the decision to embolise, which needs to take into account the location of bleeding, severity, haemodynamic status, co-morbidities, and aetiological factors.
Conclusion: the increasing availability of MDCT and emerging technological advances (rapid image acquisition time and ability for multi-planar imaging) makes it a modality of choice in investigating gastrointestinal bleeding as well as lending itself useful in the context of pre intervention.

P-493

Magnetic resonance imaging of extracranial vascular malformations at 3-Tesla

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Learning Objectives: 1) Review appropriate scan protocols for the evaluation of vascular malformations at 3 T. 2) Review the relative value of different contrast-enhanced MRA (ce MRA) techniques in the assessment of VM, including ultrafast time-resolved techniques. 3) Review the appearance of the different pathological types of VM's and their 3T MRI/MRA appearance. 4) Review the appearance of the different pathological types of VM's and their 1.5T MRI/MRA appearance.
Background: • Technical background of 3T MRI and MRA. • Sequence selection at 3T, parallel imaging techniques. • Time-resolved versus non-time resolved ce MRA protocols. • Artifacts, pitfalls, and ways to minimize these. • Discuss optimized scan protocols at 3T.
Clinical findings: • Review Mulliken classification of vascular malformations. • Review MRI/MRA appearance of different VM's at 3T. i. Arteriovenous malformations. ii. Venous malformations. iii. Capillary malformations. iv. Lymphatic malformations. v. Mixed types. vi. Syndromes. • Review MRI/MRA appearance of different VM's at 1.5T.
Conclusion: • 3T MRI is useful for the assessment of complex vascular and nonvascular anatomy in the abdomen and pelvis. • 3T MRI is not necessarily superior over state of the art 1.5T MRI. • Fast time-resolved MRA techniques offer advantages in the assessment of AVM's and capillary venous malformations.

P-494

Correlation between MD-CTA and DSA before percutaneous embolization in cystic fibrosis patients affected by massive hemoptysis

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Learning Objectives: the purpose of the study is to evaluate the diagnostic role of multi-detector CT angiography (MD-CTA) in depiction of bronchial systemic arteries in cystic fibrosis patients with massive hemoptysis. MD-CTA imaging correlation with digital subtraction angiography (DSA) was performed.
Background: between 2005 and 2008, 34 patients affected by cystic fibrosis and massive hemoptysis were evaluated. All patients underwent MDCTA and subsequent DSA with the aim of superselective embolization of the pathological bronchial arteries.
Clinical findings and procedure details: MDCTA with MIP reconstruction allowed a detailed delineation of the origin, course, traceability, caliber of the affected bronchial arteries. In all patients a complete correspondence between MIP images from MDCTA scan and selective DSA was obtained in depiction of pathological bronchial arteries.
Conclusion: currently MDCTA represents the gold standard in the imaging of cystic fibrosis patients with massive hemoptysis. MDCTA permits to accurately plan the subsequent interventional procedure, reducing procedure time and the radiation dose given to the patient.

P-495

Vascular imaging for Takayasu arteritis

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Learning Objectives: to review Takayasu arteritis and to evaluate the combined use of Doppler US, CT, MRI, MRA and DSA for the diagnosis and follow-up of Takayasu arteritis.
Background: Takayasu arteritis is characterized by granulomatous inflammation of the arterial wall, which leads to stenosis, occlusion and sometimes aneurysm formation. Classical diagnosis has been based on angiographic findings. Recent developments in US, CT, MR have increased the diagnostic radiological capacity and changed concepts for the follow-up.
Clinical findings and procedure details: US and Doppler US examinations may show direct and indirect hemodynamic data about vessel wall and arterial blood flow. Thoracoabdominal 3D MRA and vascular black-blood MRI examinations might reveal arterial stenoses, occlusions, vessel wall changes and activity of the disease with Gd enhancement of the vessel wall. CT examinations may also show arterial wall involvement with luminal findings of CTA. DSA is the gold standard for luminal findings. Endovascular interventions are usually performed on the inactive stage of the disease. During the follow-up US, MRA, MRI and CT findings about vessel wall thickening and contrast enhancement of the arterial wall can be evaluated with interventional findings.
Conclusion: multi-modality radiological evaluation for the diagnosis and follow-up of Takayasu arteritis has the advantages of showing the vessel wall changes with luminal abnormalities and evaluating the response to the medical and interventional treatment.

P-496

Whole-body magnetic resonance angiography for Takayasu arteritis

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Learning Objectives: to evaluate technical details of the whole-body MRA with clinical application for Takayasu arteritis.
Background: the diagnosis of Takayasu arteritis and decision of appropriate treatment requires rigorous analysis of the vascular morphology. Localizing the lesions and specifying their severity are also important for follow-up and therapeutic road-map.
Clinical findings and procedure details: whole-body MR utilizes a moving table-top and scans the whole-body in the required plan in several rapid stages. It provides the visualization of the whole arterial system in a short period of time ideal for Takayasu arteritis with multi-focal artery involvement. The enhancements of the dedicated surface coil designs, the automation of the table motion, improvements in parallel imaging techniques, the utilization of the high field scanners, 32 channel MR systems and new contrast agents increase the resolution of the images and provide larger anatomical coverage. Depending on the location and severity of the vasculitis, the clinical findings show variety. Since whole-body MRA is capable of visualizing the whole arterial system except the cardiac and cerebral, it is an appropriate non-invasive technique to visualize the simultaneous vasculitic lesions in separate regions without exposure to ionizing radiation.
Conclusion: Takayasu arteritis might involve different regions of the body and whole-body MRA visualizes the main arterial system with minimal patient preparation requirement and reduced room time. It also enables the diagnosis of asymptomatic focal lesions along with the symptomatic ones. MRA can be considered as an alternative to screen the patients with high risk of Takayasu arteritis.

P-497

Role of dual energy CT to identify the bleeding site in the patients with massive hemoptysis: comparison with lung perfusion scintigram and conventional angiography

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Learning Objectives: to identify the bleeding site in the patients with massive hemoptysis using dual energy CT (DECT) and lung perfusion images.
Background: hemoptysis of pulmonary arterial origin is a diagnostic challenge in patients admitted to a respiratory ICU for treatment of hemoptysis. Its early accurate recognition and treatment reduce morbidity and prevent mortality. Multidetector row CT angiography is an accurate method for imaging the systemic vascular network and additional information is achieved using lung PBV imaging on DECT.
Clinical findings and procedure details: the pulmonary arterial flow is only shown on lung perfusion imaging with 99m-Tc MAA. The diameter of iodine contrast material is much smaller than that of 99m-Tc MAA ranges from 10 to 60 µm, and the difference of material size affects the visualization of remodeled pulmonary circulation including systemic to pulmonary artery shunts. The patients with massive hemoptysis due to chronic inflammation or advanced lung carcinoma underwent contrast enhanced DECT and lung perfusion scintigram using 99m-Tc MAA within 3 days. Pulmonary angiography and systemic (bronchial, intercostal or subclavian branches) arteriograhies were also performed within 1 week. Pulmonary angiography was used as the standard of reference for the lung perfusion and lung perfusion images were compared with

conventional angiograms.
Conclusion: in comparison between lung PBV and lung perfusion imaging, the perfusion disturbance of lung parenchyma is helpful in confirming the diseased site of pulmonary parenchyma before the transcatheter embolization or intraarterial infusion.

P-498

CT angiography - tips and tricks for a high-quality examination

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Learning Objectives: This text is intended for examining physicians with some experience with CT angiography (CTA) who wish to improve their outcomes. The center where most of the diagnostic angiographic procedures are undertaken using noninvasive methods, has to create a team of well trained physicians and technologists involved in the clinical assessment, imaging of the pathological conditions, indications, and surgical and interventional treatment.
Background: We present our experience with CT angiographies performed at 64 slices CT unit. In last years CT became a method of choice in vascular pathology imaging. More and more physicians are now experiencing the results of CTA. Compared to DSA the interpretation of CTA images is more complex and requires experience. Therefore it is very important to keep the same algorithms and methods in creation of reconstructed images to avoid misinterpretations of CTA findings.
Clinical findings and procedure details: General part concerns technical conditions necessary for high quality CTA including software. We report the possible image artifacts and other risks that could impair examination quality. In special part we present the indications suitable for CTA in different anatomical regions, the most frequent mistakes and misinterpretations and technical aspects of the images.
Conclusion: While the results of CT angiography in extracardiac indications are very good and of high diagnostic quality, and CTA (together with MRA) has made DSA an almost obsolete diagnostic tool, the results are not that reliable with the coronary arteries, as attested to by the predominance of conventional coronary angiography in diagnosing coronary heart disease in most renowned centers.

P-499

Post hepatic biopsy arterioportal shunt

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Arterioportal shunts may be congenital (Rendu-Osler disease) or acquired (trauma, iatrogenic causes, cirrhosis). We report the case of a 46-year-old cirrhotic man that presented a large intrahepatic arterioportal shunt secondary to a previous right hepatic lobe biopsy.

P-500

Reversible diffuse arterial spasm in a patient with primary oxalosis

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Few reports have been made on severe vascular complications of primary oxalosis. We report the case of a 22-year-old girl with diffuse arterial spasm involving the abdominal aorta, iliac arteries and lower limb arteries that partially reversed with vasodilating drugs.

P-501

Asymptomatic bilateral ureteropelvic junction obstruction due to supernumerary renal arteries

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We report a healthy renal transplant donor with bilateral UPJO, which appeared to be secondary to supernumerary renal (inferior polar) arteries. We believe that the bilateral occurrence of asymptomatic UPJO associated with supernumerary renal arteries has not been previously reported.

P-502

Giant bronchial artery aneurysm with rare origin from the distal descending aorta

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Thoracic MRI displayed an aneurysmatic retrocardial vessel with eccentric thrombosis. CT scan revealed a connection from the descending aorta into the pulmonary parenchyma. We consequently diagnosed a bronchial artery aneurysm with an atypical origin from the distal descending aorta.

P-503

Anomalous origin of bilateral vertebral arteries associated with an aberrant right subclavian artery and a common carotid trunk

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We present MDCT angiography findings of an extremely rare combination of anomalies of the aortic arch consisting of an aberrant right subclavian artery, a common origin of both carotid arteries and anomalous origin of bilateral vertebral arteries.

P-504

Inferior pancreaticoduodenal artery aneurysm associated with celiac artery occlusion diagnosed by MDCT angiography

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Herein, we present a case of inferior pancreaticoduodenal artery aneurysm associated with celiac axis occlusion dignosed by multidetector-computed tomographic angiography.

P-505

MDCT angiography of isolated right subclavian artery

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We present multidetector-computed tomographic angiography findings of an isolated right subclavian artery associated with a common carotid trunk and an anomalous origin and proximal interruption of the left pulmonary artery in a 3-year-old boy with tetralogy of Fallot.

P-506

Pulmonary artery dissection diagnosed by multidetector-computed tomographic angiography

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We present multidetector-computed tomographic pulmonary angiography findings of a case with multiple dissections of intrapulmonary arteries and a previous history of pulmonary artery thromboemboli.

P-507

Iliac thrombosis associated with angiosarcoma

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We report a case of vascular tumor of large vessel wtih intraluminal growth simulating artrial occlusive disease. Treatment consisted in surgical resection. Immunohistorical studies permitted to classify the tumor.

P-508

Partial anomalous pulmonary venous return with sinus venosus atrial septal defect diagnosed by 64-slice computed tomography

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[2]Cardiology, Türkiye Yüksek İhtisas Hastanesi, Ankara, Turkey.

We present 64-slice multidetector-computed tomographic angiography images of a 38-year-old woman who had partial anomalous pulmonary venous return of the right upper lobe into the superior vena cava and sinus venosus atrial septal defect.

P-509

Isolated partial anomalous pulmonary venous return diagnosed by 64-slice computed tomography

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We present 64-slice multidetector-computed tomographic angiography images of a 11-year-old girl with isolated partial anomalous pulmonary venous return of the left upper lobe into the left innominate vein.

P-510

Brachial artery occlusion as the only manifestation of thromboangiitis obliterans (Buerger's disease) in a young female smoker

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Young female, heavy smoker, presented with upper extremity digital gangrene and no radial or ulnar pulse. Angiography revealed "corkscrew" collaterals of brachial artery on left upper limb (Buerger) only, which was impossible to recanalize and no pathology on lower limbs.

P-511

Role of mesenteric angiography in chronic gastro-intestinal haemorrhage

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We present a patient with chronic gastrointestinal bleeding extensively investigated with various endoscopic techniques. Mesenteric angiography requested after several months led to the diagnosis. We discuss the prevalent variable clinical practice in this setting and discuss the role/timing of angiography.

P-512

Non-splanchnic vessels as supply of obstructed splanchnic vessels

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Abdominal angio-CT performed for aortic stent-graft follow up. Obstructed celiac trunck, superior and inferior mesenteric arteries were noticed with normal distal contrast filling. Collateral supply pathways from internal mammary, cardiophrenic and sacral artery were observed. Patient still asymptomatic.

P-513

Embolotherapy for hepatopulmonary syndrome

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Hepatopulmonary syndrome is a rare condition with pulmonary vascular dilatation. In our patient, liver transplantation was insufficient due to previous pancreatic operation, and embolization of portosystemic shunt was performed. Various imaging and pathological findings will be presented.

P-514

Treatment of primary intraosseous arteriovenous malformation (PIAM) with percutaneous injection of polymethylmethacrylate (PMMA)

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We report the case of treatment of PIAM with percutaneous injection of PMMA in a 25-year-old girl. A 13-gauge needle was placed in the osteolytic lesion of right homerous and 4 ml of PMMA was injected with flow disappearance.

P-515

Persistent sciatic artery (PSA): vascular imaging of a case

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Persistent sciatic artery is a rare embryogenetic abnormality.
We refer to a 53-year-old male with gluteal claudicatio in which MDCT-Angiography showed a left PSA, associated with an aneurysm located caudal to the sciatic notch and incomplete superficial femoral artery.

P-516

Unusual presentation and imaging features of a rare case of leiomyosarcoma of femoral vein

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Deep vein thrombosis is a rare presentation of Leiomyosarcoma of right femoral vein. The tumour underwent multiple cystic necrosis after chemotherapy requiring repeated ultrasound-guided aspiration and sclerotherapy. We present imaging findings of this unusual entity.

P-517

Left vertebral artery dissection: etiology on angiography; more than vessel analysis alone

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A left vertebral artery dissection was diagnosed on angiography. Additional 3DA/3DCT acquisition during the same examination disclosed the uncommon etiology of the dissection.

Venous intervention

P-518 withdrawn by authors

P-519

Phase II study of metallic stents therapy for malignant vena cava syndrome (JIVROSG-0402)

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Purpose: this multi-center prospective study was conducted to evaluate the efficacy of metallic stents therapy for vena cava syndrome (VCS) caused by malignant tumors.
Materials/methods: twenty-eight patients (pts) with restricted activities by VCS, uncontrolled symptoms by medications, adequate hematological, hepatic, renal and cardiac functions, grade 0-3 performance status (PS), estimated prognosis ≥4 weeks and written consent were enrolled [SVCS (16), IVCS (12); PS0 (1), 1 (11), 2 (10), 3 (6)]. Vena cava stents were placed by transfemoral or transjugular procedures. Adverse events were evaluated by CTCAE, and the severity of symptoms was evaluated by VCS score composed by CTCAE grades for respiratory, cardiac and neurological symptoms, edema and ascites. Efficacy was classified as effective (≥50% reduction of VCS score for more than 2 weeks) and ineffective.
Results: procedures were completed in all pts employing Z stents, smart or luminexx stents, and both in 19, 5 and 4 pts, respectively. Angiographical improvement of venous flow was observed in 27 pts. The effective rate was 71.4% (95%C.I. 54.7-88.1%). Five pts died within 30 postoperative days caused by primary disease progression in 3 pts and pulmonary embolism in 2 pts. Median survival time was 78 days (2-649 days) and 6-months survival rate was 10.7%. VCS recurred in 2 pts (44, 144 days). As adverse reactions, grade 3 hypotension and lumbago, grade 2 stent occlusion, hypoalbuminemia, anorexia, thrombocytopenia and confusion occurred in each.
Conclusion: metallic stents therapy is a feasible and effective treatment option in the management of pts with malignant VCS.

P-520

Chest port placement using the single-incision insertion technique

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Purpose: to evaluate the use of the single-incision technique for the placement of subcutaneous chest ports. Advantages, technical success, and complications of this insertion technique were assessed.
Materials/methods: from March 2007 to May 2008, the authors consecutively placed 161 chest ports in the interventional radiology suite using a modified single-incision technique and sonographic and fluoroscopic guidance. 130 patients had port placement via the right internal jugular vein (IJV), 1 via the right external jugular vein, 2 via the right subclavian vein, and 28 via the left IJV. Advantages, technical feasibility, safety, and complication rates were evaluated for patients having this modified technique for chest port placement.
Results: among the 161 patients with ports implanted using the single-incision percutaneous technique, the technical success rate was 100%. Chest ports were placed in patients ranging in age from 19 months-93 years (mean, 56.3 years), with a mean follow-up of 203.6 device-days/patient and a total of 32,779 catheter access days. No occurrence of procedure-related complications, pocket hematoma, venous thromboses, or pneumothorax was observed. One port was removed in less than 30 days post implantation due to infection of the chest port pocket (0.61%, 0.003 infections per 100 catheter days).
Conclusion: the use of a single-incision technique for chest port implantation in adult and pediatric oncology patients is feasible. Further evaluation in a prospective setting is needed to determine whether this modified technique is associated with decreased procedure and fluoroscopy times, decreased costs, and improved patient satisfaction when compared with the conventional two-incision technique.

P-521

Endovascular stenting of upper extremity central venous obstruction in hemodialysis patients: long-term results of Wallstent and nitinol stent placements

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Purpose: to report and compare long-term results of nitinol stent and Wallstent placement for central venous obstruction in hemodialysis patients.
Materials/methods: forty-seven patients aged 15-77 years who underwent successful stenting for 50 central venous obstructions between November 1998 and October 2008 were retrospectively reviewed. Balloon angioplasty was the primary choice of treatment. Stents were indicated in frequently recurring lesions after angioplasty (twice within two months), technical failure of angioplasty (complete recoil, significant residual stenoses or presence of collaterals with significant pressure gradient) and angioplasty resulting in prominent venous perforation. Angioplasty was used primarily in treatment of stent obstructions. Additional stents were also placed in failure of angioplasty. Survival curves for primary and assisted primary vein patency between nitinol stent and Wallstent groups were generated with Kaplan-Meier survival analysis and compared with log rank test.
Results: mean follow-up was 23.14±15.61 months. Mean primary patency rates of nitinol (15.38±3.21) and Wallstent groups (17.21±4.21 months) were equivalent. Mean assisted primary patency rates of

nitinol (28.86±3.96) and Wallstent groups (30.47±4.67) were also equivalent. Overall mean primary patency was 16.11±2.49 months and assisted primary patency was 30.09±3.20 months. Average number of interventions per vein to survive assisted primary patency in nitinol (3.10±2.75) and Wallstent groups (2.63±2.27) was also equivalent.
Conclusion: nitinol stents and Wallstents offer similar results for central venous obstruction in hemodialysis patients.

P-522

Computational flow modeling of renal vein inflow for IVC filter placement: is there an ideal filter position relative to the renal veins?

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Purpose: the positioning of IVC filters below renal vein inflow has generally been advised, but little clinical or scientific data exist regarding the effects of renal vein inflow on filters. The purpose of this study was to use computer models to determine the optimal placement of an IVC filter in relation to the renal veins.
Materials/methods: a three-dimensional model of the TrapEase IVC filter was constructed using methods of computer aided design. The IVC and renal veins were modeled as straight tubes. Average renal vein angles, diameters, and cranial-caudal distance between the renal veins were measured from 24 CT scans of patients without renal venous anomalies/renal disease. The steady-state hemodynamics was examined for unoccluded and partially occluded filters with varying thrombus sizes and filter positions relative to the renal veins.
Results: our computational results were corroborated with similar results from published in-vitro experiments. In all cases, stagnant and recirculating flow was observed downstream of the bilateral renal vein inflow. These regions were observed along the wall of the IVC and led to low wall shear stresses, which may be thrombogenic. Several hemodynamic scenarios were evaluated including varying volumes of nonocclusive thrombus, different thrombus trapping positions, and multiple placements of the filter in suprarenal, infrarenal, and juxtarenal positions.
Conclusions: our computer models provide an easily adaptable platform to evaluate the effects of renal vein inflow on filter hemodynamics. This information is useful in identifying potential regions that may be thrombogenic due to flow and trapping phenomena.

P-523

Placement of retrievable filters in alternative location in the iliac veins in high risk surgical patients

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Purpose: retrospectively review experience with iliac filters in patients with megacava or other contraindication to IVC placement.
Materials/methods: during the study period, ten patients had bilateral common iliac filters placed for megacava or other contraindication to placement in the IVC. There were 5 men and 5 women with average age of 45 years. Indications for IVC filter were prophylaxis for bariatric surgery in high risks patients (n=9) defined as body mass index >50 kg/m2. These nine patients had megacava defined as IVC diameter >3 cm. The last patient undergoing removal of a retroperitoneal primitive neuroectodermal tumor received bilateral iliac filter placement to prevent potential surgical field disruption caused by IVC placement. Filters were removed when filtration was no longer necessary. Patients were followed clinically.
Results: there were 20 filters placed (18 Günther Tulip and 2 Celect; Cook Inc.) in the 10 patients successfully. Filters were placed via the right internal jugular vein, or common femoral veins, into the common iliac veins. Filter retrievals were performed successfully in all patients. The mean dwell time was 40 days (range 30-71). No complications were seen with placement or retrieval of these filters. There was no incident of clinically evident pulmonary based on clinical follow-up. No development of DVT was seen on the pre-retrieval Doppler ultrasound. No iliac vein thrombosis was noted on the pre-retrieval venograms.
Conclusion: placement of retrievable filters in alternative location in the iliac veins in patients with megacaca or other contraindication to IVC placement appeared safe and effective.

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Inferior vena cava (IVC) filters: use or abuse?

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Purpose: to review the IVC filter experience in a single institution.
Materials/methods: retrospective study with IRB approval. The records of all patients who underwent IVC filter placement in a 14 month period (from 01/07 to 03/08) were reviewed. A total of 122 consecutive patients (46 M/76 W) underwent IVC filter placement. Indications, type of filter, retrieval and complications were recorded. Indications for IVC filter placement were classified as: 1) Direct: proven venous thromboembolic disease (VTE) and a contraindication or failure to anticoagulation, 2) Indirect: pre-surgical in patients with history of VTE or pre-surgical in patients with no history of VTE (truly prophylactic). Optional (retrievable) and permanent filters were placed. Data are presented in a descriptive fashion.
Results: all 122 filters were successfully placed; 78/122 (64%) patients had a direct indication, 44/122 (36%) indirect. Retrievable filters were placed in 113/122 (92.6%) patients and permanent in 9/122 (7.4%). Günter-Tulip filter was placed in 45/113 (40%) and Bard G2 in 68/113 (60%). Only 28/113 (24%) of patients with an optional filter were sent back for retrieval and 20/28 (71%) were successfully retrieved. Failure to retrieve was related to: Thrombus within the filter in 5/28 (19%) and technical failure in 3/28 (11%). No major complications were recorded.
Conclusion: most patients in our series had a direct indication for IVC filter placement. Most patients had optional filters placed, but only a minority was referred for retrieval. These preliminary results indicate that the use of IVC filters at our institution needs to be critically revised.

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Pharmacomechanical DVT thrombolysis using spiral technique

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Purpose: to evaluate the safety and efficacy of pharmacomechanical treatment of DVT, using a catheter spiraling technique.
Materials/methods: retrospective analysis of 82 patients who underwent pharmacomechanical thrombolysis for DVT using a thrombolysis catheter spiral method between 9/2000 and 3/2008. Forty-two clots were acute (14 days or less), 10 subacute (15-28 days) and 3 chronic (>28 days). Either 10 mg Reteplase or 25 mg tPA was added to the thrombolysis insulflate. Pharmacomechanical thrombolysis was performed using a pullback spiraling technique with the Xpedior RT catheter inserted coaxially through an 8 French angled guide catheter. Extent of clot removal was based on the

completion venogram. Doppler examination and the VEINES quality-of-life questionnaire were performed between 30 days and 1 year.
Results: clot removal: Complete (>95%) in 53 patients; substantial (50-95%) in 17 patients; none to partial (<50%) in 11 patients. Ultrasound follow-up: Twenty-one patients underwent follow-up ultrasound examination between 30 days and one year post thrombolysis. Twelve patients demonstrated no residual DVT; six demonstrated patency with chronic changes or minimal residual thrombus; three demonstrated significant recurrent thrombus. QOL results 1 year out: Thirty-seven patients returned the QOL questionnaire. Ten patients reported their "leg problem" as "much better"; eight as "about the same or somewhat worse"; two as "much worse". Adverse events: 9 adverse events intra or post procedurally. Re-clotting during same admission: 2. Transfusion: 1. Acute renal failure: 4. GI bleed: 1 Non-debilitating cerebellar hemorrhage: 1.
Conclusion: spiral pharmacomechanical DVT thrombolysis is safe and effective.

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Clinical suspicion of pelvic congestion syndrome (PCS): venography features and results after embolization

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Purpose: to retrospectively overview typical venography findings in patients suffering PCS, and evaluate clinical results after embolization. Patients and method: 34 women classified as high clinical suspicion of PCS were referred to our department between 2000 and 2008 for ovarian vein venography after other pelvic pathology was ruled out. Initial diagnostic was made by a single vascular surgeon from varicose veins pool of patients. Selective venogram was performed and varicose veins embolized with coils if needed. Clinical follow-up was obtained by a telephonic survey.
Results: in 22 patients, the PCS was confirmed by venography, showing a left ovarian incompetence or varices depending on iliac veins. In 9/22 Doppler ultrasound study also demonstrated evidence of greater saphenous incompetence. Clinical symptoms included pelvis heaviness in 20/22 and chronic dull pelvic pain in 18/22. Previous psychiatric disturbances were confirmed in 8 patients. Percutaneous embolization was performed by right femoral approach in 13 women and in 9 by right brachial vein approach. The immediate success in closing the offending pelvic varices with coils was 100% (in 2 women internal iliac vein branches were also embolized). Clinical follow-up: disappearance of pelvic heaviness in 14/22 patients, complete extinction of pelvic pain in 10/18 and pain decreasing in 2/18 with an average follow-up of 31 months.
Conclusions: in our study, embolization with coils in varicose veins improved the pelvic symptoms in patients with PCS.

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Pulmonary embolism: mechanical and fibrinolytic fragmentation

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Purpose: massive pulmonary embolism is a severe clinical condition that requires prompt therapeutic intervention. We report our experience with a hybrid treatment involving systematic fragmentation of the embolus with an angiographic catheter associated with fibrinolytic therapy over the following days.
Materials/methods: from 1999 to 2007, 430 patients were referred for severe pulmonary thromboembolism; we treated 196 patients with massive pulmonary embolism. We used angiographic catheter to confirm the diagnosis, for mechanical fragmentation (rotational manouvre) and for administration of fibrinolytic agent (urokinasi 50.000 UI/h) for 24-72 hours. Results were assessed on the basis of changes in mean pulmonary artery pressure.
Results: in 89 patients, mean pulmonary artery pressure fell rapidly below 25 mmHg with only one passage of catheter. Fibrinolytic agent was infused for 24 hours. In 49 patients, two passages of catheter were required to achieve the same results. Fibronolytic agent was infused for 48 hours. In 32 patients, more than three cycles of mechanical fragmentation were required before means pulmonary pressure fell down 35 mmHg. Fibrinolytic agent was infused for 72 hours. In 26 patients, at no time did the mean pulmonary artery pressure fall below 35 mmHg.
Conclusion: mechanical fragmentation with angiographic catheter and administration of fibrinolytic agent effectively brought about a rapid improvement in patient's clinical status by moving the embolus towards the periphery. Mean pulmonary pressure helps to distinguish four types of haemodynamic conditions, how to manage the clinical status and witch kind of hybrid therapy to apply.

P-528

Endovascular treatment for iliac vein compression syndrome: comparison between with and without secondary thrombosis

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Purpose: to evaluate the value of early identification and endovascular treatment of iliac vein compression syndrome (IVCS) with or without deep vein thrombosis (DVT).
Materials/methods: IVCS without DVT (group 1, n=39) and IVCS with fresh thrombosis (group 2, n=52) and IVCS with non-fresh thrombosis (group 3, n=34) were detected by Doppler ultrasonography, magnetic resonance venography, computed tomography or venography. Fresh venous thrombosis (n=52) was treated by aspiration and thrombectomy, ilac vein compression was treated with self-expandable stent. In those cases with fresh thrombus, the inferior vena cava filter were inserted before thrombosis suction, mechanical thrombus ablation, PTA, stenting and transcatheter thrombolysis.
Results: stenting was performed in 111 patients, catheter and guide wire failed to pass the lesion in 3 cases. The initial patency rate was 94.9% (group 1) and 88.5% (group 2) and 64.7% (group 3), respectively, with significant difference (P=0.001); the 6 months patency rate was 92.6% (group 1) and 82.8% (group 2) and 50.0% (group 3), respectively, with significant difference (P=0.001). Both initial and 6 months patency rate in IVCS patients without thrombosis or with fresh thrombosis were significantly greater than it in IVCS patients with non-fresh thrombosis.
Conclusion: endovascular treatment for IVCS with or without thrombosis is safe and effective.

P-529

C-arm CT during adrenal vein sampling: improving an underutilized test for primary hyperaldosteronism

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Purpose: primary hyperaldosteronism is the most common curable cause of hypertension with a prevalence of up to 15% in the hypertensive population. Adrenal vein sampling is underutilized due to high technical failure rate (up to 33%). C-arm CT provides real time catheter selectivity confirmation and may eliminate the failure rate.
Materials/methods: 50 consecutive patients underwent adrenal vein sampling augmented by C-arm CT. If C-arm CT indicated incorrect

catheter location (enhancement of tissue other than adrenal), catheter was repositioned. Pre- and post-cosyntropin stimulation, cortisol and aldosterone levels were used to document selectivity and lateralization. We calculated and compared the technical success of adrenal vein sampling with and without C-arm CT, as well as costs in terms of time, intravenous contrast and radiation. Clinical outcomes (antihypertensive medications, potassium levels and supplementation) were followed after adrenalectomy.
Results: all except one patient had successful procedure. Adrenal vein sampling with C-arm CT had a 98% success rate compared to 73% without (P-value=0.008, 95% CI=2-45%). When C-arm CT and classic sampling were discordant for selectivity (4/50), C-arm CT was shown to be correct based on clinical response to adrenalectomy. All adrenalectomy patients guided by C-arm CT, had clinically proven adrenal adenoma based on significant improvements in hypertension and serum potassium levels.
Conclusion: adrenal vein sampling augmented by C-arm CT improves the technical success of the procedure to nearly 100%. Establishing this as the new diagnostic "gold standard" will likely result in more widespread use and better diagnosis and treatment for those with primary hyperaldosteronism.

P-530

Budd-Chiari syndrome with intrahepatic vena cava stenosis: vena cava stenting prior to mesocaval shunting

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Purpose: to evaluate the safety and efficacy of inferior vena cava (IVC) stenting followed by mesocaval shunting in the treatment of Budd-Chiari-syndrome with caval compression.
Materials/methods: between 09/1990 and 06/2008, 11 patients (10 females, 1 male; mean age, 36 years; age range, 23-63 years) with Budd-Chiari syndrome, a hypertrophic caudate lobe, and intrahepatic compression of the IVC underwent vena cava stenting before mesocaval shunt surgery. Ten patients were treated with Wallstents (Boston Scientific, Natick, Mass), one patient with a Sinus-Aorta-Stent (Optimed, Ettlingen, Germany). Mean follow-up was 58 (range, 1-169) months. Outcome measures included technical outcome, clinical outcome, and the rate of complications.
Results: stent placement was technically successful in all patients (100%). The pressure gradient across the intrahepatic IVC decreased from 23±3 mmHg before to 11±1 mmHg after stent implantation. During follow-up, all IVC stents were patent. Primary cumulative shunt patency was 81% at 12 months, 67% at 24 months, and 54% at 60 months. Two patients presented with shunt occlusion 10 months after shunt surgery and underwent successful revision due to variceal bleeding and ascites. Two patients with shunt occlusion received orthotopic liver transplantation 100 and 117 months after shunting. One patient with shunt occlusion died due to her bad general condition 1 month after shunt surgery. Procedure-related complications were not observed.
Conclusion: IVC stenting is a safe and effective method in the treatment of Budd-Chiari syndrome with caval compression, with a high stent patency rate and a moderate prognosis concerning shunt patency.

P-531

Increased inferior vena cava filter retrieval rate with improved clinical follow up

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Purpose: inferior vena cava (IVC) filters, although efficacious, are associated with long term complications. Time limited indications for inferior vena cava filtration make filter retrieval an attractive option, when possible. We hypothesized that improved clinical follow up using a multidisciplinary protocol will increase the filter retrieval rate.
Materials/methods: following institution of a multidisciplinary follow up protocol, the records of all patients who had an IVC filter placed, during a 22 month period, were retrospectively reviewed. After placement of the IVC filter, a referral was made to the hematology clinic for a three month clinical follow up evaluation and determination of one of three recommendations: 1) filter to remain in place indefinitely, with or without adjunctive anticoagulation; 2) filter to be retrieved; or 3) filter to remain in place for an additional time period, with or without adjunctive anticoagulation, with another follow up appointment made for further evaluation.
Results: 257 IVC filters were placed in 252 patients. 80 patients were recommended to have their filters retrieved. 76 filters were successfully retrieved, for a retrieval rate of 29.6%, which is significantly increased compared to a previously published retrieval rate of 19.3%, prior to instituting the protocol (p=0.005). The median dwell time of all filters successfully retrieved was 176.5 days. The technical success rate for retrieval was 95%.
Conclusion: more aggressive clinical follow up with a multidisciplinary protocol will increase the removal rate of retrievable IVC filters.

P-532

High pressure versus conventional port-systems: comparison of complications and pain perception

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Purpose: the aim of our study was to compare two different totally implantable access ports (TIAP) devices with respect to intrainterventional pain perception, tip-migration and complications.
Materials/methods: from April 2008 to October 2008, a TIAP was implanted in 94 oncological patients (36 male, 58 female; mean age: 52±4 years) via the internal jugular vein. Indication for placement was systemic intravenous chemotherapy. Patients in whom follow-up contrast-enhanced CT-scans were planned within tumour aftercare; a high pressure port-system (PowerPort, Bard Access System, UT, USA) with an 8-F catheter was implanted (n=49). Other patients received a conventional port-system (Bardport, Bard Access System, UT, USA) with a 6-F catheter (n=45). Intrainterventional pain perception (visual analogue scale from 1 to 10), tip-migration and radiation dose were documented for each port-system and implantation side. Differences were compared with Wilcoxon´s t-test. For ordinal variables, comparison of two groups was performed with the Fisher's exact test. P<0.05 was considered as statistical significant.
Results: no major periinterventional complication occurred. Intrainterventional pain perception was similar in both groups. Significantly less tip migration was observed in the PowerPort-group (p=0.03) and in case the port-system was implanted on the right side

(p=0.03).In the BardPort-group catheter-occlusion and catheter loops occurred in 3 and 1 patient, respectively. In the PowerPort-group, none of these problems occurred. One case of vein thrombosis was observed in the Powerport-group, but none in the BardPort-group.
Conclusion: implantation of normal as well as of high pressure TIAPs via the internal jugular vein is safe. Regarding the tip-migration and port-dysfunction, the PowerPort-system seems to be advantageous.

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Stenting in superior vena cava syndrome: balloon expandable stent versus self expandable stent

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Purpose: to compare the results of balloon expandable and self expandable stenting in superior vena cava syndrome.
Materials/methods: one hundred forty eight patients with superior vena cava syndrome (SVCS) underwent stent placement. There were 122 male and 26 female patients, aged 35 to 86 years old, mean 59.2 years. Self expandable stents were used in 90 patients and balloon expandable stents in 58 patients. The end points were recurrence of symptoms or death. Data was analyzed by intent-to-treat with Fisher's exact test.
Results: there were 12 technical failures, 8 (13.8%) with balloon expandable stents and 4 (4.4%) with self expandable stents (p=0.06) and 4 thrombosis at the time of stenting; therefore, the primary clinical success was 89.2% (n=132). As the 4 initial thromboses were treated successfully by local fibrinolysis, there was an assisted primary technical success in 136 patients (91.9%). Complete clinical relief was achieved in 49 (54%) patients with self expandable stents and in 14 (24%) patients with balloon expandable stents (p<0.001). The patients were symptom free from 4 days to 22 months (mean 9.2 months). Among those patients treated successfully, there were 4 recurrences (8.2%) with self expandable stents and 8 recurrences (57.1%) with balloon expandable stents (p<0.001).
Conclusion: in SVCS self expandable balloon stents have better technical and clinical results and fewer recurrences than balloon expandable stents.

P-535

MDCT imaging of the pulmonary veins in the pre-RFCA planning: accuracy and radiation exposure with ECG-gated and not-gated acquisition

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Purpose: detailed pulmonary vein (PV) anatomy is useful for atrial fibrillation (AF) ablation, but pre-procedural computed tomography (CT) radiation exposure is not a negligible issue. Our purpose is to assess accuracy and radiation exposure (RE) comparing ECG-gated with non-gated 64-slice CT imaging.
Materials/methods: 44 pts were considered, divided in two groups: Group-1 included 30 pts and Group-2 24 pts submitted to ECG-gated and non-gated CT, respectively. Match accuracy between the electro-anatomy map (EAM) and computed tomography (CT) images was defined both by manual (maximum distance -MD- between correspondent CT/EAM PV ostia) and automatic calculations ("surface registration").
Results: match was excellent in 95/118 (80.5%) PVs in Group-1 and in 83/95 (87%) PVs in Group-2; unacceptable in 15/118 (13%) PVs in Group-1 and in 5/95 (5%) PVs in Group-2. Match was excellent/acceptable in >3 PV ostia in 25/30 pts (83%) in Group-1 and in 22/24 pts (92%) in Group-2: in both groups the "surface registration" average value was significantly inferior to that observed in the pts with a mismatch of >2 PV ostia. Match accuracy was independent from rhythm during CT/EAM acquisitions. RE was 10-13 mS in Group-1; 0.7-1.7 mS in Group-2 (p<0.001).
Conclusion: in our population, integration of both ECG-gated and non-gated CT images with EAM resulted in excellent match in >80% of the PV ostia allowing real-time guided ablation in most patients. Non-gated CT was associated to a significantly decreased RE.

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Difficult filter retrievals: what else is there to do?

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Purpose: to report techniques and outcomes of difficult inferior vena cava (IVC) filter retrievals.
Materials/methods: following IRB approval, we have reviewed our database retrospectively between 1996 and 2008. All standard optional vena cava filter retrievals were excluded from our study. We have included patients with optional filters that had unsuccessful filter retrieval attempt with standard method with loop snare. We are reporting alternative filter retrieval techniques, filter retrieval failure reasons and successful alternative techniques.
Results: 24 patients with optional filters, dwell time mean of 11 weeks. Technically successful procedures were 19/24 (79%). In all patients, IVC hook was embedded in the IVC wall. Successful retrieval procedures (19 patients): guidewire loop (17/19), catheter spin (1/19), tip deflecting wire (1/19). Unsuccessful filter retrievals (5 patients) associated with pain on traction (2/5), unsuccessful separation of the hook from the IVC (3/5).
Conclusion: filter retrieval failures using standard methods attributed to the hook embedded in the IVC wall. Alternative filter retrieval maneuvers appear to be safe and increase successful filter retrieval rates.

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Previous PICC placement is associated with tunneled chronic hemodialysis catheter-related infections in patients undergoing hemodialysis

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Purpose: catheter-related infections are a significant source of morbidity and mortality in patients receiving hemodialysis. Peripherally-inserted central catheters (PICCs) have been hypothesized to compromise hemodialysis access due to vascular damage and venous thrombosis. Venous thrombosis itself in the context of catheter use has been associated with catheter-related septicemia. Here, we examine the association between PICC placement and tunneled chronic hemodialysis catheter outcomes.
Materials/methods: a computer search of medical records and retrospective review of all chronic tunneled hemodialysis catheter placements and exchanges at a large university hospital from 9/2003 to 9/2008 was performed. History of PICC placement was assessed by computer search of radiologic studies performed at the same institution from 12/1993 to 9/2008. Indication for dialysis catheter removal was determined from report text and classified into four categories: 1) infection, 2) malfunction, 3) no further use needed and 4) unknown/other.
Results: 191 patients with 764 HD chronic tunneled hemodialysis catheter placements were identified. 47 of those patients (24.6%) had a history of PICC placement; these patients were more likely to have catheters removed due to infection [OR=2.35, 95% CI=1.70-3.27,

p<0.001]. There was no difference between the two groups in age or number of catheters placed.
Conclusion: previous PICC placement may be a risk factor for catheter-related infections in patients undergoing hemodialysis.

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Percutaneous transluminal angioplasty in management of central venous stenosis in haemodialysis patients: our experience with multiple endovascular interventions

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Purpose: to evaluate our recent experience of repeat percutaneous transluminal angioplasty (PTA) in management of central venous stenosis in end stage renal failure patients on haemodialysis.
Materials/methods: a total of 115 patients underwent 297 central venous PTA procedures for central venous stenosis at our institute over a period of 25 months from January 2007 to February 2009. A prospective follow-up was performed on the efficacy of the repeat procedures in maintaining patency of the central veins. The minimum follow-up period was one year.
Results: 68 patients (mean age 60 years, M:F ratio 32:36) underwent initial central venous angioplasty between January 2007 and February 2008. 48/68 (70.6%) were followed up for a minimum duration of one year with remaining 20 patients lost to follow-up. The repeat procedures were performed on an average of every 4.5 months. The one year, eighteen month and two year assisted primary patency rates were 62.5, 37.5 and 14.8%. In patients with patent central veins on follow up, those with more than four PTA interventions had a mean patency of 22 months, whereas patients with four or less interventions had a mean patency of 18 months (p=0.04).
Conclusion: there is beneficial effect of repeated PTA in maintaining patency of central venous stenosis in the mid-term. Multiple interventions are required to ensure patency of central veins in these patients.

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Safety and efficacy of retrievable inferior vena cava filters

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Purpose: to study the safety and efficacy of retrievable inferior vena cava (IVC) filters in the management of deep venous thrombosis (DVT) and prevention of pulmonary embolism (PE).
Materials/methods: a retrospective review of retrievable IVC filter insertions between January 2004 and December 2008 was performed. Ninety-five patients (44 Males, 51 Females, mean age 58 years) out of 241 patients (39.4%) who had IVC filter insertions during the study period received retrievable filters. The COOK Günter Tulip IVC filter was used in all cases. Fifty-five of 95 patients (57.9%) underwent filter retrieval subsequently. Mean interval between filter insertion and retrieval was 15.2 days (range 7 to 48 days).
Results: eighty-one of 95 patients (85.3%) had documented DVT and 42/95 patients (44.2%) had documented PE before filter insertion. The main indications for retrievable IVC filter insertion were contraindication to anticoagulation (n=41) and prophylaxis against PE (n=21). None of the patients had documented new PE after filter insertion. There was no filter migration. Forty-seven out of 55 (85.5%) filter retrievals were successful. Main reasons for failed retrieval were excessive filter tilt and thrombi load. The longest insertion interval and successful retrieval was 48 days.
Conclusion: retrievable IVC filters are safe and effective in preventing pulmonary embolism. The majority are easily retrieved and retrieval up to 48 days after insertion has been successfully performed at our institution.

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Clinical sequelae of asymptomatic CT-detected inferior vena cava filter thrombus

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Purpose: to assess the clinical sequelae of asymptomatic CT-detected thrombus in the IVC filter.
Materials and methods: of 1718 patients who received IVC filter between 2001 and 2008, 598 (35%) had contrast-enhanced CT during follow-up. 117 (20%) had asymptomatic filter thrombus on CT. The clinical, imaging and follow-up data of these patients were reviewed to assess the clinical sequelae of filter thrombus detected on CT.
Results: asymptomatic filter thrombus on CT was seen in 117 (47 M, Mean age 64.7 y) after a median 35 days (range 0-2082 d) following filter placement. Imaging prior to filter insertion demonstrated DVT (39/105, 37%), PE (28/105, 27%) and both (38/105, 36%). The underlying medical diseases included cancer (67/117, 57%), trauma (15/117, 13%), stroke (13/117, 11%) and others (22/117, 19%). The indications for filter included contraindication (49/117, 42%), failure (5/117, 4%), or complications (2/117, 2%) of anticoagulation, prophylaxis (12/117, 10%) and added protection (49/117, 42%). The following filters were placed: TrapEase (101/117, 86%), Tulip (2/117, 2%), Recovery (3/117, 3%), Celect (5/117, 4%), OptEase (4/117, 3%) and others (2/117, 2%). Following filter placement, 87 patients received anticoagulation for a median of 6 months. On CT, the filter thrombus extended superiorly in 5 (4%). IVC occlusion was seen in 12/117 (10%). Once thrombus was detected on CT, 55/87 (63%) patients were started on anticoagulation. During follow-up (median 11.5months), filter thrombus regressed completely in 22/60 (37%), decreased in 11/60 (18%), and progressed in 7/60 (12%). In 1/60 (2%), thrombus progressed to IVC occlusion. Thrombus regressed in 16/55 (29%) of patients who were on anticoagulation and 10/30 (33%) of patients who received no therapy.
Conclusion: asymptomatic, CT-detected filter thrombus rarely progresses to IVC occlusion. There was no significant difference in thrombus resolution rates whether or not anticoagulation is given.

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Catheter-directed thrombus aspiration or ectomy for acute extensive iliofemoral deep venous thrombosis caused by may-thurner syndrome

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Purpose: the authors report their experiences on the management in acute extensive iliofemoral DVT due to May-Thurner syndrome using catheter-directed techniques.
Materials and methods: during a 5-year period, 16 patients (men 3, women 13) with a mean age 51.8 years (age range, 36-68 years) were referred. At the beginning, the patient lie on dorsal position, the filter was placed into inferior vena and the left common iliac vein was detected by retrograde venography from rightside access. After that, ascending venography was performed. A 8 Fr catheter sheath was placed into popliteal vein. The thrombus aspiration or thrombus ectomy with a 8F guiding catheter (n=10) or a 8 Fr Straub Ratarex catheter (n=6) was performed from the catheter sheath. The

residual left common iliac vein narrowing was treated by means of angioplasty and placement of Wallstents. All patients continued to receive oral warfarin. In some patients, the retrieval able filter was taken out after 2 weeks. Patients were followed-up by means of clinic visits and sonography.
Results: after procedure, the iliac vein narrowing was successfully treated by placement of a Wallstent. Significant clinical improvement in the form of decreased extremity or facial edema was noted in 16 patients. During the follow-up, 2 of 16 patients showed the symptoms of valvular insufficiency in the popliteal veins. Their symptoms were improved using elastic stockings therapy.
Conclusions: catheter-directed thrombous aspiration or ectomy therapy for the treatment of acute extensive iliofemoral DVT due to May-Thurner syndrome is an effective method for restoring venous patency and provides relief of the acute symptoms.

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Prospective trial of the relief of symptoms of lower extremity swelling in patients with malignancy by venous stenting only

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Purpose: lower extremity swelling in patients with malignancy is often attributed to advanced, untreatable pelvic or abdominal carcinomatosis combined with a low albumin. We prospectively evaluated symptom relief in patients with lower extremity swelling following venous stenting using a simplified scoring system.
Materials/methods: the study was carried out in a tertiary care university teaching hospital with a large cancer population. Using computed tomography, 30 consecutive patients with histology proven malignancy and lower extremity swelling, unilateral (n=16); bilateral (n=14), were evaluated. Inclusion criteria were unresolved leg oedema, and life expectancy greater than 2 weeks. Patients with a life expectancy less than 2 weeks and acute deep venous thrombosis on either CT or Ultrasound were excluded. Due to the patient population, a very simplified scoring system for evaluation of symptoms was used. Inability to weight bear, inability to walk, and inability to put on shoes (not sandals) were awarded 3 points each. The presence of blisters or skin discolouration was each awarded 5 points. Total score is 19.
Results: mean score pre treatment was 13.4, mean score at 3 and 7 days post treatment was 5.4 and 2.3, respectively. The vast majority of patients experienced profound and prolonged relief from their symptoms.
Conclusion: venous stenting should become first line therapy for relief of swollen limbs in patients with cancer. A multi-centre randomised trial is suggested.

P-543

Radial Hoop strength of large diameter stents: application for venous circulation at sites of venous flexion

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Purpose: self- and balloon-expanding metallic stents differ in their physical properties to make each more appropriate in specific circumstances. Venous stents are liable to be compressed as venous stenoses have higher elastic recoil than arterial stenoses. This is particularly important near joints. Hoop strength is the ability of the stent to maintain its structural integrity. The ideal venous stent should have good radial hoop strength to resist compression, and sufficient malleability to reshape following deformation. We aimed to objectively assess 6 commercially available large diameter stents within independent laboratory conditions.
Materials/methods: prospective blinded trial. Six self expanding stents underwent standardised physical testing under laboratory conditions in a medical manufacturing facility. Cell area and strut thickness were measured under high magnification. Hoop strength was tested on a Machine Solutions Rx500 radial force testing machine. Crush resistance was also calculated and compared.
Results: the Protege 80 mm long stent has a high radial force (0.55 N/mm) and crush resistance (0.65 N/mm). The Wallstent 30 mm had the least radial force, measuring 0.015 N/mm. The greatest strut thickness (0.18 mm) and effective cell area (22.4 mm2) was found in the Bard E Lumminexx (14 x 120 mm).
Conclusion: the characteristics and location of the venous lesion to be treated affect stent choice. Clinicians should use a self-expanding stent at least 2-3 mm in diameter greater than the lesion they are attempting to treat, and should consider the degree of axial compression and torque in a given vessel prior to stent selection.

P-544 withdrawn by authors

P-545

Transhepatic and translumbar central venous catheters: a reappraisal

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Purpose: percutaneous translumbar (TL) and transhepatic (TH) placement of catheters in the inferior vena cava (IVC) and right atrium (RA) is the last effort to maintain access in patients who have depleted all approaches for long-term chronic hemodialysis (HD), total parenteral nutrition (TPN), or other purposes. The TL and TH access approaches to the IVC and RA has been described in isolated reports and some small series in adults. A current review of the topic is needed.
Materials/methods: we represent a retrospective review of our 10-year experience in 12 patients with a total of 9 catheters placed for HD (n=8) and 5 catheters placed for TPN (n=5). Prior to TL or TH catheter placement, the patients had an average of 4.8 placements in the central veins and/or in the common femoral veins.
Results: our technical success was 100%. The TL catheters remained patent and functional for 19.7 days per patient, per catheter versus 187.6 days per patient, per catheter, for the TH catheters. Mean follow-up was 1460 days. Three patients were lost to follow up and there were two documented deaths unrelated to catheter placement.
Conclusion: the TL and TH accesses to the IVC and RA for HD or TPN are safe and durable procedures. The patients are better maintained with the TH approach with a significant longer indwelling time per patient per catheter, compared to the TL approach. A more liberal performance is encouraged in a selected patient population. IRs must be familiar with these approaches.

P-546

Over the wire placement of tunelled dialysis catheters using single incision technique

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Materials/methods: retrospective analysis over 18 months from 7/07 to 2/09. Placement sites, catheter types/lengths, placement success, procedural and late complications recorded. All patients had at least a 30 day follow up for evaluation of catheter related infections.
Results: 104 catheters placed using de novo technique. The procedure involves access of the jugular vein from the expected

catheter exit site in the delto pectoral fossa using a curved micropuncture needle followed by placement of the microwire and sheath. An Amplatz wire is then passed into the right atrium and following subcutaneous tract dilatation with fascial dialtors, the tunelled catheter is then placed over the wire or through a peel away sheath. Technique was successful in 104/105 intended placements, 1 patient had conventional double incision technique for placement. 84 catheters placed on right side (RIJV 80, REJV 4); 20 catheters placed in LIJV. No immediate placement related complication seen. 30 day follow up revealed CRI in 6 patients, 4 requiring removal. 3 patients had poor flow through catheter at 30 days. Catheters used include 70 Merit Proguide, 24 Bard Hemostar, 3 Hemosplit, 4 Medcomp Ash-Split and 3 Arrow Edge catheter. 92 catheters placed without peel away sheath. 4 patients had a tracheostomy.
Conclusion: de novo placement using single incision technique viable method of catheter placement. Complication rates within standard, cosmetic appearance and ease of performance are significant advantages over conventional technique.

P-547

Hybrid endovascular interventional treatment of acute massive pulmonary thromboembolism: mechanical fragmentation, local fibrinolytic therapy, and clot aspiration

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Purpose: to evaluate the efficacy and safety of hybrid treatment by mechanical fragmentation, local thrombolysis and clot aspiration for acute massive pulmonary thromboembolism with hemodynamic impairment.
Materials/methods: within a period of 70 months, 70 patients with hemodynamic impairment were treated by mechanical thrombus fragmentation with a modified rotating pigtail catheter. After embolus fragmentation, all patients received an intrapulmonary injection of recombinant human-tissue plasminogen activator, followed by manual clot aspiration using a large-lumen guiding catheter.
Results: all the patients survived and their clinical status improved. Angiography in all patients after treatment demonstrated improvement of pulmonary perfusion (mean Miller score before treatment 22.1; after treatment 13.1; $p<0.01$). Mean pulmonary arterial pressure decreased from 32.6 to 23.4 mmHg ($p<0.01$). Mean treatment time was 124 min. Complications: (Major) One case of cardiac arrest during pigtail catheter rotation, but recovered. One case of pulmonary artery perforation during aspiration, but rescued by micro-coil embolization. (Minor) One case of catheter shaft fragmentation during catheter rotation, easily pulled out.
Conclusion: hybrid endovascular intervention by mechanical fragmentation using a rotating pigtail catheter with local fibrinolysis and manual clot aspiration achieved a rapid and safe improvement of the hemodynamic situation in patients with acute massive pulmonary thromboembolism. Although no controlled clinical trials are available, this hybrid intervention may be a minimally invasive alternative to surgical embolectomy.

P-548

Safe reiterative use of the ALN vena cava filter

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Purpose: the recent development of retrievable filters has strongly modified the indications of caval filtration. The purpose of this study is to evaluate the safety of iterative procedures of insertion and extraction of a retrievable filter in the same patient.
Materials/methods: between December 1999 and December 2008, 505 *ALN filters were inserted in 500 consecutive patients in the same department. 162 of these filters were retrieved with a final success rate of 98.1%. For five patients, with previous history of DVT and PE, the indication for a long temporary caval filtration was the necessity of an iterative heavy surgery due to neoplastic condition. An *ALN filter was twice inserted and twice retrieved.
Results: in each patient, the two filters were inserted by a femoral approach without any complication. They were retrieved by an iterative jugular approach without any difficulty nor adverse event or alteration of the post-procedural cavogram. The pathologic examinations of the filters showed a microscopic piece of caval endothelium on a strut of one filter.
Conclusion: this study confirms the safe reiterative use of the *ALN filter and the easiness of iterative insertion and retrieval procedures.

P-549

Techniques and considerations in the treatment of central venous occlusions associated with hemodialysis access

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Learning Objectives: to present approaches to treating central venous occlusions while maintaining hemodialysis access, emphasizing long term patency, and preservation of future hemodialysis options.
Background: central occlusions of the axillary, subclavian and brachiocephalic veins and/or superior vena cava occur frequently in association with hemodialysis catheters, fistulas and grafts. Appropriate management is essential for maintaining dialysis access, and preventing or alleviating clinical symptoms resulting from impaired central venous return. Management choices are influenced by thoracic inlet anatomy, occlusion location, presence or absence of venous collaterals, and available access routes for intervention.
Clinical findings and procedure details: we present representative problematic cases of central venous occlusions causing either significant clinical symptoms (e.g., head, neck or upper extremity swelling, headache, visual disturbances) or impaired/failing hemodialysis access. Techniques for recanalizing occlusions including optimal approaches, role of angioplasty, stenting (covered and non-covered) and thrombolysis are discussed and illustrated with clinical examples. Potential management pitfalls, anatomic considerations, complications, technical and clinical success rates, long-term patency and re-intervention options are illustrated and discussed. Postprocedural management strategies including the role of anticoagulants and surveillance imaging are examined.
Conclusion: central venous occlusions are known complications of hemodialysis catheters, fistulas and grafts and may cause considerable morbidity. Although collaterals typically develop and provide central venous return, these channels are inefficient and usually inadequate for maintaining dialysis access. Significant symptoms of impaired venous return may be present. Recanalization of these occlusions may alleviate symptoms and preserve hemodialysis access, but long-term patency rates are significantly affected by techniques used for re-establishing patency.

P-550

Paget-Schroetter disease and upper extremity deep venous thrombosis (DVT): imaging and treatment

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Learning Objectives: to review the presentation, natural history, imaging characteristics and management of Paget-Schroetter

disease.
Background: Paget-Schroetter disease refers to DVT of the axillary and/or subclavian veins. History and physical examination and multimodality imaging are employed in diagnosing this abnormality; management requires a multidisciplinary approach that includes anticoagulation, catheter-directed thrombolysis, angioplasty and surgical decompression.
Clinical findings and procedure details: in Paget-Schroetter disease, the subclavian vein is compressed between the clavicle and subclavius muscle anteriorly and the first rib and anterior scalene muscle posteriorly. Chronic intimal injury results, which worsens with strenuous shoulder activity, and ultimately leads to thrombosis. There is sudden onset of unilateral upper extremity swelling, rubor or cyanosis and prominent shoulder and chest collateral veins. Untreated symptoms usually improve and may become mild or unnoticeable at rest, but recur with activity, causing varying degrees of disability from chronic venous hypertension. Initial imaging with Doppler ultrasonography directly images the axillary vein, but the medial subclavian vein is indirectly imaged because of overlying osseous structures. Further CTA or MRA imaging is sometimes employed. Contrast venography, the "gold standard" for diagnosis, also allows for catheter-based interventions. Treatment consists of clot dissolution using catheter-directed therapies including mechanical or pharmacologic thrombolysis and angioplasty. Once venous function is restored, decompressive surgery is performed to correct the anatomic abnormality. Patients are maintained on anticoagulation afterwards. This educational exhibit illustrates, with clinical and multimodality imaging examples, the diagnosis and treatment of this entity.
Conclusion: knowledge of the characteristics of Paget-Schroetter disease allows for appropriate management.

P-551

Techniques and "pearls" for removal of tilted or embedded retrievable inferior vena cava (IVC) filters

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Learning Objectives: to review and illustrate various techniques for removing retrievable IVC filters that have become embedded in the caval wall or in which standard recovery techniques prove unsuccessful because of excessive filter tilting.
Background: in most patients, retrievable IVC filters can be successfully removed using standard techniques. However, removal may be difficult if the filter is excessively tilted within the IVC, if the tip is directed into a renal vein or other caval tributary or if a portion of the filter has become embedded within the IVC wall.
Clinical findings/procedure details: we initially attempt to remove retrievable IVC filters using the standard recovery techniques that employ a snare device or recovery cone. If these fail, or if imaging suggests standard techniques will likely fail, we employ alternative options, including non-traditional retrieval devices and methods. These alternative techniques include straightening a tilted filter by using a tip-deflecting guidewire or by introducing a wire loop through the filter struts, using an angled guiding catheter to direct a snare toward the filter tip, and using rigid endobroncial forceps to gently dissect tissue and grasp the tip of filters that have become embedded within the caval wall. With many of these techniques, we also utilize a standard snare device after the filter has been successfully reoriented within the IVC.
Conclusion: use of novel methodologies and non-traditional retrieval techniques has allowed for successful removal of tilted or embedded retrievable IVC filters that could not be removed using standard techniques.

P-552

Clinical utility of intravascular ultrasound (IVUS) during venous interventions

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Learning Objectives: to review and illustrate, with real-time and static imaging examples, the clinical utility of IVUS in evaluating venous anatomy and pathology, and to examine the role of IVUS in directing various venous interventions.
Background: IVUS has become an increasingly useful tool in a number of catheter-based vascular diagnostic and therapeutic procedures. IVUS allows for intraluminal and transmural cross-sectional imaging of arteries and veins, and provides highly detailed and accurate information regarding vascular anatomy and lesion morphology. IVUS may be used to guide various catheter based venous interventions such as inferior vena cava (IVC) filter placement, pharmacomechanical thrombolysis, intravascular stent placement and embolization or exclusion procedures. IVUS has particular applicability in patients in whom there is renal dysfunction or an allergic history that prevents the safe use of intravascular contrast media; it may also be used in unstable patients or in those in whom transportation to an imaging laboratory is problematic.
Clinical findings/procedure details: we examine the expanding role of IVUS in the evaluation and management of diagnosis of venous disorders and illustrate normal venous anatomy, vascular variants, anomalies and pathologic processes as seen on IVUS imaging. Representative cases of IVUS directed venous interventions are presented, along with accompanying procedural suggestions and intraprocedural imaging examples.
Conclusion: IVUS is a useful imaging tool in diagnosing and managing various venous disorders and may be used to guide a variety of catheter based venous interventions. Knowledge of pertinent venous anatomy as depicted by IVUS is essential for achieving predictable and successful outcomes.

P-553

Consecutive or late foam sclerotheraphy after EVLA: which one is more effective and tolerated by patients?

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Learning Objectives: to evaluate whether saphenous veins ablation with foam sclerotheraphy (FS) or ablation with or without late sclerotheraphy is more effective and tolerated.
Background: EVLA and foam FS as a one step treatment may be unpleasant. FS one month after EVLA will be an alternative method. 87 patients (130 veins: GSV 123, SSV: 10, large branches: 7) were treated with 980 nm diode laser. Patients were divided in two groups. In the first group, forty-five patients were treated in a single session. In the second group, forty-three patients were treated with laser ablation without FS. FS was done if residual varicose veins were detected after one month.
Clinical findings/procedure details: there was no major complication. In the first group, superficial thrombophlebitis was detected in three patients. In second group, focal parasthesia of the calf was detected in a patient with diabetes mellitus. Incidence of skin changes was almost same in both groups. Complaints of patients such as pain and tender skin were seen more often in the first group than in the second. Only one partial recanalization was detected in the second

group and one revascularization in first group.
Conclusion: there was no significant difference between the two groups according to the outcome of treatment. But patient complaints were significantly higher in first group. Because of this, it is better to treat patient with the EVLA and late foam sclerotheraphy, which seems to be a more comfortable treatment for the patients.

P-554

Successful recanalization of chronic benign central venous occlusion with radiofrequency (RF) puncture wire technique

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Learning Objectives: describe the use of RF wire puncture technique for the recanalization of chronic central venous obstructions in patients with previous failed attempts using conventional endovascular techniques.
Background: between June/08 and February/09, 3 patients (2 males/1 female), age ranging from 52 to 72 years, all presenting with swollen arm secondary to unilateral benign central venous occlusions (one subclavian, two brachiocephalic veins) related to previous catheter placements for hemodialysis access. The patients were successfully treated with RF wire after previous failed attempts at recanalization using mechanical catheter/wire techniques.
Procedure details: upper extremity and central venograms showed the central occlusion site. Venous access through the arm was obtained followed by the PowerWire, which was advanced within a 5-Fr KMP catheter. A straight wire tip combined with a semi-curved catheter provides higher tissue puncture precision. Once in contact with the occlusion site, the RF energy was delivered while the wire was gently advanced for a few millimeters towards a target catheter (second venous access in the groin), which was kept in the other side of the obstruction as a reference. The KMP catheter was advanced and a gentle test injection was performed to confirm its position. If inadequate, a new location was pursued. Once the contra-lateral side of the venous obstruction was catheterized, the RF wire was exchanged for a stiffer wire. Six/eight millimeters balloon angioplasties were followed by stent-graft placement, without immediate/delayed clinical complications and with symptoms resolution.
Conclusion: RF wire offers a promising alternative in benign chronic central venous occlusions when conventional techniques failed.

P-555

Bridging technique for vena cava stenting in three cases with tumor thrombus invading into the right atrium

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We treated three cases of vena cava syndrome complicated with tumor invasion into the right atrium, applying multiple stent insertion bridging from SVC to IVC. In all cases, technical and clinical success was achieved without stent migration or serious complications.

P-556

Venoplasty using pull-through technique by hepatic venous stenosis after living-donor liver transplantation

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We report the case of a 7-year-old girl who suffered abdominal distension by ascites after living-donor liver transplantation. We describe successful venoplasty by hepatic vein stenosis using the pull-through technique after living-donor liver transplantation.

P-557

Visualization of gastric varices with C-arm angiographic CT during retrograde transvenous sclerotherapy

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Balloon-occluded retrograde venogram is sometimes ineffective in identifying gastric varices due to adjacent dilated collateral vessels. C-arm CT helped to identify the target varices and to predict distribution of sclerosant, which allowed the operators to perform sclerotherapy more confidently.

P-558

Successful pharmacomechanical thrombolysis for massive pulmonary and IVC thromboembolism with Trerotola thrombectomy devise in acute versus chronic disease

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Successful mechanical thrombectomy with specially designed devise for fragmenting large amount of acute and chronic massive thromboembolism on pulmonary artery, IVC and both iliac veins has not been reported. A new treatment modality in variable periods of the disease suggested.

P-559

Venous lysis by loco-regional arterial infusion of thrombolytic: systemic low dose, local high dose

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Pregnant lady, K=10.
Occlusive DVT from Infra-renal IVC to left foot.
Treated with low-dose streptokinase infusion through left superficial femoral artery cannula.
Cleared in 48 hours.
IVC filter used.

P-560

May-Thurner syndrome with behcet vasculitis

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Male patient with Behcet vasculitis presented with recurrent left lower limb deep vein thrombosis; CT scan revealed May-Thurner syndrome. After IVC filter insertion and catheter- directed thrombolysis, stenting of left common and external iliac veins restored their patency.

P-561

Emergency suprarenal positioning of inferior vena cava (IVC) filter in a patient with diffuse IVC thrombosis after cholecystectomy

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Choleperitoneum after laparoscopic cholecystectomy in a 55-year-old man with variant biliary anatomy. Diffuse IVC thrombosis obliged filter positioning at the height of sovrahepatic veins prior right hepatectomy. Early and late follow-up CT showed filter integrity and unmodified positioning.

P-562

Placement of a port catheter through collateral veins in a patient with central venous occlusion

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A 31-year-old woman presented with chronic central venous occlusion. A 0.014-inch Whisper guidewire was chosen to maneuver through the collateral veins and a port system was implanted. We suggest this approach to avoid unfavorable translumbar or transhepatic CVC access.

P-563

Superior vena caval placement of a tempofilter

N. Chang, **J.-K. Kim***, N.-Y. Lim, H.-J. Oh;*
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We placed Tempofilter within SVC (right femoral approach) in two patients with thrombosis in left brachiocephalic vein and left axillary vein to prevent pulmonary embolism during mechanical thrombectomy and thrombolysis

P-564

Pacemaker lead migration: endovascular treatment with stent fixation in the pelvic vein

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We report treatment for migrated pacemaker lead into the pulmonary artery with retraction and stent fixation in the pelvic vein. This simple method can be used in cases of unsuccessful lead extraction; however, the retracted lead must be long enough.

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PART 4

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