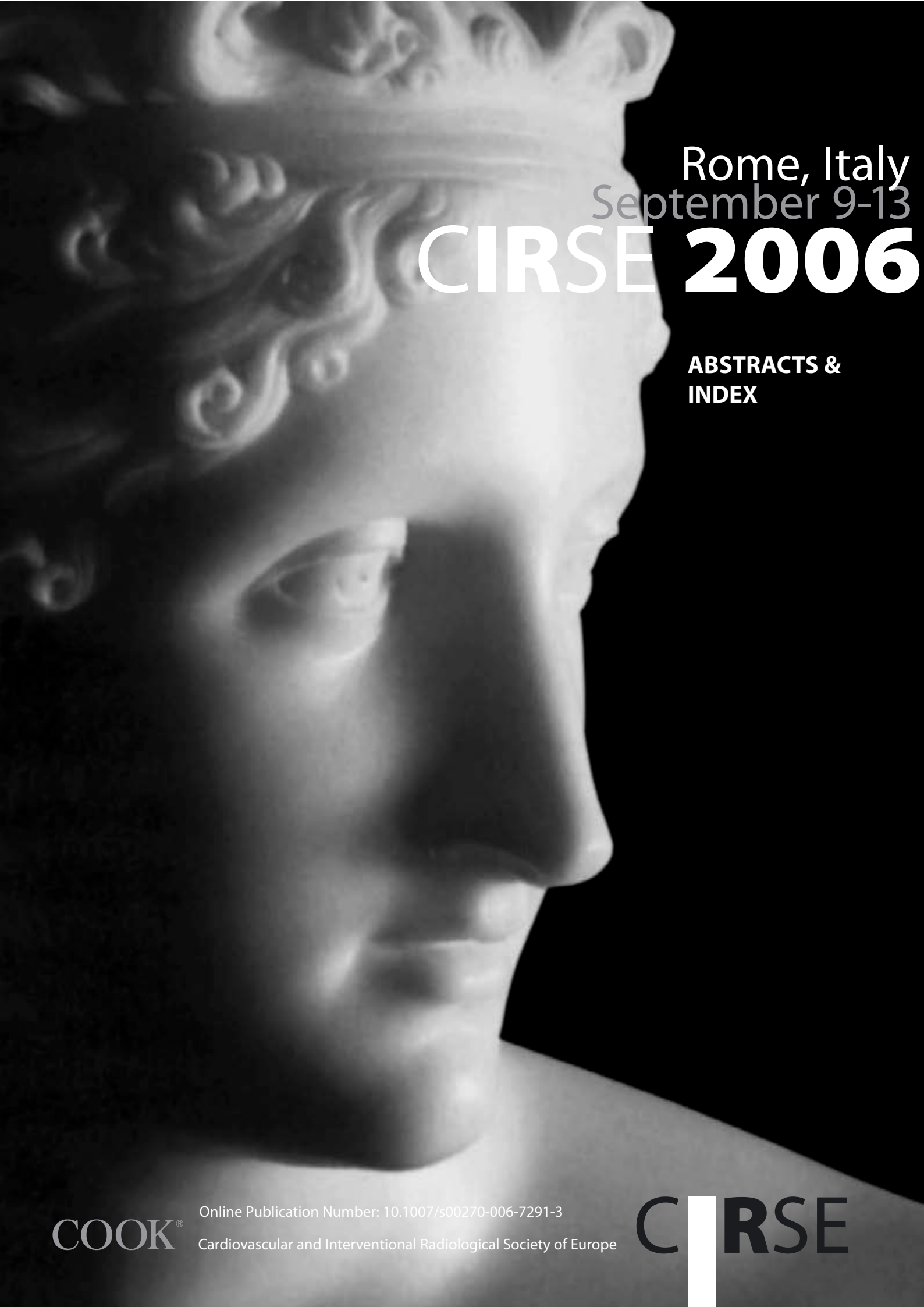

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ABSTRACTS & INDEX

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Special Session
Trauma

1.1

Imaging strategies for the multiple trauma patient

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Introduction

Injured patients are considered serious or as "polytrauma victims" according to the mechanism of injury (fall of height superior to 3 meters, speed of the accident superior to 50km/h, context of drugs, expulsion of a vehicle, incarceration, death of co-passenger etc.) or the number of lesions, at least one being life threatening. Polytrauma victims have an important socioeconomic impact as they cause high health expenses and as most of the patients are young (up to 45 years) (1).

The "golden hour" of polytrauma management

In respect of the "golden hour" of polytrauma management, the "conventional" work-up of these patients upon arrival in hospital is performed according to the ABCD schema. Sufficient and fast therapy of life threatening lesions is very important and enhances the chances of survival significantly (2).

After stabilization and during monitoring of the patient, first diagnostic examinations (radiography and ultrasound scan of the thorax, abdomen and the pelvis, lateral plain films of the cervical spine) are performed. If no indication for direct therapeutic intervention as for example angiography, embolisation or surgery exists (e.g. due to massive mediastinal enlargement, intra-abdominal fluid or air, important pelvic fracture with acute deglobulisation), on demand Computed Tomography (CT) of the clinically suspect body region is performed. Only afterwards complementary plain films of the peripheral skeleton are obtained (3).

Imaging modalities of trauma patients

Abdominal sonography

The use of ultrasound as a detection tool for free fluid is called **FAST** (**F**ocused **A**ssessment with **S**onography for **T**rauma) (4). It may be performed by emergency staff (with limited experience in sonography), including nonragiologists or surgeons. Abdominal sonography is a easy and fast diagnostic toll for depicting free fluid (5), whereas its sensitivity compared to contrast enhanced CT in the detection of organ lesions is low (41%) (6). Nevertheless it is a good tool for guiding the polytrauma management by differentiating between those patients who have to be operated immediately (due to instability and massive haemoperitoneum) and those needing further investigations. The clinical examination and other clinical criteria underestimate largely abdominal injury (7), therefore CT is the gold-standard of examination for depicting parenchymal organ lesions in stable polytrauma patients (8). Moreover it has to be taken into consideration that ultrasound scan conditions in the intensive care unit are difficult and operator-dependent.

Thoracic radiography

It has been shown that plain films of the thorax miss a certain number of lesions (especially small anterior pneumothorax which can rapidly lead to a large pneumothorax under ventilation). Grieser at al. (9) showed in a prospective study that CT is more sensitive than conventional radiography in depicting trauma-lesions. Moreover 58,8% of these lesions did require therapeutic intervention. Certain authors state that Multi Slice CT (MSCT) is the "gold standard" for diagnosing a traumatic aortic arch disruption (10).

Plain films of the spine

Wintermark et al. (11) have shown that plain films of the spine have a sensibility of only 33,3% in detecting unstable fractures, whereas a sensitivity of 97,2% is obtained by MSCT. Moreover instable fractures were missed, which can potentially lead to a longer hospital stay and to a higher morbidity of the trauma patient.

Whole Body CT (WBCT)

Introduction of Multi Slice CT (MSCT) allows a fast acquisition of large body regions, multiplanar reconstructions and Volume Rendering (VR), making a complete scan of a trauma patient from head to toe possible. Thereby the role of imaging modalities in polytrauma management changed tremendously. Hence, **Whole Body CT (WBCT) is adopted successfully in the management of polytrauma victims** by several authors (12-17) while the last years and became part of specific algorithms.

The concept consists mainly in WBCT of stable polytrauma victims after initial diagnostic examinations (RX and sonography scan) in the intensive care unit. Other authors (18) suggest, if the workflow and the interdisciplinary teams are prepared, a total replacement of initial conventional plain films and ultrasound by WBCT in only partially stable polytrauma victims. Also described are the existence of a CT scan in the resuscitation unit that can avoid position changes of the patient and an on-place angiography suite. On the other hand not performing initial diagnostic examinations encounters the danger to perform diagnostic procedures in an instable patient and to retard therapeutic procedures (19).

Protocol of WBCT

The protocol of WBCT depends on the type of machine and local protocols that exists in the department:

The standard protocol includes a non-injected acquisition of the brain. A helical non-injected acquisition of the cervical spine is carried out afterwards while the arms are positioned next to the thorax if no cervical spine injury is obvious. The arms are positioned upwards during the thoracic acquisition. Others tolerate the artifacts to avoid time-consuming adjustments of the arms. Usually only an arterial injection on the thorax is performed, followed by a portal phase on the abdomen and the pelvis down to the pubis. Reconstructions of the cervical, thoracic and lumbar spine are performed in all three planes in bone and soft tissue windows if necessary (e.g. exclusion of haematoma).

Even though the protocol of WBCT is performed systematically, it may and should be adapted to the clinical context. E.g.: if extravasation of blood is suspected (e.g. deglubilisation) a non-injected acquisition is performed prior to injection in order to view an acute hemorrhage (e.g. suspected lesion of the aortic arch). A suspected lesion of the urinary excretory system, massive intra-abdominal fluid of unclear origin or haematoma may make a tardive acquisition mandatory.

Reading out pearls

Real time reading out of the images during acquisition is mandatory for an effective WBCT polytrauma algorithm. A second "final reading out" with reconstructions should follow at the workstations, thus leading to the final report.

The growing experience with WBCT for polytrauma conditions helps us further develop the protocol of the examination.

Potentially missed lesions

Vessels of the neck

Recent reports (20, 21) have suggested that lesions of the neck vessels may be missed and therefore an increase of brain injuries can occur. If the mechanism of injury or the symptoms of the patient may suggest injury of the neck or superior thorax, we suggest after a non-injected acquisition of the brain, a CT-angiography starting at the base of the skull (including the vessels of the neck), followed by an acquisition of the thorax and abdomen. According to the CT findings a "conventional" angiography can be performed either for diagnostic confirmation of the findings or directly for treatment of the injury. In most cases MRI-angiography is too time consuming in emergency conditions. However it is an excellent non-invasive follow-up measure for stable patients.

Abdomen

Further important injuries that may be missed are abdominal ones, especially contusions of the intestine, spleen and liver.

Pneumoperitoneum has to be excluded carefully. Therefore a concise knowledge of anatomy is necessary: Sometimes a perforation of the tube (e.g. the duodenum) causes no pneumoperitoneum, but retropetoneal air, or no air at all. Focal abnormal wall thickening or intra-abdominal fluid make follow-up scans mandatory.

Thorax

Important and potentially live threatening conditions not to be missed in the thorax are mainly injuries of the aortic arch, contusions of lung parenchyma and serial costal fractures leading to a pneumothorax. If a lesion of the aorta is suspected, but the acquisition artifacts (due to ventilation, reanimation material etc.) do not allow a precise diagnosis, angiography should be performed for diagnostic and therapeutic purposes.

High-quality images obtained by 16 to 64 slice CT allow millimetric reconstructions, 3-dimensional reformates and VR, help avoid missing lesions as in the past due to solely use of conventional plain films.

Training

Furthermore the experience and training of the radiologist is an important aspect of the diagnostic performance of WBCT, especially since reading out of this large amount of images (1000-3000 images) particularly at night, may be very demanding and tiring for the on-duty radiologists.

A different important aspect of quality-polytrauma-management is a multidisciplinary good functioning trauma-team including intensivists, anesthesiologists, surgeons and radiologists who have concise experience in trauma medicine. Studies have shown that this may reduce mortality significantly (22).

Irradiation

Irradiation aspects suggest a high irradiation exposure due to WBCT. A recent study (23) showed that the irradiation is maximum 3 fold compared to the "conventional" algorithms using exclusively conventional radiography and even equal to the irradiation of conventional radiography and subsequent additional CT.

Other Polytrauma-Approaches

The concept of **ATSL** (Advanced Trauma Live Support) guidelines for Doctors by the American College of Surgeons Committee of Trauma (24) advocates a slightly different concept of polytrauma treatment that is concentrated on "damage control" in order to reduce the mortality of severely injured patients. They have to be admitted to a specialized intensive care unit and treatment is performed in knowledge of the physiological reactions of the patient to severe trauma: In the first hours only absolutely necessary surgical procedures are performed and all more time-consuming surgical procedures are performed after the phase of hyperinflammation (2^{nd} to 4^{th} day) and immunosupression (2^{nd} to 3^{rd} week) in order to avoid a "second hit" due to iatrogenic interventions. Imaging modalities adapted to this concept include only the necessary ones after stabilization of the patient. Into which extend WBCT-imaging can be included into this concept depends mainly on the stability of the patient.

In conclusion, WBCT is a key element of up-to-date level one trauma management, allowing an accurate and fast diagnosis in stable severely injured patients.

References

1. Krotz, M., P. J. Bode, et al. (2002). [Interdisciplinary shock room management: personnel, equipment and spatial logistics in 3 trauma centers in Europe]. Radiologe 42(7): 522-32.
2. Kuhne, C. A., S. Ruchholtz, et al. (2004). [Personnel and structural requirements for the shock trauma room management of multiple trauma. A systematic review of the literature]. Unfallchirurg 107(10): 851-61.
3. Hauser, H. and K. Bohndorf (1998). [Radiologic emergency management in multiple trauma cases]. Radiologe 38(8): 637-44.
4. Scalea, T. M., A. Rodriguez, et al. (1999). Focused Assessment with Sonography for Trauma (FAST): results from an international consensus conference. J Trauma 46(3): 466-72.
5. McGahan, J. P. and J. R. Richards (1999). Blunt abdominal trauma: the role of emergent sonography and a review of the literature. AJR Am J Roentgenol 172(4): 897-903.
6. Poletti, P. A., K. Kinkel, et al. (2003). Blunt abdominal trauma: should US be used to detect both free fluid and organ injuries? Radiology 227(1): 95-103.
7. Poletti, P. A., S. E. Mirvis, et al. (2004). Blunt abdominal trauma patients: can organ injury be excluded without performing computed tomography? J Trauma 57(5): 1072-81.
8. Foley, W. D. (2002). Special focus session: multidetector CT: abdominal visceral imaging. Radiographics 22(3): 701-19.
9. Grieser, T., K. H. Buhne, et al. (2001). [Significance of findings of chest X-rays and thoracic CT routinely performed at the emergency unit: 102 patients with multiple trauma. A prospective study]. Rofo 173(1): 44-51.
10. Gavant, M. L., P. G. Menke, et al. (1995). Blunt traumatic aortic rupture: detection with helical CT of the chest. Radiology 197(1): 125-33.
11. Wintermark, M., E. Mouhsine, et al. (2003). Thoracolumbar spine fractures in patients who have sustained severe trauma: depiction with multi-detector row CT. Radiology 227(3): 681-9.
12. Kloppel, R., D. Schreiter, et al. (2002). [Early clinical management after polytrauma with 1 and 4 slice spiral CT]. Radiologe 42(7): 541-6.
13. Linsenmaier, U., M. Krotz, et al. (2002). Whole-body computed tomography in polytrauma: techniques and management. Eur Radiol 12(7): 1728-40.
14. Albrecht, T., J. von Schlippenbach, et al. (2004). [The role of whole body spiral CT in the primary work-up of polytrauma patients--comparison with conventional radiography and abdominal sonography]. Rofo 176(8): 1142-50.
15. Kalai A, Maratos YK, Clément O, Frija G. (2003) Assessment of the gravity of the polytrauma victims. In: RSNA. 89th Scientific Assembly and Annual Meeting, Chicago, 179.
16. Maratos YK, Kalai A, Clément O, Loeb T, Frija G. (2005) Which assessment should be preferred for polytrauma victim? ECR, Vienna, Springer,15 supp 1:367
17. Maratos YK, Kalai A, Loeb T, Clément O, Frija G. (2005) Three year experience by Whole-body CT scanner. The outcome of a level 1 Trauma center. In: RSNA. 91st Scientific Assembly and Annual Meeting, Chicago, 642.
18. Boehm, T., H. Alkadhi, et al. (2004). [Application of multislice spiral CT (MSCT) in multiple injured patients and its effect on diagnostic and therapeutic algorithms]. Rofo 176(12): 1734-42.
19. Poletti, P. A., M. Wintermark, et al. (2002). Traumatic injuries: role of imaging in the management of the polytrauma victim (conservative expectation). Eur Radiol 12(5): 969-78.
20. Cothren, C. C., E. E. Moore, et al. (2004). Anticoagulation is the gold standard therapy for blunt carotid injuries to reduce stroke rate. Arch Surg 139(5): 540-5; discussion 545-6.
21. Mutze, S., G. Rademacher, et al. (2005). Blunt cerebrovascular injury in patients with blunt multiple trauma: diagnostic accuracy of duplex Doppler US and early CT angiography. Radiology 237(3): 884-92.
22. Ruchholtz, S., D. Nast-Kolb, et al. (1994). [Early mortality in polytrauma. A critical analysis of preventable errors]. Unfallchirurg 97(6): 285-91.
23. Wedegartner, U., M. Lorenzen, et al. (2004). [Diagnostic imaging in polytrauma: comparison of radiation exposure from whole-body MSCT and conventional radiography with organ-specific CT]. Rofo 176(7): 1039-44.
24. ATSL (Advanced Trauma Live Support) for Doctors by the American College of Surgeons Committee of Trauma 7th edn. (2003) Chicago/IL.

Special Session
Robotics for Interventional Procedure

2.1

Value of robotics in patient care

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Computer assisted percutaneous interventions: applications from head to toe

3D navigation systems allow for an interactive visualization of the actual position of a surgical instrument with respect to the preoperative acquired image datasets. The surgeon can navigate on multi-planar reconstructed images in real-time. In contrast to conventional surgery the surgeon can identify, localize and access structures behind and in the vicinity of the surface. This is especially important if one deals with vital structures like vessels and nerves. Due to pre-operative planning and simulation standard surgical approaches can be adapted to the individual anatomic situation.

Principles of navigation systems

Computer-assisted surgery is based on preoperatively acquired CT or MR images. Frameless stereotactic navigation systems consist of a workstation, a monitor, a three-dimensional coordinate-detection system and various instruments. They show the actual position of the probe with respect to cross sectional images of the preoperative dataset. Most tracking systems are based on optic principles:

Active optical systems (Medtronic, Brainlab, Stryker, Radionics, Robodent,...) are equipped with a probe with infrared light-emitting diodes, two or three infrared position sensor cameras that are mounted on a trolley-stand and a dynamic reference frame (DRF).

Instruments and anatomic structures are assumed as rigid bodies. DRFs are used to track the actual position of the patient in space by providing a spatial coordinate system relative to the patient's anatomy. The DRF is rigidly attached to the patient. Once the patient is registered the rigid body (= patient with tracker or bone fragment with tracker) and the camera can be moved with respect to each other without loosing the spatial information. In frameless stereotactic neurosurgery the tracker is usually attached to the head fixation device or the DRF may be screwed directly to the patient's head or mounted on a non-invasive dental cast.

In contrast to active optical systems the instruments of passive systems (Medtronic, Brainlab,…) are equipped with reflective markers. Infrared light signals that are emitted by two cameras are reflected by the markers and detected by the same cameras. The computer calculates the actual spatial position of the markers (instruments) on the basis of the angles of the incoming reflected light. The bench accuracy of active and passive instruments is in the range of 0.2 to 0.4 mm. DRFs may also be equipped with passive markers. In contrast to conventional active infrared systems the passive instruments are wireless which improves the surgeon's flexibility.

A Navigation in the cranial area

Usually 1 mm or 3 mm axial contiguous CT slices of the patient's head are obtained the day before surgery. Most authors use fiducials applied to the patient's skin during CT - or MR imaging. They must remain in place until surgery. The two dimensional CT data are transferred to the navigation system and reconstructed to a 3D - dataset. After intubation the DRF has to be rigidly attached to the patient by means of an immobilization device. Various instruments including pointer, forceps, suction tube, endoscope are calibrated. The key step is the registration, during which the spatial configuration of the patient in the OR, is correlated with the pre-operative images of the patient. It is a correlation of the imaged space with the physical space. This is done by indicating the reference points (e.g. skin fiducials) on the patient with the probe of the navigation system and selecting the respective points on the dataset. Using skin fiducials an accuracy of about 2-3 mm is usually achievable. Once the registration process has been completed, the tip of the probe is displayed in real time on the computer monitor. The position of the instrument's tip appears on the screen within various reconstructed images of the surgical area. Before the navigation system can be used during surgery the accuracy has to be checked by touching clearly identifiable landmarks. If the accuracy is not satisfactory the registration procedure may be repeated. Additional surface registration or landmark registration techniques may be added to improve the accuracy.

Alternative registration methods

The simplest registration method is the use of anatomical landmarks. Clearly defined external (nasion, spina nasalis, tragi, medial canthi) and/or internal landmarks are touched with the probe and correlated with their locations in the imaged CT- or MR-dataset. The advantage of using landmarks is that the diagnostic dataset can be used, thus necessitating an additional scan. Identification of the landmarks in both the patient and the imaged dataset is difficult, to a certain extent subjective and strongly depending on the experience of the operator (with a learning curve). Generally, these methods are inaccurate and they are time-consuming. Surface matching, which is done by touching about 40 points of the patient's skin or bone, can be used to refine anatomical registration. Pointing of the skin with the probe of the navigation system can also be replaced by a laser pointer. Such devices are commercially available from Medtronic and Brainlab. In most cases a sufficient accuracy can be obtained especially if the area of interest is close to the face whose contour is used for registration. However, all registration methods which are based on the skin surface are sensitive to skin shift which may lead to inaccuracies.

The most accurate registration can be achieved with markers implanted into the skull. Unfortunately they may cause major patient discomfort and should not left in place over an extended time.

Reproducible external reference frames (Hirschberg and Kirkeby 105-07;Bale et al. 208-13;Martin et al. 261-65;Bale et al. 208-13) in combination with dynamic reference frames allow for registering the patient in his absence the day before surgery. In addition they allow for attaching DRFs non-invasively to the patient for tracking the patient's movement during surgery. The patient has to wear the frame during the CT scan.

The headset of the InstaTrak system, which fits in the ear canals and on the bridge of the nose, provides also external reference points and compensates for head movements during surgery. In addition the system automatically detects the markers in the headset. However, should the headset inadvertently shift in relation to the patient's skull, the surgeon does not get any feedback from the system, requiring an accuracy check before each application of the guidance tool.

The Vogele-Bale-Hohner (VBH) mouthpiece (Medical Intelligence, Schwabmünchen, Germany) is an individualized dental cast that is held against the upper jaw by negative pressure. The vacuum area is connected via a tube to the vacuum pump.

The Vogele-Bale-Hohner (VBH) mouthpiece in combination with registration rods or the SIP Lab Innsbruck frame (Medical Intelligence, Schwabmünchen, Germany) has successfully been used for immobilization and registration of the patient during more than 600 computer assisted surgeries in the cranial area. In contrast to the other external reference frames, repositioning can be controlled by the amount of negative pressure on the vacuum scale. Should the required negative pressure not be attained, the mouthpiece is not precisely repositioned. A volunteer study confirmed a repositioning accuracy of the VBH mouthpiece itself with respect to the patient's head with well under one millimetre, thus providing the most accurate non-invasive external reference points(Martin et al. 261-65). The mean localization accuracy of an optical navigation system using the VBH mouthpiece for registration with 3 mm axial CT slices was in the range of 0 and 2 mm(Bale et al. 208-13). One major drawback of the mouthpiece is its dependency on a minimum of two intact teeth.

CAS using the VBH mouthpiece

A VBH mouthpiece is fabricated prior to the scan taking about 10-15

minutes. The CT/MR scan is performed with the patient wearing the VBH mouthpiece and the SIP-Lab frame. In the SIP-Lab the DRF is mounted to the VBH mouthpiece. Due to the high repositioning accuracy of the VBH mouthpiece with respect to the skull and due to the application of the dynamic reference frame the registration can be performed in the laboratory in the absence of the patient. The registration protocol is stored on the navigation system. After oral or nasal intubation the VBH mouthpiece is introduced into the patient's mouth and automatically registered by reloading the registration protocol. Due to the rigid attachment of the DRF on the mouthpiece the patient's head may be moved during surgery without loosing accuracy.

In phantom studies as well as in clinical studies as accuracy comparable to invasive markers could be achieved. This work is an important step towards a novel unified approach in the diagnosis and therapy of brain tumours.

Computer-assisted punctures in the cranial area

Besides the application of frameless stereotactic navigation systems for surgical procedures such systems may also be used for pre-planned image-guided punctures of different lesions or anatomical structures. Basically there are two ways to achieve that task: First, the CT/MR and the surgical intervention are performed in the same session. This is usually done with a conventional frame. It is invasively fixed to the skull and due to the lack of the possibility to reposition the frame with respect to the patient's skull the planning procedure and the intervention have to be performed in the same session, the patient being anaesthetized during the whole procedure in most cases.

The second option is the separation of image acquisition and therapy in time and location, necessitating precise markers for registration and rigid immobilization. Therefore the VBH mouthpiece/headholder is an ideal non-invasive registration and immobilization tool.

Before applying the VBH head holder the repositioning accuracy had to be evaluated.

Due to the fact that precise repositioning of the patient is also an important prerequisite for fractionated radiotherapy our group decided to adapt the VBH head holder to the requirements of radiotherapy. In contrast to the studies performed by Martin et al. where only the repositioning accuracy of the VBH mouthpiece with respect to the patient's skull was determined the repositioning accuracy of the patient's head in the VBH head holder was evaluated. In 5 volunteers and in 250 measurements the mean repositioning accuracy was 1.02 mm, as compared to 3.05 mm using the conventional mask immobilization system(Sweeney et al. 475-83).

Development of targeting devices for frameless stereotactic punctures

An important prerequisite for a precise linear targeting are not only a rigid patient (target) immobilization but also a rigid guidance of the instrument (endoscope, brachytherapy needle, biopsy needle, radiofrequency needle,...) that has to be advanced into the patient's body. In total four different aiming devices for computer-assisted punctures have been developed and patented by our group as early as 1995. Two of them have been commercialized in the meantime.

- Philips EasyTaxis™ Image-Guided Surgery System (Adams L., van den Brug W.P., Vogele M., Bale RJ: European Patent PHN 16.013/ alignment device).
- Medtronic VERTEK™ Targeting device (Vogele M., Bale R.J: European Patent 0871407).
- Medical Intelligence Atlas targeting device (Vogele M., Bale R.J: European Patent 0871407).

Using these targeting devices the worldwide first frameless stereotactic punctures with stabile guidance were performed by our group.

B Extracranial computer-assisted punctures

Retrograde computer-assisted drilling of osteochondral lesions of the talus for reperfusion

The principles for the therapeutic strategies of osteochondral lesions consist of debridement of the cartilaginous part and methods, which should revascularize necrotic bone. The latter is usually the intention for drilling of the sub-cartilaginous zone. Due to the fact that an antegrade drilling of lesions located dorso-medial is technically difficult or even impossible and due to the invasiveness of the conventional approach with a medial tibial osteotomy retrograde drilling techniques were developed.

Our approach using computer-aided navigation technology is a further development of these already existing techniques. An important prerequisite for precise computer-assisted targeting is a rigid fixation of the patient and a precise registration. Because osteochondritis dissecans stage 2 and 3 require additional arthroscopy and spongiosa plastic most of these procedures have to be performed in the OR. In addition we do currently not have a 3D image acquisiton tool (e.g. ISO C 3D, intraoperative CT) in the OR. Thus, a reproducible immobilization of the upper ankle is necessary in order to separate image acquisition, planning and therapy in time and location. This has been realized by the development of a special scotchcast fixation device. The steps of the procedure in this area are similar to those in the cranial area:

The patient is immobilized during CT scan in the FiscoFix cast. The CT-data are sent to the navigation system in the SIP-Lab via network. After path-planning on the 3D- object the aiming device is adjusted in the laboratory in the absence of the patient. For the actual surgery the patient's leg is repositioned in the sterilized cast and the retrograde drilling is performed under fluoroscopic control by using the pre-adjusted targeting device. There is no need for a navigation system in the OR. Depending on the shape and size of the lesion the defect may be supplied with a spongiose bone autograft. In addition special guides allow for parallel drillings.

The accuracy of pin placement in 10 cadavers was 1 to 3.5 mms. In the meantime more than 40 patients were treated with this method. The additional pre-operative efforts are compensated by the reduced operating time. Maybe this technology will be helpful in near future to guide complex retrograde cartilage-bone grafts surgery.

A novel immobilization method for computer-assisted extra-cranial interventions

In contrast to the cranial area and the ankle the remaining body parts may not be reproducibly immobilized due to the soft tissue shift. This is especially the case in adipose patients. Thus the concept had to be changed to an ,,all at once"-procedure. We developed and evaluated a novel fixation technique for immobilization during the time from the CT scan to the actual puncture. The so-called BodyFix (Medical Intelligence GesmbH, Schwabmünchen, Deutschland) is based on negative pressure technology.

The BodyFix™ fixation device consists of a vacuum pump connected to different types of machine-washable pillows which are filled with tiny Styrofoam balls (similar to a vacuum splint). A thin plastic foil is used to cover the region of interest. For hygienic reasons the patient is first covered by a thin cushion. Then, the patient's extremity is wrapped up with one of the pillows and covered with the plastic foil. The pillows are placed such that there is an area left for the surgical approach. When the vacuum pump is turned on, the air is evacuated from between the covering foil and the therapy couch, resulting in a hardening of the cushion, which is simultaneously sucked against the therapy couch together with patient. The intensity of fixation can be selected by adjusting the degree of negative pressure built up by the vacuum pump.

Usually these interventions are performed directly in the CT room. Alternatively the patient can be brought from the CT to the OR/ intervention room by a transfer-couch
which is equipped with a battery for the BodyFix pump.

Frameless stereotactic puncture in the CT-room using the BodyFix fixation system

The patient is immobilized in the BodyFix system on the CT table. Skin fiducials are attached to the patient and/or to the BodyFix. A CT scan of the area of interest is obtained (1- 3 mm slice thickness depending on the procedure). The CT datasets are sent directly to the navigation system in the CT room via intranet. The path is planned on the individual 2D and 3D reconstructed images. After sterile washing and draping a sterile DRF is mounted to the frame

of the BodyFix. Registration is performed by indicating the fiducials on the patient and selecting the corresponding markers on the 3D dataset. The navigation system provides a value indicating the registration accuracy. In most systems it is the root mean square error which is defined as the mean of the distance of the paired points that were used for registration. If the markers are optimally distributed around the volume of interest this value is a very good indicator of the overall accuracy. Usually an RMSE in the range of 1 mm can be achieved. After an additional accuracy check by indicating the markers that were not used for registration the actual navigational procedure can start.

The sterile targeting device is mounted to the BodyFix frame and adjusted according to the pre-operative plan

The needle or drill is advanced through the targeting device to the pre-planned depth. A fusion of the intra-operative control CT (with the needle in place) with the planning CT (with the planned path) is performed allowing for a precise measurement of the accuracy of the puncture.

For interventions in organs that are sensitive to respiratory motion (the liver or the bases of the lungs) general anaesthesia is required in order to reposition the liver/lung with high precision. All the CT-scans, the registration procedure and the puncture are performed in maximal exspiration, which can be easily achieved by disconnection of the endotracheal tubus. Using this technique a repositioning accuracy of 1-3 mm can be achieved (unpublished data).

This technique is routinely performed at our institution for puncturing different lesions from head to toe:

- bone tumour biopsy.
- radiofrequency ablation of bone tumours (osteoidosteoma, metastasis).
- vertebral disc biopsy.
- percutaneous fixation of pelvic fractures
- vertebral discography.
- retrograde drilling of osteochondral lesions in the ankle, knee and hip.
- liver puncture for biopsy and radiofrequency ablation

Computer assisted navigation allows for a precise 3D distribution of the needles around the tumour. The time required for set-up is about 10-15 minutes. The time from the planning CT to the placement of the needle is about 30 minutes. The application of navigation systems in combination with the BodyFix and the Vertek targeting device allows for a precise puncture in various regions of the body at the first attempt without the need for a correction of the position of the needle, thus even tiny lesions, which cannot be reached with conventional puncture techniques can be reached. In contrast to conventional CT guided punctures double angulated approaches are feasible with high accuracy.

Current developments in cooperation with the SIP-Lab Innsbruck - a short overview

Current navigation systems were designed for the application in the OR. The use of navigation systems for percutaneous punctures in a CT suite is an additional application of these conventional navigation systems. In cooperation with CAS Erlangen and the Institute of Medical Physics we developed the CAPPA® IRAD, a novel navigation system which is adapted to the requirements for percutaneous punctures in the CT

The reference frame that is scanned simultaneously with the patient is equipped with reflective markers that are automatically detected by the navigation system, thus allowing for an automatic registration. The interventional radiology can immediately start with the targeting procedure using our special targeting devices. This is an additional step towards a system which may also be used by radiologist who are not familiar with navigation technology. Another project focuses on the application of 3D - rotational angiography for percutaneous punctures of osseous lesions. Other projects deal with the development and/or evaluation of robots for an automatic adjustment of an aiming device along a given trajectory:

- A73 robot: cooperation with Medical Intelligence (Schwabmünchen, Germany), Medizinphysik Erlangen, ENT department Erlangen and CAS Innovations (Erlangen, Germany).
- B-rob for CT-guided punctures: Cooperation with Seibersdorf, University Hospital Vienna and Medical Intelligence (Schwabmünchen, Germany).
- Innomotion robot for MR-guided punctures: Cooperation with Innomedic (Germany).

Conclusion

The progresses in the area of image-guided and minimal-invasive procedures lead to an increasing use of imaging data for planning, simulation and therapy. Many classical surgical approaches are replaced by less invasive methods. All these methods require pre-operative imaging data in order to allow for a safe navigation in the patient's body.

The spectrum of conventional CT-US-MR-guided punctures is enlarged by an additional computer-assisted puncture technique utilizing 3D image data. The 3D-guided puncture technique provides a better accuracy and a more sophisticated planning of the percutaneous path because the puncture plane can be selected individually. The pathway can be planned precisely thus sparing vital structures. In our opinion navigation system will be increasingly important for the radiologist. Besides data acquisition, data preparation and interpretation the radiologist of the near future should also use the navigation system for percutaneous interventions.

By transfer of the planning phase and the adjustment of the targeting device out of the OR expensive OR time can be saved. Standardized surgical approaches can be adapted to the respective individual anatomical situation as visualized on the preoperative images.

However, computer-assisted navigation will never fully replace the surgeon. The novel technologies are only designed to assist the surgeon. The responsibility lies always in the hands of the surgeon/interventionalist. A fundamental knowledge of the basic principles and functionalities of the novel technologies is an important prerequisite for a reliable task in order to provide benefit for our patients.

References

1. Bale, R. J. et al. „Computer-assisted neurosurgery by using a noninvasive vacuum-affixed dental cast that acts as a reference base: another step toward a unified approach in the treatment of brain tumors." J.Neurosurg. 93.2 (2000): 208-13.
2. Bale, R. J. et al. „Computer-assisted neurosurgery by using a noninvasive vacuum-affixed dental cast that acts as a reference base: another step toward a unified approach in the treatment of brain tumors." J.Neurosurg. 93.2 (2000): 208-13.
3. Bale, R.J. et al. Application of the Vogele-Bale-Hohner (VBH) Head Holder in Computer-assisted Neurosurgery. In: Lemke HU et al. (eds). Computer Assisted Radiology and Surgery, Elsevier, Amsterdam, New York, pp. 686-690. (1999)
4. Bale, R. J. et al. „Head and neck tumors: fractionated frameless stereotactic interstitial brachytherapy-initial experience." Radiology 214.2 (2000): 591-95.
5. Bale, R. J. et al. „[First experiences with computer-assisted frameless stereotactic interstitial brachytherapy (CASIB)]." Strahlenther.Onkol. 174.9 (1998): 473-77.
6. Bale, R. J. et al. „Osteochondral lesions of the talus: computer-assisted retrograde drilling--feasibility and accuracy in initial experiences." Radiology 218.1 (2001): 278-82.
7. Bale, R. J. et al. „[Noninvasive head fixation for external irradiation of tumors of the head-neck area]." Strahlenther.Onkol. 174.7 (1998): 350-54.
8. Bale, R. J. et al. „Minimally invasive head holder to improve the performance of frameless stereotactic surgery." Laryngoscope 107.3 (1997): 373-77.
9. Caversaccio, M. et al. „The „Bernese" frameless optical computer aided surgery system." Comput.Aided Surg. 4.6 (1999): 328-34.
10. Drake, J. M. et al. „Frameless stereotaxy in children." Pediatr. Neurosurg. 20.2 (1994): 152-59.

11. Fink, C. et al. „[Computer-assisted retrograde drilling of osteochondral lesions of the talus]." Orthopade 30.1 (2001): 59-65.
12. Fried, M. P. et al. „Image-guided endoscopic surgery: results of accuracy and performance in a multicenter clinical study using an electromagnetic tracking system." Laryngoscope 107.5 (1997): 594-601.
13. Hirschberg, H. and O. J. Kirkeby. „Interactive image directed neurosurgery: patient registration employing the Laitinen stereo-adapter." Minim.Invasive.Neurosurg. 39.4 (1996): 105-07.
14. Hoser, C. et al. „A computer assisted surgical technique for retrograde autologous osteochondral grafting in talar osteochondritis dissecans (OCD): a cadaveric study." Knee.Surg. Sports Traumatol.Arthrosc. 12.1 (2004): 65-71.
15. Martin, A. et al. „Vogele-Bale-Hohner mouthpiece: registration device for frameless stereotactic surgery." Radiology 208.1 (1998): 261-65.
16. Rosenberger, R. E. et al. „[Computer-assisted drilling of the lower extremity. Technique and indications]." Unfallchirurg 105.4 (2002): 353-58.
17. Smith, K. R., K. J. Frank, and R. D. Bucholz. „The NeuroStation--a highly accurate, minimally invasive solution to frameless stereotactic neurosurgery." Comput.Med.Imaging Graph. 18.4 (1994): 247-56.
18. Sweeney, R. et al. „Repositioning accuracy: comparison of a noninvasive head holder with thermoplastic mask for fractionated radiotherapy and a case report." Int.J.Radiat.Oncol. Biol.Phys. 41.2 (1998): 475-83.
19. Sweeney, R. A. et al. „Multimodality cranial image fusion using external markers applied via a vacuum mouthpiece and a case report." Strahlenther.Onkol. 179.4 (2003): 254-60.
20. Zinreich, S. J. et al. „Frameless stereotaxic integration of CT imaging data: accuracy and initial applications." Radiology 188.3 (1993): 735-42.

2.2

MR guided robotic intervention

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INTRODUCTION

MR-guided percutaneous interventions have been clinically established with open low field MR systems [1]. As imaging quality of closed bore scanners is superior but the access to the patient limited a fully MR-compatible assistance system INNOMOTION (Innomedic, Herxheim & FZK Karlsruhe Germany) [2,3] was developed to provide precise and reproducible instrument positioning inside the magnet. Platform compatibility has been achieved for 1.5 T MR scanner, Magnetom Symphony, Siemens, Erlangen, Germany and 1.0 T Gyroscan and 1.5 T Intera Philips, Eindhoven NL. Targeting recision have been determined with a FARO arm, on ex vivo organ models (embedded in Agarose) The evaluation of target precision has been proven during MRI guided percutaneous interventions in an porcine animal model is beeing described.

MATERIALS AND METHODS

Instrumentation

The pneumatic robotic assistance system is fully MR-compatible and consists of a robot arm which can be manipulated in 6 degrees of freedom [2,3]. The robot arm is attached to a 260° arch that is mounted to the patient table of the scanner and can be passively prepositioned on the orbit at vertical 0°, 30° and 60° at each sides of the orbital according to the region of interest (e.g. spine, liver, kidney, breast). Active positioning measurements are achieved via fiber optically coupled limit switches, rotational and linear incremental sensors. The kinematics has been specially designed for the purpose of the close bore MRI scanners and CT units. Piezzo electric drives have been tested but due to the RF noise during MRI scanning and the risk of inductive heating of the electric power lines pneumatic cylinders with slow motion control have been developed. The cylinders drive all five degrees of freedom (DOF).

A module for application of coaxial probes (e.g. cannulae for biopsies, RF or Laser Probe, endoscopes, etc) provides two degrees of freedom in X and Z axis and is attached to a robotic arm with 4 degress of freedom. This design assures stabile positioning of the instrument with in a tool center point that keeps the "invariant point of insertion" through the skin.

Fig 1. Application module for manual cannula insertion

The application module (Fig 1) for clinical use provides manual translation and rotation of the cannula. A pneumatic drive has been developed to insert the cannula in incremental steps of 1 - 20 mm. In conjunction with the two axes for movements in the tool center point (+/- 30°) the instrument trajectory can be changed to other targets without moving the robot arm or repositioning the arm on the arc. The arch is movable and can be firmly attached to the patient table of the MR system with exchangeable fittings suitable for other MRI platforms. A graphical user interface provides planning of insertion on the MRI images.

The patient can be placed in the predetermined position suitable for the intervention (supine, prone or lateral). The system is prepositioned and firmly attached to the table with clamps. According to the pre-interventional images and according to the anatomical regions of interest the table is moved using the projection of the laser vizier of the MRI. The robot is referenced with the coordinate system of MR scanner using the same laser line. The arm moves back and force and returns so that the light detectors at the upper part of the application module are aligned with the laser (with in +/- 0.5 mm). The laser light is switched off and the table is automatically moved in to the MRI bore until the position of the laser line matched with 0 of the Z axis of the MRI. Planning of interventions is performed by using fast gradient echo sequences in transverse, sagittal or coronal orientation. Suitable slices are selected and sent via network in DICOM format to the computer of the assist system. Insertion site and a target point are selected on the graphical user interface monitor and the coordinates sent to the control unit. The drives are activated and the application module is moving with the tool center point to the insertion site on the skin. The cannula can then be inserted through a guiding sleeve or along an open angle.

EVALUATION OF TARGETING PRECISION

Mechanical targeting precision have been determined with a FARO arm under dry lab conditions. The MRI procedures were performed a 1.5 T Siemens Magnetom Symphony, Erlangen, Germany, 1.0 T Gyroscan and 1.5 T Intera Philips, Eindhoven, NL, on ex vivo organ models (fresh porcine kidney embedded in Agarose and Gelatine).

The evaluation of target precision has been proven during MRI guided percutaneous interventions in an porcine animal model. The evaluation of target precision has been proven during MRI guided percutaneous interventions in an porcine animal model under general anesthesia (Isoflurane). The animalprotocol was approved by the animal IRB of Heidelberg University. The animals (four 3-month old domestic pigs 30 - 40 kg) were placed prone on the patient table and a surface coil was fixed around the planed insertion site lateral to the spine.

T1- and T2-weighted planning images, the appropriate region of trajectory was defined on the graphical user interface of the Innomotion control computer and the robot arm then moved and oriented the needle holder to the insertion point accordingly. 20 and 22 G MR-compatible Titanium grade 4 cannulae (MRI Devices-Daum, Schwerin, Germany) were then manually inserted. Subsequent to an initial insertion of ca. 10 mm the table was repositioned on MRI bore and control images were acquired. Precision of insertion point and insertion angle has been determined by using overlays of the pre-

interventional images of the graphical user interface monitor with the new MRI image.
The intervention was completed within the magnet from the rear opening, where an MR-compatible in-room monitor was placed. During insertion of the needle, real-time MR images were acquired to control. To visualize advancement of the cannula in the tissue fast Gradient Echoes sequences (TR = 4.4 ms; TE = 2.2 ms; FA 70°; TA = 0.7 s) were used. At the desired region of interest (nerve root, plexus coeliacus) spin echo images were acquired for verification the cannula position through a test bolus of contrast agent solution (NaCl/GdDTPA: 100/1itre of 0.8% saline solution). The injection was done under real-time MRI (TR = 1.8 ms; TE = 4.3 ms ; TA = 0.5 - 0.8sec.; FA = 20°) to visualize the drug distribution. Final therapeutic injection of 10-25 ml with contrast dotted Mepivacainhydrochlorid (Scandicain®1%, Astra - Zeneca, Germany) was performed.
RESULTS
All procedures were then completed successfully e.g. injection at sympathetic chain, sciatic nerve and coeliac plexus. The direct MRI control with new sequences techniques allows correction of the insertion path in case of deterioration due to anatomical structures. The insertion site and the insertion angle have been evaluated by manual measurement on overlays of the planning image of Innomotion and the subsequent MR control image. Position and orientation of all cannula insertions were appropriately visualised on axial MRI images. Precision of insertion site in axial plane was +/- 1mm (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°.
CONCLUSION
Cross platform MRI compatibility can be achieved by using polymer, ceramics, pneumatic drives and optoelectronic sensors. For MRI guided cannula interventions. As the cannula is currently to be advanced manually the access is difficult if insertion is done inside the magnet. However the direct control of the insertion under real time MRI is recommended as to be able to correct insertion in case of deterioration of the cannula and to precisely position the tip of the cannula in the volume of interest. To ease the procedure tip tracking techniques haven been evaluated [4].

References

[1] Melzer A, Seibel R. MR Guided Therapy of Spinal Diseases. Min Inv Ther All Techn, 3:1999 , 89-93
[2] Melzer A, Gutmann B, Lukoschek A, et al. Experimental Evaluation of an MRI compatible Telerobotic System for CT MRI guided Interventions. Radiology Suppl. 444, p.409 (2003).
[3] Gutmann B, Gutmann B, Gumb L, et al. A. Principles of MR/CT Compatible Robotics for Image Guided Procedures. Radiology Suppl. 0032CEVI, p. 677 (2002)
[4] Bock M, Zimmermann H, Gutmann B, Melzer A, et al: Combination of a fully MR-compatible robotical assistance system for closed-bore high-field MRI scanners with active device tracking and automated image slice positioning, Radiology Supplement SSE16-02 p. 398

2.3

Robotic-assisted interventions for US and CT Guidance

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PURPOSE
Percutaneous biopsy performed using ultrasound (US), or Computed-Tomography (CT) for imaging guidance has been shown to be a safe and reliable alternative to excisional surgical biopsy. The high efficacy of these techniques, however, depends on the accuracy of the needle placement and the quality of the harvested tissue. At times, access to a target can be technically challenging due to various factors, including a limited space at the skin entry site or a difficult angulated access. Thus, a robotic-assisted biopsy device using the guidance of US or CT is of great clinical value for several reasons: (1) it will provide very stable needle guidance, even for angulated approaches, (2) it will allow access to lesions when the width of the CT gantry would limit the access for a biopsy needle or other interventional tools, such as thermal ablation probes, and (3) it may further expand the time window for exploration of a lesion when using contrast agents because more time can be spent to target a lesion. Then, the robot may be able to guide the needle into the most promising region of the lesion without the need for a second contrast injection. Thus, more efficacious characterization and treatment, particularly for lesions that are difficult to target, can be anticipated [1-5]. Several groups have already used CT imaging to guide roboticassisted procedures.To our knowledge, however, none of these systems was designed to use both imaging modalities, ultrasonography (US) and CT. [6, 7]. Our goal was to develop a prototype robotic system (B-Rob I) designed to be used for US- and CT-guided biopsies. Using US- and CT guidance, we sought to prove the feasibility, accuracy, and efficacy of B-Rob I, a robotic system, during robotassisted biopsy, validated by in vitro biopsy tests [8, 9].
MATERIALS AND METHODS
The complete robotic system, B-Rob I, includes the following components: (1) an optical tracking system (Polaris, Northern Digital Inc., Waterloo, Ontario, Canada) for continuous update of positional data of the US-transducer or CT scanner, the phantom bag's position), and the robot position; (2) a Linux (SUSE 7.1)-based industrial PC (Pentium III, 1 GHz, 128 MB RAM) equipped with a video capture card (WinTV-PCI-FM 718, Hauppauge Computer Works Inc.), including the medical planning software „ROBUST"; (3) a 4-degree of freedom (DOF) robotic arm for gross positioning; (4) a 3-DOF needle-positioning unit (NPU), including a needle holder; and (5) the robot control system (MS Windows 2000-based industrial PC, Pentium III, 1 GHz, 128 MB RAM), which includes custom input devices and safety switches to control the robot kinematics. According to the requirements of clinical practice, the entire robotic system was mounted on a mobile platform. Thus, the robotic system could easily be transferred to different interventional sites. Because the video output is a standardized interface of US scanners and can be used to connect to CT displays easily as well, we used the video signal as input for the robot system. Fine needle adjustments are possible with 3 DOF without simultaneous movement of the 4 main axes (A1A4), which ultimately contributes to system safety. For easy sterilization, the 2 fingers, including the cylindrical needle holder, can be disconnected from the NPU by means of a rapid-change bayonet connection.
Registration of the System Components:
To determine the spatial relationship between the 3 involved system components (US transducer/CT-gantry, phantom bag, and robot), the positional data of each item was obtained by 3 optical tracker tools that were registered to the robot's coordinate system by means of a point-to-point registration process. This procedure had to be performed only once, and the resulting fiducial registration error was between 0.7 and 0.9 mm.
Registration of CT Coordinates to the Robot:
To transfer the spatial coordinates of the needle, as measured by the robot during the intervention, to the coordinate system of the phantom (i.e.patient), the transformation between the robot coordinate system and the US- or CT scanner coordinate system was determined by a rigid transformation of 2D-US or CT-slice coordinates and slice location into the 3D coordinates of the robot using an acrylic glass (Perspex) cube with fiducial spheres attached, of which the position and orientation in space was defined with a registration process previously. After selection of 2030 fiducial spheres, the fiducial markers were identified by selection at the graphical user interface of the calibration system and combined with the known

sphere's coordinates using a 6-DOF transformation matrix.
Phantom Model and CT Imaging:
For the in vitro tests, a phantom model filled with gelatin and equal-sized peas (mean diameter, 9.9 ± 0.4 mm), was prepared. For CT-guided biopsy a tracker tool mounted on the front side of the phantom was used to obtain the CT table's position while scanning and moving the table. Thus, the spatial relationship to the robot coordinate system could be established, while moving the CT table in or out during imaging. Once a pea was selected for biopsy, the CT table was moved to the appropriate table position, and a CT scan was acquired in the multisclice biopsy mode (80 kV, 80 mAs, rotation time 0.5 seconds, slice collimation 12 ± 0.75 mm, slice width 9.0 mm, FOV 380 mm, Kernel B30f). Simultaneously, the corresponding image of the target was „grabbed" from the video output of the CT scanner and converted into a digital file. At the same time point, the coordinates of the CT table position were measured by the optical tracking system and transferred to the planning workstation.
Planning of the Intervention:
Planning of the intervention was performed by means of custom software („ROBUST") developed using C++programming language with Qt-Library (1.45) and SUSELinux 7.1. Using the acquired CT image, the „skin" entry point, as well as the center of the target, were selected on the planning workstation. After computation of the trajectory, relevant data, such as angulation of the needle and distance to the target, was calculated and sent to the robot controller via a TCP/IP socket connection.
Positioning of the Robot and Execution of the Intervention:
After confirming the planned access, the 4-DOF robotic arm was moved near the phantom's entry point into a safety position, approximately 4 cm above the „skin" entry point. Fine adjustments of the NPU, according to the calculated coordinates, were performed by a constrained motion of the robot kinematics before the NPU was lowered at the „skin"level. Then, after blocking the 6 main axes (A1-A6), the NPU finally moved caudally to the skin entry point by activation of an auxiliary linear axis, A7, with reduced speed and force. At this position, a 17-gauge puncture needle with a surgically sharp 4-sided bevel tip (length 130 mm; Bard, Angiomed, Karlsruhe, Germany) was inserted into the robotic needle holder. According to the insertion depth calculated during planning, the small rubber marker of the puncture needle was moved to the position displayed to indicate the appropriate insertion depth. Once the puncture needle was inserted into the phantom, the stylet of the puncture needle was removed and the 18-gauge biopsy needle with a beveled tip (Bard, Angiomed, length 160 mm) was inserted. Using an automated biopsy device (Magnum Core high Speed, 22-mm excursion), one biopsy sample was obtained coaxially. The complete intervention was monitored and documented on the control window by means of graphical information from the planned and real biopsy trajectory superimposed on the actual US or CT scan. The actual trajectory of the needle guide was calculated constantly via a standard kinematic transformation based on the internal sensor systems of the robot as well as by using the position measurement based on the optical tracker mounted at the NPU. Intermittent US- or CT control-scanning confirmed the appropriate needle position. Should there have been a need for a correction of the needle angulation, this could have been easily accomplished by means of manual correction using a robot-input device. All biopsies were performed by one experienced radiologist (J.K.), whereas the length of the harvested pea specimen was measured independently by 2 investigators (J.K,M.F.) after the 18-gauge biopsy needle was removed. The average of these 2 measurements was used for further analysis. To evaluate the deviation of the biopsy trajectory from the targeted pea, the deviation of small linear artifacts caused by gas bubbles along the biopsy trajectory within the gel phantom were measured with US within two orthogonal planes.
RESULTS
The skin entry point was selected arbitrarily to be more at the „edge" of the phantom, and the needle was always placed perpendicular to the convex surface of the phantom. Thus in many cases, an oblique angle, compared with the horizontal table, was achieved within the imaging plane (x- and y-axis). The median distance of the target center from the surface of the phantom bag („skin") was 3,7 (range, 1.56.9) cm for the US-guided biopsy and 7.0 ± 0.3 cm (range, 6.4 7.5 cm) for the CT-guided biopsy respectively. In both experiments, only 1 needle pass was necessary to obtain a biopsy specimen. The mean length of the harvested specimen, as calculated from measurements obtained by 2 different observers, was 5.5±1.2 mm and 5.6 ±1.4 mm for US and CT-guided biopsies respectively. The mean deviation between the needle trajectory and the center of the target along the x-axis (transverse plane) and the z-axis (sagittal plane) was 1.1±0.8 mm and 1.4±0.9 mm the for US-guided biopsies and 1.2 ± 0.9 mm and 0.6 ± 0.4 mm for CT-guided biopsies. The mean duration of the procedure, including targeting, planning, biopsy, and retrieval of each specimen, was 2.6±1.0 (range, 1.56.0) min for US-guidance and 2.8 ±0.4 (range, 2.4 3.4) minutes for CT-guidance. Using US for the guidance for robot-assisted biopsy, the maximum deviation along the transverse plane and the z-axis was 2.9 mm and 3.6 mm, respectively. In this study, under the guidance of CT, the maximum deviation along the transverse plane and the z-axis was 2.5 mm and 1.1 mm, respectively. Although the mean deviation along the x-axis was not significantly different for either US or CT guidance ($P < 0.643$), the mean deviation along the z-axis was significantly ($P < 0.026$) lower using CT guidance. The mean insertion depth of the puncture needle was significantly lower ($P < 0.001$) in the US study than in the CT study (3.7 ± 1.5 cm vs. 7.0 ± 0.3 cm, respectively). However, with both US and CT guidance, the difference in quality and length of harvested specimens (5.5 ± 1.2 mm vs. 5.6 ± 1.4 mm, $P < 0.403$), as well as the mean duration of the procedure, was not significant (2.6 ± 1.0 minutes vs. 2.8 ± 0.4 minutes, n.s.).
DISCUSSION
Robotic systems can enhance surgical and interventional procedures through improved precision, stability, and dexterity. Furthermore, a robot is resistant to infection and radiation and also can be used for telerobot applications. The ability to use detailed, quantitative information from US, CT, or magnetic resonance imaging (MRI), in particular, allows robots to accurately guide instruments to pathologic structures deep within the body. Robotic-assisted biopsy may further expand the time window to explore a lesion when using new ultrasound agents, since more time can be spent to target a lesion [13]. Thereafter the robot may guide the needle into the most promising region of the lesion without the need of a second contrast injection. We demonstrate that percutaneous biopsy is feasible and safe using our prototype robot system designed to remotely guide a biopsy needle to small targets localized with US and CT imaging. The high precision of registration, planning, and movement of the robotic NPU enabled an effective biopsy in all cases, with a high accuracy for even relatively small targets such as peas. The results from other groups who used CT-guidance for robot-assisted interventions support our results. Although high precision could be achieved during in vitro tests, for clinical applications, small movements of the patient could be registered with a tool attached to the patient's body. The added benefit of a real-time compensation for patient motion however, must be carefully evaluated. In addition, an immobilization device (BodyFix immobilization device, Medical Intelligence, Schwabmuenchen, Germany) has been proven to be useful in reducing patient movement during an intervention. Registration techniques to compensate for movement of organs during breathing are under development elsewhere and further developments may consider the use of motion filters, similar to those used by cardiac robots (10).
CONCLUSION
These phantom experiments indicate that our robotic system can be used for several percutaneous interventions. Easy transfer and conversion for use with either US or CT guidance, a 7-DOF remote-

controlled needle guide with the pivot point at skin level, and the potential benefit of real-time compensation for patient motion differentiate our work from others. Our new prototype will be mounted on the CT table so it will move with the same speed and provide the same relative position as the target. To avoid cumbersome and expensive optical tracking systems for registration we will relay on internal sensors of the robot and fiducials mounted at the NPU. Two passive arms with 7-DOF and 2-DOF positioning modules with short axes will further reduce mechanical instabilities. Then, clinical safety will be evaluated and future studies will compare US- and CT-guided biopsies on randomized targets.

References

1. Fichtinger G, DeWeese TL, Patriciu A, et al. System for robotically assisted prostate biopsy and therapy with intraoperative CT guidance. Acad Radiol 2002;9:60-74
2. Yanof J, Haaga J, Klahr P, et al. CT-integrated robot for interventional procedures: preliminary experiment and computer-human interfaces. Comput Aided Surg 2001;6:352-359
3. Masamune K, Fichtinger G, Patriciu A, et al. System for robotically assisted percutaneous procedures with computed tomography guidance. Comput Aided Surg 2001;6:370-383
4. Ng WS, Davies BL, Timoney AG, Hibberd RD. The use of ultrasound in automated prostatectomy. Med Biol Eng Comput 1993;31:349-354
5. Vilchis A, Masuda K, Troccaz J, Cinquin P. Robot-based tele-echography: the TER system. Stud Health Technol Inform 2003;95:212-217
6. Kronreif G, Fürst M, Kettenbach J, Figl M, Hanel R. Robotic guidance for percutaneous interventions. ADVANCED ROBOTICS 2003;17:461--576
7. Melzer A, Gutmann B, Lukoschek A, al. e. Experimental Evaluation of an MRI compatible Telerobotic System for CT MRI guided Interventions. Radiology Suppl 2003;444:409
8. Kettenbach J, Kronreif G, Figl M, et al. Robot-assisted biopsy using ultrasound guidance: initial results from in vitro tests. Eur Radiol 2004
9. Kettenbach J, Kronreif G, Figl M, et al. Robot-assisted biopsy using CT-guidance: initial results from in vitro tests. Invest Radiol 2005;40:219-228
10. Bale RJ, Lottersberger C, Vogele M, et al. A novel vacuum device for extremity immobilisation during digital angiography: preliminary clinical experiences. Eur Radiol 2002;12:2890-2894

2.4

The future of robotics in medicine and health

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Among the most significant applications of robotics, the adoption of robotic systems for medicine and health has been receiving a great deal of attention in the scientific community. The goal of this presentation is twofold: 1) to provide a taxonomy of medical robotics; 2) to discuss the challenges of new developments in the field.

Medical robotics can be classified in three broad areas: robotics for surgery, rehabilitation robotics, biorobotics. Robotics for surgery is concerned with the study of robotic tools which improve quality of intervention, in terms of accuracy, reduced invasiveness, predictability of results. The background for the area is constituted by the results in mechanical design, kinematics, control algorithms, and programming that were developed for industrial robots, which are directly applicable to many surgical applications (since late ,80s). Enhanced robotic capabilities through adaptability (the use of sensory information to respond to changing conditions) and autonomy (the ability to carry out tasks without human supervision) have contributed to the development of the area. Useful techniques for surgery are: image processing, spatial reasoning and planning, real-time sensing and control, haptics. The strengths and limitations of humans vs. robots are discussed, and the „surgical robot" is identified as one element of a larger system designed to assist a surgeon in carrying out surgical procedures: preoperative, intraoperative, and postoperative. Minimally-invasive procedures, e.g. laparoscopy, are presented in terms of their benefits vs. the inherent limitations on dexterity in manipulation. The robotic assistance is perceived as: the design of devices with good dexterity and intuitive control that can be inserted through small incisions; the development of general purpose systems that can execute a range of procedures in general, thoracic, and gynecological surgery; the ability to perform stable and untiring tasks, such as endoscope pointing and organ retraction, and to work at microscopic scales. Next, image-guided procedures are presented which employ noninvasive imaging techniques such as: computer tomography and magnetic resonance [3D]; ultrasonography, fluoroscopy, conventional X-ray radiography [2D]. These allow the precise location of pathologies, and wishfully the treatment while sparing surrounding healthy tissue, e.g. a biopsy and resection of brain tumors. The interaction modes of such procedures, from autonomous mode to interactive/assistive mode, to full control by surgeon are critically discussed, also for what concerns the applications in surgical training and simulation, through e.g. the adoption of haptic interfaces. Technical issues (mechanical design, sensing and control) as well as clinical implementation issues (safety and acceptance) are discussed in view of the main challenges in the area.

Rehabilitation robotics is concerned with the study of robots and machines which improve the quality of life of impaired and elderly people, mainly through increased personal independence. To this category also belong the robots employed for motor therapy, with the largest group of end-users, i.e. the stroke survivors suffering from impaired movement. The main features of omnidirectional smart wheelchairs and therapist robots (for simultaneous therapy delivery and measure of recovery of limb control) are presented. Then, the new concept of personal robot is discussed, where physical interaction with user and environment demands for safety and dependability. Mobile robotic system for personal assistance and for service in hospitals are being developed, which are more or less acceptable by the user, depending on the type of control (pleasant tasks) vs. the level of autonomy (unpleasant tasks). Further, the emerging area of domotics is introduced as the integration of robotics, telematics and home automation for the house of the future. The main challenge in the area is the high cost/benefit ratio, which is related to: high technical complexity, difficulty to use, low efficiency, scarce functionality, poor reliability, narrow market; which all may lead to low impact on life quality of impaired. As such, the greatest impact of rehabilitation robotics is not concerned with the devices themselves, but rather with their effect on the infrastructures supporting rehabilitation.

Biorobotics is concerned with the study of human-like or animal-like robots, as well as the use of robots as tools for better understanding of human neuro-physiology and pathologies. In details, biorobotics can be defined as the correlation of biology (biomechanics, neuroscience, physiology) to robotics (mechanics, control, sensors) and, as such, has lead to the development of humanoids, biomechatronic prostheses, and even cyborgs. Physio-anatomical, mechanical, and psycho-cognitive features are discussed which should lead to the development of a „more human robot", while the phenomenon of the social robots in Japan is underlined. The neurophysiological model of sensory-motor coordination in humans is at the basis of a bio-inspired robot design (visual information, motor commands, hand/arm proprioceptive information, haptic information) and ultimately of a neurorobotic artifact consisting of: an anthropomorphic robot arm, a biomechatronic hand, human-like tactile sensors, a retina-like visual system, an anthropomorphic neck and head, and a brain model. Wearable robots, such as the endoskeleton prosthetic limbs and exoskeletons, and bionic components aimed at substituting and/or augmenting sensations, such as the artificial nose, artificial tongue, artificial retina, and artificial cochlea, are introduced to have a strong link to this area. As a challenge,

robotics technology is conjectured to be mature to be adopted as "the tool" for studying human kind and other biological systems, although some phylosophical and ethical issues naturally arise which deserve careful consideration by the scientific community.
In perspective, the paradigm of „disappearing robots" is put forward, in the sense that robotics technology is becoming ubiquitous, distributed and/or "embedded" into smart environments and thinking things, just like computers which have already become so pervasive in our society: dream or reality?

References

1. E. Bender, "Robo rehab", Technology Review, Apr. 2004
2. P. Dario, E. Guglielmelli, B. Allotta, M.C. Carrozza, "Robotics for medical applications", IEEE Robotics and Automation Magazine, 3(1), 1996
3. R.D. Howe, Y. Matsuoka, "Robotics for Surgery", Annual Reviews on Biomedical Engineering, 1, 1999
4. H. Inoue et al, "Overview of humanoid robotics project of METI", 32nd International Symposium on Robotics, Apr. 2001
5. S. Jacobsen et al, "Research robots for applications in AI, teleoperation and entertainment", Experimental Robotics VIII, B. Siciliano, P. Dario (Eds.), 2003
6. T. Kanade, "Toward a more human robot", Business Week, Nov. 2004
7. H. Kazerooni, "These legs are made for walking", IEEE Spectrum, Mar. 2004
8. B. Siciliano, O. Khatib, Handbook of Robotics, Springer, in preparation
9. H.F.M. Van der Loos, "Immersive user environments in rehabilitation robotics and mechatronics", Artificial Life and Robotics, 4, 2001
10. IEEE Transactions on Robotics and Automation, Special Issue on Medical Robotics, R.H. Taylor, P. Dario, J. Troccaz (Eds.), 19, 2003
11. Journal of Rehabilitation Research and Development, Special Issue on Rehabilitation Applications of Robotic Technology, N. Hogan (Ed.), 37, 2000

Special Session Clinical Practice

3.2

How to setup an out patient department

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Background
Interventional Radiology (IR) has transformed in the United States to a clinical specialty, comparable to a surgical subspecialty. Most busy IR practices have established a clinic to see patients before and after IR procedures. Commonly these clinics are within the hospital, where the interventional radiologists have their practice. A setup in the hospital is often not ideal to see patient for evaluation or follow-up. An outpatient practice setup is the next logical step for IR to become a true clinical specialty.
Reasons for an outpatient IR practice
As a true clinician the modern IR physician sees patient before performing a procedure to review the indication and to discuss the procedure with the patients. An outpatient office is an ideal environment to meet patients because of a relaxed atmosphere and the generally easy accessibility compared to a hospital. An outpatient office also allows an organized schedule because there is no interruption by emergencies.
Moving to an outpatient office does not only bring the IR physician closer to the patients, but also, maybe as important, to the primary care physicians. The vicinity to the main group of referring physicians will help to establish and maintain a good relationship.
In the United States insurance companies also try to move smaller procedures away from the hospital to outpatient offices by giving financial incentives to do so, for example the laser treatment of varicose veins. The Medicare Physician's Fee schedule 2006 reimburses the physician performing a laser treatment for varicose veins more than four times better if the procedure is done in an outpatient office compared to the hospital.
Requirements
Besides the clinical skills the physician has to be interested in entrepreneurship to run an outpatient office. The key to success is a good location and a motivated team.
The location should be easy accessible by car and ideally by public transportation. The latter will be even more important in Europe. Providing parking space is important for many patients according to our own patient population. The office personnel are a key for success. A practice manager is very helpful for accounting and negotiation with insurance companies. Friendly and competent ancillary personnel at the front desk and in the examination room will help to create a positive impression on the patients and will also create familiarity upon repeat visits.
Ideally the office is run for five days a week in order to be available for your patients and to efficiently use the personnel and rent of the place. Typically the office is shared among a group of physicians.
Besides providing good patient care, it is important to not neglect the business aspect of an outpatient practice. It starts with the evaluation of the location. An area with good primary care coverage, but without many specialists offering similar services should be chosen. Timely letters to the referring physician is a must to maintain a good relationship.
Ideally the patient come to the clinic with some understanding of what the procedure is about. Besides sending the patient information by regular mail, the internet is a great tool for patient to look up procedures, get directions to the office. In the future the internet maybe used for scheduling purposes as well.
Programs performed at an outpatient practice
The primary task of an outpatient practice is to see patients before and after IR procedure which are performed in a nearby hospital. However with the increasing number and possibilities of minimal invasive procedures in IR, an outpatient practice can also serve as a location for small procedures. Possible procedures are the treatment of varicose veins with laser, ambulatory phlebectomy or sclerotherapy; dialysis access management including placement of tunneled catheter and angiography and interventions on malfunctioning AV fistulas and grafts. Further possibilities are chest port placements, fibroid embolization and vertebral augmentation procedure. It is obvious that the practice setup has to be adjusted to the level of procedure performed. These adjustments include appropriate equipment, recovery facility and additional nursing personnel. Also it is helpful to have a close affiliation to a nearby hospital in case a sudden hospitalization is required.
Example of an IR vein center
Driven by the above mentioned reasons the author's institution opened an outpatient vein center. The vein center is located about 20 car-minutes away from the main hospital directly off a main highway. The clinic has two examination rooms and one procedure room. The clinic personnel include a practice manager, a front-desk person and two medical assistants. Each week day one attending is working at the vein center. A typical day consists of 3-5 new consults, 4-6 follow-up visits and 3-4 procedures. During the initial visit a history and focal physical examination are obtained as well as a duplex ultrasound to evaluate reflux in the superficial venous system. Then the treatment plan is discussed with the patients. We offer endovenous laser treatment (EVLT), ambulatory phlebectomy and sclerotherapy. Typically the patients are seen twice after a procedure at two weeks and three months for follow-up. The vein center is well perceived by the patients, the referring physicians and primary care provider. The vein center also helped to build the clinical practice at the hospital by increasing the referrals for other procedures such as fibroid embolization or vertebral augmentation.

Conclusion
Setting up an outpatient practice is the logical next step for IR physicians in order to establish a clinical practice. It is important to choose an appropriate location. Even more important is a good team dedicated to patient care and to a well organized practice.

3.4

Informed consent for IR

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There has been a rapid growth in procedures performed by interventional radiologists, and these procedures are becoming increasingly more complex. There is now no doubt that expectations regarding informed consent are changing. There is an increasing onus upon us, as interventional radiologists to ensure that patients receive all the necessary information to make an informed decision before we embark upon interventional procedures. Informed consent was first paraphrased by the California Supreme Court in 1957. It is the legal embodiment of the concept that each individual has the right to make decisions affecting his or her well-being. Guidelines from the Medical Defence Union and General Medical Council, in the UK suggest that details of the proposed treatment, common and serious side effects and the probability of success should be discussed with the patient. The patient should be made aware of alternative treatment options available. The necessary patient preparation for the procedure should also be explained to the patient. Consent should be obtained prior to the procedure and before any sedation is given. The patient should receive appropriate information through verbal, written and other educational aids to enable them to make an informed decision. The patient has a right to change their mind, or seek a second opinion. The patients consent should be obtained by the operator or if this responsibility is delegated, by a person suitably trained and qualified, who understands the risks and benefits of the procedure, and who will act in accordance with available guidelines. If the proposed treatment is experimental or being performed for research purposes, the operator should ensure that the procedure is not contrary to the individual patients interest, and that the patient understands that the procedure is being performed as part of a research protocol.
The above consent guidelines are reasonably standard in many countries. It can be difficult in many European countries where interventional radiology practitioners are few, and perhaps do not soley practice interventional radiology. We should however, strive to obtain consent for our own procedures and standardise the consent process where practical. Patient information leaflets should be available in Outpatient Departments or on wards, where the procedure to be performed is first organised. Adhering to the above guidelines will help better inform our patients about the ptocedures to be performed and may also minimise legal liability.

Special Session
Vascular Biology Statins:
Ubiquitous Therapy for All?

4.2

Statins: Mechanisms of action

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Introduction: The heart protection study published in 2002, clearly demonstrated that statin therapy in patients with peripheral arterial disease (PAD) reduced the risk of major vascular events including myocardial infarction, stroke and revascularisation[1]. The study recruited patients with a total cholesterol greater than 3.5mmol/ and the observed benefits were independent of the patients baseline cholesterol levels[1]. Furthermore, the reduction in major vascular events was evident following one year of treatment, whereas other non-statin therapies that lower low-density lipoprotein (LDL)-Cholesterol require up to five years to show a clinical effect[1]. This had lead to a debate over the exact mode of action of statins, in particular the relative contributions of their lipid and non-lipid lowering properties to cardiac risk prevention.
Mode of action: Cholesterol lowering effects
Statins competitively inhibit the enzyme 3-hydroxyl-3-methylglutaryl coenzyme A (HMG-CoA) which catalyzes the conversion of HMG-CoA to mevalonate, an early step in the biosynthesis of cholesterol. This leads to a reduction in hepatocyte cholesterol concentration and increased expression of LDL receptors, which are involved in the clearance in LDL and LDL precursors from the circulation[2]. A prospective meta-analysis of 14 randomised trials of statins has shown that the reductions in cardiovascular risk were proportional to the achieved absolute LDL cholesterol reduction[3]. Overall statins reduced the 5 year incidence of major coronary events, coronary revascularisation and stroke by one fifth per mmol/l reduction in LDL- cholesterol, irrespective of the patients baseline lipid profile[3]. A further meta-analysis has shown that over a 5 year period statin and non-statin interventions (diet, surgery or bile acid sequestration), reduced coronary and cerebrovascular events in a similar manner, consistent with the achieved reduction in LDL-cholesterol[4]. These studies, therefore raise some doubts about the clinical significance of the non-lipid lowering effects of statins, especially as reductions in LDL-cholesterol may in itself result in anti-inflammatory and anti-oxidant effects[5]. LDL-cholesterol is oxidized by free radicals and may cause direct oxidative damage to endothelial walls. A reduction in the levels of LDL cholesterol by the use of statin therapy will result in reduced superoxide production. This in turn leads to reductions in macrophage activation, increased MRA stability and nitric oxide production. While many of the anti-inflammatory effects may be due to the reduction in LDL-cholesterol, the reduction in vascular events achieved by statin therapy is greater than would be predicted from the lipid lowering effects alone[6].
Mode of action: pleiotrophic effects
The non-lipid lowering effects of statins have been attributed to their ability to inhibit the generation of proteins called isoprenoids[7]. Mevalonate is the precursor of these compounds and inhibited by statins. The isoprenoids bind to a number of signaling proteins (Rho and Ras) on the cell membrane which are involved in the inflammatory response[8]. Through these mechanisms statins have widespread effects on the endothelium, coagulation pathways and platelet function all of which are implicated in the pathogenesis of acute ischaemic events and have been shown to be activated in patients with PAD[9].
A reduction in endothelial dysfunction as assessed by increased flow-mediated dilation has been show to occur as early as 3 hours after commencing statin therapy[10]. This is believed to be mediated through the increased availability of nitric oxide[11]. Furthermore, in the endothelium, statin therapy has been shown to reduce expression of monocyte chemoattractant protein, adhesion molecule expression (ICAM-1 and E-selectin) and binding of lymphoctes, all of which are likely to reduce cell adhesion and migration and lead to plaque stabilisation[12,13]. They also reduce macrophage activity and production of matrix-metalloproteinases within the plaque[14].
Statins have also been shown to reduce tissue factor expression on endothelial cells and factor V activation resulting in decreased thrombin generation[15]. The effects of statins on thrombin generation are evident following only 3 days of therapy and clearly were not associated with any changes in serum lipid variables[16]. Furthermore, statin therapy by increasing endothelial thrombomodulin expression may increase the activbity of the protein-C anticoagulant pathway[17]. A further important anti-coagulant effect of statins is their ability to reduce platelet aggregation through a non-lipid lowering

mechanism[18]. The combination of these effects may lead to reduced clot formation and a reduction in acute ischaemic events.
Statins are also known to reduce the production and release of various cytokines, in particular interleukin-6 and tumour necrosis factor-alpha which in turn lead to reduced levels of C-reactive protein[19]. CRP has been implicated in the pathogenesis of atherosclerosis and is an independent prognostic indicator of future cardiovascular events[20]. In the Pravastatin Inflammation/CRP Evaluation (PRINCE) trail, statin therapy lowered CRP levels in all subgroups, regardless of smoking status, age, BMI and presence of diabetes[21]. This effect was evident after 12 weeks of statin therapy. However, in this and other studies there was little correlation between the reductions in CRP reduction and LDL-cholesterol, which adds weight to the non-lipid lowering properties of statins[22].
Variations in pleiotrophic effects may occur between different statins and warrant further investigation although the clinical significance of these effects remain unclear. However, many of the pleiotrophic effects of statins may account for the recent observation that statins decrease the incidence of peri-operative cardiac events in patients undergoing noncardiac vascular surgery[23]. Vascular surgery has been shown to result in endothelial activation and a pro-thrombotic state, as indeed has lower limb angioplasty[24,25].
Conclusion: The early onset of the pleiotrophic effects, indicate the value for starting statin therapy prior to interventions such as surgery and angioplasty. However, it should now be routine for all patients with peripheral arterial disease to be aggressively treated with statin therapy with the aim of achieving substantial reductions in LDL-cholesterol.

References

1. Heart Protection Study Collaborative Group. MRC/BHF Heart protection study of cholesterol lowering with simvastatin in 20 536 high-risk individuals: a randomised placebo controlled trial. Lancet,2002;360;7-2212.
2.Tobert JA. Lovastatin and beyond;the history of the HMG-CoA reductase inhibitors. Nat Rev Drug Discov.2003;2:517-26
3. Cholesterol Treatment Trialists (CTT)collaborators. Efficacy and safety of cholesterol-lowering treatment: prospective meta-analysis of data from 90 056 participants in 14 randomised trials of statins. Lancet;2005:366:1267-78.
4. Robinson JG, Smith B, Maheshwari N, Schrott H. Pleiotropic effects of statins: Benefit beyond cholesterol reduction. A meta-regression analysis. J Am Coll Cardiol.2005;46:1855-1862.
5. Steinberg D, LewisA. Conner memorial lecture. Oxidative modification of LDL and atherogenesis. Circulation,1997;95:1062-1071.
6. Kay KR, Cannon CP. The potential relevance of the multiple Lipid-Independent (Pleiotropic) effects of statins in the management of acute coronary syndromes. J Am Coll Cardiol, 2005;46:1425-33.
7. Dichtl W, Dulak J, Frick M et al., H MG-CoA reductase inhibitors regulate inflammatory transcription factors in human endothelial and vascular smooth muscle cells, Arterioscler Thromb Vasc Biol,2003, 23; 58-63.
8. Moosmann B. Behl C. Selenoproteins, cholesterol-lowering drugs, and the consequences: revisiting of the mevalonate pathway. Trends in cardiovasc Med, 2004;14:273-81.
9. Cassar K, Ford I, Bachoo P et al. Markers of coagulation activation, endothelial stimulation and inflammation in patients with peripheral arterial disease. Eur J of Vasc & Endovasc surgery. 2005;29:171-6.
10. Omori H, Nagashima H, Tsurumi Y et al., Direct in vivo evidence of a vascular statin a single dose of cerivastatin rapidly increases vascular endothelial responsiveness in healthy normocholesterolaemic subjects, Br J Clin Pharmacol , 2002;54:395-399.
11. Laufs U, La Fata V, Plutzky J et al., Upregulation of endothelial nitric oxide synthase by HMG CoA reductase inhibitors, Circulation, 1998; 97: 1129-1135.
12. Hernandez-Perera O, Perez-Sala D, Navarro-Antolin J et al., Effects of the 3-hydroxy-3-methylglutaryl-CoA reductase inhibitors, atorvastatin and simvastatin, on the expression of endothelin-1 and endothelial nitric oxide synthase in vascular endothelial cells, J Clin Invest,1998; 101: 2711-2719.
13. Seljeflot I, Tonstad S, Hjermann I et al., Reduced expression of endothelial cell markers after 1 year treatment with simvastatin and atorvastatin in patients with coronary heart disease, Atherosclerosis,2002;162:179-185.
14.Luan Z, Chase AJ, Newby AC. Statins inhibit secretion of metalloproteinases-1, -2, -3, and -9 from vascular smooth muscle cells and macrophages. Arterioscler Thromb Vasc Biol,2003;23: 769-775.
15. Eto M, Kozai T, Cosentino F et al., Statin prevents tissue factor expression in human endothelial cells role of Rho/Rho-kinase and Akt pathways. Circulation, 2002; 105: 1756-1759.
16. Undas A, Lowenhoff C, Brummel-Ziedins M et al. Simvastatin given for 3 days can inhibit thrombin generation and activation of Factor V and enhance factor Va inactivation in hypercholesterolaemic patients. Arterioscler Thromb Vasc Biol,2005;25:1524-1525.
17. Masamura K, Oida K, Kanehara H et al., Pitavastatin-induced thrombomodulin expression by endothelial cells acts via inhibition of small G proteins of the Rho family, Arterioscler Thromb Vasc Biol, 2003; 512-517
18. Tannous M, Cheung R, Virnini A, Mutus B. Atorvastatin increases ecNOS levels in human platelets of hyperlipidemic subjects. Throm & Haemost, 1999;82:1390-4.
19. Rezaie-Majd A, Maca T, Bucek RA et al. Simvastatin reduces expression of cytokines interleukin-6, interleukin-8, and monocyte chemoattractant protein-1 in circulating monocytes from hypercholesterolemic patients. Arterioscler Thromb Vasc Biol, 2002;22:1194-1199.
20. Pasceri V, Willerson JT, Yeh ET. Direct proinflammatory effect of C-reactive protein on human endothelial cells. Circulation,2000;102: 2165-2168.
21. Albert MA. Danielson E. Rifai N. Ridker PM. PRINCE Investigators. Effect of statin therapy on C-reactive protein levels: the pravastatin inflammation/CRP evaluation (PRINCE): a randomized trial and cohort study. JAMA.2001; 286:64-70.
22. Ridker PM, Cannon CP, Braunwald E. Response to C-reactive protein levels and outcomes after statin therapy (letter), N Engl J Med,2005; 352:1603-1604.
23.O'Neil-callahan C, Katsimaglis G, Tepper MR et al. Stains decrease peri-operative cardiac complications in patients undergoing noncardiac vascular surgery. J Am Coll Cardiol.,2005;45:336-42.
24. Cassar K, Bachoo P, Ford I et al. Clopidogrel has no effect on D-dimer and thrombin-antithrombin III levels in patients with peripheral arterial disease undergoing percutaneous transluminal angioplasty. J Vasc Surg, 2005;42:252-8
25. Collins P, Ford I^, Macaulay E**, Greaves M^, Brittenden J Surgical revascularisation increases platelet aggregation and coagulation in patients with peripheral arterial disease. Platelets in press.

4.3

Who should take statins

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"Statins: Ubiquitous therapy for all?"

Christoph W. Kopp

Physicians working in the cardiovascular field intuitively answer this question with „yes": every patient with incipient or manifest atherosclerotic, cardio- or cerebrovascular disease, who is either been treated conservatively or by endovascular or surgical intervention in addition to best medical treatment, should be placed on statin therapy! All of us know that this recommendation is based on both,

„lipid" and „non-lipid" effects attributed to HMG coenzyme A reductase inhibitors . However, "who should take statins" according to AHA/ACC/NCEP guidlines, based on which studies and how does this patient benefit from the lipid lowering effect of statins and statin-associated pleitropic non-lipid effects?

Background

Modern statins belong to a class of 3-hydroxy-3-methylglutaryl-coenzyme A reductase inhibitors, which act by decreasing cholesterol synthesis and by increasing "low density lipoprotein" - catabolism via increased LDL receptor activity. Pleitropic, non-lipid effects of statins, such as the anti-inflammatory and antithrombotic effect, are mediated via the inhibition of the NF-k-B pathway by upregulation of IkB, primarily due to suppression of mevalonate-derived products Next to decreased subintimal lipid accumulation, statins were shown to reduce expression of serum and plaque-associated matrix metalloproteinases , which play a central role in atherosclerotic plaque destabilisation and rupture. Thus, statins mediate plaque stabilisation and regression. Furthermore, statins suppress monocyte tissue factor expression, the main trigger of coagulation in vivo, generally limiting the prothrombotic state and the process of atherothrombosis. Lastly, statins are thought to improve re-endothelialisation after angioplasty and stenting by augmenting the mobilisation of endothelial progenitor cells from bone marrow significantly reducing the development of restenosis.

Statins as baseline therapy for patients with atherosclerosis

In 2006 statin therapy plays a central role in best medical treatment of patients with advanced atherosclerosis. Statins were among the first group of drugs, which showed potential regression of manifest atherosclerosis in patients with cerebrovascular disease (CVD) and standard doses of statins were shown to reduce the risk of for cardiovascular disease (CVD) events by approximately one third.

One of the first trials which demonstrated the benefit of statins was the Scandinavian Simvastatin Survival Study , a multi centre, double-blind, randomized, placebo-controlled trial with simvastatin (20-40mg daily) in 4444 (3617 men and 827 women) patients aged between 35 and 70 years, mean cholesterol level 261mg/dl at study entry, with established coronary artery disease. In this study simvastatin caused a highly significant reduction in the risk of death and morbidity in patients with coronary heart disease followed for a median of 5.4 years. The study also could provide evidence for a beneficial effect of simvastatin on fatal und nonfatal cerebrovascular events.

Importantly, in randomized trials with 3 years of follow-up, cholesterol lowering by statins has been shown to reduce the progression of carotid atherosclerosis, defined by intima - media thickness, in patients with cholesterol levels >6 mmol/L before treatment.

Surprisingly, even in patients with cholesterol levels <6mmol/L, statins reduced the development of carotid atherosclerosis when patients were followed up over a period of 4 years eluding to the potent, non-lipid, pleotropic effects of statins.

The Cholesterol and Recurrent Events (CARE) study, a double - blind trial in 4159 patients lasting for 5 years, demonstrated that the benefit of cholesterol - lowering therapy using pravastatin extended to the majority of patients with CHD who have average (mean 139mg/dl) LDL - Cholesterol levels. The frequency of stroke was reduced by 31%.

In the Long - Term Intervention with Pravastatin in Ischemic Disease (LIPID), a double - blind, randomized trial compared the effect of pravastatin (40mg daily) with those of placebo over a mean follow-up period of 6.1 years in 9014 patients (7498 men and 1516 women) who were 31 to 75 years of age with a median LDL - Cholesterol level of 150mg/dl. This study showed a 24% relative risk reduction (RRR) of death from CHD and a 22% relative risk reduction from overall mortality in the pravastatin group. The relative stroke risk reduction was by 19%.

The "Heart Protection Study" (**HPS**) extended the knowledge about the effect of statins to a much broader population. During a period of five years, 20536 patients with CVD, other occlusive arterial disease or diabetes were randomly allocated to receive 40mg simvastatin daily or placebo.

There was highly significant reduction of the primary combined endpoint of non - fatal myocardial infarction or coronary death, for non - fatal or fatal stroke, and for coronary and non - coronary revascularisation by approximately 25%.

Due to the large number of patients included, this study demonstrated substantial benefit not only in patients with manifest CVD, but also in those with cerebrovascular disease, peripheral arterial disease or diabetes.

Enhanced LDL- lowering beyond that obtained with standard doses of statins may further reduce CVD events. Current guidelines for cholesterol management patients with advanced atherosclerotic cardiovascular disease set an LDL-C goal of <100mg/dL. Findings from the heart protection study (HPS) strongly suggested that high risk patients with a baseline level of LDL-C <100mg/dL will still benefit when when LDL-C levels are reduced to well below 100mg/dL by drug therapy. The Pravastatin or Atorvastatin Evaluation and Infection Therapy (PROVE-IT) trial, testing a high dose of statins that reduced LDL-C levels to 62mg/dL and comparing it to a standard dose that reduced levels to 925 mg/dL, showed a 16% fewer CVD events with the high dose of statins.

On the basis of the results from the HPS and the PROVE-IT trials, the National Cholesterol Education Program proposed that an LDL-C goal of <70mg/dL is a therapeutic option in high-risk patients with advanced atherosclerotic CVD.

The extremely low rates of myopathy and the increase in liver enzymes found in these trials confirmed the safety of statins. Thus, the muscle or liver enzymes do not need to be measured routinely in most patients.

Special Session
UAE: Where do we stand?

5.1

REST study results

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Randomised comparison of uterine artery Embolisation (UAE) with Surgical Treatment in patients with symptomatic uterine fibroids (REST trial): 1 year results: randomised controlled trial

The REST trial participants *

Summary

Background Uterine fibroids are the most common tumour in the female reproductive system. They are estimated to occur in 25% of women of reproductive age and as many as 40% of women still menstruating beyond the age of 50 years. [4] Their presence may cause menstrual disorder or can be associated with subfertility, miscarriage and pressure effects. [5] For women who have completed their families the established treatment is hysterectomy. There were 42,500 hysterectomies carried out in the UK in the year April 2003 - March 2004 with approximately 30% indicated for fibroids (the second largest group). [6] Women who wish to maintain their fertility are treated with myomectomy if technically possible. Although this operation conserves the uterus, the effect on both symptoms and subsequent fertility is unclear. [7]

Ravina in 1995 first reported uterine artery embolisation (UAE) as an alternative technique for treating fibroids. [8] Since then it has become increasingly accepted as a minimally invasive uterine sparing procedure and upwards of 100,000 procedures have been carried out over the last 10 years, mainly in the USA and Western Europe. [9] Early results of an open prospective voluntary US registry recently reported 30 day data on 3160 patients. Major complications occurred in 5.5% with 3 (0.1%) requiring a hysterectomy at 30 days. [10] In the UK the National Institute for Health and Clinical Excellence (NICE) issued guidance on UAE in October 2004, stating that the procedure

appeared safe for routine use and that there is symptomatic relief in the majority of patients in the short term. [11] Data from observational studies suggest that the procedure is both efficacious and safe although some serious complications have been reported. [1, 2] Its place can only be confirmed following comparison with the 'gold standard' treatment in a prospective randomised trial. [3] The REST trial was instigated to make this comparison.

There are two published randomised trials comparing UAE with surgery. Both reported early outcomes (maximum 6 weeks) and showed reduced hospital stay in the UAE arm. [12, 13] However, the procedure is carried out to improve quality of life for those women who have symptoms resulting from their fibroids and it is important that this is thoroughly assessed. [14]

The REST trial is the first to report 12 month clinical outcomes.

Methods

Women with symptomatic fibroids that would justify surgery were recruited from gynaecological outpatient clinics and then randomised using a computer-generated schedule. The presence of fibroids was confirmed with magnetic resonance imaging (MRI). The primary outcome was quality of life (QoL) assessed using the short form 36 (SF-36) and additional information was obtained concerning the procedure, the hospital stay, length of time to reach milestones to recovery and symptom relief. Follow up was assessed at 12 months. Analysis was on the intention to treat principle.

Findings

Between November 2000 and May 2004 157 patients were randomised on a 2:1 basis between UAE (n=106) and surgery (n=51) from 25 Scottish and 2 English centres. 95% (149 of 157) of patients underwent their allocated treatment. (UAE=101, hysterectomy = 40 and myomectomy = 8).

There was no statistically significant difference in any of the eight components of the SF-36 scores at 1 year. The length of hospital stay was significantly shorter in those having UAE (UAE 1 day (1-2) versus surgery 5 days (3-6); median (inter-quartile range)). The time to performing routine tasks was significantly shorter in the UAE group. Symptom scores were significantly better in the surgical arm at all time points. Ten (9%) patients in the UAE arm had required further invasive treatment (repeat UAE or hysterectomy) for inadequate symptom control by 12 months.

There were 33 (31%) serious adverse events (SAEs) (which includes treatment failures) in the UAE arm and 9 (18%) in the surgical arm at latest follow up (maximum 56 months). At 1 year following treatment women randomised to UAE had a 4% probability of having a repeat UAE and an 8% chance of a hysterectomy.

Economic analysis showed a significant difference in cost over 12 months (UAE £1757 vs surgery £2702).

Interpretation

Both surgery and UAE provide a successful treatment for a majority of women with symptomatic fibroids. No difference in quality of life at 1 year was detected. Faster recovery following UAE must be weighed against the need for further treatment, in a minority of patients, following UAE. UAE appears more cost effective than surgery at one year. There is however a continuing need for longer-term follow up beyond 1 year particularly since a number of major complications occurred many months after treatment.

References

1. Vashisht A, Studd JW, Carey AH, McCall J, Burn PR, Healy JC, et al. Fibroid embolisation: a technique not without significant complications. British Journal of Obstetrics & Gynaecology 2000; 107: 1166-70.
2. Spies JB, Spector A, Roth AR, Baker CM, Mauro L, Murphy-Skrynarz K. Complications after uterine artery embolisation for leiomyomas. Obstet Gynecol 2002; 100: 873-80.
3. Moss J.G. Uterine fibroid embolisation: more evidence is required. Cardiovascular and Interventional Radiology 2005; 28: 150-52.
4. Buttram VC, Jr., Reiter RC. Uterine leiomyomata: etiology, symptomatology, and management. [Review] [71 refs]. Fertility & Sterility 36(4):433-45, 1981.
5. Lumsden MA, Wallace EM. Clinical presentation of uterine fibroids. [Review] [88 refs]. Baillieres Clinical Obstetrics & Gynaecology 12(2):177-95, 1998.
6. Edozien LC. Hysterectomy for benign conditions. BMJ 2005; 330(7506):1457-1458.
7. Lumsden MA. Embolization versus myomectomy versus hysterectomy: which is best, when? [Review] [65 refs]. Human Reproduction 2002; 17(2):253-259.
8. Ravina JH, Herbreteau D, Ciraru-Vigneron N, Bouret JM, Houdart E, Aymard A, et al. Arterial embolisation to treat uterine myomata. Lancet 1995; 346: 671-2.
9. Committee on Gynecologic Practice ACoOaG. ACOG Committee Opinion. Uterine artery embolization. Obstetrics & Gynecology 103(2):403-4, 2004.

5.3

HOPEFUL study results

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HOPEFUL is a retrospective cohort study examining the efficacy and safety of two interventions for treating women with symptomatic fibroids. The traditional standard treatment is the surgical removal of the uterus (hysterectomy) and the less invasive uterus-conserving treatment is uterine artery embolisation (UAE). The project is a comparative analysis of these two treatments in British women treated since the mid 1990s. It is a multi-centre study funded by the HTA and managed by the University of Oxford involving 18 collaborating hospital centres in England and Scotland.

Both the National Institute for Clinical Excellence (NICE) and The Joint Working Party of the Royal College of Obstetricians and Gynaecologists (RCOG) have recognised the lack of medium to long-term data comparing UAE with surgical options for symptomatic fibroids and have emphasised the need for randomised comparisons. Fully informed large randomised studies between major surgery, which terminates reproductive function and an intervention which deals with the specific cause of symptoms, are problematic. This project seeks to collate systematically clinical and patient-reported data retrospectively from experience within the UK to provide comparable preliminary data in an observational setting. UAE is available in over 50 centres in the UK.

In total there were 1734 eligible women we were able to trace (762 hysterectomies and 972 UAE). Of these 1734, 28 are now deceased (21 hysterectomy and 7 UAE) so although we do not have patient questionnaire data for these women we do have clinical data. Out of the eligible women contacted currently there are a total of 1094 women who have consented to participate (438 hysterectomies and 656 UAE).

The Outcome analysis is summarised as follows:

1. **Main Primary Outcome analysis** - Comparison of complication rates (severe/major/minor) by cohort.
2. **Secondary Outcome - Success/Failure of treatment** - comparison of efficacy of treatment to resolve symptoms by cohort. From clinical data including further investigations and treatment and patient reported data from questionnaires regarding satisfaction with outcome.
3. **Secondary Outcome - Subgroup UAE analysis** - includes description of objective clinical outcomes including fibroid shrinkage, reported pregnancies following UAE.

The initial comparative findings of this study will be reported for the first time.

Special Session
IVC filters

6.2

Retrievable filters: The holy grail?

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Pulmonary embolism is the most severe presentation of venous thromboembolic disease(1). About 10 % of patients with symptomatic pulmonary embolism die within one hour of symptom onset and 15% die within three months following acute pulmonary embolism, with 50 % of deaths due to recurrence of the event (2). Pulmonary embolism may also be complicated by long-term morbidity with up to 3,8% of patients developing chronic pulmonary hypertension within two years despite state-of-the-art-treatment(3). Prevention of the recurrence of pulmonary embolism is therefore a prime goal of treatment in patients with venous thromboembolic disease(4). In most cases, this is effectively and safely achieved by anticoagulant drugs. However, patients in whom anticoagulant treatment is contraindicated or associated with complications, and in those with recurrent thromboembolism despite adequate anticoagulation, partial interruption of the inferior vena cava with a filter may be indicated(4), since pulmonary embolism mainly results from thrombi originating in veins in the pelvic or legs(5).These filters appear,right now,as the less bad additional device for preventing pulmonary embolism and represent the conclusions of years of experimental and clinical research procedures,but, up to now, the perfect filter (the „graal"? the „grail" ?) obviously does not yet exist.

During the two last decades of the 19th century, surgeons, medical doctors and scientists have tried to find the best way to avoid these migrations, the first suggestion beeing the ligature of the femoral vein (Hunter in the USA in 1874), but with no efficacy on the recurrence of pulmonary embolism. The next step was the ligature of the inferior vena cava performed until the mid 20th century, but with a high mortality rate (14 %), an important rate of pulmonary embolism (6%) or chronic venous insufficiency (33%). Then were proposed different devices for partial interruption of the inferior vena cava such as plication, sutures, and the caval clips(Miles, Meretz and Adams-Dewese) but withdrawn for the same reasons and a high rate of caval thrombosis (33%). The first endoluminal dam was the Mobin-Uddin umbrella in 1967, however responsible for migrations and vena cava thrombosis.

The first vena cava filter has been proposed in1973 by Greenfield but needed venotomy because of its external caliber (29,5 F). The first real percutaneous filter was born in 1981 (Greenfield again) and was followed by an explosion of new filters and, unfortunately, by an explosion of indications of vena cava filtration with permanent filters. Here is an non exhaustive list of the names of vena cava filters that, at least for a few days, have been available on the market. Some have disappear as soon as they were born, some have had a longer life, some have had several lifes, and some are still alive :Amplatz, Bird-nest, Grenfield 1, Grenfield 2, Grenfield 3, Gûnther Tulip 1, LGM 1, LGM 2, Simon-nitinol, Pietri FCP 2000, Pietri FCP 2001, Pietri FCP 2002, Filcard 1, Filcard 2, Anthéor, Cardial, Vascor, Meadox, Jonhson-Johnson, Dibie-Musset, Crag-nitinol, Bruneau, Maass, Helix Filter, Jefferson University Filter, Dil, Angiocor ....This to better explain how long and difficult could be the quest for The Graal ! In addition, the pursuit of that Graal meets different difficulties depending on the country where you are living : there are so many variations in the number of vena cava filters inserted each year and that cannot be explained only by differences in the demography or in the quality of medical cares or in the public health's wealth of these countries : 140 filters/million inhab./year in the US, 60 filters/million inhab./year in France, 3 filters/million inhab./year in Sweden....So, the goal is still far away !

Although permanent vena cava filters have been shown to effectively prevent recurrent pulmonary embolism(6), they increase the risk of deep-vein thrombosis(7- 9). This study,the PREPIC study, was the first randomized controlled study able to evaluate the ratio benefit/risks of permanent caval filtration. Moreover, permanent vena cava interruption is not always necessary. Short-term temporary filters designed to be left in place for one or two weeks have been largely abandoned because of the significant risk of infection due to the need for a lasting percutaneous access (10, 11). Long-term temporary filters may be left in place for up to three months but their use in clinical practice has been disappointing. Currently, the most attractive alternative to permanent vena cava filters are retrievable filters (also called optional filters),which may be either left in place permanently or retrieved if patients no longer require vena cava interruption (11, 12). However, while retrievable filters appear promising(13), only retrospective studies(14-23), small prospective trials (83 patients in the largest series) (24,25), and studies with a short follow-up(26-28) have been conducted to date. Moreover, several of these studies included retrievable filters that must be removed shortly after insertion (24, 26, 28), but some filters have no retrieval delay. For most filters, the recommended dwell time for retrievable filters is 10-14 days after implantation. Since the anchoring struts are gradually incorporated into the caval wall, it was thought that filter retrieval after that time was too risky but that point depends mainly on the type of the filter.

Five retrievable vena cava filters are currently available on the market : the Günther Tulip (Cook Inc.),the RNF (Bard Comp.), the Optease (Cordis), the ALN Filter (ALN implants chirurgicaux) and the SafeFlo (Rafael Medical) with different clinical experience, specific qualities and use difficulties that will be discussed later, the most important point beeing the easiness and the delay for the retrieval procedure, taking into account that some filters seem difficult or impossible to retrieve and that one can find papers in the literature about complaint reports(29).

In our opinion, the „holly graal", speaking of vena cava filters, should be a retrievable one in order to avoid the late complications of caval filtration but could be able to disappear (to disintegrate?)at the right moment when the patient does not need it any longer, this avoiding a second aggressive procedure . May be the companies should make progress on that point.

References

1. Kearon C. Natural history of venous thromboembolism. Circulation 2003; 107(23 Suppl 1):I22-30
2. Goldhaber SZ, Visani L, De Rosa M. Acute pulmonary embolism: clinical outcomes in the International Cooperative Pulmonary Embolism Registry (ICOPER). Lancet 1999; 353:1386-1389
3. Pengo V, Lensing AW, Prins MH, et al. Incidence of chronic thromboembolic pulmonary hypertension after pulmonary embolism. N Engl J Med 2004; 350:2257-2264
4. Buller HR, Agnelli G, Hull RD, et al. Antithrombotic therapy for venous thromboembolic disease: the Seventh ACCP Conference on Antithrombotic and Thrombolytic Therapy. Chest 2004; 126(3 Suppl):401S-428S. Erratum in: Chest 2005; 127(1):416
5. Goldhaber SZ. Pulmonary embolism. Lancet 2004; 363:1295-1305
6. Streiff MB. Vena caval filters: a comprehensive review. Blood 2000; 95:3669-3677
7. Decousus H, Leizorovicz A, Parent F, et al. A clinical trial of vena caval filters in the prevention of pulmonary embolism in patients with proximal deep-vein thrombosis. Prevention du Risque d'Embolie Pulmonaire par Interruption Cave Study Group. N Engl J Med 1998; 338:409-415
8. White RH, Zhou H, Kim J, et al. A population-based study of the effectiveness of inferior vena cava filter use among patients with venous thromboembolism. Arch Intern Med 2000; 160:2033-2041
9. The PREPIC Study Group. Eight-year follow-up of patients with permanent vena cava filters in the prevention of pulmonary embolism: The PREPIC (Prevention du Risque d'Embolie Pulmonaire par Interruption Cave) randomized study. Circulation 2005; 112:416-422

10. Ricco JB, Bouin-Pineau MH, Camiade C, et al. Emergency interruption of the inferior vena cava: a debatable issue. Cardiovasc Surg 2000; 8:411-421
11. Kinney TB. Update on inferior vena cava filters. J Vasc Interv Radiol 2003; 14:425-440
12. Millward SF, Grassi CJ, Kinney TB, et al. Reporting standards for inferior vena caval filter placement and patient follow-up: supplement for temporary and retrievable/optional filters. J Vasc Interv Radiol 2005; 16:441-443
13. Hull RD. Changes in the technology of inferior vena cava filters promise improved benefits to the patient with less harm, but a paucity of evidence exists. J Thromb Haemost. 2005; 3:1368-1369
14. Owen RJ, Krarup KC. Case report: the successful use and removal of the Gunther Tulip inferior vena caval filter in pregnancy. Clin Radiol 1997; 52:241-243
15. Ponchon M, Goffette P, Hainaut P. Temporary vena caval filtration. Preliminary clinical experience with removable vena caval filters. Acta Clin Belg 1999; 54:223-228
16. Millward SF, Oliva VL, Bell SD, et al. Gunther Tulip Retrievable Vena Cava Filter: results from the Registry of the Canadian Interventional Radiology Association. J Vasc Interv Radiol 2001; 12:1053-1058
17. Yamagami T, Kato T, Iida S, et al. Retrievable vena cava filter placement during treatment for deep venous thrombosis. Br J Radiol 2003; 76:712-718
18. Pieri S, Agresti P, Morucci M, et al. Optional vena cava filters: preliminary experience with a new vena cava filter. Radiol Med (Torino). 2003; 105:56-62
19. Wicky S, Doenz F, Meuwly JY, et al. Clinical experience with retrievable Gunther Tulip vena cava filters. J Endovasc Ther 2003; 10:994-1000
20. Stein PD, Alnas M, Skaf E, et al. Outcome and complications of retrievable inferior vena cava filters. Am J Cardiol 2004; 94:1090-1093 16
21. Pancione L, Mecozzi B. Permanent/removable vena cava filter ALN (France): our experience with 96 patients. [abstract] Proceedings of the 90th Annual Meeting of the Radiological Society of North America, Chicago, 28 November - 3 December 2004. http://rsna2004.rsna.org/rsna2004/V2004/conference/event (Abstract SSJ03-01)
22. Morris CS, Rogers FB, Najarian KE, et al. Current trends in vena caval filtration with the introduction of a retrievable filter at a level I trauma center. J Trauma 2004; 57:32-36
23. Cheung MC, Asch MR, Gandhi S, et al. Temporary inferior vena caval filter use in pregnancy. J Thromb Haemost 2005; 3:1096-1097
24. Neuerburg JM, Gunther RW, Vorwerk D, et al. Results of a multicenter study of the retrievable Tulip Vena Cava Filter: early clinical experience. Cardiovasc Intervent Radiol 1997; 20:10-16
25. Imberti D, Bianchi M, Farina A, et al. Clinical experience with retrievable vena cava filters: results of a prospective observational multicenter study. J Thromb Haemost 2005; 3:1370-1375
26. Linsenmaier U, Rieger J, Schenk F, et al. Indications, management, and complications of temporary inferior vena cava filters. Cardiovasc Intervent Radiol 1998; 21:464-469
27. Asch MR. Initial experience in humans with a new retrievable inferior vena cava filter Radiology 2002; 225:835-844
28. Offner PJ, Hawkes A, Madayag R, et al. The role of temporary inferior vena cava filters in critically ill surgical patients. Arch Surg 2003; 138:591-594; discussion 594-595
29. Bangalore C Anil Kumar, Chakraverty S, Zealley I Failed retrieval of potentially retrievable IVC filters : a report of two cases. Cardiovasc. Intervent.Radiol 2006, 29 : 126-127.

6.3

Filter complications

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Filter Complications

Introduction

Inferior vena cava (IVC) filters are undergoing a major change in utilization for the management of venous thromboembolism (VTE). Historically, permanent type IVC filters were placed in patient with know VTE and contra-indication or complication of anticoagulation therapy. Pharmacologic therapy remains the primary mainstream treatment modality for patients with VTE. Despite a long, multi-decade history of placement of these permanent IVC filters, significant controversy existed about the real clinical efficacy of IVC filters in preventing pulmonary emboli (PE) and favorably influencing patient survival. Recent studies have confirmed what most interventional radiologists believed, which is that IVC filters are effective in preventing PE (1,2). However, the benefit of IVC filtration is associated with a higher recurrent deep venous thrombosis rate and no survival benefit can be documented when compared prospectively with anticoagulated patients. Since VTE is a condition known to be associated with high mortality rates, particularly when not treated (approximately 30 %); it is perplexing that IVC filters which reduce PE do not confer a survival benefit! Possible explanations include poor selection of patients at greatest risk for life-threatening PE, inability of follow-up studies to accurately determine VTE as cause of death, and lastly that patient survival may mainly reflect the patients underlying condition and health status. In patients with VTE that cannot be treated with standard therapy, IVC filters appear to have a favorable risk/benefit profile (3). Expanded indications for IVC filters have included patients with conditions that place them at greater risk for VTE, but do not yet have objective evidence for VTE including patients who cannot be anticoagulated either transiently or indefinitely (Prophylactic IVC filters). IVC filters for patients subjected to massive trauma has been the first and most well documented indication for such prophylactic IVC filters. Other such prophylactic IVC filter indications being considered are for bariatric surgery patients, orthopedic patients, and neurosurgical patients. The insertion of IVC filters for such prophylactic indications places added burdens on the risk profile as the risks of VTE may be lower than in patients with documented VTE. The confluence of expanded indications for IVC filters combined with the recognition of long-term complications of IVC filters has encouraged much interest in retrievable IVC filters. These retrievable ICV filters may have added complications in comparison to permanent filters, as they are specifically designed for ease of retrieval and these patients are subjected additional procedures with attendant risks and costs. Lastly, it is important to keep in mind that long-term complications of filters are hard to detail as follow-up on most filters, whether permanent or temporary rarely extend beyond five years. This is an important consideration when young patients that are subjected to IVC filter placement may have these devices in situ for decades.

Complications of IVC filters can occur at any stage of IVC filter placement, including pre-operative work-up and assessment, placement procedure, and as delayed complications (4). While retrievable IVC filters may have many similar complications as permanent devices, some unique complications exist.

Pre-Operative Assessment

This is a rare source for filter complications but deserves a few comments. Historically, the pre-operative assessment of VTE status and risks may have been hampered as clinicians attempted to avoid the perceived risks or actual limitations of both pulmonary angiography and lower extremity venography. Patients without documented VTE may be subjected to low incidence but highly morbid complications (i.e.- hemorrhagic complications from

anticoagulation). An antidotal case I recall, is a younger patient with a contra-indication for anticoagulation referred for IVC filter insertion for suspected profunda femoral DVT. When re-imaged in radiology just prior to IVC filter placement, no DVT was found with ultrasound imaging and the filter procedure was cancelled. In certain cases, it is beneficial for the interventional radiologist to suggest additional imaging studies to document the status or risk of VTE. With the advent of lower extremity venous ultrasound and spiral CTA, the clinical VTE status of a particular patient is less problematic than in the past. The advent of CT venography may add visualization of previous difficult to detect venous segments that may lead to clinically signficant PE.

The other consideration is that most if not all clinically significant anatomical details required for IVC filter insertion are available on cross-sectional images that most of our patients have as part of work-up for their pre-existing conditions. Careful review of these images is crucial in planning the route of access, necessity and extent of venography required for insertion, and sites of placement of IVC filter(s) (supra- or infra-renal or duplicated IVC).

Peri-procedural Complications

Puncture Site Complications

As access systems have become progressively smaller, puncture site complications appear to have decreased. Puncture site complications may include hemorrhage or hematoma, access site thrombosis, arteriovenous fistula, infection, and pneumothorax (jugular accesses). Hemorrhage and hematoma are rare with current generation IVC filters. Utilizing ultrasound guidance and jugular access has been particularly useful for patients with coagulopathy including anticoagulation therapy in terms of reducing bleeding particularly with outpatient procedures. Another consideration is brachial vein access in such cases. Access site thrombosis occurs more commonly than bleeding complications. Access thrombosis detected at 30 days after insertion by ultrasound occurred in 35 % of patients who underwent IVC filter placement with 12-14 Fr delivery sheaths (5). Note, 10 % of patients had occlusive thrombus and the rest non-occlusive thrombus; the majority of patients (97%) with thrombus were asymptomatic. The occurrence of arteriovenous fistulas can be reduced by using single-wall puncture techniques and ultrasound guided puncture.

Insertion Complications

Continued improvements in delivery systems have made insertion complications less problematic than with earlier, larger systems. Sheath kinking, a rare complication presently, has more often been associated with left sided approaches such as the left femoral or jugular venous accesses than with the usual right sided approaches. The operator is cautioned against forceful advancement of a filter with longitudinal stiffness into a kinked sheath as rare reports have documented extrusion of filters through kinked sheaths with associated venous injuries. Venous air embolism has been documented with percutaneous IVC filter placement, but again this is less common with smaller current generation IVC filters. Paradoxical embolism during IVC filter insertion can occur in patients with patent right to left shunts (cardiac or pulmonary) and requires careful technique to minimize any such thrombotic complications (6). Caval injuries, traumatic venous injuries, retroperitoneal hemorrhage, and cardiac tamponade and arrythmias are all rare complications from IVC filter insertion. Death from insertion of IVC filters is extremely rare (<0.012%).

Malpositioning of IVC filters can occur because of unrecognized important vena caval anomalies, suboptimal imaging of venous anatomy, or by operator erros or technical problems with the delivery system (7). Generally, it is felt that placement of the IVC filter should be infra-renal with the top of the filter at the level of the renal vein insertion to the IVC. A large gap between the top of the filter and the renal venous insertions, may potentially harbor thrombus which may result in recurrent VTE. If a duplicated IVC is missed, the patient may suffer VTE from the unprotected lower extremity. Good quality venography and selective renal venography has been demonstrated to improve technical success and unmask clinically important variants (8,9). In certain cases, supra-renal IVC filter insertion is required such as clot extending upto the level of the renal vein, renal vein thrombus, ovarian vein thrombus, and pregnancy. During jugular venous insertions, the pathway of the gonadal, renal, or hepatic veins may mimic the course of the IVC and filters may be mistakenly deployed in such locations, again leaving the patient unprotected. Tilting of the IVC filter is a type of malposition with regard to the three-dimensional shape of the filter as it lies within the elliptoidal shaped IVC. This is a controversial subject, with certain investigators believing that this may adversely effect filter efficacy while others believe there is no clinically important effect (10,11). Rarely, a deployed filter may incompletely open into the expected size of the IVC. It is often unclear why this occurs, but this may relate to interlocking or splaying of the filter legs during deployment, thrombus formation around the filter struts while the filter is constrained within the filter sheath, device failure, deployment in a partially thrombosed IVC or recannalized chronically thrombosed IVC, or erroneous deployment of filters in other veins (renal, gonadal or hepatic). Again, careful assessment must be made to determine if the patient is adequately protected from VTE and the risk of filter migration. While controversial, some have advocated careful manipulation of such filters with catheters or balloons to properly deploy them (12, 13).

Delayed Complications

Recurrent PE

Recurrent clinically symptomatic PE after IVC filter insertion, a key functional attribute of IVC filters, is an infrequent occurrence, occurring in approximately 2-5 % of such cases (10). Unfortunately, many clinicians assume that a patient with an IVC filter in place is permanently protected from the risks of additional PE. This misconception often results in delayed diagnosis and therapy in the work-up of patients with IVC filters and recurrent symptoms suggesting PE. Recurrent PE after IVC filter insertion can occur for a number of reasons. Rarely, the embolic source may be from atypical sites such as the upper extremities or right atrium. If emboli from unusual sites are excluded, PE may occur despite IVC filtration in several ways. IVC filters are designed to trap the larger, life-threatening PE while allowing smaller clots to pass. The filter itself may be the source of PE, and this needs to be studied by cross-sectional means or with vena cavography. Clot within a filter may occur by de novo thrombus formation, trapped embolized thrombus within the filter, or cephalad propagation of thrombus through an IVC filter. Rarer causes of recurrent PE include an incompletely opened IVC filter, a migrated filter, or a misplaced IVC filter (gonadal, renal, hepatic veins). In situations where a significant thrombus burden is present above the filter, or in such a manner that the filter cannot protect against recurrent VTE, the patient may need to be treated with another IVC filter, anticoagulation, and/or thrombolytic therapy (14).

IVC Thrombosis

Thrombotic complications after IVC filter placement, another key functional attribute of IVC filters, presumably results from factors related to filter design and the patients' underlying thrombogenic tendencies. On the one hand, filter and IVC thrombosis may reflect sequela of trapped massive PE, in effect having protected the patient from a life-threatening PE at the cost of IVC thrombosis. On the other hand, the filter may effect caval flow in such a way (turbulence or pressure gradients) that the tendency for recurrent DVT including caval thrombosis is increased (1,2). The reported incidence of IVC thrombosis after IVC filter insertion (0-28%) is more widely variable than that associated with recurrent PE. To some degree this is a result of how vigorously the thrombus is sought out (symptomatic versus asymptomatic patients, type of imaging used) and the patients included in the analysis. Patients vary in their response to IVC thromboses with filters from asymptomatic to chronic venous stasis to full blown phlegmasia cerulean dolens. The ultimate irony is performing thrombolysis on a thrombosed IVC filter in a patient who had previously been considered to contraindicated to anticoagulation.

IVC Penetration

While penetration of the IVC can occur immediately after placement,

penetration of the IVC by filters is more commonly seen as a late sequela. The incidence of this complication varies from 9-24%. Most often, patients are asymptomatic from such IVC penetration; however, in rare cases unusual complications may result from penetration of filter struts into the small bowel, kidney, aorta, and lumbar nerves.

Filter Migration

Migration of IVC filters may be caudal or cranial, with the latter associated with potentially more severe complications. Filter migration is most often asymptomatic with wide ranges reported (3-69%), which in part may reflect on varying definitions as to amount of motion (1-2 cm) before migration is reported. One important consideration in minimizing filter migration is proper assessment of IVC size before filter deployment as filters are designed for certain diameters of the vena cava. Fortunately, migration to the heart or pulmonary circulation, the most severe migration complication is quite rare and has been reported with essentially all IVC filters. Some of these migrations have been in association with massive VTE to the filter. The management of filter migration needs to be individualized, but should include an assessment of whether the patient is adequately protected with the migrated filter and whether the patient is a candidate for anticoagulation therapy. Case reports of retrieval of migrated filters are available, while other reports suggest leaving the migrated filter in place if the patient does not have symptoms related to the filter.

Guide wire Entrapment of IVC Filters

Several authors have reported entrapment of J-tipped guide wires used for central venous catheterization in various vena caval filters (15). This is an under-recognized and infrequently reported complication; the actual incidence of this complication is not known. Complications have included entrapment of the guide wire on the filter, migration of the filter, and cava perforation. This complication can be minimized by awareness of the patients IVC filter, use of straight wires with fluoroscopic imaging, and minimizing the amount of guide wire insertion to that required for the procedure.

Filter Fracture

Fracture of filter struts is another potential late complication, which may be of low clinical significance. It has been reported in approximately 1 % of cases. Migration of the fractured fragments may rarely cause problems.

Infectious Complications

Infectious complications of IVC filters are extremely rare and essentially case reportable (16). These can occur either with implantation or secondary to infection from other organs. When infection has been demonstrated with IVC filters, successful management seems to depend upon removal of the IVC filter, either by surgical or trans-catheter methods. This is a controversial complication as some investigators report IVC filters are effective in patients with septic emboli (17).

Unique Complications of Retrievable IVC Filters

Since retrievable IVC filters have been available for a shorter period of time than their permanent counterparts, the long-term performance characteristics of these filters if left in place as a permanent device may be less certain. Clinicians intuitively assume that the long-term performance characteristics of such retrievable filters should mimic those of permanent IVC filters. The ability to remove these filters may alter the filter wall interaction, which may adversely affect the tendency for such filters to migrate or to with-stand massive thromboembolic insult. Whether the assumption that the long-term performance characteristics of retrievable filters is the same as permanent filters will require direct prospective comparisons. Other complications of retrievable filters relates to the removal process. Specific complications may include PE, caval injury, filter migration, inability to remove the filter, and access site thrombosis. The occurrence of PE after retrieval filter removal is another complication which may occur and many patients may need to have additional filters inserted based upon their clinical situations (18).

References

(1). Decousus H, Leizorovicz A, Parent F. A clinical trial of vena cava filters in the prevention of pulmonary embolism in patients with proximal deep-vein thrombosis. N Engl J Med 1998;338:409-415
(2). The PREPIC Study Group. Eight-year follow-up of patients with permanent vena cava filters in prevention of pulmonary embolism. Circulation 2005; 112:416-422
(3). Athanasoulis CA, Kaufman JA, Halpern EF, Waltman AC, Geller SC, Fan CM. Inferior vena caval filters: review of 26-year single-center clinical experience. Radiology 2000; 216:54-66
(4). Ray CE, Kaufman JA. Complications of inferior vena cava filters. Abdom Imaging 1996; 21:268-374
(5). Molgaard CP, Yucel EK, Geller SC, Know TA, Waltman AC. Access-site thrombosis after placement of inferior vena cava filters with 12-14 F delivery sheaths. Radiology 1992; 185:257-61
(6). Kinney TB, Rose SC, Lime GW, Auger WR. Fatal paradoxic embolism occurring during IVC filter insertion in a patient with chronic pulmonary thromboembolic disease. J Vasc Interv Radiol 2001; 12:770-2
(7). Kaufman JA, Geller SC, Rivitz SM, Waltman AC. Operator errors during percutaneous placement of vena cava filters. Am J Roentgenol 1995; 165:1281-7
(8). Savin SA, Panicker HK, Sadiq S, Albeer YA, Olson RE. Placement of vena cava filters: factors affecting technical success and immediate complications. AJR 2002:179:597-602
(9). Hicks ME, Malden ES, Vesely TM, Picus D, Darcy MD. Prospective anatomic study of inferior vena cava and renal veins: comparison of selective renal venography with cavography and relevance in filter placement. J Vasc Intervent Radiol 1995; 6:721-9
(10). Kinney TB. Update on inferior vena cava filters. J Vasc Interv Radiol 2003;14:425-440
(11). Greenfield LJ, Proctor MC. Experimental embolic capture by asymmetric Greenfield filters. J Vasc Surg 1992;16:436-444
(12). Moore BS, Valji K, Roberts AC, Bookstein JJ. Transcatheter manipulation of asymmetrically opened titanium Greenfield filters. J Vasc Interv Radiol 1993; 4:687-90
(13). Danikas D, Constantinopoulous GS, Stratoulias C, Ginalis EM. Use of a Fogarty catheter to open an incompletely expanded Vena Tech-LGM vena cava filter. Angiology 2001; 52:383-6
(14). David W, Gross WS, Colaiuta E, Gonda R, Oscher D, Lanuti S. Pulmonary embolism after vena cava filter placement. Am Surg 1999; 65:341-6
(15). Rosen MJ, Burns JM, Cobb WS, Jacobs DG, Heniford BT, Sing RF. Guide wire entrapment by inferior vena cava filters: an experimental study. J Am Coll Surg 2005; 201:386-390
(16). Shimizu M, Tatsumi K, Matsukawa R, Shima T, Miwa Y. Retrievable Günther tulip filter complicated by sepsis and retroperitoneal hemorrahage: successful management by filter retrieval. Internal Medicine 2005; 44:593-597
(17). Greenfield LJ, Proctor MC. Vena caval filter use in patients with sepsis: results in 175 patients. Arch Surg 2003; 138:1245-8
(18). Morris CS, Rogers FB, Najarian KE, Bhave AD, Shackford SR. Current trends in vena caval filtration with the introduction of retrievable filter at a level I trauma center. J Trauma 2004; 57:32-6

Foundation Course Biliary Intervention

7.1

What information do I need before drainage?

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Percutaneous biliary procedures represent a special category of interventional radiological practice. The reason for this is their complexity, the high grade of difficulty and the increased risk of associated complications. These procedures demand special training and expertise, as well as adequate level of

experience and practice. Detailed knowledge of patient's history and special preparation are important steps prior to intervention.
Specific clinical information should be in mind before we start with the procedure:
A. Information about patient's history, including any kind of clinical problems they may have, any medication administered in a temporal or permanent basis, plus all operations of the upper abdomen undertaken previously, especially affecting the hepato-biliary area, must be studied.
For example, in the clinical state of an existing kidney, heart or pulmonary disorder, the IV administration of sedatives or analgesics during biliary procedures might be restricted. For patients under anticoagulation therapy, the medication may need to be altered or stopped prior to intervention. Previous surgical operations which may have changed the normal anatomy of the region of interest, for instance a bilio-digestive anastomosis or an iatrogenic injury of the common bile duct causing bilorrhea or obstruction, are crucial to know.
B. Biochemical tests describing kidney and liver function, blood analysis and coagulation status are necessary. Any imbalances should be corrected before the procedure. In any case, an intravenous access must be established. Neutral saline should be administered during drainage, as a prophylactic measure against hepatorenal failure. If the patient's blood coagulation is abnormal, fresh frozen plasma should be given before and during the procedure. For an INR rate greater than 1.5, Vitamin K should be administered. A platelet count of less than 70.000 has to be corrected with a platelet infusion before intervention.
C. Infectious conditions, such as cholangitis, cholecystitis, pancreatitis or sepsis must be treated with IV administration of antibiotic drugs before drainage. One gram of cephalosporine or 80 mg of gentamicin could be injected in order to avoid bacterial colonization of the obstructed biliary system.
D. The history of a contrast medium allergy, plus any other kind of adverse reaction to previously administered drugs must be in our knowledge before we start with the procedure.
E. The obstruction cause must be known or at least suspected. A positive biopsy is not necessary before percutaneous bile decompression because of the acute status of the patient. Pre-interventional multimodality imaging is imperative for defining the cause of the obstruction.
F. The level of an associated stricture can usually be found with a simple Ultrasound examination of the region. US can also depict the presence of an obstructing mass, the dilated biliary system, lymph node enlargement, a hydropic gallbladder, free intraperitoneal fluid, possible vascular disorders, lobar liver atrophy or the presence of hypervascular intrahepatic masses, i.e. haemangiomas or metastases.
Nevertheless, more detailed information is usually provided by a thorough contrast enhanced CT scan of the upper abdomen. Coronal reconstruction of the CT-images in an anterior-posterior projection is very helpful for the better understanding of the anatomic background, better corresponding to the fluoroscopic imaging during an IR procedure. Additional information about bowel loop infiltration distal to the papilla of Vater is valuable before the puncture, as in this case the simple biliary drainage is not enough and there appears the necessity of duodenal stenting as well.
High quality multi-planar MRI combined with MRCP images provide the best information about the cause and level of obstruction. MRCP offers additional information about bile tree anatomy and possible variations, GB position, presence of ascites, liver size and colon interposition.
G. All this information is very helpful in presenting the global picture of the patient's intra-abdominal situation, in order to plan our intervention optimally. Depending on the site of obstruction, the presence of liver atrophy or ascites, a left lobe puncture instead of the right may be decided. The presence of liver metastases or haemangiomas may alter the puncture site as well, or even make the use of real time US guidance necessary for the initial puncture. In the case of the site of obstruction being in the distal CBD, for a patient with uncorrectable blood coagulation, we can think of performing percutaneous cholecystostomy in order to avoid the transhepatic puncture. In some cases, when dealing with patients with several intrahepatic stones centrally to a benign stricture, we might modify our standard technique by changing the puncture site and choosing a particular bile duct for the initial drainage, in order to provide the best access for the subsequent lithotripsy.
H. Detailed anatomy information of the intra- and extrahepatic bile ducts may be acquired with endoscopic retrograde cholangiography (ERC). ERC is often the first invasive procedure undertaken by patients requiring biliary intervention. Even in the failure of ERC to insert a plastic or metal stent in the CBD, it may offer us very detailed imaging of the biliary tree, the stricture or at least the distal end of the obstruction. In the case of a benign disease, ERC can be very useful for imaging of the cause of jaundice, and a prospective sphincterotomy can be valuable before the upcoming percutaneous treatment. Sphincterotomy allows better bile flow to the bowel and helps minimize the duration of the percutaneous procedure, when intraluminal lithotripsy and stone removal through the bowel appears necessary. At the presence of a benign postoperative stricture with co-existing CBD injury and intraperitoneal bilorrhea, sphincterotomy can help eliminate bile leakage and thus bring the patient to a better clinical condition before percutaneous treatment.
As you can realize, percutaneous biliary interventions should not be performed as emergency cases. Even if the patient is septic or serum bilirubin level is very high, the patient should be studied carefully and prepared thoroughly before the first touch. If there appears to be no time available for a more sophisticated pre-interventional imaging, at least a basic ultrasound examination should be performed by the interventionalist himself, in order to gain adequate information necessary to avoid a great deal of intra-procedural trouble and potential complications.

References

1. A. Hatzidakis, D. Tsetis, E. Chrysou, E. Sanidas, J. Petrakis, N. Gourtsoyiannis: Nitinol stents for palliative treatment of malignant obstructive jaundice. Should we stent the sphincter of Oddi in every case?
CardioVascular and Interventional Radiology, 24: 245-248, 2001
2. A. Hatzidakis, E. Charonitakis, A. Athanasiou, D. Tsetis, G. Papamastorakis, G. Chlouverakis, G. Roussopoulou, N.C. Gourtsoyiannis: Sedation and analgesia in patients undergoing Percutaneous transhepatic biliary drainage.
Clinical Radiology 58: 121-127, 2003
3. A. Hatzidakis, A. Adam: The interventional radiological management of cholangio-carcinoma.
Clinical Radiology, 58: 91-96, 2003

7.3

Key points for sucess

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A successful percutaneous biliary drainage (PBD) intervention begins before the actual procedure: Important points are the bile duct anatomy, the ruling out of ascites, the institution of antibiotic coverage and analgesia, the evaluation of the coagulation status, the correction of any existing dehydration.
Anatomy: The interventional radiologist (IR) should seek imaging information regarding the anatomy of the patient's bile ducts, the presence of ascites, or the interposition of colon along the anticipated catheter tract, and the presence of liver masses. Ultrasonography (US), computed tomography (CT), and magnetic resonance

cholangiography (MRC) provide the required information. The knowledge on the presence of bile duct anatomy variations is very important when drainage of hilar lesions is planned. For example, in the presence of a hilar lesion, if the patient's right posterior duct drains into the left hepatic duct -instead of the right hepatic duct, the „normal" situation- a left hepatic drainage will be the best-suited approach, because most of the liver parenchyma will be drained [1,2,4]. Multi segment obstruction caused by extensive malignant disease, on the other hand, cannot be efficiently drained, so it would be more appropriate not to intervene at all[1,2].

Antibiotics: Obstructed biliary system may be infected in 25% to 50% of the patients [1,2]. Catheter manipulations may cause bacteremia, sepsis, or septic shock, therefore antibiotic prophylaxis is recommended. Antiobiotic prophylaxis should be started the day of the procedure at the latest, and continue for two days after the procedure. Piperacillin/tazobactam 4.5 g/day is a good choice [1]. Alternatively Ampicilin 1g and gentamycin 80 mg may be given [3].

Anticoagulation: Patients with obstructive jaundice have an increased bleeding diathesis because of vitamin K malabsorption. Correction should be performed by the administration of 25- 50 mg of Vitamin K at least 4 hours before the procedure, or with fresh frozen plasma. Failure to correct the coagulation status may cause severe bleeding complications.

Ascites: The presence of large amount of ascites is considered a relative contraindication to PBD, because it may add to the difficulty of the procedure; additionally, ascites is associated with an increased risk of bile peritonitis, as the bile may leak from the transhepatic tract into the peritoneal cavity [2]. However, the procedure can be performed after sufficient drainage of the ascitic fluid. Alternatively a left-sided PBD can be done with more safety, because even in the presence of large ascitic volumes the left hepatic lobe is usually not suspended in ascitic fluid [1,2].

Anti-dehydration: Vigorous hydration should be instituted one or two days before PBD with intravenous fluids, as most patients are dehydrated to prevent the development of hepatorenal failure. Patients with obstructive jaundice are prone to dehydration because of lack of food and liquid intake as a result 21/2 liters of intravenous solutions daily are recommended [1].

Analgesia: Besides administration of local anesthesia with lidocaine, conscious sedation with intravenous administration of midazolam and fentanyl is essential for success because it makes the patients more comfortable. In addition infiltration of the transhepatic tract with local anesthetic is used by some operators.

Technique of PBD.

Drainage starts with a percutaneous cholangiography (PTC). Puncture of an intrahepatic biliary duct can be performed with fluoroscopic guidance, or with a combination of US and fluoroscopic guidance [5,6]. A suitable intrahepatic duct should be selected for drainage: Segment 5 or 8 ducts are suitable for right sided drainage, while segment 2 or 3 ducts are assessed for left sided drainage. The IR should pursue to puncture the suitable duct, not take the first duct punctured: For example, one should never use a left hepatic duct punctured from the right side to perform cannulation of the common bile duct, because the severe angulation will increase the difficulty of the procedure and possibly cause complications [1]. Also, it is desirable to puncture a peripheral rather than a central duct, to avoid bleeding complications, and to drain the liver more effectively. Real time ultrasound guidance is ideal to select the preferred duct. A fine needle (21-22 G) should be used to minimize hemorrhagic complications, even with multiple passes. Use of micropuncture set with a 0.018-inch platinum tip guidewire, and coaxial introducer (Neff set, Cook, Bloomington,IN; or Accustic set, Boston Scientific, Watertown, MA) make the procedure minimally traumatic. After gaining access into the bile ducts, a hydrophilic guidewire and a short, angle-tipped catheter are used to negotiate the obstruction. Subsequently, a stiff guidewire is placed, over which dilatation of the intrahepatic track is performed with serial Teflon dilators.

If an external -internal catheter is decided to be placed, the IR should take care to place the most proximal hole of the catheter into the biliary duct, to avoid blood from the liver parenchyma to enter into the catheter and obstruct it with clots.

Proper fixation of these catheters on the skin is another important issue to attend, because these catheters may relocate with respiratory movements.The patient returns to the ward and antiotics and intravenous fluids are continued for 24 to 48 hours. Adequate analgesia also is required to keep the patient comfortable. The external or the external/internal catheter should be flushed with saline once a day. Daily rounds by the IR or the nurse are essential to check the catheter and for evaluating the outcome of the procedure.

References

1. Lee MJ. Biliary Intervention. In Kaufman JA, and Lee MJ eds. The Requisites. Vascular and Interventional Radiology, Mosby, Philadelphia, 2004: 558-587.
2. Rosenblatt M, Aruny JE, Kandarpa K. Transhepatic cholangiography, biliary decompression, endobiliary stenting, and cholecystostomy. In: Kandarpa K, Aruny JE eds. Handbook of interventional radiologic procedures, 3rd edition, Lippincott, Williams and Wilkins, Philadelphia, 2002: 303-331.
3. Westphal JF, Brogard JM. Biliary tract infections: a guide to drug treatment. Drugs 1999; 57: 81-91.
4. Gazelle GS, Lee MJ, Mueller PR> Cholangiographic segmental anatomy of the liver. Radiographics 1994; 14: 1005-1013.
5. Das K, Kochhar R, Mehta SK, et al. A modified technique of ultrasonically guided percutaneous transhepatic biliary drainage. Surg Endosc 1989; 3: 191-194.
6. Brountzos, EN, Petropoulos E, Kelekis NL, et al. Malignant biliary obstruction : management with percutaneous metallic stent placement. Hepatogastroenterology 1999 ; 46 : 2764-2771

7.4

How to place a stent

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Percutaneous biliary stenting can be considered a safe and clinically efficacious treatment for malignant biliary strictures. It allowed physiological passage of bile into the intestine improving the quality of life especially in inoperable patients with malignant strictures.

Metallic stent can be deployed during the initial percutaneous transhepatic biliary drainage (primary stenting) or several days (from 7 to 14 days) after the biliary drainage (secondary stenting), until the biliary tree appear decompressed. Generally speaking secondary stenting has the advantage of tamponating the transhepatic tract for several days reducing the risk of subcapsular hematoma, intraperitoneal hemorrhage and bile peritonitis; moreover this technique must be selected especially if hemobilia occurred during the initial PTBD.

The diameter of the stent is correlate to the diameter of the duct into which the stent must be implanted. However, using the nitinol stents, a 1cm oversized is mandatory to get the correct wall apposition.

The length of the stent should be selected in order to cover at least 2 cm of the duct above and below the lesion just to reduce the incidence of tumor ingrowth.

Following our experience after stent deployment, at the end of the procedure a small (4-5 Fr) pig-tail catheter should be deployed through the stent and retrieved two days later after laboratory test evaluation.

Biliary stenting can be done in different ways depending on the characteristics, site and extension, of the lesion.

1) Common bile duct stricture, at least 1 cm below the hilum.

Through a single puncture site, single-duct drainage is achieved by insertion of a single stent or by an additional stent inserted telescopically through the first one to achieve an adequate stent

length for long strictures. Both bare and covered stents can be successfully implanted.
2) Common bile duct lesion localized at the level of the hilum (<1 cm), involving both right and left biliary ducts.
- After drainage of the right and left lobe, two bare stents are inserted through the separate puncture sites extending from the left and right hepatic ducts into the lower common bile duct in a parallel position so that they maintained biductal drainage (stents placement in „Y" configuration).
Moreover in case of long common bile duct, a bare stent can be released in the third medium portion of the common bile duct. After two other bare stent can be inserted trough the right and left biliary ducts both with the distal portion placed inside the previous one (three stent in "Y" configuration).
- Two uncovered stents are inserted through the same puncture site (right side). The first stent extending from the right to the left hepatic duct and a second-one extending from the right hepatic duct into the lower common bile duct, maintaining the drainage of both right and left biliary ducts system (biductal stent drainage in „T" configuration).
In the last few years, several authors have reported their experience with the use of covered metallic stents, with various synthetic materials as covering membranes, in patients with malignant biliary obstruction. Some stents were assembled by the authors with use of bare stents and different available coverings; they were not commercially available. Migration is a relevant issue in the performance of a covered stent because the smooth outer surface is friction-free and offers no resistance against stent dislocation. For this reason, subsequent generations of covered stents have been designed with anchoring appendices or with a bare portion that ensures stability after placement.
STENT DEPLOYMENT
- Through the percutaneous access, a hydrophilic angled guide-wire 0.035"inc. is inserted into the biliary catheter across the distal segment of the target lesion and advanced into the duodenum.
- The biliary drainage catheter is removed leaving the guide-wire in place.
- An introducer sheath 25 cm long is introduced though the percutaneous access site.
For bare stent deployment an 8 Fr introducer is preferable, while for covered stent-graft a 9 Fr is required. The introducer is then flush with saline, inserted through the side port, to avoid the passage of air bubbles into the biliary tree.
- Contrast-media injection is performed to visualize the anatomy and the target lesion.
- Under fluoroscopy guidance, the stent device is inserted into the introducer to the desired position, covering the entire target lesion.
- A cholangiogram is then performed to evaluate the correct position of the stent.
- The introducer is then partially retrieved to permit the correct releasing of the stent
- The stent is deployed under fluoroscopy guidance
- Remove the delivery system. If resistance is met during the withdrawal of the delivery system, re-advance the outer sheath to its pre-deployment position and then withdraw the system as one unit.
- A final cholangiogram is done to ensure proper placement and patency of the stent.
- If the stricture does not allow the complete expansion of the stent a balloon dilatation may be performed. The balloon diameter should be equal or 1mm less than the nominal stent diameter.
- A 4-5 Fr. Pig-tail catheter is placed through the stent providing access to the stent if an additional treatment is needed.
MULTIPLE STENT PLACEMENTS
If placement of more than one stent is required in a patient, the following recommendations should be considered:
- In relationship to the operator, the distal area of narrowing should be stented first, followed by the proximal locations (i.e., a second stent should be placed proximally to the previously placed stent)
- Stents placed in tandem should slightly overlap

References

1. Davids PHP, Groen AK, Rauws EAJ, Tytgat GNJ. Randomised trial of self-expanding metal stents versus polyethylene stents for distal malignant biliary obstructions. Lancet 1992; 340:1488-1492.
2. Bezzi M, Zolovkins A, Cantisani V, Salvatori FM, Rossi M, Fanelli F, Rossi P. New ePTFE/FEP-covered stent in the palliative treatment of malignant biliary obstruction. JVIR 2002; 13:581-589.
3. Schoder M, Rossi P, Uflacker R, Bezzi M, Stadler A, Funovics MA, Ceyna M, Lammer J. Malignant biliary ostruction: treatment with ePTFE-FEP-covered endoprostheses-Initial technical and clinical experiences in amulticenter trial. Radiology 2002;225:35-42
4. Kanasaki S, Furukawa A, Kane T, Murata K. Polyurethane-covered nitinol Strecker stents as primary palliative treatment of malignant biliary obstruction. Cardiovasc Intervent Radiol 2000; 23:114-120
5. Young-Min H, Gong-Yong J, Seung-Ok L, et al. Flared polyurethane-covered self-expandable nitinol stent for malignant biliary obstruction. J Vasc interv Radiol 2003; 14:1291-1301
6. Inal M, Akgul E, Aksungur E, et al. Percutaneous self-expandable uncovered metallic stents in malignant biliary obstruction. Acta radiological 2003;44:139-146

Special Session Musculoskeletal Intervention

12.3

Bone biopsy techniques

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The **purpose** of this special session is to demonstrate techniques used in bone biopsy. Bone biopsy has a crucial role in the diagnostic armamentarium. This presentation is an overview of bone techniques used in an area of non-vascular interventions. It will explain the patient selection, indication and possible approaches to a bone lesion. Available materials will be discussed, as well as possible combinations of them in order to yield maximum results, while reducing possible drawbacks. This special session will help the novice understand the technical challenge and determine why and how each of above procedures is performed, while at the same time help the experienced user to choose the correct material or to combine techniques. We will review the differences between malignant and benign infectious disease, the characteristics of various needles used for fine needle aspiration as well as the designs (beveled vs diamond tip) and use (rotation vs taping) of core biopsy needles. Imaging techniques will be addressed, including fluoroscopy, ultrasound, computed tomography and magnetic resonance with the benefits and drawbacks of each modality. Size and types of samples will be discussed. Anatomic and positional landmarks will be addressed. Analgesia is being discussed, as well as mobilization and drugs. Complications are analyzed, as well as techniques to minimize potential permanent lesions.
By the end of this presentation, novices of biopsy techniques should be aware of the possible landmarks to be used, both in spinal and peripheral approach, the anesthesia to be applied and the difference in approach for benign and malignant disease, as well as the possible advantages and disadvantages of each device used and ways to overcome potential material failure. Results of biopsies will be discussed with histological and pathologic correlation. Fixation of the biopsy material will be presented, in order to optimize results. This will

help the novice user to create a strategy of approach, evaluate paths and sensitive tissues and optimize his sample. The advanced user will find alternative use and combination of biopsy with treatment, as well as technical solutions to deal with complications. Both will have a vision of future materials to be on the market, regarding bone biopsies and possible variations of it in spinal and peripheral bone lesions.

In **conclusion** most bone lesions are necessarily related to bone biopsy prior to excision or medical treatment. The purpose of this presentation is to allow the interventional radiologist to perform bone sampling in a safe and efficient way, minimizing the risk for his patient, while yielding all possible potential from the recruited tissue. Knowing the limitations of the material at hand seems to be important for avoiding technical complications.

References

1. Lowenthal RM, Taylor BV, Jones R, Beasley A. Severe persistent sciatic pain and weakness due to a gluteal artery pseudoaneurysm as a complication of bone marrow biopsy.
2. Steensma DP, Bennett JM. The myelodysplastic syndromes: diagnosis and treatment.Mayo Clin Proc. 2006 Jan;81(1):104-30. Review.
3. Callstrom MR, Charboneau JW. Percutaneous ablation: safe, effective treatment of bone tumors. Oncology (Williston Park). 2005 Oct;19(11 Suppl 4):22-6. Review.
4. Peh WC. Imaging-guided bone biopsy. Ann Acad Med Singapore. 2003 Jul;32(4):557-61. Review.
5. Malluche HH, Langub MC, Monier-Faugere MC. The role of bone biopsy in clinical practice and research. Kidney Int Suppl. 1999 Dec;73:S20-5. Review.
6. Bullough PG. The role of bone biopsy in evaluating bone disease. Rev Rhum Engl Ed. 1997 Jun 30;64(6 Suppl):37S-43S. Review.
7. Kelekis AD, Somon T, Yilmaz H, Bize P, Brountzos EN, Lovblad K, Ruefenacht D, Martin JB. Interventional spine procedures. Eur J Radiol. 2005 Sep;55(3):362-83. Review.
8. Bock M, Umathum R, Zuehlsdorff S, Volz S, Fink C, Hallscheidt P, Zimmermann H, Nitz W, Semmler W. INTERVENTIONAL MAGNETIC RESONANCE IMAGING: AN ALTERNATIVE TO IMAGE GUIDANCE WITH IONISING RADIATION. Radiat Prot Dosimetry. 2006 Feb 7
9. Sequeiros RB, Ojala R, Kariniemi J, Perala J, Niinimaki J, Reinikainen H, Tervonen O. MR-guided interventional procedures: a review. Acta Radiol. 2005 Oct;46(6):576-86. Review.

12.4

Disc and facet joint IR treatments

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Back back pain together with disk herniation is one of the major medical problems in health care systems worldwide. Minimally Invasive Techniques for treatment of spinal disease offer a wide range of new indications in Interventional Radiology. Especially for small free fragments in the spine new methods were developed, which are able to replace open surgery. The combination of Computed Tomography fluoroscopy and endoscopy or Magnetic Resonance Tomography with endoscopy is safe and effective to increase outcome for different treatment modalities. Image guided surgery with real time ultrafast CT enables highly precise procedures. Use of the latest hardware generation in addition to a CT fluoroscopy device delivers images with high resolution, which are displayed immediately.

Percutaneous techniques for treatment of spinal diseases like disk herniations had been limited to contained disks (1). 1990 we developed a new technique for micro endoscopic interventions in the spine. Sequestrectomy for small free fragments and dissection of spinal scar tissue became possible. CT and MRI allow imaging of smallest structures in the spinal canal.

The accuracy of guidance of instruments in the body is 1mm3 for CT. Contrary to X ray fluoroscopy CT and MRI provide accurate localization of nerves, vessels and herniations in the spine. The possibility to monitoring of instruments and effects during the procedure, show the potential of these methods.

For diagnosis CT and MRI are very important and should performed after conservative treatment of two weeks without success or immediately if neurological symptoms are present.

Different methods for treatment of chronic diseases of the spine are possible and can be performed under local anesthesia:

1. facet joint denervation;
2. periradicular therapy (PRT);
3. percutaneous nucleotomy (PNT);
4. micro endoscopic sequestrectomy;
5. micro endoscopic scar dissection.

Facet joint denervation

Low back pain without sciatica is often related to degenerative diseases of the facet joints. About 80 % of facet syndromes are located in L4/5 and L5/S1. In 1971 Rees (2) introduced facet joint denervation as a surgical procedure. A few years later electrocoagulation of the facet joints was introduced (3). Facet joint block with local anesthetics or facet joint denervation with 96% ethanol is performed under CT and MRI guidance in our institute. The neurolysis should be done in both joints of the level. If there is an additional compression of the nerve root the treatment can be combined with PRT. Good results of the treatment can be archived in 65 to 75 % of the patients. CT is monitoring the distribution of ethanol, so that accidental injections to the nerve root or into vessels are nearly impossible (4,5).

Periradicular therapy

In patients with failed back surgery syndromes we use since 1986 CT guided and since 1988 also MRI guided periradicular therapy (PRT). Under CT guidance a 22 or 23 Gauge coaxial needle system can be advanced step by step to the nerve root. The puncture should be made in the lower third of the foramen and undercross the nerve root. Local anesthetics and local acting cortisone were applied after test injection of contrast. The treatment should be repeated after three to four weeks four to six times. After the first good results of this method we treated disk herniation as well as spinal stenoses (Tab 1). PRT restitutes the function of the nerve root. If patients denied surgery even weakness of the leg could be treated successfully. We performed different studies on PRT (6). The results are listed in Tab.2.

Tab. 1 Indications of periradicular therapy (PRT)

disk herniation
failed back surgery
spinal stenosis
stenosis of recessus lateralis
stenosis of foramen vertebralis
weakness and loss of sensibility

Tab.2 Results of PRT. First group (N=370)

symptoms improved after first therapy 15 %
symptoms improved after fourth therapy 72 %
no symptoms at the end of treatment 78 %
no symptoms three months after treatment 83 %
no symptoms two years after treatment 68 %
disk surgery after PRT 3 %

A prospective randomized study with 40 patients (21 male and 19 female) was performed in 1990. The study compared PRT with 10mg triamcinolonacetonide versus 40mg per treatment. Two independent examiners analyzed the CT images before and after the study and evaluated the results. All patients suffered from chronic pain by disk herniation with radicular symptoms in the treated level. The patients had to answer a questionnaire including the visual analogous scale (VAS) before and after treatment. 0 value means no pain, 100 is maximum pain. Additional neuro orthopedic examinations were made by independent physicians. Every 3 to 4 weeks 4 to 8 treatments were performed. Statistical evaluation was

carried out with Mann Whitney test for analysis of comparison of both groups before and after treatment as double sided plausibility test (7). Results are shown in table 3.

Tab. 3 Results of a randomized prospective double blind study (N=40) on PRT

Improvement after treatment 40 mg triamcinolocacetonide versus 10 mg

Group N Mean SDA Min Q1 Media Q3 Max

all 40 67.5 34 0 42.5 80 97.5 100

V40 30 72.3 34.71 0 57.6 90 100 100

V10 10 54 29.14 0 37.5 55 75 100

V10 triamcinolon 10mg group

V40 triamcinolon 40mg group

SDA standard deviation

Q1 lower quartile

Q3 upper quartile

Statistically the range of pain according the VAS was not different in both groups. After therapy in V40 group a high significant improvement of symptoms could be archived. In the V10 group we found only slight improvement. The neuro orthopedic examination showed a complete improvement of the stretched leg test from initial 30 to 60 degrees in most cases.

After PRT Complication and side effects are seldom. 1 patient with a diastematomyelia had immediately after PRT a plegia of the leg. The weakness disappeared after conservative treatment of a few weeks. Therefore we recommend to exclude patients with spinal cord abnormalities for this treatment. Two patients had a spondylodiscitis and a spondylitis after PRT. No bacterial infection was found at biopsy. These patients were treated conservative in the hospital. A list of side effects is given in Tab. 4.

Tab.4 Side effects of PRT. Results of two studies.

study (n=40) study (n=370)

n % n %

indigestibility 1 2.5 0 -

edema 1 2.5 11 3

acne 1 2.5 15 4

tensions and blushing 1 2.5 7 2

hair loss 2 5 0 -

hormonal disorder 2 5 5 (of 170 female) 3

weight increase 4 10 30 8

stomach disorder 5 12.5 0 -

calf cramps 15 37.5 30 8

petechia 0 2 0.5

Percutaneous nucleotomy

Percutaneous techniques for nucleotomy were first described by Hijikata in 1975 (8). Friedman (9), Kambin (10) and Suezawa (11) have further developed this technique. Suezawa added diskoscopy to fluoroscopy for monitoring of the treatment. For these procedures general anesthesia was needed. Two trocar systems were advanced to both foramen intervertebrale with a diameter of 11 mm. Onik introduced a new automated nucleotomy device with a probe of 2mm in diameter (12). The procedure has been performed under local anesthesia with fluoroscopy since 1985.

Since 1988 we have performed percutaneous nucleotomy with combined CT and fluoroscopy guidance. First we started with the automated probe of Onik (PNT). This cutting device is able to remove material of the nucleus pulposus. Later we switched to Laser nucleotomy (PLNT). We use Holmium and Neodymium YAG Laser. Free fragments in the spinal canal or mass herniation can not be treated by percutaneous nucleotomy. Small herniation and contained disk, this means the herniation is within the disk level without free fragments, with compression of the nerve roots and correlative neurological symptoms are a good indication for percutaneous therapy.

We have treated 110 patients with PNT (13) and 116 with PLNT (14). There were no significant difference in outcome of both groups, but it is easier to treat with Laser. We use 20 to 18 gauge introducer sets and are testing now 23G for Laser. So the diameter is only 1.2 to 0.65mm. In the study we used Laser fibers with 0.4mm diameter. The risk of nerve root injury in the foramen is very low. For the automated suction device we used introducers with diameters from 2.8 to 4.0mm.

For a safer procedure of PNT we modified the set and started the puncture with a 22G fine needle with pull off connector, that could be removed after safe puncture of the disk under CT monitoring. Then the puncture canal is dilatated step by step until the next size of the introducer could be inserted to the annulus fibrosus under fluoroscopy (PNT).

Patients

PNT: 110 patients were treated from 1988 to 1991 The mean age was 45 years with a range from 25 to 66. Two patients underwent PNT at the level L3/4 (2%), fifty eight at level L4/5 (53%), and fifty at level L5/S1 (45%).

PLNT: In 116 a Laser nucleotomy was performed between 1989 to 1991. The mean age was 47 years (range 15 to 81 years).

The procedures were performed at the level L2/3 in three patients (2%), at level L3/4 in nine patients (8%), at level L4/5 in 71 patients (62%) and at level L5/S1 in 33 patients (28%).

Follow up

Time schedule for follow up examinations was 3 weeks, 6 weeks, 3 month, 6 month and 1 year after PNT and PLNT. The success of both methods was proven by clinical and neurological examinations at all follow ups and by CT 3 weeks and 6 month after therapy. A MRI study of the lumbar spine was routinely done 6 weeks after treatment to exclude discitis. Visual Analogous Scale (VAS) was used for evaluation of pain.

Results

In 82% of the patients (n=110) a complete pain relief after PNT. Neurological findings like pathological stretched leg test or weak muscle reflexes are improved immediately after PNT in 92%.

Complications and side effects

One patient after PNT and one patient after PLNT suffered from a spondylodiscitis. 26 % of the patients had an irritation of the segmental nerve root for three to five weeks after PNT and 21% in the PLNT group.

New treatments for uncontained disk and scar tissue

The nucleotomy methods described above were only indicated in contained disk. Therefore free fragments in the spinal canal and the foramen are very common and could not be treated. We developed a new technique with a combination of CT, fluoroscopy and micro endoscopy to visualize very small structures inside the foramen and the spinal canal percutaneously. With new endoscopes this technique now can also be used inside an open magnet. We started the new technique for dissection of scar tissue in the spine (15) and for treatment of small free fragments (16) in 1990 in our institute.

A study of 20 patients with chronic low back pain was initially published. Four of them had free fragments in the spinal canal. In 8 cases lateral herniation with free fragments in the foramen were treated. 7 patients had prior open surgery with scar tissue in the spinal canal and were also treated under endoscopic combined CT fluoroscopic and micro endoscopic monitoring. In one patient an abscess in the foramen was removed. Overall mean age was 51.9+/-14.8 years. Level L4/L5 was treated in 12 patients and L5/S1 in 8 patients. 17 patients were outpatients.

Immediately after therapy, pain relief and improvement of neurological symptoms were assessed. Furthermore within the context of a follow up the patients were asked to evaluate treatment success, defined as improvement of pain symptoms estimated on VAS

Instrumentation

Special introducer sets with diameter from 1.2 to 4mm had to be developed for the procedure. The smallest fiberscope with a diameter of 0.29mm fits into a 22G coaxial interventional needle set. A good view is obtained with endoscopes of a diameter more than 0.6 mm. The best view is given by endoscopes with flexible tips and a diameter of 1.4mm. We developed micro instruments with 0.9 mm diameter, which can be used in the foramen and spinal canal like micro forceps, scissors and other instruments. Different laser systems

were used for ablation: a NdYAG and HoYAG laser.
Results
Before treatment 20 patients had a pain score between 70 to 100 (VAS). 80 % of the patients (n=16) had neurologic deficits before micro operation: weakening of the patellar reflex, weakness of the tibialis anterior as well as weakness of the extensor brevis and decreased ankle jerk. Immediately after micro surgery improvement of reflexes or weakness could be archived in 75% of these patients. In 94% of the cases stretched leg test decreased more than 50 degrees or was negative.
50% improvement of pain symptoms was present in all patients at the end of the procedure. The average pain score decreased from 88 to 8%. Pain relief more than 50 (VAS) at follow up after 6 month was obtained in 90% of the patients (n=18).
Complications and side effects
Complications of CT-guided spinal endoscopic procedures were not seen in this few cases. 5 of our patients complained slightly of nerve root irritation at the treated level. This lasted several days, sometimes up to two weeks. Conservative treatment with PRT was necessary in 4 patients. These symptoms were related to mechanical irritation by pressure to the nerve root during PLNT. 3 of these 5 patients suffered from pseudo-radicular pain. This was treated with blockades of both facet joints (3 times in a distance of 8 days) by injecting a local anesthetics.
Discussion
Open surgery of the spine is limited because of limited results and post nucleotomy syndrome with severe disability after surgery. This reason is challenging to develop new less invasive techniques for treatment of spinal diseases.
In the therapy of the vertebral column and intervertebral structures percutaneous procedures offer safe alternatives to conventional open surgery of the disk. PRT, PLNT and PNT and micro endoscopic procedures are successful because of decompression and restoration of the function of the nerve root. Even if a complete replacement of the open surgery is not possible at this moment, these micro invasive techniques have a wide field for application. Especially in post nucleotomy syndromes with chronicle pain Minimally Invasive Therapy can offer a new way of treatment (17).
The limitation of percutaneous nucleotomy techniques are free fragments in the spinal canal and in the foramen (18). CT or MRI guided micro endoscopy of the spinal canal enables the possibility for treatment of dislocated herniations. First preoperative planning of the best access and the right angle can be done in 3D technique. Then CT and MRI give nearly real time imaging for monitoring and instrument guidance. In addition micro endoscopy gives a good view to the surface of the operative field. The combination of these techniques permits the highest safety for procedures in the spine. After intensive training the accuracy for handling of instruments under this conditions is 1/10 of one millimeter.
In Oncology CT or MRI guided Interventions have two main fields: pain therapy and local tumor therapy. Even in pathologic anatomy CT and MRI allows precise access to nerves and tumors. The control of the puncture and monitoring of treatment modalities, like local cytostatic drugs, ethanol injection, heat application with laser, coagulation, RF ablation, hyperenergetic ultrasound or cryosurgery demonstrate the advantages of this techniques. Accidental injection of local anesthetics into the vertebral artery can cause a convulsion immediately (19). Even negative aspiration test gives not enough safety to avoid injuries of arterial wall without CT guidance (20). Because of these reasons we recommend strongly the use of CT and MRI for local application of toxic materials in tumors.
An advantage of combination of CT and fluoroscopy is that patients can be treated or examined without movement or transportation from one machine to the other. This makes it easy to do high sophisticated procedures for diagnosis and therapy in one examination room.

References

1) Onik G, Helms CA, Ginsberg I, Hoaglund FT, Morris J: Percutaneous lumbar discetomy using a new aspiration probe: Porcine and cadaver model. Radiology 155 (1985) 251
2) Rees WS: Multiple bilateral subcutaneous rhizolysis of segmental nerves in the treatment of the intervertebral disc syndrome. Ann Gen Prac 26(1971) 126-127
3) Shealy CN: Percutaneous radiofrequency denervation of spinal facets: Treatment of chronic back pain and sciatica. J Neurosurg 43 (1975) 448-451
4) Seibel RMM, Groenemeyer DHW, Grumme TH: New treatments of the spinal column diseases using Interventional Radiological Techniques. in Seibel RMM, Groenemeyer DHW: Interventional Computed Tomography. Blackwell, Oxford 1990, 95-97
5) Lora J, Long MD: So called facet denervation in the management of intractable back pain. Spine 1 (1976) 121-126
6) Seibel RMM, Groenemeyer DHW, Grumme TH: New treatments of the spinal column diseases using Interventional Radiological Techniques. in Seibel RMM, Groenemeyer DHW: Interventional Computed Tomography. Blackwell, Oxford 1990, 100-115
7) Groenemeyer DHW, Seibel RMM, Schindler O, Schattauer K, Lange S, Schmidt A: Die mikroinvasive CT gesteuerte periradikulaere Therapie zur Behandlung von chronischen bandscheibenbedingten Funktionsstoerungen. Wien Med Wschr 145 (1995) 129-139
8) Hijikata S., Yamiagishi M., Nakayama T, Oomori K.: Percutaneous diskectomy: a new treatment method for lumbar disc herniation. J. Toden Hosp 1975; 5: 5-13
9) Friedman W. A.: Percutaneous discectomy: an alternative to chemonucleolysis? Neurosurgery. 1983; 13: 542-547
10) Kambin P, Gellman H. Percutaneous lateral discectomy of the lumbar spine. A preliminary report. Clin Orthop 1983;174:127
11) Suezawa Y.: Kreuzschmerzen in der Orthopaedie - Heutiger Stand ihrer Therapie. Schweiz. Rundsch. Med. Prax. 1982;71:783
12) Onik G, Helms CA, Ginsberg I, Hoaglund FT, Morris J: Percutaneous lumbar discetomy using a new aspiration probe: Porcine and cadaver model. Radiology 155 (1985) 251
13) Seibel RMM, Groenemeyer DHW, Soerensen RAL: Percutaneous nucleotomy with CT and fluoroscopic guidance. JVIR 1992; 3: 571-576
14) Groenemeyer DHW, Seibel RMM, Schmidt AM, Kremer G, van Leeuwen P: Atraumatic CT-Controlled percutaneous laser nucleotomy. Min Inv Ther 1993; 2: 247-255
15) Seibel RMM, Groenemeyer DHW: Technique for CT guided microendoscopic dissection of the spine. End Surg 1994; 2: 226-230
16) Seibel RMM: CT guided endoscopy of sequestered disk herniation. JVIR 1996; 1 Sup: 222
17) Seibel RMM, Groenemeyer DHW. Micro-invasive CT-guided dissection technique. End Surg 1994; 2: 226-230
18) Onik G.: Percutaneous automated discectomy: Technique. In: Onik G., Helms C. A. (eds.) Automated percutaneous lumbar discectomy. Rad. Res. Educ. Found. Univ. Cal. Print. Dep. 1988, 77-110
19) Ariani J, Parmley J, Ochsner A: Facilities and complications after attempts at stellate ganglion. Surgery 32(1952)615
20) Mastroianni A.: The effects of stellate ganglion block. Schmerzdiagnostik und Therapie, Volume 2 Bochum (1986) 80-93

Special Session
Intermittent Claudication 1

13.3

Interpretation of non-invasive imaging tests

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Non invasive imaging of vascular structures revolutionized interventional radiology by adding a powerful tool in the precise pre - interventional evaluation of the vascular patient. It was based on the development of the new innovative techniques starting with Ultrasound, later the development of MRI with its special applications for angiography (MRA), and with the latest rapid developing

techniques in multidetector-row Computed Tomography. For the vascular and interventional radiologist it is increasingly important to be familiar with the latest vascular imaging technique, and how to read and interprete the large angiographic data sets and their reformatted images for clinical decision making and treatment planning.

Ultrasound Angiography:

Aside from imaging , the introduction of the ultrasonic Doppler technique in the 1960s made for the first time a non-invasive, on line evaluation of the blood flow characteristics in vessels possible. Principally advanced vascular ultrasound is based on the Doppler phenomenon: Scattering echoes from the erythrocytes travelling towards the probe have a higher frequency in relation to the transmitted frequency. This frequency shift is proportional to the rate and direction of the blood flow velocity. Continuous-wave Doppler (CW Doppler) and the pulsed wave Doppler (PW Doppler) can detect the flow velocity along a single sound beam using a fast Fourier transformation. With the CW Doppler mode, this measurement is carried out over the entire depth of the sound beam, whereas only echo signals from a sample volume in a user-selected depth are analysed with the PW Doppler mode. In the case of Colour Doppler, the blood flow is detected from a multitude of sample volumes distributed over the entire 2D image, using autocorrelation or related algorithms, and displayed as a colour coded- image.

Colour Doppler yields flow interpretation about flow direction and mean flow velocity over the entire sectional image. The so called "Power Doppler" has a higher sensitivity by using only the amplitude of the Doppler signal and not the Doppler frequencies. The power Doppler is almost independent of the Doppler angle. Therefore, an angiogram like image can be presented. However it is also more sensitive to artefacts.

Although CTA and MRA are nowadays the "trendsetters" among the imaging vascular tools, there are still good indications for US evaluation of vessels. One of its most important use is the evaluation of carotid arteries. It particularly provides detailed information about blood flow velocities and flow dynamics, which are reliable factors for the estimation of stenoses and add therefore valuable information, even if MRA or CTA is already performed. For peripheral arteries US is a good alternative for a first line approach, or when MRA and CTA are not available.

Magnetic Resonance Angiography (MRA)

There are currently three types of MRA techniques: One of the first applications relied on the inflow phenomenon and is called the time of flight (TOF) technique. A second group was based on the phase behaviour of the macroscopic magnetization and is called phase contrast Angiography (PC). However, with the progress in hardware development and the ability to acquire a 3D MRA within a breath hold the so called contrast enhanced MRA techniques have shown a dramatic improvement and are more and more becoming the standard procedure of choice. The technique is based on a Gradient echo technique, with the shortest suitable echotime (TE) selected, the shortest possible repetition time (TR), and a moderate excitation angle. The aim is to provide an image of a passing contrast bolus. The T1 shortening of the blood as a consequence of administering a paramagnetic contrast agent allows then the imaging of the vascular tree. The most critical part the timing between injection of the bolus and the start of the breath hold acquisition, with the goal of acquiring the low k-space frequencies at the time the bolus passes through the region of interest.

To cover large regions as required in the MRA evaluation of the peripheral vessels, protocols are offered that include automatic table feed to cover several stations .

Drawbacks for MRA are several artefacts that may lead to misinterpretation, such as chemical shifts, the flow and motion artefacts, and magnetic field inhomogeinities. Particualrly stents or metal implants from previous surgery produce artefacts, that hinder an interpretation. Calcifications are another potential limitation, and may cause overestimation of stenoses.

The main advantage of MRA is the lack of iodinated contrast agents, which is particularly important in patients with a decreased kidney function.

Computed Tomography Angiography (CTA)

It was not before the introduction of multiple-detector row CT that adequate resolution imaging of the entire inflow and runoff vessels became possible with a single acquisition and a single intravenous contrast medium injection .

Scanning technique: In general a tube voltage of 120kV and a maximum tube amperage of 300mA is used for peripheral CT angiography , which results in a similar radiation exposure and dose (12.97mGy, 9.3 mSv) as abdominal CT angiography. Breath holding is required. Lower amperage (voltage) can be used in patients with low body mass index.

Scanning protocol: a full scanning protocol consists of the digital radiograph (scout image) an optional non-enhanced acquisition one series for a test bolus or bolus triggering the actual CT angiography acquisition and a second optional "latephase" CT.

Image acquistion and Reconstruction parameters: The choice of acquistion parameters depends on the type and model of the scanner. "Standard resolutions" can be provided from a 4-channel CT, with overlapping image reconstructions every 1-2mm, which are adequate for visualization of the aortoiliac and femoropoliteal vessels and also provide enough detail to assess the patency of crural and pedal arteries if vessel calcification is absent or minimal. Four channel CT therefore provides adequate imaging in patients with intermittend claudication in acute embolic disease, aneurysms, anatomic vascular mapping and also in traumatic cases.

To cover the entire peripheral artery tree the detector configuration is usually set to 4x2.5mm.

On the other far end of vascular scanning, data acquisition with a 64-channel CT ensues on a submillimeter scale (64x0.6mm or 64x0.625mm), Submillimeter isotropic images with a section thickness as small as 0.6-1.0mm, spaced every 0.4-0.7 mm, may be reconstructed from the same acquisition. This maximum spatial resolution may translate into improved visualization and treatment planning.

Visualization and Image interpretation:

Various two-and three-dimensional postprocessing techniques are available. Reviewing of transverse CT slices is mandatory for the assessment of extravascular pathologic processes. Source images may also serve as a reference when two-dimensional or 3 D reformatted images suggest artifactual lesions.

Asessment of vascular abnormalities is facilitated by MIP (multiple intensity projection) or VR (volume rendering) techniques. MIP provides the most angiography-like images. However, MIP requires that bones are removed from the data set, which is time consuming. Moreover inadvertent removal of vessels in close vicinity to bony structures may lead to spurious lesions.

Volume rendering (VR) preserves 3D depth information. Interactive adjustment of the opacity transfer function allows the user to blend in or carve out exquisite vascular detail when necessary.

The main limitation of MIP and VR is that vessel calcifications and stents may completely obscure the vascular flow channel.

MPR and CPR In the presence of calcified plaques or endoluminal sents cross sectional views are essential to assess the vascular flow channel. Multiplanar reformations (MPRs) are useful. Alternatively CPRs (curved planar reconstructions) along a predefined vascular center line provide the most comprehensive cross sectional display of luminal pathologic processes, but require manual or semiautomated tracking.

Pitfalls: The most important pitfall is related to the use of narrow viewing window settings in the presence of arterial wall calcifications and stents. High attenuation objects appear larger than they really are (blooming artefact), which may lead to an overestimation of lesion. In the setting of extensive calcifications the lumen may not be resolved regardless of the window/level selection. In these circumstances other imaging techniques (MRI) may be preferable to

CT. Other misinterpretation of editing artefacts in MIP images and pseudostenoses and/or occlusions in CPRs results from inaccurate center-line definition .

Literature:

Fleischmann D, Hallett RL, Geoffrey D, Rubin D CT Angiograpy of Peripheral Arterial Disease. JVIR 2006;17:3
Reimer P, Parizel PM, Stichnoth FA (EDs. Clinical MR Imaging, a practical approach; Springer Verlag Berlin; 1999
Baert AL, Heuck FH, Youker JE; Zeitler ed. Radiology of peripheral vascular disease. Springer Berlin Heidelberg; 2000

Special Session
Stroke Therapy

14.2

Stroke lysis & when to do it?

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Current Stroke Endovascular Treatment: Multimodal Approach

Introduction:

Cerebrovascular disease, particularly ischemic stroke, remains among the leading causes of serious long term disability and is the third leading cause of death behind heart disease and cancer. Cerebral ischemia is the significant reduction of blood flow to all or part of the brain. The clinical effects of a cerebral ischemic event depend upon the duration and degree of flow impairment and the volume and location of brain tissue affected. Restoration of adequate perfusion to prevent or limit the progression of cerebral ischemia to irreversible infarction is the goal of early intervention in acute stroke management. The evaluation of a patient considered for intra-arterial thrombolysis begins with a cranial CT to exclude an intra-cranial hemorrhage, a contraindication to thrombolysis. Once the CT has been reviewed, discussion between the stroke neurologist and endovascular neuroradiologist will determine if the patient is a candidate for intra-arterial thrombolysis.

One of the leading areas of change in neuroendovascular therapy has been the progress on stroke traetment. Researchers addressed the following therapeutic targets:

1. Cardioembolic stroke
2. Carotid Stenosis
3. Vertebral Arteries Disease
4. Acute Ischemic Stroke
5. Symptomatic intracranial atherosclerosis
6. Dural Sinus thrombosis
7. Cerebral Vasospasm

This article reviews the current understanding of different mechanisms stroke, and the endovascular options that are adopted in each particular group.

Materials and Methods: We retrospectively analyzed the treatment of patients which presented stroke history. We assess the feasibility, safety and effectiveness of endovascular approach. Diagnosis, clinical and radiological presentation, inclusion criteria were developed especially for this review. We included hereby patients which were treated to carotid angioplasty with acute oculsion or dissection. We performed mechanic fibrinolysis (Merci) and pharmacological fibrinolysis (intra arterial injection rtpa and inhibitors II b-IIIa.

Recent technological advances in microcatheters allow the navigation of small catheters through the tortuous cerebral arteries and directly into the blood clot that is causing the stroke. Several thrombolytic agents have been developed, the most
commonly used agents currently are urokinase and tissue plasminogen activator. The effect of the thrombolytic agent can be augmented by direct mechanical disruption of the clot with the microcatheter and guidewire.

Inclusion Criteria

No prior neurological event that would obscure the interpretation of the signal neurological deficits. Clinical signs consistent with the diagnosis of ischemic stroke, including impairment of language, motor function, cognition, gaze, and/or vision, or neglect. Ischemic stroke is defined as an event characterized by the sudden onset of focal neurological deficit presumed to be due to cerebral ischemia following exclusion of intracranial hemorrhage by baseline CT scan.

Onset of new neurological signs of a stroke that are:

a. Within 6 hours of the time to initiation of fibrinolytic therapy and
b. The most recent significant, acute worsening of documented neurological event, or
c. Related to a catheter-based endovascular procedure.

Note: In the case of basilar artery thrombosis or embolus (or other posterior fossa stroke), there is no specific time window for therapy because of the extremely poor prognosis without therapy.

A minimum NIHSS score of 10, except for isolated aphasia, isolated hemianopia, or posterior circulation ischemic signs.

Normal CT scan or early findings that do not meet CT scan exclusion criteria.

Complete occlusion or minimal residual perfusion of the appropriate symptom-related vessel (Thromboembolus in Cerebral Ischemia [TICI] 0 or 1 flow).

Exclusion Criteria (Relative)

Coma (except in the case of basilar thrombosis).

Significant spontaneous neurological recovery prior to administration of fibrinolytic agent (minor fluctuations are acceptable).

Major acute stroke symptoms (>30 on the NIHSS) (except in the case of basilar thrombosis).

Known hereditary or acquired hemorrhagic diathesis, e.g., activated partial thromboplastin time (aPTT) or prothrombin time (PT) greater than normal; unsupported coagulation factor deficiency.

Baseline laboratory values which reveal platelets <100,000/µl, hematocrit or packed cell volume <25 volume %, or international normalized ratio (INR) >1.7.

Uncontrollable hypertension with systolic blood pressure greater than 185 mm Hg not controllable by medical therapy by the start of the procedure.

Early CT scan changes:

a. High density lesion consistent with hemorrhage of any degree.
b. Evidence of significant mass effect with midline shift due to a large infarct.

8. Other CT scan findings:

a. Evidence of an intracranial tumor (except small coincidental meningioma).
b. Subarachnoid hemorrhage.

Results: Available evidence supports a role for Endovascular Therapy (e.g., minimally invasive technologies) in the treatment of Stroke of multiple etiologies. This analysis apply specially to results in symptomatic intracranial stenosis and Acute Stroke , however, do not preclude benefit from medical therapy which involves modalities other than those studied in this paper. Endovascular methods of treating intracranial atherosclerosis
have only recently been developed. Technological advancements, such as angioplasty with
stent placement, have expanded the current catalog of diseases amenable to endovascular treatment. Proper patient selection for endovascular treatment of intracranial atherosclerosis is critical in obtaining favorable outcomes. Identifying individuals who would most benefit from treatment should involve a thorough preoperative evaluation by an experienced clinician to correlate
signs and symptoms accurately with the presumed vessel of interest..
Treating physicians must also take into consideration the anatomical configuration of the lesion as wellas the patient's neurological and hemodynamic status. The complexity of atherosclerotic lesions is another factor that plays an important role in the success of endovascular treatment. Mori and colleagues16,18 generated a
classification system based on angiographic findings that may be used

to predict outcome after cerebral revascularization accomplished with primary angioplasty alone. Using this classification, Type A lesions, which are short (< 5 mm long), concentric or moderately eccentric, and
nonocclusive,. Type B lesions, which are tubular (5-10 mm long), extremely eccentric,and moderately angulated (curved),. Type C lesions, which are diffuse (> 10 mm long), extremely angulated (> 90°), and have a very tortuous proximal segment.
Conclusions: The Endovascular Management was Feasible, safe and effective for alleviating symptoms and improving final outcome. Further studies are required to determine whether the Endovascular Approach for Stroke is of benefit (or results in harm) in some special situations. For acute stroke Intra-arterial therapy remains an option for a subgroup of patients with large vessel occlusions principally in the middle cerebral artery distribution. Carotid Angioplasty and Stenting are now widely available. Improved imaging modalities, has allowed the early identification of newer sources of stroke and permit and optimal therapeutic strategy . Close clinical cooperation between the stroke neurologist and endovascular neuroradiologist is necessary to maximize patient selection, treatment options and definitive care.

14.3

Outcomes of Lysis

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Acute ischemic stroke is still the 3th leading cause of death although there has been a lot of research and development to be able to treat effectively this devastating disease in the last 2 decades. Since started to be applied during late 80s early 90s, there has been considerable proggress in the catheter directed intrarterial superselective trombolytic/revascularization treatment with the help of not only the substantial improvement in the endovascular tools but also neuroimaging technology. It is now possible to demonstrate the penumbra around the core area of infarction much more effectively and reliably with very fast neuro magnetic resonance imaging tools. So, the treatment decision can be made more accurately and target of treatment can be adjusted. Acute revascularization of an occluded cerebral vessels can be performed with either pharmocological or mechanical thrombolysis. The pharmocological treatment is usually performed with intraarterial injection of urokinase or tissue plasminogen activator directly into the clot via microcatheters. Mechanical thrombolysis/revascularization can be performed via; *1.Manipulation of clot with micro guide wire 2.Balloon angioplasty of clot, and 3. cerebral clot retrievers.* All these 3 technique has been used adjunctively to facilitate the lysis of clot. When a partial opening can be created with above mechanical attempts, the intrinsic fibrinolytic activity of the human body starts to breakdown the clot very fast resulting in augmented thrombolysis. In many centers, before and after the treatment, vessel occlusion and opening/treatment results are demonstrated by TICI (Thrombolysis In Cerebral Infarction) flow grading system that will be mentioned in the presentation.
With previous plasebo controlled studies like ECASS(European-Australasian Acute Stroke Study), ATLANTIS(Alteplase Thrombolysis for Acute Noninterventional Therapy in Ischemic Stroke) and especially NINDS(National Institute of Neurological Disorders and Stroke), intravenous trombolytic treatment in the first 3 hours of acute stroke is now an FDA approved treatment and it has been widely used in Europe and North America in many centers. However, it has been also known that the efficacy of this treatment is somewhat limited comparing to IA treatment, if the level of occlusion is in the proximal and relatively bigger vessels like carotid termination or proximal middle cerebral artery and basilar artery. IA trombolytic treatment has also been evaluated with big randomized studies like PROACT(The Prolyse in Acute Cerebral Thrombolysis) 1 and PROACT 2 has been shown its efficacy superior to the IV treatment although its use is not applicable in all medical centers and needed dedicated stroke teams. Lately, combined IV and IA thrombolytic treatment is getting more and more used by such teams to be able to optimize the treatment results.
In our center(Hacettepe Department of Radiology, Neurointerventional Unit), our treatment approach is as in the paragraph below;
When a patient arrives in emergency department in the first 3 hours of acute stroke, a CT scan is performed followed by a fast CT angiography to be able to demonstrate the level of occlusion. Perfusion defect can also be rougly demonstrated with CT angiography with adjusting window settings.If CT scan does not show any ischemic changes, an intravenous thrombolytic treatment is started immediately and the patient is transferred to angio suite in the same time.The patient is neurologically monitored and if the symptomps does not recover back in the first hour of IV treatment, angiography performed and thrombolytic treatment is continued with IA treatment. If the patient arrives in emergency department between the 3th and 6th hours of acute stroke, after very fast CT and CT angiography, the patient is immediately transferred to angio suite for IA thrombolytic treatment. Thrombolytic treatment is always performed under general anesthesia with blood pressure control.
Between 1992 and 2006, 54 patients were treated with thrombolytic treatment in the appropriate therapeutic window.We have been conservative applying thrombolytic treatment and the treatment is only started when the stroke team, which is consisted by one neurointerventionalist, one neurologist, one neurosurgeon and one anesteziologist, considered that the revascularization can be accomplished before 4 hours of the onset of stroke in a patients with proximal big vessel occlusion which is the case in most of the patients excluding the basilar artery occlusions. In 49 patients, pharmocological and mechanical thrombolysis were used.In 5 patients that were carefully selected, only mechanical stent assisted revascularization is performed in the patients who were having long standing progressive stroke. Complete recanalization is achieved in 54% of the patient with TICI 3 flow. Partial recanalization is achieved in 22% of the patients with TICI 2 flow. In 24% of the patient, no recanalization can be achieved. Before the admission of the patients and discharge, the mean NIHSS(National Inst[[Unable to Display Character: ı]]tute of Health Stroke Scale) was 19 and 8 respectively.Mortality in one month after discharge developed in 11 patients (23%). Full recovery of the patient with mRS score of 0 or 1, before the discharge, was observed in 34% of the patients. In 25% of the patients, partial recovery with mRS score of 2 or 3 was seen and no recovery in 17 %.All kind of hemorrhagic transformation either symptomatic or asymptomatic was observed in 45% of the patients. However, it was symptomatic in 9 patients that is 19% of the patients. In 6 of these 9 patients, mortality developed due to the bleeding. In all these 9 patients with symptomatic reperfusion bleeding, the revascularization had been achieved after 4 hours of stroke onset. No complication developed secondary to catheterization and wire manupilations.
Author herein this presentation, will summarize where we are in the intrarterial trombolytic treatment of ischemic stroke with briefly mentioning the data of previous randomized studies and presenting the data of Hacettepe experience in the last 14 years.

References

1. Furlan A, Higashida R, Wechsler L et al: Intraarterial prourokinase for acute ischemic stroke. The PROACT II study: a randomized controlled trial. Prolyse in Acute Cerebral Thromboembolysm. JAMA 1999 Dec 1; 282 (21):2003-11 Medline
2. Greenberg Rk, Ouriel K, Srivastava S, et al: Mechanical versus chemical thrombolysis: an invitro differentation of thrombolytic mechanisms. J Vasc. Interv. Radiol. 2000 Feb: 11 (2Pt 1); 199-205
3. Edwards MT, Murphy MM, Geroghty JJ et al: Intraarterial cerebral thrombolysis for acute ischemic stroke in a community hospital. AJNR 1999 Oct. : 20 (9); 1682-7

4. Gregory J. del Zoppo, Randall T. Higashida, Anthony J. Furlan. PROACT: A Phase II Randomized trial of recombinant Pro-urokinase by direct arterial delivery in acute middle cerebral artery stroke. Stroke: 1998; 29; 4-11

Special Session
Lessons Learned

16.2

EVAR

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EVAR - Lessons learned

Since the introduction of endovascular aneurysm repair, a large body of experience has accumulated worldwide. However, until recently the published evidence for this procedure has been limited to level 2 data. In the last year, three prospective randomized trials have appeared in the literature which has evaluated the outcomes of endovascular aneurysm repair (EVAR) with other treatment methods (1-4). The EVAR 1 and 2 trials were carried out in the United Kingdom and were published in the Lancet in 2005. The EVAR 1 trial compared EVAR with conventional abdominal aneurysm repair and the EVAR 2 trial compared EVAR with best medical therapy in patients who were unfit for conventional surgery (1, 2). The Dream trial was a Dutch collaborative study which compared EVAR with open surgery (3, 4).

The aim of these trials was to answer questions asked by many surgeons and interventional radiologists regarding the efficacy of this relatively new treatment. The main issues that were addressed by the trials were the short and long term morbidity and mortality of EVAR compared with surgery or no intervention, the durability of the treatment and devices, and whether the EVAR procedure is cost effective compared with traditional management options. Although the trials have addressed some of these issues, it would be wrong to say that the trials have provided all of the answers; and in some areas, the trial results have resulted in further confusion. The aim of this article is to provide an overview of these trials and to discuss their main findings and drawbacks.

EVAR 1

One thousand and eighty two patients with abdominal aortic aneurysms were randomized to either endovascular repair or conventional surgery. The inclusion criteria for this study were age over 60, aneurysms of at least 5.5cm diameter, anatomically suitable aneurysms for endovascular repair, and fitness for open repair (OR). Only hospitals that were proficient in the EVAR technique were eligible to participate - proficiency was defined as experience of at least 20 procedures with regular submission of their data to the UK RETA Registry. Patients were randomized by 34 hospitals during the course of the study. Fitness for OR was determined by the local physicians. The primary end point of the EVAR 1 study was all cause mortality. Secondary end points were aneurysm related mortality, quality of life, post operative complications and hospital costs.

Five hundred and forty three patients were randomized to EVAR and 539 patients were randomized to OR. There were 983 men and 99 women with a mean age of 74 years. The mean aneurysm diameter was 6.5cm. Ninety four per cent of patients complied with their allocated treatment and 209 had died by the end of the follow up period in December 2004. The 30 day mortality for the EVAR group was 1.7% v 4.7% in the group undergoing OR ($P = 0.009$). At follow up, 4 years after randomization, although this advantage for EVAR was maintained with respect to aneurysm related deaths (4% in the EVAR group v 7% in the open surgery group), the all cause mortality was similar in both groups - around 28%. Complications and reinterventions were higher in the EVAR group compared with OR. Complications occurred in 41% of EVAR patients v 9% of OR patients ($P< 0.001$). Similarly, reinterventions occurred in 20% of EVAR patients v 9% of open repair patients ($P< 0.001$). There was no significant difference in the quality of life between the two groups. The cost analysis of both treatment arms revealed higher costs for the EVAR group (£13,257 v £9946 for the OR group).

Dream trial

The aim of the Dutch randomized endovascular aneurysm management (DREAM) trial was to compare the mortality from any cause and complications of endovascular aneurysm repair with open surgery. Over a two-year period, patients were randomized to either EVAR or OR at 30 hospitals (26 in the Netherlands and 4 in Belgium). Inclusion criteria for randomization were similar to the EVAR 1 study except for the threshold aneurysm diameter, which was 5cm (cf. 5.5cm in the EVAR trial). The primary end point was a composite of operative mortality and moderate or severe complications. The trialists also analysed all cause mortality, aneurysm-related deaths, complications and reinterventions. Similar to the EVAR 1 trial, the 30 day mortality of EVAR was lower by a factor of 3 compared with OR (1.2% for EVAR v 4.6% in the open repair group), although this did not reach statistical significance. Also similar to the EVAR group, 2 years after randomization the early advantage seen after EVAR was abolished. At 2 years, the cumulative survival of both groups was similar at around 90%. However also similar to EVAR 1, the aneurysm related deaths were lower at 2 years in the EVAR group (2.1% v 5.7% {p=0.05}). These findings were identical to the EVAR 1 study which demonstrated no difference in all course mortality at follow up but a consistent 3% reduction in aneurysm related mortality even at a medium follow up of 2.9 years. Similar to the EVAR 1 trial, the intervention and complication rates were more common in the EVAR group compared with OR. In the first 9 months after aneurysm repair, the reintervention rates for EVAR were about three times the rate for surgery. After nine months, the reintervention rates were roughly similar for the two arms of the trial. Complications occurred in 19.4% of patients in the EVAR group v 16.9% in the open surgery group and reinterventions were performed in 14% of EVAR patients v 5% of OR ($P = 0.03$).

Comment on the EVAR 1 and DREAM trials.

Both trials reported a three fold reduction in 30-day mortality for EVAR compared with OR, which was maintained in terms of aneurysm related mortality at follow-up. Unfortunately, there was no survival advantage for EVAR in terms of all cause mortality in either trial at follow-up. This fact together with the increase in complication rate, reintervention rate and the increased costs of EVAR have prompted opponents of the technique to conclude that endovascular repair offers no real advantage over traditional open repair in medically fit patients with abdominal aortic aneurysms.

However, the reduction in the aneurysm related mortality is a real benefit and most patients given the choice between surgery and EVAR would likely choose EVAR on the basis of the reduced mortality alone.

Both trials had methodological flaws. One of the main drawbacks was that a mature procedure i.e. open surgery perfected over at least 60 years, was compared with a new, still evolving technique using a variety of devices which were themselves undergoing constant modification. Thus the EVAR results were a summation of a combination of experience of new designs of endografts and tried and trusted devices. The centers that contributed patients into the trials had a large variety of experience with EVAR. Forty one centers registered for the EVAR 1 trial, although 11 centers contributed 75% of the patients. In the DREAM trial 66% of patients were recruited by 5 out of the 28 centers registered for the trial. It would be interesting to speculate on the effect that the above factors had on the overall results.

The complication and reintervention rates are also worthy of discussion. The practice of reintervention for type 2 endoleaks has changed substantially since the trials started recruiting patients. Current practice is that patients with type 2 leaks only undergo reintervention if there is evidence of aneurysm sac enlargement. Given the above, it is a point of contention whether type 2 leaks should be regarded as a complication unless they are associated

with enlarging sac size. The type 2 leaks made up 79 (42%) out of the 186 complications in the EVAR 1 trial and they almost doubled the overall complication rate of 41%. Similarly, 17 patients underwent reintervention for type 2 leaks in the EVAR 1 trial who may not have undergone reintervention at the current time. Finally, there was wide variation in practice with respect to the indications for reintervention among centers.

EVAR 2

In the EVAR 2 trial, patients who were unfit for open surgery were randomized to either endovascular repair including best medical therapy or to best medical therapy only. The inclusion criteria were otherwise similar to the EVAR 1 trial, namely that patients should be over 60 years of age, the aneurysms should be greater than 5.5cm and they should be anatomically suitable for endovascular therapy. The primary and secondary outcome measures were also similar to the EVAR 1 trial. Four hundred and fifty seven patients were considered for inclusion and around 75% of these agreed to be randomized. Three hundred and thirty eight patients were randomized to either EVAR (n=166) or to conservative management (n=172). Survival analyses were performed after follow up of at least one year after randomization.

The 30 day mortality for the patients in the EVAR group was 9%. The overall mortality at four years was 64%. There was no significant difference in all-cause mortality between the two groups , and neither was there a difference for aneurysm-related mortality between the two groups. Similar to the EVAR 1 trial, the mean hospital costs per patient were substantially increased in the EVAR group - £13, 632 v £4,983 in the no intervention group. There was no difference in the quality of life scores whether patients were treated or managed conservatively.

The trialists concluded that EVAR had a considerable 30 day operative mortality in patients already unfit for OR of their aneurysm. Moreover EVAR did not improve patients survival compared with no action and was associated with a need for continued surveillance and reinterventions at a substantially increased cost. Their final conclusion was that attention should be directed at improving the fitness of these patients rather than subjecting them to early endovascular therapy.

Discussion of the EVAR 2 trial:

The main reason to perform the EVAR 2 study was to define the role of EVAR in patients unfit for surgery. Secondary aims of the trial included the collection of information on rupture rates in patients with aneurysms who are managed conservatively and to define the cause of death in unfit patients. It is clear that the EVAR 2 trial was difficult to perform and the results have been difficult to interpret. There are several contentious issues concerning the data interpretation.

The determination of whether patients were fit for surgery or not was left to local clinicians to decide; some patients considered unfit on one hospital might have been considered to be fit for surgery in another hospital.

The results indicate that the 30-day mortality for EVAR in this trial was 9%. Some clinicians have used the fact that patients who underwent EVAR had a 30-day mortality of 9% to support their views that patients unfit for surgery should not be offered EVAR. However, the mortality figure of 9% is equivalent to the mortality figures for open repair in FIT patients. Therefore, the relatively low 30-day mortality rate in this selected high risk group might equally be interpreted as supporting EVAR in unfit patients.

In the EVAR group, 150 of the 166 patients underwent repair of their aneurysms (146 EVR and 4 open repair). In the conservative group, 125 out of the 172 patients originally randomized had had no treatment at follow-up or at death. Therefore 47 (27%) patients in the conservative group crossed over (35 EVR and 12 OR) to the treatment group because of various reasons including aneurysm tenderness and patient preference. The 30-day mortality in the patients who crossed over and underwent EVAR was 2.1%. The large proportion of patients who crossed over has made analysis of the outcomes of the conservative group problematic for two main reasons: First, the data on the outcomes of patients who are managed conservatively compared with intervention has been rendered imperfect making it difficult to compare conservative management with active intervention i.e. EVAR. Second, complete data on rupture rates and cause of death in patients managed conservatively have not been provided by the trial.

The other main cause of criticism has been the length of time between randomization to treatment in the EVAR group. The trial design committee anticipated that once enrolled, patients allocated to EVAR would undergo their aneurysm repair within 30 days. In the event, the median time from randomization to implantation was 57 days. The interquartile range of 39-82 days indicates that a large proportion of patients in the intervention arm exceeded the anticipated time from randomization to treatment. Thirty percent of the deaths in the EVAR group occurred before they underwent the procedure (14 patients, 6 from aneurysm rupture). As unfit patients with aneurysms above 6cm have at least a 10% risk of rupture per year, which increases dramatically with larger and larger aneurysms, if more patients in the EVAR had undergone more rapid intervention and within the specified treatment interval, some of the deaths before intervention in the EVAR group may have been avoided.

Finally, the medical management for patients in both arms of the trial is open to criticism. Only 40% of patients in both groups were taking Statin medication. Similarly only around 55% of patients in both groups were taking antiplatelet medication. Thus the medical management in both arms of the trial was very suboptimal. One might assume that as the poor medical therapy was similar in both groups, this should not have influenced the overall results. In fact, it is known that Statins and antiplatelet medication significantly reduce mortality following aneurysm repair. Thus the absence of optimal medical therapy in the EVAR group may have obscured a small benefit for intervention in this group.

Summary

The EVAR 1 and 2 and the DREAM trials have made very important contributions to the body of literature on endovascular aneurysm repair. However, the trials had shortcomings. The main flaw is that a mature technique i.e. open surgery was compared with a new evolving procedure.

Regarding patients with aneurysms who are fit for surgery, EVAR offers a three fold reduction in 30-day mortality which is maintained beyond this period. Although there is no survival benefit in terms of all cause mortality at follow-up, the two treatments are equivalent and most patients informed of the reduced procedural mortality would likely choose EVAR. The high complication rates and reintervention rates after EVAR are likely to be lower at the present time than was reported by the trials because of a change in practice particularly in the management of type 2 endoleaks.

The EVAR 2 trial was difficult to perform and this is reflected in difficulties apparent in the interpretation of the results. Although the all cause mortality was equivalent in both arms of the study, it is evident that issues such as the crossover of almost 30% of patients from the conservative arm to the treatment arm, and the time to delay to treatment in the EVAR group (which seems to have contributed to up to 30% of the deaths in the EVAR arm) have confused the conclusions to be drawn from this study. Until there is more evidence from future randomized studies, unfit patients will likely be managed by EVAR or conservatively dependent on local issues.

References:

1. EVAR Trial participants. Comparison of endovascular aneurysm repair with open repair in patients with abdominal aortic aneurysm (EVAR trial 1), 30-day operative mortality results: randomized controlled trial. Lancet 2004; 364: 843-848.
2. EVAR Trial Participants. Endovascular aneurysm repair versus open repair in patients with abdominal aortic aneurysm (EVAR trial 1): randomized controlled trial. Lancet 2005
3. Prinssen M, Verhoeven ELG, Buth J, et al. A randomized trial comparing conventional and endovascular repair of abdominal

aortic aneurysms. N Engl J Med 2004; 351: 1607-18.
4. Blankensteijn JD, de Jong SECA, Prinssen M, et al. Two-year outcomes after conventional or endovascular repair of abdominal aortic aneurysms. N Engl J Med 2005; 352: 2398-405.

16.3

UFE

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More than a decade ago UFE was introduced as a therapeutic option to treat symptomatic leiomyoma (Ravina et al., 1995). While it was rapidly adopted by interventional radiologists throughout the world, many open questions concerning technique, indications and longterm efficacy remained.
During the last 5 years our understanding of the optimal use of embolic agents for UFE, the anatomical and technical reasons for failure and the pathophysiology behind a successfull UFE has broadened. Different embolic agents ranging from gelatin sponge to non-spherical PVA, trisacryl-microspheres and spherical PVA have been successfully used for UAE (Goodwin et al., 1999, Katsumori et al., 2002, Pelage et al., 2002, Pelage et al., 2003, Siskin et al., 2000). Each of these embolic agents have different characteristics both in vitro and in vivo which and different recommendation emerged from animal inverstiagtions and clinical studies with respect to their optimal use in UFE. Lately, randomized comparative trials have been conducted to evaluate the effectiveness of different embolic agents (Spies et al., 2004, Ryu et al., 2003, Spies et al., 2005). At the same time our understanding of the pathologic changes - including coagulative necrosis, hyaline changes and calcification- at the macroscopic and histologic level that occur after UFE has considerably increased (Chua et al., 2005, Colgan et al., 2003, Weichert et al., 2005). MRI has emerged as an objective tool to assess baseline characteristics of uterine fibroids. However, neither size, location or signal intensity characteristics emerged as useful predictive factors of clinical success (Spies et al., 2002). With the use of contrast-enhanced MRI the success of UFE was linked to the visible infarction of treated fibroids rather than reduction in uterine and leiomoyma size than has been previously used as a surrogate measure for success of the procedure (Pelage et al., 2004). Moreover, it became clear that a common endpoint for different causes of failure exist: incomplete infarction. Collateral supply due to anatomic variants, incomplete delivery of the embolic agent because of vessel spasm, inapporpriate use of the embolic agent and the wrong endpoint end up with incomplete infarction of fibroids which in turn has profound impact on the clinical success of UFE.
A number of comparative multicenter studies have been published that clearly demonstrate that outcomes of UFE are comparable to hysterectomy and myomectomy at short- and midterm follow-up (Broder et al., 2002, Goodwin et al., 2006, Pinto et al., 2003, Razavi et al., 2003, Spies et al., 2004). UFE and hysterectomy substantially improved symptoms for most patients, with an advantage for hysterectomy at 12 months for pelvic pain as reported by Spies et al. Serious complications were infrequent in both groups. Goodwin et al. compared UFE with myometomy, and found no significant differences in bleeding improvement, uterine volume reduction, uterine fibroid quality of life score improvement, and overall quality of life score improvement. But patients receiving UAE required fewer days off work, fewer hospital days, and experienced fewer adverse events. From the results of an earlier study, Razavi et al. concluded that UFE is a less invasive and safer treatment option in women with symptomatic leiomyomas than myomectomy. Menorrhagia may be better controlled with embolization, and myomectomy may be a better option in patients with mass effect. Both procedures were equally effective in controlling pain. Broder et al. reported that women who underwent UFE were more likely than those who had myomectomy to need further invasive treatment durng longh-term follow-up (3-5 years). Among women who did not need such treatment, satisfaction and relief of symptoms were similar. In addition to the impressive results of early case series, the use of validated questionnaires in recent studies confirmed the positive impact of the procedure on health-related quality-of-life (Bucek et al., 2006, Smith et al., 2004, Spies et al., 2005, Worthington-Kirsch et al., 1998). More and more centers report long-term data on UFE one of the key questions that need to be answered. Durable clinical results can be expected in >75% of patients according to these studies (Katsumori et al., 2006, Spies et al., 2005).
The limitations of UFE still need to be defined and valuable studies have been performed to analyze the efficacy of UFE in subgroup of patients. Prollius et al reported UFE to be safe in HIV patients and women with ver large uteri (> 24 weeks of gestation (Prollius et al., 2004, Prollius et al., 2005). Katsumori et al. reported excellent results for patients with large fibroids but also with pedunculated subserosal fibroids which have been a concern to many interventionalists (Katsumori et al., 2005, Katsumori et al., 2003). Kido et al. reported of successfull treatment of diffuse leiomyomatosis of the uterus (Kido et al., 2003). The issue of ovarian function and fertilty has been a focus of interest lately. While an effect of UAE on ovarian function in younger women was not observed in the majority of reports, patient > 45 years may experinece amenorrhea more often. Hormonal changes can be observed in this group of patients but their significance is unclear to date (Ahmad et al., 2002, Chrisman et al., 2000, Healey et al., 2004, Tropeano et al., 2004, Tulandi et al., 2002). While the data on fertility after UFE suggests that uneventful pregnancies are possible, there are still to few studies to draw definite conclusions (Carpenterand Walker, 2005, Goldberg et al., 2002, Goldberg et al., 2004, Pron et al., 2005).
In summary, a growing body of evidence supports UFE as a valuable alternative to treat symptomatic uterine fibroids. Interventional radiologists should be aware of the new insights to ensure up-to-date care.

Special Session
Venous Insufficiency

17.2

Tools for ablation & sclerotherapy

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When setting up a new minimally invasive venous insufficiency service one has to consider a whole range of specialist requirements ranging from Health and Safety regulations, to physical environments, staff, marketing and business plans and the tools of the trade. The problems are magnified for radiologists embarking on a clinical treatment service like this as they will be likely to encounter significant resistance from the players already in this market; in North Europe the vascular surgeons and in Southern Europe the established phlebologists. They will also have to relearn, or at least demonstrate that they have, the clinical skills necessary to complete the management of the entire patient journey. This can be daunting but is also very exciting and rewarding.
This talk will focus on the tools which are necessary to have at ones disposal in order to offer a treatment service which is safe, effective and credible. It is vital to have the necessary skills and facilities to offer effective treatments to the vast majority of patients who come to you for help. To offer only one type of ablation therapy is to court commercial and professional failure and will not satisfy your patients expectations. To do the job properly requires much training under the supervision of experts in the field but also a range of tools and facilities (including appropriate well motivated and trained staff) to

cope with most cases.
I will describe the various items of equipment essential to the start-up venous service and those necessary to be considered when the service is fully established. Some consideration will be given to the various models of equipment currently on the market and where I am able I will give indication of the leasing and purchase costs.
Non-surgical venous ablation is always carried out under imaging guidance and takes many forms.
IMAGE SYSTEMS
At a minimum the image system needed is a high frequency and high resolution ultrasound scanner capable of producing clear detail of vessels just under the skin and down to 10 cm depth.for the obese patient. Although it is possible to undertake needle placement for the actual treatment without a duplex system in reality the planning of the treatment has to be confirmed at the time of the treatment. Also at follow up it is far more efficient to undertake the diagnosis of the source of any residual varices and immediately undertake any guided injection therapy. The diagnosis and planning requires directional knowledge of the flow of the blood and for these reasons one has to have at ones disposal a high quality **duplex** ultrasound system whenever one is seeing a patient whether for initial diagnosis, initial treatment or follow up. It is useful but not essential to have voice commands for the ultrasound scanner.
I will discuss the various models of scanner available on the market at the time of the talk. This field changes rapidly so what is available now at the time of writing may well have been superseded CIRSE 2006.
A sterile probe cover is vital and the cheapest and easiest comprises a long narrow polythene bag that will hold the probe and about a meter of cable. Latex condom type covers are far less user friendly.
Although most patients can be adequately diagnosed and treated using ultrasound alone there are some in whom the additional facility of fluoroscopy can be very useful. Surgeons unused to using fluoroscopy guidance often state that 30% of patients are either unsuitable for endovenous ablation or the procedure fails for technical reasons. Fluoroscopy is very useful in expanding the range of patients who can be treated, reducing technical failures and adding reassurance and safety to situations where ultrasound alone fails to give a clear enough image. This is especially so when treating two veins on the one leg when the second often goes into spasm after the first treatment; when trying to negotiate particularly tortuous or veins or those affected by spasm and just when one is not absolutely certain of a safe or most appropriate position of the tip of the laser. The fluoro system does not need to be highly sophisticated and I have found an old barium table to be perfectly acceptable.
ENVIRONMENT
The prime requirement is somewhere warm and friendly. It is a good idea to have music playing and if you can afford it appropriate DVD type monitor to keep patients minds off the procedure. Chatty staff are very helpful and it is amazing what confessions one hears from anxious patients chatting away to the radiographer or nurse.
A couch is needed which will tip along its whole length. A tilting fluoro table is good but rather too high for comfort of the operator especially when tilted.
The room needs to be approved (and possibly modified slightly) for use of class 4 medical lasers (if doing EVLT).
It is helpful to have a large indoor corridor or other space where the patient can walk around for 10-15 mins after or sometimes at an intermission during the procedure if spasm is a problem.
Two assistants (one scrubbed) are ideal but it is possible to manage without the scrub nurse if pushed.
ABLATION SYSTEM
There are three main techniques used for image guided percutaneous venous ablation.
The longest established is foam sclerotherapy; second the VNUS RF system of which there is one dominant manufacturer and the latest Endovenous Laser Therapy originally developed by Diomed and marketed as EVLT, but with now several generic and very similar diode laser systems.
Endovenous laser treatment often requires adjunctive procedures like sclerotherapy or microavulsions (ambulatory phlebectomy) to deal with any residual varices.
TOOLS FOR FOAM SCLEROTHERAPY
Foam sclerotherapy basically comprises injections of a home made foam of STD or polidocanol into the veins to be ablated under ultrasound guidance.
Chemicals: I personally use only STD sodium tetradecyl sulphate. Some experienced practitioners use polidocanol also but for me I find the use of just one agent easier and entirely satisfactory. STD comes in 4 dilutions; 0.2% which I use for thread veins usually in neat liquid form, 0.5% for reticular veins, 1% for small and medium varicose tributaries and 3% for perforators (or truncal veins occasionally).
Manufacture of the foam: As there is as yet no commercially available foam for varicose vein treatment one has to make it oneself just prior to the treatment. This requires rapid injection from one syringe into another, through a connector of some sort, of a mixture of air and liquid drug . I use small, usually 3 mls, luer lock syringes as this reduces the chances of excessive use of agent which when a foam is stable for only 1-2minutes and thus it is better to mix multiple batches of small quantities rather than one large lot which will quickly go off. The easiest connector to use is a three way tap which also allows one to alter the size of the connecting hole to change the consistency of the foam. You can if you wish use a straight syringe connector (2 female ends).
Sterility: No drapes are necessary and the skin can be adequately prepared with just a steret. Gloves are worn by the operator but gowns and masks are unnecessary.
Positioning of leg: Particularly when treating truncal veins, but also in large residual varices after EVLT , it is useful to have a leg hanger to enable one to have both hands free but be able to elevate the leg just prior to injecting to help empty the vein and to prevent passage of large quantities of foam into the deep veins. Such a device can be home made and simple just a modified drip stand with crepe bandage sling.
Injection of the foam: The 3ml syringe filled with foam can either be used with a needle directly or via a flexible extension tube (butterfly) or a cannula (eg. venflon).I tend to use a 25g needle for reticular and small varicose tributaries, a 23g butterfly for moderate varicosities and a 21 or 19g venflon or butterfly for large varicosities, truncal veins and perforators. If using venflons or butterflies place them all before injecting any to prevent spasm.
Dressings: A crucial part of the sclerotherapy process is adequate compression of the veins. This increases the likelihood of adequate destruction of the endothelium, reduces the chance of recanalisation and reduces the chance of complications like skin staining and thrombophlebitis. Radiologists are not very au fait with bandages and compression stockings but you will have to get the hang of them in this game. For residual varices after EVLT I have found class 2 compression hose to be perfectly adequate though practitioners of truncal foam sclerotherapy also apply cotton wool pads over the treated vein and limited stretch cohesive bandages then all held in place by the compression stocking. If patients prefer I use limited stretch cohesive bandage from the toes to just above the most proximally treated vein. This has to stay on for a fortnight. If class 2 stockings are used then I advise these be kept on for 3 days continuously whence they can take them off for a bath but keep them on otherwise for two weeks.
Coagulum aspiration: When seen at two - three weeks large veins treated by foam are often distended and firm and painful. Scanned at this time they are usually echopoor and can be aspirated. This requires a large needle. Don't bother trying a 21 g needle you are best with the metal needle out of a 14g venflon. Aspiration at this time reduces discomfort, speeds healing and reduces the chance of staining of the skin.
TOOLS FOR VNUS RF ABLATION

I will not spend much time on this as I believe that RF ablation has inherent drawbacks compared to laser for truncal ablation and as a treatment for truncal reflux is a technique that has had its day. There is however a promising modification of the VNUS system which is designed to deal with incompetent perforators. This requires the standard VNUS console, which may be available on the secondhand market as practitioners move over to laser, and special RF needles (TROLOP! Transluminal occlusion of perforators).

TOOLS FOR LASER ABLATION

Laser generator: At the time of writing there are at least 3 different manufacturers of diode laser systems of appropriate power and wavelength. The requirements are at least 14 watts of power and a wavelength of 810nm.-940nm. I will illustrate what I believe are the respective advantages and disadvantages of the systems on the market at the time of the presentation.

Laser fibres: The laser generator has to be connected to a disposable 600nm glass fibre which transmits the laser energy into the patient. All the laser manufacturers produce their own sterile kit comprising the laser fibre with a standard connector, and a 19g needle, 0.035" guidewire, and a sheath about 6F to enable placement of the tip of the fibre in the appropriate spot.

Drugs\fluids: You will need supplies as follows: 100mls Povidone iodine or alternative skin prep solution. 5ml lignocaine 1% without adrenaline to anaesthetise the skin entry points for the sheath. 20mls 2% lignocaine with adrenaline diluted with 180ml (one vein) or 380ml (two veins) for tumescent anaesthesia. 500 mls 0.9%saline for general flushing.

Items on sterile trolley: A standard sterile trolley about a metre by a half is needed for all sterile supplies. There are companies who will put together a totally disposable sterile pack which contains all you need apart from the drugs and fluids. Two small bowls are needed for the local anaesthetic and the flush. One large drape to cover the whole patient. A pair of scissors to cut a hole in the drape to expose the inside of the thigh. Sterile cover for ultrasound probe. 11 blade. Micropuncture set (this is not essential but I highly recommend it to prevent spasm stopping access especially in young fit females). Sterile packs of ultrasound gel. Gauze swabs. 2 x 20ml luer loc syringes for tumescent anaesthesia, 1 x 5ml luer loc syringe, 1 x 20ml standard syringe for flushing , 2 x 25g 10cm needles for tumescent anaesthesia.1 25g needle for initial local anaesthetic. Marker pen.

Additional items needed on shelf in case of difficulties: Terumo guide wire, stiff terumo guide wire, cobra catheter, contrast media, nitroglycerine.

Dressings: Gauze swabs over puncture site. Micropore tape to apply pressure and fix gauze. Class 2 compression stocking full length with waist attachment or cohesive limited stretch bandages.

Drugs to take home: diclofenac 150mg OD 3-5 days

TOOLS FOR MICROAVULSIONS

Microavulsions (or ambulatory phlebectomy) are sometimes used after laser treatment.(Immediately or delayed) to deal with residual varicosities. They are very simply performed and can be painlessly undertaken under tumescent local anaesthesia.

The tools needed for this are : 200 mls 0.2% lignocaine. 1 x 20ml syringe. 25g 10cm needle for local anaesthesia..Ophthalmic blade to make very small but 3mm deep cut. Phlebectomy hooks (Need resterilising. I am trying to source disposable ones but with no luck so far) Mosquito forceps x2.

Dressings: Best to use compression dressing to minimise bruising which can be substantial. Usually microavulsions are in the lower leg so cohesive limited stretch bandages work well. Can use class 2 compression hose with underlying gauze and cotton wool.

17.3

How I do it

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There are a wide variety of image guided therapies now available for treatment of virtually every manifestation of lower extremity superficial venous insufficiency. For ablation of the greater or lesser saphenous vein or major tributaries there is endovenous laser, radiofrequency ablation, and ultrasound guided foam sclerotherapy. For large residual varicosities left after ablation of the highest point of reflux, there is ultrasound guided injection of foam or liquid sclerosant, stab avulsion or trivex. For reticular and spider veins there is meticulous sclerotherapy or topical laser. The choice of therapy is a matter of physician and patient preference; the author performs EVLT for truncal vein reflux, ultrasound guided foam for large residual varicosities, perforators or recurrent or short truncal reflux, and leaves sclerotherapy to those expert and enthused in it.

Clarification of the anatomy and identification and treatment of the highest point of reflux is essential before starting any therapy. The author performs ultrasound with the patient standing. The greater saphenous vein (GSV), the longest vein in the body, begins in the medial marginal vein of the dorsum of the foot (formed by the union of the dorsal vein of the great toe and the dorsal venous arch of the foot), and ascends in front of the medial malleolus along the medial aspect of the calf. It extends behind the medial condyles of tibia and femur, along the medial side of the thigh, passes through the fossa ovalis, ending at the saphenofemoral junction about 3 cm below the inguinal ligament. Duplication is common, especially in the calf. The valves are more numerous in the calf than in the thigh. Common tributaries and communications include: communications with the SSV, the anterior tributary vein, accessory saphenous vein (tributaries from the medial and posterior aspects of the thigh frequently unite to form this vein), posteromedial vein of thigh, and the antero-lateral thigh vein, among others. There is great variability in frequency, location, and drainage of these veins. Immediately before the saphenofemoral junction, the GSV is usually joined by three veins, the superficial epigastric vein, the superficial circumflex iliac vein, and the superficial external pudendal vein. The anatomy in this area can also be highly variable.

The short saphenous vein begins behind the lateral malleolus as a continuation of the lateral marginal vein of the foot. It then perforates the deep fascia and passes between the two heads of the gastrocnemius, ending in the popliteal fossa where it enters the popliteal vein at the sapheno-popliteal junction. The sapheno-popliteal junction is extremely variable in its level and the short saphenous may not enter the popliteal vein at all. A true sapheno-popliteal junction is present in 60% of the population, with the level of this junction between 2 cm and 7 cm above the knee joint In another 30% there is no communication to the popliteal vein, instead the SSV ends in the midthigh by communicating with the deep femoral vein, the superficial femoral vein or greater saphenous vein. The Giacomini vein refers to a communicating branch from the SSV just before it pierces the deep fascia which passes upwards and medially to join the GSV.

If the patient is a candidate for EVLT, ultrasound is used to map all reflux and to define the refluxing greater saphenous vein from the saphenofemoral junction to the upper calf.

Clarification of the anatomy and identification and treatment of the highest point of reflux is essential before starting any therapy. Ultrasound is used to map all reflux and to define the refluxing greater saphenous vein from the saphenofemoral junction to the upper calf. A puncture site is selected aat the lowest point that permits cannulation with a micropuncture set. The length of the treatment segment is calculated, and 5 cm increments marked on the leg. Under sterile technique and ultrasound guidance the vein is

punctured and the guidewire is passed through the SFJ. A 5 Fr 45 cm sheath is inserted and the guidewire and stylet removed. The laser fiber is measured and advanced through the sheath until it protrudes 1-2 cm from the tip of the sheathand the postion noted on the laser fiber using Steri-Strips. Under ultrasound, the introducer and laser fibers are withdrawn as one until the tip is 1 cm below the SFJ.
The tumescent anesthesia is mixed by adding 50 cc of 1% lidocaine with epinephrine and 10 cc of bicarbonate to a 500ml bag of N saline. Using ultrasound tumescent anesthetic is injected along the entire course of the vein from catheter insertion point to the SFJ.
The aiming light of the laser is switched on, if a red dot is not visible through the skin at the groin, the laser tip is malpositioned. Manual pressure is applied to achieve venous wall apposition around the laser fiber tip, and the laser is fired using 14 watts continous power,. The sheath and laser fiber are pulled back as a unit at a steady rate of approximately 1-2mm/sec rate for first 10cm and 2-3mm/sec rate for the remaining distance. When the red guiding light is 2 cm from the entry point, the laser is switched off and the sheath and fiber are withdrawn and pressure is applied to the puncture site.. Immediately after the procedure, a panty hose style compression stocking with a gradient of 30-40 mm Hg is applied and worn for 1 week. The patient is sent for an immediate 20 minute walk. Vigorous activity is avoided but normal activity is otherwise encouraged for that week. Patients are instructed to take OTC anti-inflammatory agents four times daily for the week. A followup ultrasound is performed at 6 - 12 weeks, treatment of any residual varicosities or spider veins no sooner than 3 months post laser.

References

1. Caggiati A, Bergan JJ, Gloviczki P, Eklof B, Allegra C, Partsch H; International Interdisciplinary Consensus Committee on Venous Anatomical Terminology Nomenclature of the veins of the lower limb: extensions, refinements, and clinical application. J Vasc Surg. 2005 41:719-24.
2. Min RJ, Khilnani NM: Endovenous laser treatment of saphenous vein reflux. Tech Vasc Interv Radiol 2003; 6: 125-31Min RJ, Khilnani N, Zimmet SE: Endovenous laser treatment of saphenous vein reflux: long-term results. J Vasc Interv Radiol 2003;14: 991-6

17.4

Outcome and follow up

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Before we can discuss the outcomes of minimally-invasive therapies for Superficial Venous Insufficiency (SVI), we need to review the current outcome data for surgical treatment. Ligation and Stripping (L&S) of the saphenofemoral junction and great saphenous vein (SFJ/GSV) or the saphenopoliteal junction and small saphenous vein (SPJ/SSV) is still considered by many to be the 'gold standard' for the treatment of SVI. Unlike the precious metal, in medicine 'gold' does tarnish - and L&S is one of the most tarnished 'gold standards' in current practice.
Initial success at L&S is popularly quoted at close to 100%. Recent series with careful follow-up show technical success rates of about 90% for surgery at the SFJ/GSV and about 75% for surgery at the SPJ/SSV. These rates are even lower if the presence of residual reflux from lesser perforator veins is considered a failure of surgery. This author has also seen several cases of failure of L&S because of incomplete stripping of the target vein and/or failure to recognize and treat a parallel channel or accessory saphenous vein.
Symptom relief immediately after L&S is achieved in 75-90% of patients. Patients having surgery for recurrence, SPJ/SSV disease, or more complex SVI (multiple perforators) are more likely to have poorer initial outcomes.
Recovery from L&S typically requires 10-14 days before return to full activity levels. The overall complication rate for L&S is typically about 5%, most of them minor (SIR Code A-B). Major complications (SIR Code C or worse) occur in no more than 1-2% of cases.
Clinical recurrence is very common after L&S. At three months after L&S, 10-15% of patients will already have clinically recurrent disease. This increases to about 30% by one year post-procedure, and to about 50% by 3 years post-procedure. The greatest predictor of recurrence appears to be reflux at 3 or more sites before surgery, and thus is probably due to a failure to eliminate all sources of reflux at initial surgery.
There are two technologies commonly being used for minimally invasive treatment of insufficiency of the major superficial veins (GSV, SSV, Vein of Giacomini, etc) - RadioFrequency Ablation (RFA) using the VNUS Closure ™ device and laser ablation using devices from a number of manufacturers (Vascular Solutions, Angiodynamics, Dornier, Diomed, etc). These two procedures are commonly lumped together for discussion under the term EndoVenous Ablation Therapy (EVAT). In addition, there are some physicians (most commonly in France) who treat the GSV and/or SSV by injection sclerotherapy and/or microincision ambulatory phlebectomy (MAP).
RFA and Laser ablation are technically similar procedurally, but ablate the vein in different ways. Laser ablation is a high temperature technique, while RFA is a low temperature technique. Both are approved by the FDA in the USA and are routinely covered by health insurance plans. Laser ablation typically takes 30-40 minutes to treat a GSV, while RFA takes a bit longer, 60-75 minutes for a typical GSV. The time difference is due to the faster treatment time of laser once the device is activated.
Both techniques have initial success rates somewhat higher than L&S, nearly 100%. Durability appears to also be better after EVAT than after L&S. The clinical recurrence rate after RFA is reported to be about 10% at 5 years; and that of Laser EVAT is reported to be about 5% at 2 years.
In addition to a higher success rate and better durability than L&S, recovery after EVAT is faster than after L&S. Typical recovery times after RFA are 1-3 days, and 2-4 days after Laser. Bruising is an expected post-procedure sequela of both treatment methods, although more common after Laser EVAT. Other complications are rare. The most feared complication of EVAT, DVT, appears to occur in less than 1% of cases.
Treatment failure after EVAT usually occurs within the first few weeks. One cause may be technical - due to inadequate energy deposition in the vein. The author typically treats veins at 85-100 J/cm using laser, and formerly treated veins to 90ºC using RFA. Another major cause may be patient noncompliance with compression hose, the use of which is essential after either procedure to ensure that the damaged vessel walls adhere to one another rather than allowing recanalization. The author's personal experience has been that 10-20% of veins treated by RFA have shown extensive recanalization, with recurrence of symptoms, within 2 years. The author has seen recanalization of less than 5% of veins treated by Laser EVAT. Recanalization of short segments without clinical recurrence is apparently fairly common after both techniques - and is easily treated by ultrasound guided injection sclerotherapy using microfoams.
It is important to realize that treatment of the SFJ/GSV and/or SPJ/SSV alone is usually not sufficient to relieve symptoms. Patients often will require adjunctive therapy to treat refluxing perforators and/or residual abnormal tributary vessels. Perforators can be treated using minimally invasive techniques including ultrasound-guided injection sclerotherapy or EVAT by direct puncture (e.g. 'spot-welding' a large perforator closed with either laser or RFA through a short cannula such as a 12G angiocath). Tributary varicosities and symptomatic telangiectasias can be treated by either injection sclerotherapy or MAP. The author prefers to treat vessels larger than 3-4mm in diameter by MAP, and vessels this size and smaller by injection sclerotherapy. In any case it is essential to commit to treatment of the patient's global concerns with his or her vein disease, not just offering the most 'interesting' (or best reimbursed) therapies.

In addition, the author feels that SVI should be considered to be a chronic disease. At least some patients with SVI have a genetic predisposition to venous valve failure. Even after successful treatment of all symptomatic and demonstrably refluxing veins, regular surveillance for development of valvular failure in other veins is essential.
In summary, EVAT works reliably and is safe. It has a higher success rate, no greater complication rate, and better durability than L&S. L&S should certainly no longer be regarded as the 'gold standard' for treatment of SVI. In the author's opinion L&S is an obsolete procedure. The published literature suggests little difference between RFA and Laser EVAT. There is some evidence that Laser may be associated with slightly longer recovery times and more post-procedure discomfort than RFA. The author's experience has been that Laser EVAT is more reliable than RFA and yields consistently better results.

References

1. Bartholomew JR, King T, Sahgal A, Vidimos AT. Varicose Veins: New Better Treatments Available. Cleve Clin J Med 2005; 72:312-328
2. Merchant RF, Pichot O, et al. Long-Term Outcomes of Endovenous Radio Frequency Obliteration of Saphenous Reflux as a Treatment for Superficial Venous Insufficiency. J Vasc Surg 2005; 42:502-509
3. Min RJ, Khilnani N, Zimmet SE. Endovenous Laser Treatment of Saphenous Vein Reflux: Long-Term Results. J Vasc Interv Radiol 2003; 14:991-996
4. Pannier F, Rabe E. Endovenous Laser Therapy and Radiofrequency Ablation of Saphenous Varicose Veins. J Cardiovasc Surg 2006; 47:3-8
5. Van Rij AM, Jiang P, Solomon C, Christie RA, Hill G. Recurrence After Varicose Vein Surgery: A Prospective Long-Term Study with Duplex Ultrasound Scanning and Air Plethysmography. J Vasc Surg 2003; 38:935-943

Special Session
RF Ablation for Primary Liver Cancer

18.1

Principles and device selection

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In contrast to other types of thermoablative techniques as laser, micro wave, focused ultrasound induced ablation the fundamental principle of *radiofrequency ablation* (RFA) is based upon the biophysical interaction of *high-frequency alternating current* (typically 450 - 500 kHz) and biological tissue. Ionic agitation induced by the alternating current results in frictional heat followed by "coagulative" necrosis if enough energy is deployed. Therefore, the term radiofrequency alludes to the alternating electric current oscillating in a high frequency range.
In the clinical setting the patient is turned into a resistor within a closed-loop circuit consisting of a RF generator, a large dispersive electrode (ground pad typically placed on the tights of the patient), and a needle electrode in series. Thus, an alternating electric field is created within the tissue of the patient concentrating the electrical energy around the uninsulated tip of the needle-like probe. Given the relatively high electrical resistance of tissue in comparison with the metal electrodes, there is marked agitation of the ions present in the tissue surrounding the needle-like electrode concentrating the energy.
The frictional heat is highly dependent on the amount of delivered RF energy, while the thermal damage of the tissue is dependent on the on both the tissue temperature finally achieved and the duration of heating. An increased temperature up to 42°C (i.e. hyperthermia) results in an increased susceptibility of the heated tissue to chemotherapy and radiation. A temperature of 45°C for several hours results in an irreversible cell damage. The latter effect can be drastically shortened down to a few minutes by increasing the temperature up to 50° -60°C. Almost instant coagulation of tissue is induced at temperatures between 60°C and 100°C and is manifest as irreversible damage to mitochondrial and cytosolic enzymes of the cells. At more than 100°-110°C, tissue vaporizes and carbonizes.
Due to the specific tissue resistance and the energy dispersion between the needle-like electrode and the dispersive ground pad there is a rapid decay of energy and consequently of heat around the electrode, whereas the temperature is inverse proportional to the distance from the electrode ($T \approx 1/r4$; T = temperature, r = radius around the electrode). This means that destructive thermal energy can be deployed sufficiently only within a volume of a maximum diameter of 2.2 - 2.4 cm. Beyond that the generated heat decays by dispersion into the surrounding.
Regarding achievable power, the commercially available RF generators are not significantly different, whenever the control of the ablation process is realized differently (i.e. time-, power-, impedance-control). In contrast, the design of the electrodes is much more influential on the ablative result. To increase the volume of ablation modifications can be made to the electrode design, e.g. extended electrode length (cluster needle, multi-tined design) or by internal cooling of the electrode to avoid premature carbonization around the electrode. Since recently, also bipolar probes are available potentially able to increase the local energy deployment. Using advanced needle designs volumes of up to 5 cm diameter can be ablated. Accepting an increased time for treatment needle repositioning and creating overlapping volumes may result in even larger volumes.
Since RFA efficacy is determined by the amount and duration of the energy exposure (watts, time), electrode design, and intrinsic tissue factors (heat connectivity and conversion) some of these factors might be influenced by the specific tumour situation and the potential treatment protocols have to be adjusted to this situation.
RFA can usually be performed as a minimal-invasive, percutaneous, potentially outpatient procedure under conscious sedation. Therefore, general anaesthesia is usually not necessary. Especially in surgical settings, RFA is performed laparoscopically or during open surgery. Nevertheless, there are no convincing data supporting the fact that RFA performed during open surgery is superior to a percutaneous approach.
To direct the RFA probe into the tumour and to monitor the ablation process US, CT, and MRI guidance is applicable, whereas US might be the mostly used method for guidance worldwide. Up to now there is no ideal imaging and monitoring method for RFA (or the other thermal ablative techniques) because all imaging methods provide some advantages and disadvantages.
US is widely available and allows in many cases an easy in- and off-plane access to the target and visualization of the probe. However, dependent on the given individual anatomical and pathological facts US is not able to tag the target or to follow the probe in all cases. Furthermore, during the process of ablation the target gets masked by a cloud of micro gas bubbles. This makes it difficult to identify the probe and the target during RFA as well as to assess the success of the ablation. If US contrast agents will solve this problem is not yet clarified.
CT guidance is mostly used by interventional radiologists. The advantage of superior display of anatomical and pathological structures is compromised by the lack of elbow-room within the scanner gantry, the exposure to radiation dose, and the use of contrast agent for visualisation of the potential target lesion. In contrast to US no significant changes of the treated tissue can be appreciated by CT. A contrast-enhanced CT scan immediately after RFA should display no enhancement within the ablated volume. The full extent of the ablation can be identified only after 12 to 18 hours post RFA.
In comparison to US and CT, MRI is the only method that is able to display heat related intrinsic tissue alterations directly and on-line. Several methods are available for thermal monitoring, e.g. chemical shift imaging and T1-weighted imaging. Nevertheless, MRI

monitoring of thermal ablation is mostly limited to laser applications because MR compatible RFA probes were just recently presented. General limitations for performing ablative interventions under MRI guidance are - similar to CT - the restricted freedom of movement, the high technical complexity and costs.
The control of the process of ablation itself is dependent device-dependent. The heat related dehydratation results in a progressive coagulative necrosis and a loss of conductibility followed by the rising tissue impedance. Most RFA systems are using the relative increase of impedance as parameter for controlling the ablative process while the ascending impedance is down regulating the delivered power. At present, only one system is equipped with multiple thermistors at the tips of the antennas offering an on-line monitoring of the temperature.
From a procedural and technical point of view, RFA has to be considered as a safe and minimally invasive method. The needles used are typically small (14 to 17.5 gauge) comparable to needles used for biopsy, complemented by the intrinsic capability of cauterization and coagulation (to avoid bleeding from the needle track and tumor seeding along the track cauterization of the track is recommended). While the reported technical success rate is around 95 % for the liver, the complication rate is with 2 to 6 % rather low. Typical complications are hemorrhage, effusion, fever, and in rare cases infection of the necrotic tumors (be aware of an increased risk of severe infection with abscesses in patients post Whipple's procedure after thermoablation), pneumothorax, or vascular occlusion. Collateral damage to vital structures can be generally avoided if organ specific anatomical peculiarities are considered.
Lerning objectives
1. To describe basic principles of radiofrequency ablation.
2. To review the characteristics of various radiofrequency generators and electrodes.
3. To describe the standard techniques applied in radiofrequency ablation.

References

1. Gazelle, G.S., et al. (2000) Tumor ablation with radio-frequency energy. Radiology, 217(3): 633-46
2. Gillams, A.R. (2005) The use of radiofrequency in cancer. Br J Cancer, 92(10): 1825-9
3. Goldberg, S.N. (2002) Comparison of techniques for image-guided ablation of focal liver tumors. Radiology, 223(2): 304-7
4. Goldberg, S.N., et al. (2003) Image-guided tumor ablation: proposal for standardization of terms and reporting criteria. Radiology, 228(2): 335-45
5. Lubienski, A. (2005) Radiofrequency ablation in metastatic disease. Recent Results Cancer Res, 165: 268-76
6. Ni, Y., et al. (2005) A review of the general aspects of radiofrequency ablation. Abdom Imaging, 30(4): 381-400
7. Rhim, H., et al. (2004) Radiofrequency thermal ablation of abdominal tumors: lessons learned from complications. Radiographics, 24(1): 41-52
8. Shibata, T., et al. (2006) Radiofrequency ablation for small hepatocellular carcinoma: prospective comparison of internally cooled electrode and expandable electrode. Radiology, 238(1): 346-53
9. Zhou, X., et al. (2005) Hepatic transit time: indicator of the therapeutic response to radiofrequency ablation of liver tumours. Br J Radiol, 78(929): 433-6

18.3

Management of the Post-Ablation Patient

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Learning Objectives
1. To learn the spectrum of clinical management issues in the post-RFA patient
2. To learn the complications that can occur after liver tumor ablation
3. To learn the frequency, pattern, and location of tumor recurrence after RFA

Background
Chemotherapy, while widely utilized, is mostly ineffective as a treatment of primary or metastatic malignant hepatic tumors. Surgical intervention, either resection for metastatic disease or transplantation for HCC is considered the only potentially curative therapy. However, because of advanced disease, unfavorable location, impaired clinical condition, or limited donor organs, only a minority (7-15%) of patients are eligible for surgical intervention. Furthermore, the results of surgical resection are suboptimal with a 35-50% 5-year survival rate and a high risk of recurrent intra-hepatic tumor recurrence. These factors have led to the development of multiple minimally invasive forms of therapy including intra-arterial chemoembolization, ethanol ablative therapy, and interstitial cryo, laser, microwave, or radiofrequency (RF) thermal ablation. Of these techniques, RF ablation is one of the newest and most promising.

RF Mechanism
RF ablation uses alternating electrical current in the radiofrequency range to create focal thermal lesions. Special needle electrodes and ground pads act as conductors for the alternating current. The current agitates the ions in the tissue adjacent to the needle electrodes thus creating frictional heat. The heat starts in a glove-like configuration around the electrodes then expands by conduction to form a thermal sphere. Temperatures in excess of 50°C produce coagulative necrosis. The actual size of the coagulative necrosis produced by the RF ablation devices is dependant on multiple variables with the most significant being, the average sustained core temperature during the ablation, the amount of time at core temperature, and the vascularity of the tissue being ablated. The single greatest factor limiting the size of an ablation in the liver is portal venous blood flow. The high rate of blood flow delivered via the portal vein serves to cool the ablation process or to create a "heat sink" effect. This effect limits the size of ablation that can be achieved with standard (unassisted) ablation devices to approximately 3.5 cm. Larger ablations can be achieved in large avascular tumors, with modulation of the portal venous and hepatic arterial blood flow, or with the use of adjuvant ionic or chemotherapeutic solutions.

Current Results
Multiple clinical series have been published on percutaneous RF ablation of hepatic tumors. The results for local tumor kill rates vary from 45% to 98%. Local success is clearly related to the size of the tumor with the best results achieved with tumors less than 3 cm in diameter. There has not been any proof to date that tumor debulking alters survival. However, there is a good chance that patients with a minimal hepatic tumor burden will achieve survival rates equal to that seen with surgical resection.

Preprocedural Evaluation
Effective follow-up requires a high quality pre-ablation CT scan or MRI. Without a good pre-ablation scan it is difficult to judge the adequacy of the ablation on subsequent scans.

Postprocedural Management
Hepatic RFA is a safe and minimally invasive treatment technique that produces minimal morbidity or mortality. Typical acute side-effects include nausea and pain, both of which are usually well controlled by the administration of antiemetics and analgesics. In most patients

these side effects will dissipate within 4-hours after the therapy. However, in some patients the pain may persist for a few days after the procedure. Prolonged pain is more common following treatment of tumors adjacent to bowel, gallbladder, peritoneum, diaphragm, or the porta hepatus. Persistent right shoulder pain typically occurs with a diaphragmatic thermal injury and can last for several weeks.
In our clinic, most patients are discharged on the same day as the procedure after an approximate 5 hour observation period. Fifty percent of the patients are discharged with a prescription for analagesics, the other patients do not require pain medication. All patients are followed by daily phone calls for two weeks or until symptoms resolve. Approximately 1/3 of patients will develop a post-ablation syndrome that consists of fever, persistent pain, and malaise that begins within 3-5 days after the procedure and lasts 1-2 weeks. These symptoms are due to an inflammatory reaction to the ablated tissue and typically seen in patients with more extensive ablations. These patients do not have an infection and can be managed conservatively with NSAIDS.

Evaluation of Treatment Outcome

Follow-up CT scans or MRI are most easily obtained shortly after the procedure while patients are in recovery; however, if this is not technically feasible a follow-up scan should be obtained within the first week following the ablation. This baseline scan is extremely important for two reasons; it allows early evaluation of the adequacy of the ablative procedure and it becomes the baseline scan against which all subsequent scans are compared. Subsequent scans are obtained every three months for the first year; if there is no evidence of tumor recurrence the inter-scan interval is lengthened progressively to 1-year.
The appearances of local tumor recurrence can vary by modality and tumor type. Early detection of recurrent HCC typically depends on the identification of focal arterial enhancement in the margin of an ablated tumor. In the immediate post-ablation period this may be difficult to distinguish from benign post-ablation peri-tumoral hyperemia. However, the development of new focal hyperemia in the margin of a treated tumor on any scan after the baseline scan is highly suspicious for local tumor recurrence. In patients with hypovascular tumors local tumor recurrence may manifest as progressive ill definition of the ablation margin, a nodular growth adjacent to an ablation margin, or as global enlargement of the ablation zone. Recurrence in patients with PET avid tumors will be detected as a focal hot spot. However, in the early post-ablation period, tumor recurrence may be difficult to distinguish from the local hyperactivity caused by the inflammatory reaction of the ablation process itself.

Complications

Worldwide, thousands of patients have been treated by RF ablation. Overall, the complication rate has been very low (<5%). The most common complications are bleeding, tumor seeding, ground pad burns, thermal burns of adjacent viscera, and delayed infection of ablated tissue. A handful of deaths have been attributed to RF ablations; the causes have been bleeding or infection.

Conclusion

An understanding of appropriate post-ablation management, side-effects, and patterns of tumor recurrence following RFA of hepatic tumors will lead to improved patient care.

References

1.McGahan JP, Dodd GD. Radiofrequency ablation of the liver-current status. AJR, 2001:176:3-16
2.Chopra S, Dodd GD 3rd, Chintapalli KN, Leyendecker JR, Karahan OI, Rhim H. Tumor recurrence after radiofrequency thermal ablation of hepatic tumors: spectrum of findings on dual-phase contrast-enhanced CT. AJR, 2001:177:381-7
3.Dromain C, de Baere T, Elias D, Kuoch V, Ducreux M, Boige V, Petrow P, Roche A, Sigal R. Hepatic tumors treated with percutaneous radio-frequency ablation: CT and MR imaging follow-up. Radiology, 2002:223:255-62.
4.Dodd GD 3rd, Napier D, Schoolfield JD, Hubbard L. Percutaneous radiofrequency ablation of hepatic tumors: postablation syndrome. AJR Am J Roentgenol. 2005;185:51-7.

18.4

Therapeutic management of patients with liver cancer

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Therapeutic management of patients with hepatocellular carcinoma

Hepatocellular carcinoma (HCC) is a major health problem, being the fifth most common cancer worldwide and the third cause of cancer-related death. HCC has been classically considered a neoplasm with a dismal prognosis. However, with the advent of surveillance programs, the scientific community has experienced a switch in the type of tumors detected and the medical interventions potentially effective for them.

Rationale for treatment based on evidence.

Early detection of HCC allows applying potentially curative therapies such as resection, liver transplantation and percutaneous ablation in patients with early tumors[2]. These treatments are currently applied to 30-50% of the patients in the West. Resection and transplantation achieve the best outcomes in well-selected candidates (5-yr survival of 60-70%), and compete as the first option from an intention-to-treat perspective[3]. If surgery is precluded, local, non-surgical therapies are applied. Percutaneous treatments provide good results (5-yr survival of 40-60%), but are unable to achieve response rates and outcomes comparable to surgical treatments, even when applied as the first option. Radiofrequency thermal ablation provides slightly better objective response rates than ethanol injection, but no survival advantages have been fully demonstrated.
The remaining treatments have been assessed in the setting of around 77 RCT conducted during the last two decades, a figure that clearly pinpoints HCC as an *"orphan"* cancer in terms of clinical research when compared with other high-prevalent cancers world-wide. A systematic review analyzing 61 RCTs reported during 1978-2002 showed that chemoembolization provides a modest survival advantage in patients with intermediate tumors.[4] In addition, the negative studies testing tamoxifen, anti-androgen agents and systemic chemotherapy in advanced HCC evidenced the need of a first-line treatment option for these patients. These conclusions have been endorsed by the European Association for the Study of the Liver (EASL) and the American Association for the Study of the Liver (AASLD) [5,6].
After this comprehensive review, additional RCTs have been published assessing percutaneous ablation demonstrating a better local control of the disease in tumors larger than 2 cm treated by radiofrequency ablation in comparison to percutaneous ethanol injection[7-10]. Two of these studies assessed survival as primary end-point. Survival advantages favoring RF vs. PEI were identified in the study including 232 Japanese patients (4-yr survival 74% vs. 57%, p=0.02) [8], but not in the European RCT (2-yr survival rates of 98% for RF vs. 88% for PEI, ns) [7]. Therefore, the characteristics and data provided so far do not provide enough evidence to support survival benefits coming from RF, and further research is needed. No survival advantages have been obtained in recent RCTs assessing systemic treatments in patients with advanced HCC, an area that is a clear unmet need. In light of these results, there is an urgent need to conduct well-designed phase III investigations in HCC patients.

Evidence -based treatment startegy

The treatment strategy of hepatocellular carcinoma (HCC) varies throughout the world. This heterogeneous therapeutic approach can be explained by the lack of consistent data generated from well-designed randomized controlled trials (RCTs) or meta-analysis, considered the best source of evidence in medicine. Sever staging

systems and treatment strategies have been published so far. The BCLC staging system links tumoral stage with a treatment strategy, and is aimed to incorporate prognosis estimation and potential treatment advancements in a single unified proposal[2]. It may be applied to the majority of HCC patients, although individual cases may warrant special consideration, particularly candidates for CLT with impaired liver function. Patients at very early stage (Stage 0) are optimal candidates for a radical approach. Patients at early stages (Stage A) are evaluated for resection if presenting single tumours, absence of clinically relevant portal hypertension and normal bilirubin. Transplantation is considered in patients with 3 nodules < 3 cm or with single tumors <5cm with liver function impairment. When long waiting times exist, adjuvant resection or percutaneous treatments are recommended. Living donor liver transplantation can be also considered. Percutaneous treatments, either PEI or radiofrequency, are applied in small non-surgical HCC. Asymptomatic patients with multinodular non-invasive tumors (Stage B) are the best candidates for chemoembolization, particularly in Child-Pugh's A compensated cirrhosis. Patients with advanced tumors (Stage C) showing vascular involvement/ extrahepatic spread or physical impairment, PST=1-2, are assessed for new antitumoral agents. Finally, patients at a terminal stage (Stage D) with very impaired physical status (PST >2) or tumor burden (Okuda Stage III) receive symptomatic treatment.

REFERENCES

1. Parkin DM, Bray F, Ferlay J, Pisani P. Global cancer statistics 2002. CA Cancer J Clin 2005;55:74-108.
2. Llovet JM, Burroughs A, Bruix J. Hepatocellular carcinoma: The Lancet 2003; 362:1907-17.
3. Llovet JM, Schwartz M, Mazzaferro V. Resection and liver transplantation for hepatocellular carcinoma. Semin Liver Dis 2005;25:181-200.
4. Llovet JM, Bruix J. Systematic review of randomized trials for unresectable hepatocellular carcinoma: chemoembolization improves survival. Hepatology 2003;37:429-42.
5. Bruix J, Sherman M. Management of hepatocellular carcinoma. Hepatology 2005;42:1208-36.
6. Bruix J, Sherman M, Llovet JM, et al. Clinical management on hepatocellular carcinoma. Conclusions of the Barcelona-2000 EASL Conference. J Hepatol 2001;35: 421-430.
7. Lencioni RA, Allgaier HP, Cioni D, et al. Small hepatocellular carcinoma in cirrhosis: randomized comparison of radio-frequency thermal ablation versus percutaneous ethanol injection. Radiology. 2003;228:235-40.
8. Shiina S, Teratani T, Obi S, et al. A randomized controlled trial of radiofrequency ablation with ethanol injection for small hepatocellular carcinoma. Gastroenterology. 2005;129:122-30.
9. Lin SM, Lin CJ, Lin CC, et al. Radiofrequency ablation improves prognosis compared with ethanol injection for hepatocellular carcinoma < or =4 cm. Gastroenterology. 2004;127:1714-23.
10. Lin SM, Lin CJ, Lin CC, et al. Randomized controlled trial comparing percutaneous radiofrequency thermal ablation, percutaneous ethanol injection, and percutaneous acetic acid injection to treat hepatocellular carcinoma of 3 cm or less. Gut. 2005; 54:1151-6.

References from my CV

1. Llovet JM, Bruix J, Fuster J, Castells A, García-Valdecasas JC, Grande L, França A, Brú C, Navasa M, Ayuso MC, Solé M, Real MI, Vilana R, Rimola A, Visa J, Rodés J. Liver transplantation for treatment of small hepatocellular carcinoma: The TNM classification does not have prognostic power. Hepatology 1998; 27:1572-1577.
2. Bruix J, Llovet JM, Castells A, Montañà X, Brú C, Ayuso MC, Vilana R, Rodés J, Transarterial embolization versus symptomatic treatment in patients with advanced hepatocellular carcinoma. Results of a randomized controlled trial in a single institution. Hepatology 1998;27: 1578-1583.
3. Llovet JM, Bustamante J, Castells A, Vilana R, Ayuso MC, Brú C, Rodés J, Bruix J. Natural history of untreated nonsurgical untreated hepatocellular carcinoma: Rationale for the design and evaluation of therapeutic trials. Hepatology 1999: 29:62-67.
4. Llovet JM, Fuster J and Bruix J, for the BCLC Group. Intention to treat analysis for surgical treatment of hepatocellular carcinoma: resection vs transplantation. Hepatology 1999;30:1434-1440.
5. Llovet JM, Sala M, Castells Ll, Suarez J, Vilana R, Bianchi Ll, Ayuso C, Vargas V, Rodés J and Bruix J. Randomized controlled trial of interferon treatment for advanced hepatocellular carcinoma. Hepatology 2000;31:54-58.
6. Llovet JM, Moitinho E, Sala M, Bataller R, Rodríguez-Iglesias MP, Castells A, Planas R, Navasa M, Bruix J, Rodés J. Prevalence and prognostic value of hepatocellular carcinoma in cirrhotic patients with spontaneous bacterial peritonitis. J Hepatol 2000: 33:423-429.
7. Sarasin F, Majno P, Llovet JM, Mentha J, Bruix J, Hadengue A. Liver donor liver transplantation for early hepatocellular carcinoma: a cost-effectiveness persepctive. Hepatology 2001;33:1073-1079 .
8. Llovet JM, Vilana R, Brú C, Bianchi Ll, Salmeron JM, Sala M, Ayuso C, Pagès M, Boix L, Ganau S, Solé M, Rodés J, Bruix J. Increased risk of tumor seeding after radiofrequency thermal ablation for single hepatocellular carcinoma. Hepatology 2001;33:1124-1129.
9. Llovet JM, Ruff P, Tassopoulos N, Bruix J, El-Hariry I, Peachey M. A phase II trial of oral eniluracil plus 5-fluorouracil in patients with inoperable hepatocellular carcinoma. Eur J Cancer 2001; 37:1352-1358.
10. Llovet JM, Real MI, Montaña X, Planas R, Coll S, Aponte JJ, Ayuso C, Sala M, Muchart J, Solà R, Rodés J, Bruix J for the Barcelona-Clínic-Liver Cancer Group. Arterial embolization or chemoembolization vs symptomatic treatment in patients with unresectable HCC: a randomized controlled trial. The Lancet 2002;359:1734-39
11. Llovet JM, Mas X, Aponte J, Fuster J, Navasa M, Christensen E, Rodés J and Bruix J. BCLC Group. Cost-effectiveness of adjuvant therapy for hepatocellular carcinoma before liver transplantation. Gut 2002; 50:123-28.
12. Forns X, Ampurdanès S, Llovet JM, Aponte J, Quintó Ll, Martinez-Bauer E, Bruguera M, Sanchez-Tapias JM, Rodes J. Identification of chronic hepatitis C patients without fibrosis. a simple predictive model. Hepatology 2002; 36:986-992.
13. Llovet JM, Bruix J. Systematic review of randomized trials for unresectable hepatocellular carcinoma: chemoembolization improves survival. Hepatology 2003;37:429-442.
14. Burrel M, Llovet JM, Ayuso C , Sala M, Iglesias C, Solé M, Caralt T, Ayuso JR, Brú C, Bruix J. MRI angiography is superior to triphasic helical CT for detection of small HCC prior liver transplantation. Comparison with pathologic correlation. Hepatology 2003;38:1034-42.
15. Sala M, Fuster J, Llovet JM, et al. High pathological risk of recurrence after surgical resection for hepatocellular carcinoma. An indication for liver transplantation . Liver Transpl 2004;10:1294-1300 .
16. Garcia-Retortillo M, Forns X, Llovet JM, et al. Hepatitis HCV virus disease recurrence is more severe after LDLT compared with CLT. Hepatology 2004;. 40:699-707.
17. Sala M, Llovet JM, Vilana R, et al. Initial response to percutaneous ablation predicts survival in patients with hepatocellular carcinoma. Hepatology 2004 , 40;1352-1360.
18. Llovet JM, Bruix J, Gores G. Surgical resection vs transplantation for early hepatocellular carcinoma: Clues for the best strategy. Hepatology 2000;31:1919-1921.
19. Bruix J, Llovet JM. Hepatocellular carcinoma: Is surveillance cost-effective?. Gut 2001; 149-150.
20. Bruix J, Llovet JM. HCC surveillance. Who is the target population? Hepatology 2003; 37:507-9.
21. Bruix J, Fuster J, Llovet JM. Liver transplantation for hepatocellular carcinoma: Foucault pendulum versus evidence-based decision. Liver Transpl. 2003;9:700-2.
22. Bruix J, Llovet JM. Prognostic prediction in HCC: did anybody expect it to be easy?. Hepatology 2004;39:551-552 .

23. Llovet JM, Wurmbach E. Gene expression profiles in HCC:not yet there. J Hepatol 2004; 4:336-9.
24. Lencioni R, Llovet JM. Percutanoeus ethanol injection in hepatocellular carcinoma: Alive or dead. J Hepatol 2005; 43:377-80
25. Akriviadis E, Llovet JM, Efremidis S, Shouval D, Canelo R, Ringe B, Meyers W. Hepatocellular Carcinoma . Br J Surg 1998:85(10):1319-31.
26. Llovet JM, Brú C, Bruix J. Barcelona-Clínic Liver Cancer Group. Prognosis of hepatocellular carcinoma:The BCLC staging classification. Semin Liver Dis 1999;19:329-338.
27. Bruix J, Sherman M, Llovet JM, Beaugrand M, Lencioni R, Christensen E, Burroughs A, Pagliaro L, Colombo M, Rodés J. Clinical management on hepatocellular carcinoma. Conclusions of the Barcelona-2000 EASL Conference. J Hepatol 2001;35:421-430.
28. Bruix J, Llovet JM. Prognostic prediction and treatment strategy in hepatocellular carcinoma. Hepatology 2002; 35:519-524.
29. Llovet JM, Beaugrand M. Hepatocellular carcinoma: Present status and future prospects. J Hepatol 2003;38 Suppl 1:S136-49.
30. Llovet JM, Burroughs A, Bruix J. Hepatocellular carcinoma: The Lancet 2003; 362:107-17.
31. Llovet JM, Fuster J, Bruix J. The Barcelona approach: diagnosis,staging and treatment. Liver Transp 2004: 10 (Suppl 1):S115-20.
32. Bruix J, Boix L, Sala M, Llovet JM. Focus on hepatocellular carcinoma. Cancer Cell, 2004;5:215-219.
33. Bruix J, Sala M, Llovet JM. Chemoembolization for hepatocellular carcinoma. Gastroenterology 2004 ;127:S179-S188.
34. Llovet JM, Schwartz M Mazzaferro V,. Resection and transplantation for HCC. Sem Liv Dis 2005; 2:181-200.
35. Schwartz M, Roayaie S, Llovet JM. How should patients with HCC recurrence after liver transplantation be treated?. J Hepatol 2005 Hepatol. 2005;43:584-9.
36. Llovet JM. Hepatocellular carcinoma: Patients with increasing AFP, but no mass on ultrasound. Clinical Gastroenterology and Hepatology, 2006;4:29-35.

Special Session
CIRSE meets India

20.2

Current concepts in the management of IVC and hepatic vein occlusion

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Purpose: To describe our experience in treating Budd Chiari syndrome (BCS) using radiological interventions and determining the clinical outcome of the procedures, and to suggest an algorithm for treatment of BCS.
Materials and Methods: 138 patients between the ages of 1-55 years were referred for radiological management of chronic BCS. Presenting features included abdominal pain, ascites, lower extremity edema, thrombocytopenia and no symptoms. The lesion morphology was categorized as IVC obstruction, hepatic vein obstruction and combined IVC and hepatic vein obstrcuction. 120 patients were considered suitable for intervention, and were treated by IVC angioplasty/stenting (n=40), hepatic vein angioplasty/stenting (n=33), combined hepatic vein and IVC stenting (n=11), TIPS (n=23), and a combination of IVC stenting and TIPS (n=2). Follow up was obtained by clinical and Doppler for a period of 1-69 months.
Results: 109 patients had a successful interventional procedure. Complications such as bleeding (n=11), pneumothorax (n=1), lignocaine toxicity (n=1) and liver failure/encephalopathy (n=1) were noted. 1-month mortality was noted in 3 patients. Clinical success was seen in 98% patients. Restenosis was noted in 6/33 recanalised hepatic veins, and 2/40 recanalised IVCs. 8/24 TIPS had dysfunction related to suboptimal anticoagulation, IVC thrombosis or in-stent restenosis.
Conclusion: Patients with chronic BCS can be managed successfully by radiological interventions, with good short and mid term results. Anatomic definition of the venous outflow obstruction is important for selecting the type of procedure to be offered to the patient.

20.3

Interventional radiology in the management of tubercle induced hemoptysis

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Objective: We have analyzed the records of a group of patients with massive hemoptysis who underwent transcatheter embolization for control of bleeding in order to describe the vascular supply, including bronchial and non-bronchial systemic vessels in inflammatory lung disease, to study the patterns of angiographic abnormalities in presence of hemoptysis, to evaluate recurrence of hemoptysis following multi-vessel embolization, and to evaluate the importance of simultaneous embolization of bronchial and non-bronchial vessels in hemoptysis.
Method: A total of 604 patients underwent transcatheter embolization for hemoptysis in a 5-year period. All the patients had a history of frequent bouts of hemoptysis of > 50 cc or a single bout of > 200 cc in the immediate period before embolization. All patients underwent aortography, including selective injections in the bronchial (BA), subclavian, intercostal (ICA), internal mammary (IMA) and thyrocervical arterites (TCT). Pulmonary angiography was performed if the systemic arteries were normal. The abnormal vessels were embolized with 500-700µ polyvinyl alcohol particles, hydrogel 700-100µ or steel coils. The findings were classified as an active bleeding, bronchial to pulmonary artery fistula and hypertrophy with parenchymal blush.
Results: A total of 1411 vessels showed angiographic abnormalities of which 494 were BA; 357 ICA; 560 were branches off the subclavian artery. The angiographic abnormalities included active bleeding (10%); bronchial to pulmonary artery fistula (18 %) and hypertrophy with parenchymal blush (85%). In addition, three patients had aneurysms in the pulmonary artery that were embolized with steel coils. Two patients died after embolization due to recurrence of massive hemoptysis. In 5 % of the cases, the abnormal vessels could not be cannulated. The most common complication was transient local muscular pain in the thorax seen in 55 %, followed by hematoma in the groin in 4 % and head ache after successful embolization in 1 % patients. Early recurrence was noted in 5% within one month. Delayed recurrence was seen in 17% cases.
Conclusion: Post tuberculosis hemoptysis is a life threatening condition. Detailed angiography of both the bronchial and systemic arteries and embolization of the abnormal arteries is essential for low recurrence rates. Pulmonary arteries should be studied in patients with hemoptysis who have a negative systemic angiogram. The overall complication rates are extremely low.

20.4

Endovascular management of symptomatic lesions in nonspecific aortitis

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Objective: We have analyzed the acute and follow-up results of balloon angioplasty in the treatment of renovascular hypertension caused by stenosis of the aorta or the renal artery secondary to nonspecific aortoarteritis, and assessed the influence of angiographic features of the stenosis on the outcome of angioplasty.
Method: A total of 520 patients with uncontrolled hypertension (n=514) alone or with lower limb claudication (n=6) in presence of hemodynamically significant stenosis in the aorta (Group A, n=102) or the renal artery (Group B, n=418) were treated in the presence of clinically inactive disease. Bail-out stenting was performed if there was an obstructive dissection at the treatment site. The influence of angiographic features of the stenosis in the aorta, including its location (thoracic, juxta-diaphragmatic or abdominal), concentric versus eccentric, short (<4 cm) versus long (>4 cm) length, presence or absence of diffuse disease in the adjacent segments, calcification, residual stenosis (<20%, 20-30%, >30%) and residual pressure gradient (10 mm, 11-20 mm or >20 mm Hg) after angioplasty on its outcome in terms of an obstructive dissection flap at treatment site and clinical outcome during follow-up was assessed. In patients with renal artery stenosis (RAS), the influence of location of stenosis (ostial versus non-ostial), co-existing peri-renal aortic stenosis (present or absent), residual stenosis (<20%, 20-30% and >30%), and residual gradient (< 10, 10-20, and >20 mm Hg) on the outcome of angioplasty was tested. Univariate and multivariate analysis were performed. Actuarial Kaplan-Meir survival curve was applied for assessing the cumulative patency rate.
Results: In Group A, a total of 108 lesions was treated in 102 patients. Technical success was obtained in 88% and clinical success in 94%, including cure in 16% and improvement in 84% patients. The stenosis decreased from 80± 9 (range, 60-90)% to 18±17 (range, 0-100)%, systolic pressure gradient fell from 78±21(range, 30-120) to 20+17 (range, 0-90) mm Hg., blood pressure improved from 184±21 (range, 130-230)/114±13 (range, 80-150) to 130±10 (range, 110-160)/84±15 (range, 70-180) mm Hg and the drug requirement decreased from 4.3±0.5 (range, 3-5) to 1.5±0.8 (range, 0-4) (p value for all <0.001). The complications were seen in 24 patients and included an obstructive dissection in 22 (19 were treated by stent placement, two were managed conservatively and one underwent surgery) and a puncture site hematoma in 2 patients. At 26±12 (range, 1-76) month follow-up, there was restenosis in 10 patients and pseudo-aneurysm at treatment site in 3 patients. Juxta-diaphragmatic location, eccentric stenosis, long lesion length, calcification and diffuse adjacent disease showed a statistically significant correlation with the occurrence of obstructive dissection. Presence of calcification and diffuse adjacent disease also adversely affected the restenosis rate. Group B included 418 patients (540 lesions) with RAS. Technical success was obtained in 96% and clinical success in 88%, including improvement in 68% and cure in 32%. Complications were seen in 4% and included three major (renal vein injury, aortic dissection and acute thrombosis on one patient each; all of whom were salvaged by intervention) and the remaining minor at the puncture site. The follow up period was 42±11 months and showed restenosis in 24% patients. The cumulative 5-year patency rate was 67%. Osital location, presence of co-existing stenosis of peri-renal aorta and > 30% residual stenosis and >20 mm Hg residual gradient adversely affected the outcome.
Conclusion: Balloon angioplasty is successful in treating renovascular hypertension caused by stenosis of the aorta or the renal arteries due to nonspecific aortoarteitis in selected patients. The presence of specific angiographic features predisposes to an unfavorable immediate and late outcome. Such patients may be electively treated by stent placement. Sub-optimal outcome of balloon angioplasty can be successfully treated by stent placement. Successful treatment is associated with good long-term patency rates.

25.4

Endarterectomy versus stenting : Is the pendulum swinging to stents?

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In a recent article in the European Journal of Vascular and Endovascular Surgery, Janet Powell reviewed the quality and quantity of evidence that was required to introduce new techniques into medical practice. The article suggested that the introduction of new techniques followed the Technology Hype Cycle first described by Gartner. This cycle encompasses five phases. The new medical technology is first developed and tested in a restricted environment. As first reports reach the literature, there ensues a period of elevated expectation often fuelled by proponents of the technique, the media and particularly industry. The third phase describes the disillusionment that accompanies the problems that all new technologies encounter when complications occur and the technology does not appear to live up to its initial promise. Techniques then undergo refinement and the indications for application of the technology are refined in clinical practice, with widespread application and widespread availability. Finally, the technology becomes an accepted treatment and delivers real benefit to patient care.
Where does carotid stenting fit into this cycle and how will the technology be applied from here?
Certainly, carotid stenting has been tested in many single centre and registry environments, and enthusiasm for the technique is high. The initial results from registries and single centre experiences are encouraging and preliminary reports from randomised trials have reached the literature.
Enthusiasts of the technique suggest that carotid stenting should become the treatment of choice for carotid disease for the following reasons:
- the procedure may be performed under local anaesthesia with a reduction in length of stay and procedure time when compared to endarterectomy
- the success rate of carotid stenting is high, with technical success rates improving all the time
- registry and single centre experiences have suggested better outcomes when compared to the published surgical series in NASET and ECST
- the randomised trials published to date have demonstrated equivalence of carotid stenting with endarterectomy as suggested in a recent Cochrane review
- the SAPPHIRE trial has demonstrated improvements in a composite end point when high risk patients were randomised to carotid surgery or stenting
- the technology is improving at a fast rate with improved, dedicated carotid stents and cerebral protection devices
- patient preference is moving away from invasive surgery, and towards "minimally invasive" techniques

Sceptics of endovascular carotid treatment concentrate mainly on trial evidence to support the assertion that carotid stenting should still be considered an experimental procedure. Particular criticisms are that:
- the stroke and death rates in some of the published trials (CAVTAS) do not accurately reflect surgical practice and the trials were

biased against surgical units
- the SAPPHIRE trial reported a heterogeneous patient group with the majority of patients being asymptomatic. The event rate in this trial would not support the treatment of asymptomatic patients
- several randomised trials have been stopped prematurely due to a higher event rate in the stented group
- some negative trials were not reported due to industry bias

Arguments between proponents and sceptics of carotid stenting are likely to continue for some time, with the current randomised trials (EVA-3S, ICSS and SPACE) providing fuel for both viewpoints. It would be a mistake to anticipate that the publication of these randomised trials will provide a definitive answer to the widespread treatment of patients with symptomatic or asymptomatic carotid disease. The trials however may refine the indications for both procedures. Despite the opposing viewpoints regarding trial interpretation, there is no doubt that carotid stenting has a role to play in the future treatment of carotid disease. Although data from the European Endovascular Monitor suggests that the majority of carotid interventions are surgical, this balance is beginning to change.

The likely future of carotid stenting may be extrapolated from experience with coronary heart disease. In the last 25 years percutaneous coronary intervention has developed from an experimental procedure with equivocal outcomes to the most common medical procedure in the world. This evolution has occurred largely in the face of evidence which often suggested that the outcomes of PCI were inferior to surgery. It may be concluded from the "PCI story", that introduction of new medical techniques may be driven by powerful drivers other than data from randomised trials. These factors may be identified for coronary artery disease as including:
- patient preference for minimally invasive techniques over traditional surgery
- continued technological development leading to improvement of patient outcomes
- influence of industry in promoting technological advance and minimally invasive technology
- influence of available techniques on referral patterns, with economic factors being particularly influential in certain health systems.

Most of these factors may be influential in determining the future of carotid stenting. At present carotid stenting is still in the second and third phases of Gartner's Hype Cycle, with some proponents making extravagant claims as to the efficacy and applicability of carotid stenting whilst sceptics concentrate on complications and problems. It seems inevitable that carotid stenting will grow to be a major treatment modality in the treatment of carotid artery disease. What remains undefined at present is the progress that needs to occur to fulfil the 4th and 5th phases of the Hype Cycle, namely:
- refinement of the technique so that it is widely applicable
- refinement of the indications for carotid stenting. It remains likely that certain patient subgroups will be best treated with carotid stenting whilst others will be preferentially treated with endarterectomy
- consensus as to who will perform these procedures
- ensuring that carotid stenting technology is supported by advances in medical management

Finally, it must be ensured that debate over treatment modality - which may deliver a one or two percent improvement in outcome - does not detract from the urgent need to organise carotid services in order to deliver timely treatment to appropriate patients.

Special Session
IR in Liver Transplantation

26.1

HCC: Biopsy or imaging diagnosis

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The development of hepatocellular carcinoma (HCC) has emerged as the main cause of death in patients with cirrhosis. Since the sole option to apply effective therapies such as resection, liver transplantation and percutaneous ablation is to achieve diagnosis at an early stage, most experts recommend to incorporate cirrhotic patients who would be treated if diagnosed with HCC into screening plans. These should be based on Ultrasound (US) examination every 6 months. US has adequate sensitivity to detect focal lesions within a cirrhotic liver and the challenge upon detection of a suspicious mass is to establish its benign or malignant nature. Biopsy using fine needles is a useful tool, but several factors reduce its sensitivity. Large tumors may have areas of necrosis and no diagnosis can be established if such an area is punctured. More clinically important however, is the reduced sensitivity in small HCC. These are usually well differentiated and pathology is frequently unable to distinguish between high or low grade dysplasia and HCC. As a whole, a negative biopsy does not rule out HCC diagnosis and this has triggered the development of non-invasive diagnostic criteria. In that sense, it is well known that HCC develops an extense net of vessels feeded by the hepatic artery, and this results in a characteristic appearance on dynamic imaging using either contrast-US, CT or MRI. HCC is recognised as a mass with intense contrast uptake in the arterial phase followed by contrast washout in the delayed venous phase. If this pattern is observed in a mass within a cirrhotic liver the diagnosis of HCC is certain if the tumor exceeds 1 cm in size. The recent AASLD and EASL recommendations suggest that a single positive technique is enough in tumors larger than 2 cm, while coincidental findings with two techniques are required in lesions between 1 and 2 cm. Lesions < 1cm are almost impossible to be diagnosed by biopsy or imaging techniques and hence, the recommendation is to follow them up until progression or disappearance. Important to stress is that the non-invasive criteria should be restricted to patients with cirrhosis.

Table. Diagnostic criteria for HCC
- Cyto-histological criteria.
- Non-invasive criteria (cirrhotic patients)

Focal lesion >1 - ≤ 2cm Two imaging techniques with arterial hypervascularization and venous washout

Focal lesion > 2cm One imaging technique with arterial hypervascularization and venous washout

References

1. Bruix J, Sherman M. Management of hepatocellular carcinoma. Hepatology 2005; 42(5):1208-1236.

26.2

HCC management while awaiting transplant

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In orthotopic liver transplant (OLT) recipients, hepatocellular carcinoma (HCC) can represent the main indication or can coexist with liver cirrhosis as a secondary known indication, or it can be revealed as an incidental finding at the time of pathologic examination of the explanted liver. Initially, it was believed that non-resectable HCC would be an ideal indication for OLT. However, as experience accumulated, it soon became obvious that this form of therapy results in a higher than expected recurrence rate and that

to determine the risk and timing of HCC recurrence on an individual basis would greatly aid in the candidate selection process.

The observation that small HCC discovered incidentally had a much lower recurrence rate after OLT provided the impetus for subsequent studies evaluating OLT mainly for patients with small HCC. Moreover, several factors believed to influence HCC recurrence (as gender, age, presence of B or C hepatitis, alpha-FP levels, tumor size, margins, number and lobar distribution, vascular invasion, lymph-node status, extrahepatic dissemination, etc.) were retrospectively reviewed. Bismuth first in 1993 showed the better results of OLT for patients with no more than 3 nodules and none greater than 3 cm in diameter in comparison to surgical resection. In a subsequent study by Mazzaferro et al., patients with a solitary tumor non exceeding 5 cm or no more than 3 tumors with none greater than 3 cm had excellent overall and recurrence-free survival rates. These so-called "Milan criteria" were incorporated into the American Liver Tumor Study Group Modified Tumor-Node-Metastasis (TNM) staging classification for OLT, because the traditional pathologic pTNM classification did not appear to have sufficient prognostic power to provide clear-cut discrimination of patients with respect to the risk for HCC recurrence after OLT. One exception was gross vascular invasion of the portal vein, classified as stage IVA in both TNM criteria, which has been shown to be a strong predictor for HCC recurrence after OLT (microvascular invasion and poorly differentiated histologic grade also resulted as negative predictors, but they can be detected only at the pathological examination of a resected specimen and cannot be used as a clinical selection criteria of the OLT candidates). A very similar restricted evaluation of the tumor extension was also adopted by the Barcelona-Clinic Liver Cancer Group in its BCLC staging classification for the treatment of HCC.

On the other hand, Yao et al., from University of California, San Francisco (UCSF), demonstrated that, according to an "intention-to-treat" principle analysis, the survival rate of OLT for HCC strongly decreases if the waiting time is prolonged, because tumor growth exceeding acceptable limits results in patient dropout from the waiting list: if Milan exclusion criteria were adopted, cumulative probabilities for dropout at 6, 12, and 24 months were 7.3%, 25.3%, and 43.6% respectively, predictors for dropout being two or three tumor nodules or a solitary lesion greater than 3 cm at initial presentation. Three solutions can be proposed for this problem: to accelerate OLT in patients with HCC; to extend the criteria without worsening the prognosis; to treat HCC in order to improve the survival rates.

In the U.S. the United Network for Organ Sharing (UNOS) allocates livers to patients awaiting OLT on the basis of MELD, a scoring system that assigns a numeric index of the severity of their liver disease ranging from 6-40 based on prothrombine time (INR), creatinine, and bilirubin. In light of recent studies that have demonstrated that patients with unresectable T1 or T2 HCC are unlikely to experience tumor recurrence if transplanted expeditiously, the allocation scheme was modified in 1998. Since then, patients with T1 or T2 HCC receive waiting list priority on the basis of tumor: patients with T1 HCC are granted a MELD score of 20, and T2 HCC patients receive a score of 24. In order to further anticipate OLT, avoiding dropout from the waiting list, the scores for tumor patients rise every 3 months as long as the tumor does not grow to exceed priority criteria. While patients with more extensive tumors are not excluded from transplant candidacy, they are not eligible for priority on the waiting list, and thus their likelihood of receiving a deceased donor liver is low. Therefore, the use of living donor liver transplantation (LDLT) has emerged as a way to successfully transplant these patients. Cost-effectiveness analyses have shown that the benefits of LDLT are reached when the waiting time exceeds 7 months.

Regarding the expansion of the exclusion criteria, Yao et al. showed that only pT4 stage and total tumor diameter remained statistically significant in multivariate analysis. Patients with HCC meeting the following criteria - solitary tumor ≤ 6.5 cm, or ≤ 3 nodules with the largest lesion ≤ 4.5 cm and total tumor diameter ≤ 8 cm - had survival rates of 90% and 75.2%, at 1 and 5 years, respectively, after OLT versus a 50% 1-year survival for patients with tumor exceeding these limits (UCSF criteria). Despite the knowledge that, once they reach 5 cm, the large majority of HCCs (particularly those that develop in the setting of hepatitis C cirrhosis) will demonstrate microscopic invasion into portal venules and lymphatics around the periphery of the tumor, according to Yao advanced tumor exceeding UCSF criteria served reasonably well as a surrogate marker for poorly differentiated grade and microvascular invasion. Thus, they concluded that a modest expansion of the tumor size limits does not adversely impact survival and that UCSF criteria better predict acceptable post-OLT outcome than Milan criteria. More recently some authors underlined the predictive significance of other dimensional thresholds in association with Milan criteria, such as the preoperative tumor volume of more than 28 cm3 or the cumulative size of the tumor greater than 8 cm.

The third way to minimize dropout rates from the list of patients awaiting OLT for unresectable HCC is to treat the tumor. Non-surgical treatment of HCC in potential candidates for OLT can be proposed to prevent the progression in patients respecting the criteria, but also to downstage the tumor when more advanced, in order to reduce the after-OLT recurrence rate of the tumor and to improve patients survival. A multidisciplinary team of hepatologists, transplant surgeons, interventional radiologists, and oncologists is involved in making decisions regarding treatment strategies for HCC while patients are awaiting OLT. Factors determining choice of treatment include hepatic reserve, number of lesions, and size and locations of the tumors. Modalities commonly employed include transarterial chemoembolization (TACE), percutaneous ethanol injection (PEI), and radio-frequency ablation (RFA); TACE within the 24 hours just before OLT after a donor becomes available or neoadjuvant systemic chemotherapy were also used, but their impact on survival remained unproved.

TACE is a well-established treatment for HCC that has been shown to significantly prolong life independent of transplant. The details of the methods vary considerably among centers. The risk of TACE rises with worsening liver function. TACE using doxorubicin, cisplatin, or mitomycin is reserved mainly for patients with well-preserved hepatic function (Child's class A cirrhosis) and is typically employed when the tumor is > 4 cm and when there are multiple lesions within an anatomic region of the liver. PEI and RFA are commonly used for single or multiple lesions of 3 cm or less in maximum diameter if technically feasible. PEI has a long track record and has been demonstrated effective in destroying small (≤ 2 cm) HCCs, while for tumors beyond 4 cm, it is not useful. Because of its simplicity and effectiveness it could be the best choice for small, solitary lesions. RFA has rapidly come into favor, in many centers taking the place of PEI. For tumors between 2-4 cm, RFA more reliably achieves complete ablation than PEI. TACE and PEI/RFA can be combined to optimize tumor treatment.

Early experiences emphasized mainly the histologic results, which were locally better for PEI or combined therapy (TACE + PEI) than for TACE alone. Subsequently, preoperative TACE and perioperative systemic chemotherapy showed promising preliminary results in the treatment of advanced HCC: a significant proportion of patients with HCC measuring 5 to 7 cm achieved long-term survival after OLT in the context of multimodal adjuvant therapy. However, the impact of TACE before OLT on HCC recurrence and patient survival is not known. Decaens et al. recently showed that with a mean waiting period of less than 6 months and one TACE procedure, pre-OLT TACE does not influence post-OLT overall survival and disease-free survival. Graziadei et al. demonstrated that, after TACE, the 1-, 2-, and 5-years survival rates were excellent either after OLT or "intention-to-treat", due to the reduction of the dropout rate. Nevertheless, a separate group of patients with advanced-stage HCC outside the selection criteria but at least 50% tumor reduction after TACE had a significantly less favorable outcome in the intention-to-treat analysis as well as in the post-OLT survival. Therefore, they concluded that TACE is highly efficacious in preventing tumor progression while waiting for OLT, but, despite downstaging, it fails to show a beneficial effect on patient survival

in advanced-stage HCCs. Regarding histologic results after single-session RFA of small HCC ≤ 3 cm before OLT, both Mazzaferro and Pompili reported a relatively high complete response-rate, without additional complications. Lu et al. showed that tumor-related dropout rate compared favorably with published control of patients with early-stage disease and all these authors concluded that percutaneous RFA is effective, but only as a "bridge" to OLT.

Results of a multimodal therapy for HCC before OLT are also controversial. Vitale et al. excluded poorly differentiated HCC cases and did not consider as absolute selection criteria size and number of nodules, but treated HCC in 90% of patients on their waiting list by a multimodal therapy (TACE, PEI, chemotherapy). Based on their experience, they concluded that the use of routine pre-OLT tumor grading and of an aggressive HCC treatment during the waiting list resulted in a very low risk of dropout (2.5%) and post-OLT recurrence (6%). Recently, Yao et al. performed subgroup analyses according to pathologic HCC stage to test the hypothesis that pre-operative loco-regional therapy confers a survival in a subgroup at intermediate risk for HCC recurrence. In fact, according to the UNOS staging classification, the risk for HCC recurrence is probably negligible among patients with pathologic stage pT1 irrespective of whether they have received pre-operative ablation or TACE. Conversely, the risk for recurrence for patients with pT4 HCC may be too high for these pre-operative treatments to confer any survival benefit. In the subgroup with pathologic T2 or T3 HCC meeting to the proposed UCSF expanded criteria, pre-operative loco-regional therapies (TACE only; ablation only - PEI, RFA, cryoablation, acetic acid injection -; combination - TACE + PEI, TACE + RFA) conferred a survival benefit after OLT. The treatment benefit, according to 5-year recurrence-free survival, appeared greater for pathologic T3 than T2.To validate these results, we retrospectively reviewed 269 patients with HCC out of a 1261 patients series who received OLT at our center since 1991. Two-hundred-four patients underwent pre-operative loco-regional therapies (PEI, RFA, one TACE session, combined therapy), while 65 patients received no specific treatment prior to OLT. A preliminary multivariate analysis (excluding pre-operative treatments) confirmed that UNOS staging was a significant predictor for overall survival after OLT. The recurrence rates were then calculated in the treated and non-treated group according to the pathologic staging. The survival curves were also estimated in the two groups by the Kaplan-Meier method and compared using the log-rank test. In our series, no statistical differences between treated an untreated patients were demonstrated in T2 or T3 HCC subgroup either in recurrence rate or in post-OLT survival. Also comparing successfully treated patients (with complete response at histological examination) with untreated patients no statistically significant differences were found. Therefore, at our centre, loco-regional treatments are used as a bridging therapy to reduce the risk of dropout due to tumor progression in patients with HCC while in the waiting list for OLT. No neoadjuvant role can be assigned to loco-regional treatments before a post-OLT survival benefit has been demonstrated by randomized controlled trials.

References

1. Bismuth H, Chice L, Adam R, et al. Liver resection versus transplantation for hepatocellular carcinoma in cirrhotic patients. Ann Surg 1993; 218:145-151.
2. Decaens T, Roudot-Thoraval F, Bresson-Hadni S, et al. Impact of pretransplantation transarterial chemoembolization on survival and recurrence after liver transplantation for hepatocellular carcinoma. Liver Transpl 2005; 11:767-775.
3. Graziadei IW, Sandmueller H, Waldenberger P, et al. Chemoembolization followed by liver transplantation for hepatocellular carcinoma impedes tumor progression while on the waiting list and leads to excellent outcome. Liver Transplantation 2003; 9:557-563.
4. Iwatsuki S, Dvorchik I, Marsh WJ, et al. Liver transplantation for hepatocelluar carcinoma: a proposal of a prognostic scoring system. J Am Coll Surg 2000; 191:389-394.
5. Jonas S, Bechstein WO, Steinmuller T, et al. Vascular invasion and histologic grading determine outcome after liver transplantation for hepatocellular carcinoma in cirrhosis. Hepatology 2001; 33:1080-1086.
6. Llovet JM. Update treatment approach to hepatocellular carcinoma. J Gastroenterol 2005; 40:225-235.
7. Llovet JM, Bruix J, Fuster J et al. Liver transplantation for small hepatocellular carcinoma: the Tumor-Node-Metastasis classification does not have prognostic power. Hepatology 1998; 27:1572-1577.
8. Llovet JM, Burroughs A, Bruix J. Hepatocellular carcinoma. Lancet 2003; 362: 1907-1917.
9. Llovet JM, Fuster J, Bruix J, et al. The Barcelona approach: diagnosis, staging, and treatment of hepatocellular carcinoma. Liver Transpl 2004; 10:S115-S120.
10. Lu DSK, Yu NC, Raman SS, et al. Percutaneous radiofrequency ablation of hepatocellular carcinoma as a bridge to liver transplantation. Hepatology 2005; 41:1130-1137.
11. Marsh JW, Dvorchik I, Bonham CA, et al. Is the pathologic TNM staging system for patients with hepatoma predictive of outcome?. Cancer 2000; 88:538-543.
12. Marsh JW, Dvorchik I, Subotin M, et al. The prediction of risk of recurrence and time to recurrence of hepatocellular carcinoma after orthotopic liver transplantation: a pilot study. Hepatology 1997; 26:444-450.
13. Mazzaferro V, Battiston C, Perrone S, et al. Radiofrequency ablation of small hepatocellular carcinoma in cirrhotic patients awaiting liver transplantation. A prospective study. Annals of surgery 2004; 240:900-909.
14. Mazzaferro V, Regalia E, Doci R, et al. Liver transplantation for the treatment of small hepatocellular carcinomas in patients with cirrhosis. N Engl J Med 1996; 334:693-699.
15. Merli M, Nicolini G, Gentili F, et al. Predictive factors of outcome after liver transplantation in patients with cirrhosis and hepatocellular carcinoma. Tansplantation Proceedings 2005; 37:2535-2540.
16. Pompili M, Mirante VG, Rondinara G, et al. Percutaneous ablation procedures in cirrhotic patients with hepatocellular carcinoma submitted to liver transplantation: assessment of efficacy at explant analysis and of safety for tumor recurrence. Liver Transpl 2005; 11:1117-1126.
17. Ravaioli M, Ercolani G, Cescon M, et al. Liver transplantation for hepatocellular carcinoma: further considerations on selection criteria. Liver Transpl 2004; 10:1195-1202.
18. Roayaie S, Frischer JS, Emre SH, et al. Long-term results with multimodal adjuvant therapy and liver transplantation for the treatment of hepatocellular carcinomas larger than 5 centimeters. Annals of Surgery 2002; 4:533-539.
19. Salizzoni M, Romagnoli R, Lupo F, et al. Microscopic vascular invasion detected by anti-CD34 immunohistochemistry as a predictor of recurrence of hepatocellular carcinoma after liver transplantation. Transplantation 2003; 76:844-848.
20. Schwartz M. Liver transplantation in patients with hepatocellular carcinoma. Liver Transpl 2004; 10:S81-S85.
21. Veltri A, Grosso M, Martina MC, et al. Effect of preoperative radiological treatment of hepatocellular carcinoma before liver transplantation: a retrospective study. Cardiovasc Intervent Radiol 1998; 21:393-398.
22. Vitale A, Brolese A, Zanus G, et al. Multimodal therapy before liver transplantation for hepatocellular carcinoma. Hepatology Research 2005; 31:112-115.
23. Yao FY, Bass NM, Nikolai B, et al. Liver transplantation for hepatocellular carcinoma: analysis of survival according to the intention to treat principle and dropout from the waiting list. Liver Transpl 2002; 8:873-883.
24. Yao FY, Ferrel L, Bass NM, et al. Liver transplantation for hepatocellular carcinoma: expansion of the tumor size limits does not adversely impact survival. Hepatology 2001; 33:1394-1403.

25. Yao FY, Ferrel L, Bass NM, et al. Liver transplantation for hepatocellular carcinoma: comparison of the proposed UCSF criteria with the Milan criteria and the Pittsburgh modified TNM criteria. Liver Transpl 2002; 8:765-774.
26. Yao FY, Kinkhabwala M, LaBerge JM, et al. The impact of pre-operative loco-regional therapy on outcome after liver transplantation for hepatocellular carcinoma. Am J Transplantation 2005; 5:795-804.

26.3

Management of post transplant biliary complications

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Bile duct complications are an important cause of post surgical morbidity in transplant recipients and graft survival. Published series have reported an incidence of 10-25% depending on the surgical technique with the higher incidence in right liver segmental grafts and adult-to-adult live donation liver transplantation. Major risk factors for biliary complications are bile duct ischaemia resulting from arterial occlusion, prolonged cold ischaemic times, ductopenic rejection, use of organs from ABO incompatible donors and pre-existing biliary disease. The clinical spectrum of biliary tract complications ranges from an asymptomatic elevation of cholestatic enzymes to severe peritonitis and sepsis. Sonography and magnetic resonance cholangiography may be misleading with duct dilatation being a variable feature. More commonly, even in the presence of a tight stricture, a high pressure/low volume biliary obstruction may develop. Equally the histological features lack specificity with portal oedema, ductular proliferation and centrilobular cholestasis being represented in other causes of graft dysfunction. Therefore a low threshold for invasive procedures of either ERCP or PTC necessarily exists, even if to prove normality and exclusion of biliary obstruction. In broad principle the investigations are to determine the level of any strictures, whether these are anastomotic or non-anastomotic and if they should be managed by an interventional endoscopic or percutaneous technique or proceed to surgical revision.

The approach is dependant on the type of graft and anastomosis. End to end anastomosis of the donor and recipient bile ducts is the most frequent biliary reconstruction reserving hepaticojejunostomy for those recipients with a pre-existing roux loop or a diseased extrahepatic bile duct. Examples include children with a previous portoenterostomy for biliary atresia and patients with primary sclerosing cholangitis. Bile duct disconnection and formation of a hepaticojejunostomy may also be present in patients following retransplantation or following revision of the biliary drainage following a bile duct stricture or leak. T-tubes and operative stents are generally only placed if there is a discrepancy between the donor and recipient bile ducts or if there is concern as to the integrity of the bile duct anastomosis at surgery. In our experience the majority of patients who develop anastomotic strictures can be managed by dilatation with or without temporary stenting. Recurrent strictures or interventional failures are managed by surgical reconstruction. Although deployment of metallic stents is an easy technical option it could be predicted from our knowledge of stent patency that the long term patency over 5 to 10 year follow up will not match the success of biliary reconstruction in this group. However it may be the most appropriate therapeutic option in a recipient with recurrent strictures, hepatic artery thrombosis, and adequate graft function where any surgical approach may compromise arterial collaterals maintaining a reduced but adequate arterial inflow to the graft.

The development of non-anastomotic strictures carries a significantly worse prognosis than any other biliary complication. Radiological intervention with stent placement and dilatation are often temporising measures with progressive biliary strictures, stone formation and progressive graft injury the usual clinical course. This progression is almost invariable if there is continuing graft ischaemia from hepatic artery thrombosis.

Bile duct leaks in the early postoperative period are mainly due to ischaemic dehiscence of the anastomosis. In whole graft transplantation leaks may also occur from the T-tube insertion, a cystic duct remnant or from an inadvertently transected aberrant bile duct. In segmental graft transplantation this is more commonly from the cut surface particularly from the segment 4 duct if the left lobe has been implanted. The principles are to establish normal bile flow with stent placement or surgical revision, image guided drainage of any symptomatic collections and confirm integrity of the arterial inflow into the graft.

The clear association between arterial ischaemia which result in biliary strictures and leaks cannot be overstated. The early recognition of diminished arterial flow to the graft, either stenosis or occlusion and their correction will reduce the biliary complications. The key diagnostic techniques are sonography {CDUS}, potentially supplemented by microbubble contrast medium, computed tomography arteriography [CTA] or magnetic resonance arteriography [MRA]. Conventional arteriography may be needed if theses techniques, singularly or in combination, fail to make a definitive diagnosis and as a prelude to any endovascular intervention. The mechanisms and predisposing factors for hepatic artery stenosis[HAS] or thrombosis[HAT] are the same. the most common factor is failure of surgical technique, particularly related to the anastomosis of small or diseased arteries. Microemboli, harvesting injury, retransplantation and procoagulant disorders are further recognised factors. Hepatic artery stenosis has been reported to occur in between 4-5% but the impact on graft complications when present is questionable as is the debate as to what constitutes a ‚significant' stenosis. However, two studies have shown that untreated hepatic artery stenosis increases the incidence of biliary complications which adversely affect patient and graft survival. Furthermore, the graft survival and complication rate in those patients that were treated by radiological or surgical intervention matched those with normal arterial flow. The message is clear that all patients with biliary complications, both acute and recurrent should have careful non-invasive assessment of the arterial inflow to determine if there is a potentially reversible cause.

This presentation will discuss theses issues and provide a practical approach to biliary complications. Although the evidence base is limited through lack of any randomized contolled data the experience of a single centre [Kings College Hospital, London UK] conducting approximately 200 liver transplants per annum, both adult and paediatric, will form the basis of the data and individual case illustration.

Special Session
Intermittent Claudication 2

27.1

Life style adaptation and medical therapy are an effective form of treatment

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Peripheral arterial disease (PAD) has been for years, one of the most neglected areas in cardiovascular medicine. Such is surprising as in most patients, the principal causative background is, as in other vessels, atherosclerosis. Major reasons for such a surprising situation has come from an ill interpretation of symptoms and a pronounced underestimation of the risks linked to the disease.

The symptom complex of Intermittent Claudication.

All medical schools have been teaching the typical symptom complex of intermittent claudication; however, they often failed to mention that intermittent claudication is a quite specific but not very sensitive indicator of PAD. More and more recent papers have shown that many

patients come up with **atypical or misleading symptoms**; often there is overlap with symptoms fitting at least as well with abnormalities in the articulations (for example hip or knee arthritis) or muscle malfunctions; also problems with abnormal peripheral nerve function can disturb the clinical picture; this is especially the case in patients with diabetes. In female patients, symptoms of PAD often are very misleading, on top of the fact that PAD is unexpected in female patients; yet, many recent papers demonstrate a much higher prevalence of PAD in women than what clinicians have been aware of.

However, besides coming up with atypical symptoms, the problem is even greater for patients presenting with **no symptoms**; the proportion of this group of patients versus the symptomatic patients is not well known but it is accepted to be quite large as estimated by a number of population directed surveys.

The Risk linked to Peripheral Artery Disease

The other reason for low interest of physicians in this part of the cardiovascular system, is failure of correctly realising the risk linked to PAD. The Edinburgh Artery Study has clearly shown that about 40% of the claudicants also have some form of angina pectoris. If one performs a coronary angiogram on patients coming to vascular surgery, significant coronary artery disease is found in up to 90% of the patients. Cardiovascular mortality is around three times higher in PAD patients and even more importantly, this is the case both in symptomatic and asymptomatic patients! Analysing the cause of death is clearly pointing to coronary and/or cerebrovascular disease and not on whatever problem in the limbs (for summary of the data, see the CoCaLis consensus document, ref.1). Recent surveys have shown that although more and more physicians seem to have this information in their background, they still do not set the necessary steps to combat the serious consequences of this increased risk; as a consequence, they leave the patient exposed to a much higher chance for getting a heart attack or a stroke.

These arguments clearly demonstrate how important the task is to institute **prevention and medical treatment** of PAD and in particular of intermittent claudication. The principles of dealing with this issue will be divided into two parts: medical treatment of the symptom of intermittent claudication and medical treatment of the global cardiovascular risk.

Treatment of the Symptoms

Treatment of the Intermittent Claudication symptom complex is very largely linked to **life style adaptation**. The two cornerstone aspects are focused at exercise training and stop smoking.

Exercise training has been recognised for years as an effective tool to improve walking distance. Physicians often have insisted to increase walking but this in many cases, was not very well done by the patients who felt this as "contra-natural" ; the symptom of pain comes over to the patient as a negative signal and that one should not insist in eliciting it or increasing its amplitude. Also, climate or weather conditions often do not allow for walking.

Therefore, centres have been developed, allowing the patient to follow **intensive training programs,** under supervision to avoid whatever cardiovascular or other problem to occur during the performance. Programs often are quite heavy (for example three training sessions per week) but many patients do like this approach; they feel safer, feel stimulated to perform the exercises properly and clearly, very encouraging results are obtained. Several papers published in the literature show significant improvement of symptoms, increase in walking distance and even improvement of Quality of Life. As for coronary rehabilitation, these contacts also allow for giving advices for general life style adaptation, advices to decrease cardiovascular risk, unravelling social problems. Negative points are the practical aspects such as distance to the training centre, costs of the programme, difficulty of attending the training three times a week because of professional or familial duties…

Alternatives are lower level training performed by the patient in his regular living conditions by **simpler exercise performances** like heel raising or knee bending. The results of the daily exercises can be followed up in a log book. Negative here is the lower level of training, the less controlled conditions and often a lower compliance of the patients to the programme.

No doubt, walking distance is increased by training; less clear is what the mechanisms are leading to such increase. Research should be stimulated to unravel this fascinating phenomenon.

Stop nicotine abuse is a very important issue to help improving symptoms. However, addiction to nicotine has always been very strong in all general and in particular in PAD patients. Everybody knows the patient with an amputation but still continuing to smoke…Help has come from specialised centres giving the best consulting advices to the patients and this can coincide with the above mentioned supervised training centres. Nicotine replacement is one of the effective means to help the patient over this difficult period; treatment with Bupoprion has recently been shown to be quite effective; still, the addiction is very strong and a big proportion of patients fail in quitting the nicotine abuse or come back to it. Physicians and social workers need to be of permanent help for these patients; especially, physicians should give the example of not smoking as it is almost impossible to get a patient accepting the advice of quitting nicotine from someone who is not able himself to set the step…

Besides adaptation of life style, pharmacological treatment offers a lot of effective tools. The area of "vasoactive drugs" has always been obscured by non scientific studies; still two drugs have stood the time and answer positively to the very rigid scientific criteria as set by international societies. These are Cilostazol (not available in many EU countries) and Naftidrofuryl (not available in US). Both these drugs have clearly and repeatedly shown to be able to increase walking distance in well controlled conditions; they also increase quality of life in these patients, even those aspects of quality that seem not directly linked to the impairment of walking. Some other drugs could favourably impact on the complaints like those acting on muscle metabolism but proof so far is less strong as for the two drugs mentioned. Also in this area, research should be encouraged for companies to develop new drugs and for scientists to organise the necessary objective evaluation programmes.

Decrease the global cardiovascular Risk

The second part of medical treatment is focused at combating the severely increased risk in PAD patients. PAD is not only a strong risk on its own right but it is also, tightly linked to all other regular risk factors. A close look, using appropriate scoring scales, is advisable when approaching this aspect with PAD patients. **Controlling hypertension** is an essential point. Except for critical ischemia, no adverse effect is to be expected at short term of decreasing blood pressure in hypertensive patients with PAD. At longer term, clear benefits have been proven. Most likely the decrease of blood pressure is more important than the antihypertensive agent used. Still, **ACE inhibitors** seem to be slightly better positioned than other antihypertensive agents in this area for several reasons: they have a small blood flow increasing effect but more importantly, they decrease total risk (see below). It is likely but not yet convincingly shown, that AT-1 receptor blocking agents (the Sartans) could have a similar effect. In this context, it should be remembered that beta blocking agents have no unfavourable effect on walking distance which has been clearly proven by several well-controlled studies and by a meta-analysis.

Decrease the global cardiovascular Risk : Three classes of drugs

Three classes of drugs have been proven to affect the prognosis of PAD patients. There is no doubt on the positive effect of **antiplatelet drugs** when all studies are put together as was done by the Antiplatelet Trialists group. Aspirin, at low dose, obviously is the first drug to take into consideration; there is a general trend in literature and review papers, that Clopidogrel is performing better in decreasing events and avoiding side effects but the drug is more expensive.

The data from the HOPE study (2) have shown in very large numbers of patients, the beneficial effect of the **ACE inhibitor** Ramipril on the prognosis of cardiovascular patients; this was particularly clear in the PAD patients included in the study.

The Heart Protection study (3) on the other hand, has proven an impressive beneficial effect with the Statin Simvastatin; the study clearly included PAD patients and showed a quite positive decrease of events in them.
As a principle, the three classes of drugs should be given to PAD patients. Of course, problems with compliance to drug intake and elevated costs should be approached.

Conclusion

As summary and conclusion, it can be said that indeed, non interventional treatment can offer very effective tools to favourably influence the symptom complex of intermittent claudication and decrease the severe risk for cardiovascular events in PAD patients.
Obviously, such treatment does not exclude all interventional means wherever necessary: on the contrary, these measures are complementary. Non interventional treatment should comprise life style adaptation with training programs and stop smoking; symptoms can be improved by either Cilostazol or Naftidrofuryl. It is very important not to forget the different aspect of medical treatment controlling all cardiovascular risk factors; to achieve optimal results, antiplatelet drugs, ACE inhibitors and Statins should be administered. All means should be instituted to provide physicians and patients with the necessary information to understand these important steps and to improve compliance to these advices in the years ahead.

References

1. Clement D.L.; H.Boccalon et al. A clinical approach to the management of the patient with coronary (Co) and/or carotid (Ca) artery disease who presents with leg ischaemia (Lis). International Angiology: 2000: 19: 97-125.
2. Yusuf S, Sleight P, Pogue J, Bosch J, Davies R, Dagenais G. Effects of an angiotensin-converting-enzyme inhibitor, ramipril, on cardiovascular events in high-risk patients. The Heart Outcomes Prevention Evaluation Study Investigators. N Engl J Med. 2000; 342: 145-153.
3. Heart Protection Study Collaborative Group (HPSCG), MRC/BHF Heart protection Study of cholesterol lowering with simvastatin in 20,536 high-risk individuals: a randomised placebo-controlled trial. Lancet 2002; 360:7-22.

27.2

Balloon angioplasty: Where does it fit?

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When treatment of peripheral artery occlusive disease is considered by endovascular means, interventionalist should follow guidelines for the management of these specific patients suffering from peripheral arterial disease (1) These recommendations include conditions for which there is evidence for and/or general agreement that a given procedure or treatment is beneficial, useful, and effective for the patient. In terms of infrainguinal procedures (above the ligament either balloon angiolplasty and stent placement is allowed) there is conflicting evidence and/or a divergence of opinion about the usefulness/ efficacy of a procedure or treatment; weight of evidence/opinion is in favour of usefulness/efficacy; that means stents (and other adjunctive techniques such as lasers, cutting balloons, atherectomy devices, and thermal devices) can be useful in the femoral, popliteal, and tibial arteries as salvage therapy for a suboptimal or failed result from balloon dilation (e.g., persistent translesional gradient, residual diameter stenosis greater than 50%, or flow-limiting dissection), unfortunately the level of evidence is only consensus opinion of experts, case studies, or standard of care. The effectiveness of stents, atherectomy, cutting balloons, thermal devices, and lasers for the treatment of femoral-popliteal arterial lesions (except to salvage a suboptimal result from balloon dilation) is not well established. The effectiveness of uncoated/uncovered stents, atherectomy, cutting balloons, thermal devices, and lasers for the treatment of infrapopliteal lesions (except to salvage a suboptimal result from balloon dilation) is not well established also.
Based on these classifications it should be clear how to proceed when strictly following the guidelines. Completed by comparative studies (PTA versus Stent) the following results for iliac, femoropopliteal and below the knee applications are given:
Iliac: : A prospectively gathered computerized database of iliac PTA (n = 203) and stenting (n = 88), performed between 1 January 1991 and 31 December 1997, was analysed and showed that iliac stenting is associated with a significant increase in morbidity but with no improvement in symptomatic or haemodynamic outcome. These results do not justify the increased expense associated with the routine use of iliac stents (1). Other investigators found PTA with selective stent placement is a cost-effective treatment strategy compared with primary stent placement or PTA alone in the treatment of intermittent claudication caused by an iliac arterial stenosis (2). A randomly assigned study of 279 patients with intermittent claudication, recruited from departments of vascular surgery, either to direct stent placement (group I, n=143) or primary angioplasty (group II, n=136), with subsequent stent placement in case of a residual mean pressure gradient greater than 10 mm Hg across the treated site, indicated there were no substantial differences in technical results and clinical outcomes of the two treatment strategies both at short-term and long-term follow-up. Since angioplasty followed by selective stent placement is less expensive than direct placement of a stent, the former seems to be the treatment of choice for lifestyle-limiting intermittent claudication caused by iliac artery occlusive disease (3).
Femoropopiliteal: Stenting, using balloon-expandable stents, following PTA for femoropopliteal occlusions does not significantly improve neither the clinical state nor the clinical/angiographic patency. The results do not justify any routine placement of stent following PTA in the successfully recanalized femoropopliteal arteries (4). Even after a long-term follow up of more than 3 years, PTA with stent placement in the femoropopliteal artery does not produce better results than PTA alone, although it does provide better initial luminal gain after the procedure (5, 6, 7).
Using self-expanding stents, data currently available of randomized single-center experience with placement of the Hemobahn endoprosthesis (W.L. Gore & Associates) in the SFA: twenty-eight patients with claudication or ischemia were treated by PTA alone (n = 13) or PTA and endoprosthesis placement (n = 15).demonstrated a statistically significant improvement in both patency and clinical outcome compared with PTA alone (8). Trials using uncovered self-expanding stents compared to PTA alone in the SFA are on the way, unfortunately results are still missing.
Below the knee: Rand et al compared stent application as a primary treatment modality for high-grade lesions of the infrapopliteal arteries compared with treatment with percutaneous transluminal angioplasty (PTA) in critical limb ischemia in a randomized prospective study. Endovascular therapy was performed on 95 lesions in 51 patients (mean age 72.0 years, range 47-80 years) who presented clinically with Fontaine stages III and IV. Infrapopliteal stent application using Carbon coated stents is an effective treatment modality for high-grade lesions in chronic critical limb ischemia. Compared with PTA, higher patency rates can be expected after 6 months (9).
The lecture will include latest results from randomized trial comparing stent versus PTA and tries to give an objective statement when answering the question, PTA wereshould fit".

References

1. Beattie GC, Brittenden J, Gillespie I I, McBride K, McInnes G, Bradbury AW. Vascular surgical society of great britain and ireland: outcome of iliac percutaneous transluminal angioplasty with and without the use of stents in patients with intermittent claudication. Br J Surg. 1999 May;86(5):704-5
2. Bosch JL, Tetteroo E, Mali WP, Hunink MG. Iliac arterial occlusive disease: cost-effectiveness analysis of stent placement versus percutaneous transluminal angioplasty. Dutch Iliac Stent Trial

Study Group. Radiology. 1998 Sep;208(3):641-8.
3. Tetteroo E, van der Graaf Y, Bosch JL, van Engelen AD, Hunink MG, Eikelboom BC, Mali WP. Randomised comparison of primary stent placement versus primary angioplasty followed by selective stent placement in patients with iliac-artery occlusive disease. Dutch Iliac Stent Trial Study Group. Lancet. 1998 Apr 18;351(9110):1153-9.
4. Zdanowski Z, Albrechtsson U, Lundin A, Jonung T, Ribbe E, Thorne J, Norgren L. Percutaneous transluminal angioplasty with or without stenting for femoropopliteal occlusions? A randomized controlled study. Int Angiol. 1999 Dec;18(4):251-5.
5. Grimm J, Muller-Hulsbeck S, Jahnke T, Hilbert C, Brossmann J, Heller M. Randomized study to compare PTA alone versus PTA with Palmaz stent placement for femoropopliteal lesions. J Vasc Interv Radiol. 2001 Aug;12(8):935-42.
6. Cejna M, Thurnher S, Illiasch H, Horvath W, Waldenberger P, Hornik K, Lammer J. PTA versus Palmaz stent placement in femoropopliteal artery obstructions: a multicenter prospective randomized study. J Vasc Interv Radiol. 2001 Jan;12(1):23-31.
7. Grenacher L, Saam T, Geier A, Muller-Hulsbeck S, Cejna M, Kauffmann GW, Richter GM. PTA versus Palmaz stent placement in femoropopliteal artery stenoses: results of a multicenter prospective randomized study (REFSA). Rofo. 2004 Sep;176(9):1302-10.
8. Saxon RR, Coffman JM, Gooding JM, Natuzzi E, Ponec DJ. Long-term results of ePTFE stent-graft versus angioplasty in the femoropopliteal artery: single center experience from a prospective, randomized trial. J Vasc Interv Radiol. 2003 Mar;14(3):303-11.
9. Rand T, Basile A, Cejna M, Fleischmann D, Funovics M, Gschwendtner M, Haumer M, Von Katzler I, Kettenbach J, Lomoschitz F, Luft C, Minar E, Schneider B, Schoder M, Lammer J. PTA versus carbofilm-coated stents in infrapopliteal arteries: pilot study. Cardiovasc Intervent Radiol. 2006 Jan-Feb;29(1):29-38.

27.3

Implications of TASC 2

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Lars Norgren on behalf of the TASC II Working Group (Steering Committee Lars Norgren, William Hiatt, John Dormandy, Mark Nehler).
Based on the fact that management of vascular disease varies greatly not only between countries, but also between hospitals, key professional societes formulated an expert opinion consensus document, that was published in 2000 (TASC - TransAtlantic Inter-Society Consensus on the Management of Peripheral Arterial Disease).
This document has obviously had impact on daily practice among specialists, but also on the design of trials in this field, but it may have had little influence on referral pattern.
It was found important to try reaching general practitioners and other physicians referring patients, while also updating the TASC document.
TASCII was started by inviting societies from North America and Europe and this time also Japan, Australia and South Africa to create an abbreviated and updated document, including graded recommendations, but only key references.
After a primary publication in vascular journals, a dissemination process is planned, involving national societies.
TASC II includes sections on Epidemiology, Risk Factors, Intermittent Claudication, Critical Limb Ischemia, Acute Limb Ischemia, Intervention-Revascularization and Non-invasive Vascular Lab and Imaging.
In brief, there is more focus on diabetes, including diabetic foot management. Regarding the management of various lesions, the TASC classification has been kept as such, but partly modified according to improved outcome of endovascular procedures with more extensive lesions.
Regarding intermittent claudication, the more unspecific leg symptoms experienced by some patients, in contrast to the typical claudication, is stressed in order to direct these patients to specialists as required. Although wellknown by specialists, the fact that survival is reduced in patients with intermittent claudication, while the limb prognosis is fair, may be less well realized by referring physicians. The overall strategy for treatment of intermittent claudication is to start structured exercise. Some patients may benefit from pharmacotherapy. Failure of response may lead to consideration of revascularization. However, in case of proximal lesions, revascularization may be considered at an earlier stage.

27.4

Does subintimal angioplasty have a role?

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Subintimal Angioplasty of Femoro - popliteal Occlusive Disease
The technique of Subintimal Angioplasty in femoro-popliteal occlusive disease has been around for 19 years, since the first case in January 1987. Despite this prolonged period of time that the technique has been around, there has been slow uptake of the procedure on a wider scale.. This may be because it goes against the commonly held belief that dissection is a complication and is not good news because the exposure of the media and the subintimal surface is thrombogenic and therefore not desirable for recanalisation. There is sufficient evidence that this belief is mistaken, and infact, excellent results can be achieved with the use of the subintimal channel. This view is rapidly changing and a lot of centers in Europe, Far East and some in North America have embraced the technique with great enthusiasm.
Whilst the technique is applicable in infrapopliteal arteries and iliac occlusions, and also anecdotally in the profunda, subclavian and brachial artery occlusions, the widest experience has been in the femoro-popliteal segment where, over 3000 occlusions have been re-canalised.
The technique involves initiating a dissection at the origin of an occlusion with the combination of a guide wire and a catheter and then traversing the occlusion with the help of a loop in the guide wire. The commonly used catheter is the Van Andel catheter, which is made of Teflon material. This is not only a tough material, but also has a low co-efficient of friction, thus allows long calcified and tough lesions to be crossed. It is a loop in hydrophyllic guide wire that allows the dissection to be extended through the length of the occlusion and it also allows re-entry into the lumen distally. Normally, a standard hydrophillic guide wire is used, but for tough lesions, the stiff format of wire is used. 5mm X 4cm balloon is the standard for most Superficial Femoral and Popliteal lesions. 3mm X 2cm is the norm for the Tibial arteries.
Most of our patients are on low dose of Aspirin, either 75mg. or 150mg. During the procedure, 3-5000 units of Heparin are used, and if the lesion is in the distal Popliteal or Tibial vessel, we use Tolazolive, a vasodilator, in 5 mg doses, up to 10 or 15mg intra-arterially.
Subintimal Angioplasty offers an increased scope of treatment where conventional intraluminal angioplasty would not be applicable. Long occlusions, flush occlusions of the SFA and heavily calcified vessels can be treated by Subintimal Angioplasty. The technique also allows an alternative route of dissection when a perforation occurs in order to achieve a successful outcome in the majority of cases.
Our first 200 Subintimal Angioplasties had a technical success rate of 80%, which rose to 90% in the subsequent 200 cases. This experience has been shared by other workers who have noticed an improvement in the success rate once more experience begins to build up. In 1994, London et al provided the first major report of the technique for Subintimal Angioplasty on 200 consecutive femoro-popliteal artery occlusions with a median length of occlusion of 11cms (range 2 - 37

cms). Eighty nine percent of the patients treated had intermittent claudication. The median ankle brachial pressure index increased from 0.61 pre-Angioplasty to 0.90 post-Angioplasty. The actuarial haemodynamic patencies of technically successful procedures at 12 and 36 months were 71% and 58% respectively, the symptomatic patencies being 73% and 61% respectively. For all procedures including technical failures, cumulative symptomatic and haemodynamic patencies were 48 and 46% respectively and 3 years.

A number of publications have appeared since 2000, the majority demonstrating results of a mixture of intermittent claudication and critical limb ischaemia. The majority of publications have shows the technique of Subintimal Angioplasty to be very useful in Critical limb ischaemia, and infact, in our unit, it is the first line treatment for nearly all patients presenting with chronic critical limb ischaemia. However in 2004, Florenes published their experience of 116 patients with intermittent claudication, with primary success rate of 87 % and a five year secondary patancy rate of 64 % was achieved, thus convincingly showing that the technique has proved itself of value in patirents with intermittent claudication.

Subintimal Angioplasty is a safe and effective method of treating SFA occlusions the reported success rates vary with the groups treated. For patients with lifestyle limiting claudication not yet severe enough to warrant exposure to the risks of femoro-popliteal bypass, subintimal angioplasty is one method of reducing the claudication with a low associated risk.

REFERENCES

1. BOLIA A, MILES KA, BRENNANJ, BELL PRF. Percutaneous transluminal angioplasty of occlusions of the SFA by subintimal dissection. *Cardiovasc Interven Radiol* 1990; **13:** 357 - 363.
2. BOLIA A, FISHWICK G. Recanalization of an iliac artery occlusion by subintimal dissection using the ipsilateral and contralateral approach. *Clin Radiol* 1997; **52:** 684 - 687
3. BOLIA A, NASIM A, BELL PRF. Subintimal angioplasty of a brachial artery occlusion following cardiac catheterisation. *Cardiovasc Interven Radiol* 1996; **19:** 184 - 186
4. NASIM A, SAYERS RD, BELL PRF, BOLIA A. Recanalization of the native artery following failure of a bypass graft. *Eur J Vasc Surg* 1995; **10:** 125 - 127
5. REEKERS JA, BOLIA A. Percutaneous intentional extraluminal recanalisation: how to do it yourself. *Eur J Radiol* 1998; **28:** 192 - 198
6. REEKERS JA, KROMHOUT JG, JACOBS MJ. Percutaneous intentional extraluminal recanalisation of the femoro-popliteal artery. *Eur J Vasc Surg* 1994; 8**:** 723 - 728.
7. LONDON NJM, SRINIVASTIN R, SAYERS RD et al. Subintimal angioplasty of femoro-popliteal occlusions: the long-term results. *Eur J Vasc Surg* 1994; **8:** 148 - 155
8. FLORENES T, BAY D, SANDBACK G at al. Subintimal angioplasty in the treatment of patients with intermittent claudication: Long term results. *Eur J. Vasc Endovasc Surg* 2004; **28**: 645-650

Special Session
RF Ablation: Clinical Results

30.2

Radiofrequnecy of liver metastasis : clinical results

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The local efficacy of radiofrequency is reported to range from 60.9 to 96.4% [1, 2, 3 4]. Reported results are very heterogeneous, probably due to differences in tumors selection, efficacy assessment criteria's for efficacy and the duration of follow-up in the different series. Whatever the series, the tumor size is a major factor predictive of efficacy. Indeed, a complete necrosis was obtained in respectively 100%, 86%, 71%, and 50% for metastases ranging from 1.0 to 1.9, 2.0 to 2.9, 3.0 to 3.9, 4.0 to 4.9, and 5.1 to 6.6 cm for Livraghi treating breast cancer metastases [4]. Local tumor control was obtained with RF treatment of colon cancer metastases in respectively 78%, 47%, and 32% of metastases measuring less than 2.5 cm, 2.6 to 4.0 cm, and more than 4.0 cm [3]. Proximity of vessels large than 3 mm is a well known to favor incomplete ablation, and vascular occlusion can help in such situation. A recent meta-analysis reported highest local efficacy for per-operative than for percutaneous ablation, but series came from different centers and comparison is difficult. We, in our institution in a series of more than 500 ablations found the same rate of recurrence using percutaneous or per-operative approach. Moreover we recently demonstrated that the rate of incomplete local treatment was the same for radiofrequency than for a wedge resection also called metastasectomy oN the other hand, rate of incomplete treatment was higher for radiofrequency than for an anatomical liver resection. Consequently when only a metastasectomy can be performed, radiofrequency must be questioned. The previously cited metanalysis reported more complete ablation when general anesthesia is used, probably due to more comfort for patient and physician. Neuroendocrine origin seems to be more frequently fully ablated that other etiology, but one ad to be careful due to the slow growing nature of these metastases which incomplete treatment might be discovered later that in other disease. There is no differences in term of local efficacy between primary liver tumors and any type of secondary liver disease.

Does it help patients ?

To date, no increase has been clearly demonstrated in survival of patients treated with RF for liver metastases. No randomized study comparing RF with another treatment (chemotherapy, surgery, radiation therapy, …) exists. However, in our retrospective study, no significant difference was shown in survival at 30 months between patients treated with RF for recurrence after a previous hepatectomy (n=42), and patients who underwent a second hepatectomy (n=47) [5]. The largest series of RF ablation of colorectal cancer metastases reported a median survival of 36 months with 1,2, and 3 years survival of 93%, 69% and 46%. Interestingly, Livraghi et al used the RF ablation in surgical candidates to delay hepatic surgery in 88 patients who were surgical candidates with metastases smaller than 4.0cm [6]. Resection was avoided in 66% of patient unlikely to benefit from it due to local efficacy of RF ablation or tumor extension during the delayed period, while during this waiting period no patient became unresectable due to local failure of RF ablation.

Complications

Major complications occur in 2.2 to 5.7% of RF procedure [7, 8, 9, 10]. Most frequent ones are abscesses. Patient bearing a bilio-enteric anastomosis have higher risk to develop septic complications and these complications are more severe than in the remaining population [7]., even with prolonged antibiotherapy. Portal vein thrombosis was the cause of death in 3 of our 4 deaths. Pringle maneuver in non cirrhotic patient did not induce portal thrombosis, but Pringle maneuver in cirrhotic patient is very risky. Collateral damage to adjacent organ is possible for subcapsular metastase within 1 cm from this organ. Hollow viscus seems more prone to perforate and colon is probably the most dangerous organ, while very few complication have been reported to the stomach or the gall bladder. In case of contact with adjacent organ, image guided injection of gas or non ionic liquid allow to shield the adjacent organ from burns. The risk of hemorrhage seems to be increased when the tumor is situated close to the liver capsule and needle tract coagulation has been proposed to avoid hemorrhage and tumor seeding.. Needle tract seeding seems to be more frequent when the tumor is located close to the liver capsule and with poorly differentiated primary liver tumor than with metastases.. Although seeding of the tract has been reported in up to 12.5% of RF treatments in a small series of hepatocellular carcinoma, the rate appears to be much lower in larger studies, where it can be estimated to be about 0.5 to 1.5 %. Coagulation of the needle tract or using a guide needle to protect the tract could further decrease the rate of this complication.

Conclusion

RF has demonstrated a high local efficacy at short or mid-term. Whether it affords benefits for survival remains unclear. Consequently, today RF ablation of liver metastases should probably be limited to patients in whom anatomical surgery is contraindicated as there is no proof that this technique is as efficient as this type of surgery, particularly in terms patient survival. When only metastasectomy can be proposed, radiofrequency must be questioned.
Technical improvements, some of which are still in the pipeline, are being rapidly implemented. Adjuvant therapies is a large and important field that has been poorly evaluated today in combination with radiofrequency ablation and that needs to be explore.
Including patients in evaluation protocols remains a priority in order to try to find a place for this technique in the therapeutic armentarium and to evaluate its efficacy, mainly in terms of survival.

References

1. Curley SA, Izzo F, Ellis LM, Nicolas Vauthey J, Vallone P. Radiofrequency ablation of hepatocellular cancer in 110 patients with cirrhosis. Ann Surg 2000; 232: 381-391
2. de Baere T, Elias D, Dromain C, et al. Radiofrequency ablation of 100 hepatic metastases with a mean follow-up of more than 1 year. AJR 2000; 175: 1619-1625
3. Solbiati L, Livraghi T, Goldberg S, et al. Percutaneous radio-frequency ablation of hepatic metastases from colorectal cancer: long-term results in 117 patients. Radiology 2001; 221: 159-166.
4. Livraghi T, Goldberg SN, Solbiati L, Meloni F, Ierace T, Gazelle GS. Percutaneous radio-frequency ablation of liver metastases from breast cancer: initial experience in 24 patients. Radiology 2001; 220: 145-9.
5. Elias D, De Baere T, Smayra T, Ouellet JF, Roche A, Lasser P. Percutaneous radiofrequency thermoablation as an alternative to surgery for treatment of liver tumour recurrence after hepatectomy. Br J Surg 2002; 89: 752-6.
6. Livraghi T, Solbiati L, Meloni F, Ierace T, Goldberg SN, Gazelle GS. Percutaneous radiofrequency ablation of liver metastases in potential candidates for resection: the „test-of-time approach". Cancer 2003; 97: 3027-35
7. de Baere T, Risse O, Kuoch V, et al. Adverse events during radiofrequency treatment of 582 hepatic tumors. AJR 2003; 181: 695-700
8. Mulier S, Mulier P, Ni Y, et al. Complications of radiofrequency coagulation of liver tumours. Br J Surg 2002; 89: 1206-1222
9. Livraghi T, Solbiati L, Meloni MF, Gazelle GS, Halpern EF, Goldberg SN. Treatment of focal liver tumors with percutaneous radio-frequency ablation: complications encountered in a multicenter study. Radiology 2003; 226: 441-451
10. Rhim H, Yoon KH, Lee JM, et al. Major complications after radio-frequency thermal ablation of hepatic tumors: spectrum of imaging findings. Radiographics 2003; 23: 123-34; discussion 134-6.

30.3

Renal cancer

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Introduction

For over half a centaury renal cell carcinoma has been surgically treated with radical nephrectomy. Over the last two decades, nephron-sparing surgery has been shown to be an equally effective curative treatment for patients with a single, small (less than 5cm) clearly localized renal cell carcinoma and a normal contralateral kidney. In the last several years, percutaneous approaches to nephron-sparing therapy have also been reported using radiofrequency ablation, cryotherapy and microwave therapy. Image guided radiofrequency ablation (RFA) is attractive as a minimally invasive treatment option in non-surgical patients. Percutaneous image-guided ablation offers advantages over surgical methods including the minimally invasive nature of the procedure, potentially less mortality and morbidity than surgery, shorter hospital stay, and quicker recovery. Several reports have recently appeared concerning the use of both percutaneous RFA and cryoablation for treatment of small renal masses. Of these, RFA has the greater experience. McDougal and colleagues recently reported, in a small series, that radiofrequency ablation of exophytic tumors, less than 5 cm in diameter, is comparable to the efficacy of surgical extirpation at 4 years. These data and other reports of RFA of limited numbers of patients and short follow-up are encouraging.

Radiofrequency Ablation

RFA uses thermal energy to produce cell death. This thermal energy is delivered via a partially insulated electrode that is inserted into the renal mass using image guidance. The electrode is connected to a radiofrequency generator, which causes a high frequency alternating current to flow from the uninsulated tip of the electrode into the tumor and adjacent tissue. The circuit is continued via a dispersing ground pad placed typically on the thighs. The ions in the tissue adjacent to the electrode tip attempt to follow the direction of the alternating current and this ionic agitation causes frictional heating in the tissues surrounding the electrode. As the tissue is heated to between 60-100 degrees Celsius there is near instantaneous protein denaturation.

Preoperative Assessment

In most practices patients are assessed by a urologist who decides if percutaneous RFA is appropriate. This is also important for continuity of care as the patients are admitted overnight under the urology service and followed long term up by urology.
Our exclusion criteria for RFA include: (1) lesions > 3cm, (2) central tumors where more that 50 percent of the tumor extends into the renal sinus fat. Central tumors are difficult to successfully treat due to cooling form the hilar vessels (heat sink effect) and are also associated with a risk of urinary collecting system stricture, (3) tumors that are within 1cm of the ureter. Ultrasound guided installation of water into the anterior pararenal space can be used in treating anterior renal masses that are contiguous with bowel by displacing the bowel off the kidney. We currently prefer percutaneous cryoablation of renal masses greater than 3cm and those in close proximity to the collecting system as the enlarging ice ball produced during the cryoablation is easily appreciated under CT and thus injury to adjacent structure can be avoided by shutting off a particular cryoprobe.
All patients have an ultrasound to determine whether the lesion will be treated using US guidance alone or using a combination of CT and US guidance. We use US alone for tumors that meet three criteria: (1) are readily visible by US, (2) are smaller than 3 cm, and (3) are situated laterally or posteriorly in the kidney. In our experience about 25% of tumors will meet these criteria and the remaining 75% will require a combination of CT and US.

Technique

Although some advocate conscious sedation, we treat all patients under general anesthesia. This is useful for complete pain control and ensures no movement by the patient. Suspended respiration is also useful when placing the needle. General anesthesia also removes the responsibility of pain management from the radiologist who can focus their attention solely to the technique of tumor ablation.
We use the Radionics System (Radionics, Burlington, MA). No prophylactic antibiotics are administered.
Where practical, the lesion will be biopsied immediately before the ablation but ablation proceeds irrespective of the biopsy result. This is because of the reported inaccuracy in distinguishing benign from malignant disease. A recent study on percutaneous renal mass biopsy reported a negative predictive value of only 60% for masses 3cm or smaller. This is very relevant to RFA, as the majority of patients referred will have small tumors.

Postoperative Management

The patients have an immediate contrast enhanced CT study to ensure the tumor has been adequately treated. Any residual tumor evident on CT is retreated. In our experience residual tumor

necessitating retreatment is a rare event and tends to occur when larger masses are treated.

Patients are admitted overnight for anesthesia recovery and pain management. Follow up is with contrast enhanced CT or MRI at 3 months post ablation and then every 6 months.

Current Results and Complications in the Literature

While the majority of studies have quoted a success range of 80-100%, two studies have been less optimistic about the procedure quoting success rates of 0 and 36% . At Mayo we have treated 177 in 137 patients tumors with a mean size of 2.2 cm with a local tumor control rate of 95%.

Major reported complication rates are remarkable low at 0 to 4% are reported. These include chronic lumbar plexopathy pain, gross hematuria causing obstruction and requiring a stent, proximal ureteric stricture requiring stenting or pyeloplasty, and a biliary fistula. We have experienced seven major complications, four UPJ obstructions, one AV fistula, one significant hematoma and one case of pyelonephritis resulting in an overall complication rate of 5%.

Conclusion

Percutaneous imaged guided RFA is a promising minimally invasive safe treatment option for renal cell cancer. At present this therapy should only be reserved for smaller tumors in non-surgical patients because further longer-term studies are required to determine its long-term oncological outcome.

References

1. Lau WK, Blute ML, Weaver AL, Torres VE, Zincke H. Matched comparison of radical nephrectomy vs nephron-sparing surgery in patients with unilateral renal cell carcinoma and a normal contralateral kidney. Mayo Clin Proc 2000;75:1236-1242
2. Uzzo RG, Novick AC. Nephron sparing surgery for renal tumors: indications, techniques and outcomes. J Urol 2001; 166:6-18.
3. Roy-Choudhury SH, Cast JE, Cooksey G et al. Early experience with Percutaneous Radiofrequency Ablation of Small Solid Renal Masses. AJR 2003;180:1055-1061.
4. Pavlovich CP, Walther MM, Choyke PL, et al. Percutaneous radio frequency ablation of small renal tumors: Initial results. J Urol 2002;167:10-15
5. Farrell MA, Charboneau WJ, DiMarco DS, et al. Imaging-guided radiofrequency ablation of solid renal tumors. AJR 2003; 180:1509-1513.
6. Matlaga BR, Zagoria RJ, Woodruff RD, Torti FM, Hall MC. Phase II trial of radio frequency ablation of renal cancer: evaluation of the kill zone. J Urol 2002; 168:2401-2405.
7. Ogan K, Jacomides L, Dolmatch BL, et al. Percutaneous radiofrequency ablation of renal tumors: technique, limitations, and morbidity. Urology 2002; 60:954-958.
8. Mayo-Smith WW, Dupuy DE, Parikh PM, Pezzullo JA, Cronan JJ. Imaging-guided percutaneous radiofrequency ablation of solid renal masses: techniques and outcomes of 38 treatment sessions in 32 consecutive patients. AJR 2003; 180:1503-1508.
9. Rendon RA, Kachura JR, Sweet JM, et al. The uncertainty of radio frequency treatment of renal cell carcinoma: Findings at immediate and delayed nephrectomy. J Urol 2002;167:1587-1592
10. Michaels MJ, Rhee HK, Mourtzinos AP, Summerhayes IC, Silverman ML, Libertino JA. Incomplete renal tumor destruction using radio frequency interstitial ablation. J Urol 2002; 168:2406-2410.
11. Gervais DA, McGovern FJ, Arellano RS, McDougal WS, Mueller PR. Radiofrequency ablation of renal cell carcinoma: Part I, indications, results, and role in patient management over a 6-year period and ablation of 100 tumors. AJR 2005;185:64-71.
12. Varkarakis IM, Allaf ME, Inagaki T, Bhayani SB, Chan DY, Su L-M, Jarrett TW, Kavoussi LR, Solomon SB. Percutaneous radio frequency ablation of renal masses: results at a 2-year mean followup. J Urol 2005;174:456-460.
13. Shingleton WB, Sewell PE, Jr. Percutaneous renal tumor cryoablation with magnetic resonance imaging guidance. J Urol 2001;165:773-776
14. Harada J, Dohi M, Mogami T et al. Initial experience of percutaneous renal cryosurgery under the guidance of a horizontal open MRI system. Radiat Med 2001; 16:29
15. McDougal WS, Gervais DA, McGovern FJ, Mueller PR. Long-term followup of patients with renal cell carcinoma treated with radio frequency ablation with curative intent. J Urol 2005;174:61-63.
16. Farrell MA, Charboneau WJ, Callstrom MR, et al. Paranephric Water Instillation: A Technique to Prevent Bowel Injury during Percutaneous Renal Radiofrequency Ablation. AJR 2003;181: 1315-7.
17. Dechet C, Zincke H, Sebo T, et al. Prospective anlaysis of computed tomography and needle biopsy with permanent sectioning to determine the nature of solid renal masses in adults. J Urol 2003;169:71-74.
18. Dechet CB, Sebo T, Farrow G, Blute ML, Engen DE, Zincke H. Prospective analysis of intraoperative frozen needle biopsy of solid renal masses in adults. J Urol 1999;162:1282-1284; discussion 1284-1285
19. Rybicki FJ, Shu MK, Ciabas ES et al. Percutaneous Biopsy of Renal Masses: Sensitivity and Negative Predective Value Stratified by Clinical Setting and Size of Masses. AJR 2003;180: 1281-1287.

30.4

Lung cancer

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Introduction

Radiofrequency (RF) ablation has become a desired image-guided ablative method because of its ability to produce large regions of coagulative necrosis in a controlled fashion. Following recent advances in the RF technology, RF ablation has gained an increasingly important role in the treatment of unresectable hepatic malignancies, and is challenging partial hepatectomy as the treatment of choice for patients with limited hepatic tumor. Despite the experience with RF ablation of malignant tumors outside the liver is at an early stage of clinical application, several recent studies have shown that this technique could offer a valuable treatment option for unresectable lung malignancies. This abstract discusses the rationale for clinical application of RF ablation in lung malignancies as well as technique and methodology.

Rationale for Clinical Application

Lung cancer is among the most commonly occurring malignancies and is the leading cause of cancer death. Non-small cell lung cancer (NSCLC) comprises approximately 80% of primary malignant tumors of the lung, while most of the remainder are small cell carcinomas. Surgical resection is the treatment of choice for early-stage NSCLC. Unfortunately, patients with NSCLC are frequently poor surgical candidates, because of co-existent chronic obstructive bronchopneumopathy or other associated diseases. In addition, NSCLC tends to recur even after successful resection. On the other hand, conventional treatment of non-operable or non-resectable patients with systemic chemotherapy and external-beam radiation therapy has not been satisfactory in terms of survival outcomes. Lungs are also the second most frequent site of metastatic disease. There have been multiple series documenting survival benefits in patients with pulmonary metastases of favorable histologies who were completely resected as compared to unresectable individuals. However, surgery is frequently precluded by the number and location of metastatic nodules. Moreover, the high risk of recurrence in patients with metastatic disease and the need to remove functioning lung tissue along with the lesions limit the indications for surgery. Attention has therefore been focused on investigating the effectiveness of RF ablation in achieving tumor destruction in patients with unresectable primary or secondary lung malignancies. RF ablation may prove to

be a treatment option for patients with early-stages (T1-T2, N0, M0) NSCLC who are not candidates for surgery. Although RF ablation cannot realistically be expected to achieve the same degree of tumor eradication as complete lobar resection, especially in larger lesions, patients may live longer than if they had not undergone the therapy at all, as it has been shown with limited pulmonary resections. With the same rationale applied to the synergy of postoperative radiation therapy or brachytherapy and limited pulmonary resections, RF ablation may prove complementary to chemotherapy and radiation therapy. Hypoxic cells with limited blood flow such as those found in the center of necrotic tumors can be resistant to chemotherapy and external-beam radiation therapy. These central hypoxic cells may be more sensitive to RF ablation because of increased cell sensitivity to heat in the hypoxic state and decreased heat dissipation due to poor tumor perfusion. RF ablation may also be suitable for treatment of a small metastatic tumor burden or for palliation of larger lesions that cause symptoms such as cough, hemoptysis, or pain. Because ablation has to be targeted to each individual tumor, this type of therapy is probably best suited for patients with only a small number of slow-growing metastases. A similar approach has been applied to colorectal hepatic metastases whereby treatment is usually limited to four or fewer metastases with the percutaneous approach.

Technique and Methodology

Written informed consent is obtained from all patients. Before treatment, a careful clinical evaluation has to be performed, along with any relevant laboratory, imaging, and pulmonary function tests. Patients must have adequate baseline organ function, including a platelet count greater than 100 x 10^9 /L and international normalized ratio (INR) less than 1.5. Patients must discontinue coumadin, aspirin, and nonsteroidal anti-inflammatory agents at least 5 days prior to the procedure. Patients who had previously undergone pneumonectomy are currently considered uneligible for RF ablation. The histotype of the tumor is usually confirmed by CT-guided biopsy prior to the ablation. We require hospitalization of the patient. Antibiotic treatment is started the day before the procedure and usually lasts for one week. Pre-treatment CT of the chest is a key examination to determine number, size, and location of the lesions, to carefully evaluate their relationships with major vessels and airways, and to assess the status of the pulmonary parenchyma. According to our ongoing protocols, to be considered suitable candidates for RF ablation, patients are required to have 3 or less lesions per lung, each with a maximum diameter less than or equal to 3-4 cm. In addition, lesions had to be placed farther than 1 cm from major blood vessels or airways. Other centers, however, have followed wider inclusion criteria, especially with regard to tumor size. Baseline CT provides also the term of reference for post-treatment follow-up studies. To this aim, lung nodule enhancement is studied by performing thin-section CT of the lesion 1, 2, 3, and 4 minutes after the onset of injection. The procedure is performed following standard rules for CT-guided lung biopsy. The skin entry site allowing the shortest, most vertical path that avoids bullae, interlobar fissures, or pulmonary vessels is chosen and a marker is placed on the patient's skin. The depth of the lesion from the surface is carefully measured. After cleansing the needle entry site with povidine-iodine solution and anesthetizing the skin and subcutaneous tissues with a 2% solution of lidocaine, a small stab incision is made with a scalpel to facilitate needle entry through the skin. Once the position has been decided and the lesion carefully localized, the electrode needle is advanced through the skin to the proximal edge of the lesion. Needle advancement still requires careful planning. Even slight degrees of malalignment can cause the tip of the needle to miss the target. This is particularly true for small deep lesions. CT-fuoroscopy may be a tool to overcome these difficulties. An increase in resistance is palpable as the needle pierces the lesion. Once CT scans have confirmed that the needle tip has actually reached the nodule, special attention must be placed on verifying the correct placement of the active part of the electrode with respect to the tumor. In fact, unlike in biopsy procedures, a marginal location of the device is not satisfactory. The relationships of the electrode needle with the tumor must be assesed in all the different planes by using appropriate image reconstructions. When expandable needles with multiple jackhooks are used, it is crucial to check the correct placement of the deployed hooks before starting the ablation. In our center lung RF is administered under conscious sedation. under standard cardiac, pressure, and oxigen monitoring with continuous oxigen administration. After completion of the procedure, a single expiratory scan is obtained throughout the thorax and viewed at a narrow window width to detect subtle pneumothorax. The patient is then moved onto a stretcher and positioned in the needle puncture site dependent position, which helps reduce air leak and post-procedural pneumothorax and possibly prevents transbronchial spread of induced alveolar hemorrhage. A small, asymptomatic pneumothorax is managed conservatively with monitoring of vital signs, administration of nasal oxygen, and follow-up radiographs to confirm stability. On the other hand, a large or symptomatic pneumothorax usually requires the placement of a percutaneous small-bore catheher. It is generally accepted that a pneumothorax exceeding 30%, even in an asymptomatic patient, requires drainage. However, the decision to drain a pneumothorax must be determined on an individual basis. Because patients tolerate pneumothorax differently depending on underlying lung function, a pneumothorax smaller than 30% may also require drainage. Follow-up studies include clinical evaluation, pulmonary function tests, CT of the chest, and quality of life assessment. The examinations are usually performed 1 month, 3 months, and 6 months after the procedure and at 3-month or 6-month intervals therafter. Despite CT is currently the most widely used method for follow-up of treated lesions, MRI and positon emission tomographic imaging may ultimately prove useful as important tests for assessing the adequacy of thermal ablation. Subject with questionable imaging findings can be submitted to biopsy. If there is imaging or cytology evidence of residual or recurrent tumor, the patient can be considered for repeated RF ablation, provided that requirements for treatment are still met.

Conclusions

RF ablation is a new, minimally invasive procedure that shows promise for the treatment of primary and secondary lung cancer. Results of pilot clinical trials have shown that this technique can achieve effective and reproducible tumor destruction with acceptable morbidity. Owing to the relatively small number of treated cases, no definite conclusion can currently be drawn concerning the potential clinical role of the technique. Nevertheless, it can be predicted that - with continued improvement in technology and increasing clinical experience - RF ablation could represent a viable alternate or complementary treatment method for patients with non-small cell lung cancer or lung metastases of favorable histotypes who are not candidates for surgical resection.

Special Session
IR/OR Suite of the Future

31.3

Who will use it?

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Learning objectives:

1. To understand the reasons for changes in the training needs of interventional radiologists.
2. To explore the need for further subspecialization in medicine.
3. To analyse the factors that will influence the pattern of practice of those treating patients in interventional radiological/surgical/endoscopic rooms in the future.

Imaging guidance is becoming essential in the treatment of many conditions previously treated with traditional surgical techniques.

Endoscopy, laparoscopy, fluoroscopy and cross-sectional imaging are gaining increasing importance in the clinical management of many conditions. The operating room of the future is likely to be equipped with instruments that require the skills of radiologists, endoscopists and laparoscopic surgeons.

Collaborative use of endoscopic, laparoscopic and radiological skills may be necessary for the optimal management of many conditions. Whilst it is possible to achieve collaboration between clinical specialists possessing these skills, in the future economic and logistic considerations are likely to lead to increasing pressures for specialists to gain expertise in techniques that do not currently form part of their armamentarium. This is easier to achieve in the case of clinical disciplines, which have a curriculum for training that focuses on clinical aspects. It is more difficult for radiologists, as the integration of surgical and endoscopic techniques into radiological training programmes would pose insurmountable logistic challenges, unless diagnostic and interventional radiology diverged to a much greater extent than at present.

Subspecialization

The body of knowledge required in modern medicine is formidable and is increasing inexorably. Although 'generalists' will always be needed, the need for super-specialists is showing inexorable increase. The ascendance of molecular medicine and gene therapy will increase the demand for specialists. It is unlikely that interventional radiology can survive in the future as an independent clinical discipline unless it embraced the need for subspecialization. The most realistic way of achieving this would be by integration into clinical departments.

Access to patients

Interventional radiologists are the only medical practitioners directly administering treatment who do have direct access to patients. The main reasons for this are the historical evolution of interventional radiology from the service specialty of diagnostic radiology, the fact that interventional radiologists in Europe do not usually have resident junior staff, and the perception among many other medical practitioners that radiologists do not have sufficient clinical training and expertise to be in charge of patients. In the US, many interventional radiologists have patients referred to them directly by primary-care physicians. In Europe, this is the exception.

In come European countries, the degree of clinical expertise possessed by radiologists is indeed limited, and this problem would have to be rectified before direct patient access can be justified. In the UK, the great majority of radiologists possess a postgraduate medical or surgical qualification. These are not 'exit' examinations, but they cannot be acquired without a significant amount of clinical experience. Clinical training for at least one year after full registration with the General Medical Council is a requirement for entry into radiological training.

A doctor should possess sufficient clinical expertise to deal with situations commonly encountered in his or her own practice; the interventionalists should know, for example, that following the insertion of external biliary drainage, a large amount of bile may be lost, disturbing the fluid and electrolyte balance of the patient, and perhaps leading to renal failure if appropriate measures are not taken. Such knowledge would be expected of interventional radiologists because they are the ones most likely to encounter problems connected with the procedures they perform. It is illogical and inappropriate to relinquish the pre- and post-procedure care of patients to physicians or surgeons who are less familiar with the problems encountered in interventional radiology.

It should be recognised, however, that present circumstances make it difficult for most European interventionalists to be independent clinical practitioners: their numbers are too small, they do not have sufficient time to be involved in outpatient clinics, and the discipline is not sufficiently well-known for patients with appropriate conditions to be referred to them directly in the majority of cases. Even more importantly, most doctors undertaking interventional radiological procedures are unwilling to become fully fledged clinicians, preferring instead to combine diagnostic and interventional radiological work in varying proportions. The re are several reasons for this, including the relative lack of confidence of some radiologists undertaking primary clinical responsibility for patients, as well as lifestyle and financial considerations.

Advances in radiology

Radiological images are becoming increasingly easier to interpret. Rapid coronal or 3D CT reconstructions, 3D ultrasound images and the use of colour produce images that are much more similar in orientation to the anatomy of patients as is known to most physicians and surgeons. It is likely that in the future most non-radiologists will routinely learn to interpret radiological images.

The future

The need to combine surgical, endoscopic and radiological skills, the ever increasing need for subspecialization and the realities of the control of patients make it likely that the IR/OR suite of the future will be used by interventional imaging specialists integrated into clinical departments. The absorption of parts of interventional radiology will create the need for clinicians such as neurosurgeons, urologists and gastroenterologists to improve their diagnostic radiological skills. When that happens, the need for such skills to be taught formally will lead to their incorporation into the training curricula for such specialists. These specialists will probably possess a variety of surgical, endoscopic and interventional radiological skills, in varying combinations, depending on the needs of the particular specialty.

Foundation Course SFA Angioplasty

33.1

Antegrade Access

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Antegrade puncture is generally more difficult than retrograde. It requires that the skin of the abdomen is entered above inguinal ligament, while the tip of the needle should enter the common femoral artery (CFA) below the ligament. It is well known, that the puncture ,,too high"(above the ligament to the external iliac artery) precludes adequate compression and postprocedural tamponade causing the risk of retroperitoneal hemorrhage. The puncture too low" is associated with increased incidence of AV fistulas and pseudoaneurysms.

Fluoroscopy can be helpful tool as the needle tip should hit the femoral artery at the level of midpoint of femoral head. In obese patients it may help to retract abdominal folds cephalad and medially.

A steep needle puncture should be avoided because catheters and sheaths may kink during or after placement. As deep femoral artery (DFA) arises posterolaterally the guidewire tends preferentially enter it

There are several tricks how to manipulate the wire into SFA, but essential is to know that the common femoral artery was punctured, an injection of contrast medium is sometimes helpful.

If wire enters the DFA the first step is flatten the needle and to try to point its tip towards SFA. If the problem persists, steerable guidewire or preshaped catheter (Cobra-like) can help.

Another possibility is to insert 4Fr dilator to the DFA, withdraw it slowly to the CFA and select the SFA origin with angled hydrophilic guidewire.

With a dilator in the deep femoral artery it is also possible to place 0.014-inch safety wire into the vessel periphery, withdraw the dilator tip to the CFA and insert another 0.018-inch (preferably rigid) steerable wire. When this wire is manipulated to the SFA the safety wire is removed and the dilator is advanced over the 0.018-inch wire to the SFA.

Once the SFA position is reached it should be always kept in mind, that the smallest possible diameter catheters/sheaths should be used for further procedures.

33.2

Retrograde to antegrade access

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Retrograde common femoral artery (CFA) is by far the most frequently used vascular access and interventional radiologists usually have a great deal of experience with it. The ideal arterial entry point is the mid-third of the CFA because arterial pulsations are most prominent, and the artery can be securely compressed against the underlying bone for optimal haemostasis after the procedure. In order to allign the needle completely with the CFA, the course of the artery should be palpated by three buckled fingers in a straight line with the distal phalanges flattened rather than with the finger tips end-on. The three fingers are placed just cephalad to the skin entry site and over the intended arterial entry point. In case there is a weak or absent femoral pulse due to severe obesity or high grade iliac stenosis, fluoroscopy of the femoral region can be used to direct puncture over the medial aspect of the femoral head or identify calcification in the arterial wall and so direct puncture. If available, ultrasound may be used in difficult cases to assist in femoral puncture. A double or single wall puncture technique can be used safely, however the later is more desirable when thrombolysis is contemplated.

Contralateral retrograde CFA (cross-over) is a very important and commonly used vascular access which enables percutaneous treatment of lesions located in the ostium or proximal portion of the contralateral superficial femoral artery (SFA). Some centers advocate the use of this approach for the majority of SFA interventions. Important advantages of the technique compared to the antegrade access include technical easier retrograde femoral puncture and non-obstruction of the post-interventional flow in the recanalized segment due to the fact that the haemostatic compression bandage is applied in the contralateral leg. Following arterial puncture, a 5-6 F sheath is inserted in most of the cases over a standard J-tipped guidewire. The use of hydrophilic guidewires for initial introduction through the neddle should be avoided as these wires can be cut by the sharp needle. However, after initial insertion of the first centimeters of the sheath a hydrophilic guidewire can be used to pass an obstructed or tortuous iliac artery and to facilitate subsequent advancement of the sheath. To navigate the guidewire in cross-over position a curved diagnostic 4-5 F catheter (Cobra, Simmons 1, sos Omni) is positioned at the aortic bifurcation. The catheter is manipulated so that the tip of the catheter „engages" the ostium of the contra-lateral common iliac artery. During this manoeuvre care has to be taken particularly when using a Simmons or sos Omni catheter so that the limb of the catheter does not dissect the arterial wall. An angled terumo (0.035" Glidewire, Meditech, Watertown, MA, USA) is then advanced into the femoral artery and the diagnostic catheter is positioned in the artery. The Glidewire is then exchanged for an Amplatz superstiff wire, which is advanced into the distal femoral artery. At this point a 6 F cross-over sheath with its dilator is advanced over the stiff guidewire and positioned in the contralateral external iliac artery. This allows injection of contrast, during lesion dilation and more back-up support. When an attempt is made to recanalize chronic SFA occlusions, inadequate forward pressure maybe a problem in the contralateral approach especially when catheters and wires are manipulated in tortuous and irregular iliac arteries. It should be mentioned that in patients with excessive calcification at the aortic bifurcation or extremely acute angle between the origin of both common iliac arteries, this access maybe very difficult or even impossible. In such cases excessive force should be avoided as there is high risk of dissection of the distal abdominal aorta and/or ostium of the common iliac arteries.

Ipsilateral retrograde CFA puncture with antegrade conversion can be used alternatively in difficult patients who are not anatomical candidates for treatment with the standard ipsilateral antegrade or contralateral retrograde CFA approach. These include obese patients with a large overhanging „apron" or who have had previous surgery with colostomy or ileostomy and patients with tortuous and severely calcified iliac arteries. The site of puncture is higher (1-2 cm above the inguinal skin crease) and the needle is angled more vertically at approximately 60 degrees to the skin surface compared to standard retrograde puncture for diagnostic angiography or contralateral cross-over approach. This facilitates turning of a suitably shaped catheter (sos Omni or Simmons 1) which is advanced over a standard 5 mm J guidewire and formed in the lower aorta. The standard guidewire is then exchanged for an angled 0.035" Glidewire which is advanced back down the ipsilateral iliac arteries and both wire and catheter are withdrawn into the CFA. At this point the Glidewire is further advanced into the proximal SFA and the loop in the Glidewire is reduced by further withdrawal of the catheter until it is just traversing the arterial puncture site. Finally, the Glidewire and catheter are advanced into the mid or distal SFA until there is sufficient support for placement of a 6F sheath. Despite it's clear advantages over direct antegrade puncture, the main drawback which may discourage interventional radiologists from routine use of this technique, is the substantially longer screening time due to specific catheter and wire manipulations resulting in a higher radiation dose than antegrade puncture.

While arterial cannulation above the inguinal ligament increases significantly the danger of intraperitoneal bleeding, it is important to remember that "correct" puncture of the CFA below the inguinal ligament can be complicated by the development of abdominal wall or retroperitoneal haematoma. This less recognized complication is the result from bleeding in the femoral sheath which is the inferior extension of the pelvic and abdominal wall fascial layers around the femoral artery and vein. When the femoral sheath is transgressed at the time of vessel puncture, blood collected in this space after catheter or sheath removal may spread along the fascial planes continuous with the sheath into the retroperitoneum or, indeed, into the anterior abdominal wall. It should always be remembered that the development of a retroperitoneal haematoma is a recognized complication of anticoagulant and thrombolytic therapy and this type of complication may be quite unrelated to the performance of femoral artery puncture.

References

1. Seldinger SI. Catheter Replacement of the Needle in Percutaneous Arteriography. Acta Radiologica 1953; 39: 368-376
2. Hessel SJ, Adams DF, Abrams HL. Complications of Angiography. Radiology 1981; 138: 273-281
3. Lechner G, Jantsch H, Waneck R. Kretschmer G. The relationship between the common femoral artery, the inguinal crease, and the inguinal ligament; a guide to accurate angiographic puncture. Cardiovasc Intervent Radiol 1988; 11: 165-169
4. Lilly MP, Reichman W, Sarazen AA, Carney WI. Anatomic and Clinical Factors Associated with Complications of Transfemoral Arteriography. Annals of
Vascular Surgery 1990; 4: 264-269
5. Kashdan B, Trost D, Jagust M, Rackson M, Sos T. Retrograde approach for contralateral iliac and infrainguinal percutaneous transluminal angioplasty: Experience in 100 patients JVIR 1992; 3: 515-521
6. Nice C, Timmons G, Bartholomew P, Uberoi R. Retrograde vs Antegrade Puncture for Infra-Inguinal Angioplasty. Cardiovasc Intervent Radiol 2003; 26: 370-374
7. Raphael M, Hartnell G. Femoral artery catheterization and retroperitoneal haematoma formation (Letter) Clin Radiol 2001; 56: 933-934
8. Jackson J. Femoral artery catheterization and retroperitoneal haematoma formation (Commentary) Clin Radiol 2001; 56: 934-935

33.3

Popliteal Access

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Introduction: For the endovascular treatment of superficial femoral artery (SFA) lesions, ipsilateral antegrade or contralateral retrograde femoral approaches are generally preferred. There are however, a number of situations in which these access sites are difficult or even impossible to use for SFA angioplasty: a) For ipsilateral antegrade femoral access: obesity of the patient, groin scars due to previous operations, severe common femoral artery atherosclerosis and lesions located at the beginning of the SFA. B) For contralateral retrograde femoral access: a narrow aortoiliac angle, severe tortuosity of iliac vessels and chronic calcified SFA occlusions which require more pushing force for crossing. In such instances, retrograde transpopliteal access offers a valuable alternative1-3.

Anatomy of the popliteal fossa: The popliteal fossa is a diamond-shaped area located on the posterior aspect of the knee. It is bordered by the biceps femoris muscle laterally, semitendinosus and semimembranosus muscles medially, and the medial and lateral heads of gastrocnemius muscle inferiorly. The popliteal fossa contains the popliteal artery and vein, a number of nerves including the common peroneal nerve, a few small lymph glands, and a considerable quantity of fat. Along most of its course in the popliteal fossa, the popliteal vein lies posterior and posterolateral to the artery, and because of this anatomy, an arterial puncture in prone position may result in AVF if the needle and sheath traverse the popliteal vein before entering the artery1-3. To avoid this complication, Trigoaux et al4 studied the anatomic relationship of the popliteal vessels and recommended a mediolateral and caudocranial puncture at 6-7 cm above the knee joint.

Technique: The retrograde transpopliteal access can be performed in a number of ways. If the patient's popliteal pulse is present, the puncture can be made without any imaging guidance. To minimize the risk of AVF, the needle is directed mediolaterally and caudocranially4-6. If the popliteal pulse is absent, the puncture should be made with guidance. In the literature, three types of guidance have been described for the popliteal access. 1) The popliteal artery can first be localized on the fluoroscopy with contrast injection via a femoral access, and the popliteal puncture can be performed under road map fluoroscopic guidance5-9. Although this is a well-established method, it requires a second vascular access, patient repositioning and resterilization, and exposes the operators hands to ionizing radiation 2) A Doppler needle can be used to localize the arterial and venous flow at the popliteal fossa, and the needle is directed towards the artery and avoided from the venous flow3,10. Although it is quite simple to use, this device is not widely available and adds approximately 150$ to the total cost of the procedure 3) The popliteal puncture can be performed under real time ultrasonography (US) guidance. With this method, the operator sees both popliteal vessels and safely punctures the popliteal artery without traversing the vein1,2,11. The method requires a simple gray-scale US device which is available in almost all interventional radiology centers, however, it may be difficult if the operator is not familiar with US-guided interventions.

Results: Whatever the method is used, retrograde popliteal artery catheterization seems to be a safe procedure; AVF, which is the most characteristic complication of popliteal access, has been very rarely reported1-12. In our own series which includes 241 popliteal punctures in 180 patients, we have seen only one case of AVF, which was treated with US-guided compression2. Dissection or thrombosis of the popliteal artery at the puncture site, which is another anecdotal concern, has not been seen in our series and not been reported in the literature.

Other complications of the popliteal access are nonspecific and include hematoma and pseudoaneurysm at the puncture site. Most hematomas are small and do not require any treatment. In our series, we have seen 2 major hematomas; one occurred despite use of a puncture site suturing device13, and the other occurred in a diabetic patient which resulted in transient common peroneal nevre palsy14. In another patient, a pseudoaneurysm developed and could not be treated with US-guided compression due to excessive pain. This patient was then successfully treated with surgery. In the literature, the overall complication rate for the popliteal access varied 4-10% and seems comparable to those reported for the retrograde femoral puncture in patients undergoing angioplasty1-12.

Personal experience: During a 9 years period, we have used retrograde popliteal access in 180 patients at our institution. These patients either had a difficult or impossible femoral access, or their lesions favored popliteal approach (e.g. tandem femoral and iliac lesions, proximal SFA or common femoral artery lesions). In all our patients, we performed the popliteal puncture under real-time US guidance whether the popliteal pulse was present or not. After the patient was laid in prone, the popliteal fossa structures were examined with US, using 3,5-5 mHz transducers. The popliteal artery and vein were differentiated based on basic US features and with a simple compression maneuver. After the level of the knee joint was identified on fluoroscopy, the transducer was held in transverse position and a suitable puncture point was chosen around the knee where the operator saw the popliteal vessels side by side on US without superimposition of the surrounding muscles. This point was generally several centimeters above the level of the knee joint and in the medial part of the posterior popliteal region. After local anesthetic was injected, a 2 mm skin incision was made. The transducer was then put 1-2cm cranial to the incision point, and the popliteal artery was punctured through the incision with a 18-19 gauge needle by easily avoiding the popliteal vein.

In our series, US-guided retrograde popliteal access was successfully performed in all attempted procedures. Punctures were bilateral in 24 patients15, and 37 repeat popliteal punctures were made for restenoses or reocclusions during the follow-up. In 122 procedures, we used 4-5F sheaths, and in 119, we used 6-7F sheaths. Our overall complication rate was 6%, and puncture-related complication rate was 4%. After recanalizations, hemostasis was obtained in 6.9±2.3 minutes with manual compression1,2.

Conclusions: In contrast to general concerns, SFA angioplasty via retrograde popliteal access is a safe procedure with a low complication rate and short hemostasis times. It is a good alternative in patients where femoral access is difficult or impossible, but it can also be the primary choice in patients with common femoral artery or proximal SFA lesions or tandem femoral and iliac lesions. In popliteal access, US is an ideal imaging tool, particularly for interventional radiologists who are most familiar with US-guided interventions.

References

1. Yilmaz S, Sindel T, Ceken K, Alimoglu E, Luleci E. Subintimal recanalization of long superficial femoral artery occlusions through the retrograde popliteal approach. Cardiovasc Intervent Radiol 2001;24:154-160.
2. Yilmaz S, Sindel T, Luleci E. Ultrasound-guided retrograde popliteal artery catheterization: experience in 174 consecutive patients. J Endovasc Ther 2005;12:714-22.
3. Saha S, Gibson M, Magee TR et al. Early results of retrograde transpopliteal angioplasty of iliofemoral lesions. Cardiovasc Intervent Radiol 2001;24:378-382.
4. Trigaux JP, VanBeers B, DeWispelaeree J. Anatomic relationship between the popliteal artery and vein: A guide to accurate angiographic puncture. AJR 1991;157:1259-1262.
5. Tonnesen KH, Sager P, Karle A et al. Percutaneous transluminal angioplasty of the superficial femoral artery by retrograde catheterization via the PA. Cardiovasc Intervent Radiol 1988;11:127-131.
6. Henry M, Amicabile C, Amor M et al. Peripheral arterial

angioplasty: value of the popliteal approach. Apropos of 30 cases. Arch Mal Coeur Vaiss 1993;86:463-469.
7. Sievert H, Ibers H, Scherer D et al. Retrograde catheter recanalization of long-range occlusion of the superficial femoral artery. Dtsch Med Wochenschr. 1994;119:948-950.
8. McCullough KM. Retrograde transpopliteal salvage of the failed antegrade transfemoral angioplasty. Australas Radiol 1993;37:329-331.
9. Zaitoun R, Iyer SS, Lewin RF et al. Percutaneous popliteal approach for angioplasty of superficial femoral artery occlusions. Cathet Cardiovasc Diagn 1990;21:154-158.
10. Kluge A, Rauber K, Breithecker A et al. Puncture of the PA using a Doppler-equipped (SMART) needle intranspopliteal interventions. Eur Radiol 2003;13:1972-1978.
11. Yilmaz S, Sindel T, Yegin A et al. Subintimal angioplasty of long superficial femoral artery occlusions. J Vasc Interv Radiol 2003;14:997-1010.
12. Beyer-Enke SA, Adamus R, Loose R et al. Indications and outcome effectiveness of transpopliteal angioplasty. Aktuelle Radiol 1997;7:297-300.
13. Yilmaz S, Sindel T, Erdogan A, Mete A, Luleci E. Hematoma after percutaneous transpopliteal stenting and remote suturing of the popliteal artery. J Endovasc Ther 2002;9:703-706.
14. Yilmaz S, Altinbas H, Senol U, Sindel T, Mete A, Luleci E. Common peroneal nerve palsy after retrograde popliteal artery puncture. Eur J Vasc Endovasc Surg 2002 May;23(5):467-469.
15. Yilmaz S, Sindel T, Luleci E. Bilateral transpopliteal approach for treatment of complex SFA and iliac occlusions. Eur Radiol 2002 Apr;12(4):911-4.

33.4

Crossing the lesion and PTA

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For infrainguinal disease, clinical indications for treatment include claudications for femoropopliteal lesions but should be limited to severe symptoms such as rest pain, non-healing ulceration or, at least, severe claudication if a lesion is located in a subpopliteal location. Endovascular treatment, however, has been proven to cause a low morbidity and even a lower mortality being followed by a satisfactory outcome.

Endovascular vs. surgical treatment

Endovascular therapy is known to be of low invasiveness with good technical success and a fair overall patencyIn femoropopliteal endovascular interventions (taken from 8 publications reporting on 1469 procedures), weighted average technical success was 90%, complication rate was 4.3% and 3-year patency rate was 51%. Stents do not improve patency showing a 3-year patency of 58% after 3 years (1).

Surgery offers acceptable results for distal reconstruction; an average 5-patency of 80% for vein bypasses and 65-75% for ePTFE bypasses has been reported. Combined mortality and amputation risk was calculated to be about 2.2 % for aortobifemoral reconstructions and 1.4% for femoropopliteal reconstructions (1).

Location of lesion

Claudication is mainly related to lesions in the aortoiliac or the femoropopliteal region. It is unlikely to be due to infrapopliteal lesions and there is general agreement that treatment below the knee is strictly limited to patients with critical limb ischemia i.e. stage III and IV (Fontaine) or category 4 to 6 (Rutherford).

Type of lesion

Morphology of a lesion treated will have an influence on the technical outcome, follow-up results and also risk of treatment. The TASC document therefore introduced a classification system that tries to categorize lesions with regard to their accessability to either percutaneous treatment or surgery with type A lesions ideal for percutaneous approach, type B lesions where percutaneous approach is still the preferred technique, type C lesions where surgical approach should be preferred and type D lesions where surgery is the option of choice. The TASC classification overrules older classifications since it takes into account all available and published techniques including stent technology which offer a much wider variation of treatment and also an effective tool to deal with current acute complications of balloon angioplasty such as occluding dissection or vascular rupture.

If we consider percutaneous therapy as the preferred method to deal with those patients presenting with mild or moderate claudications, treatment might be offered to those presenting with type A and B lesions but should be discussed in depth with patients with type C lesions since the risk and the potential benefit of treatment will be related to the underlying morphology .

In the femoropopliteal field, type A lesions are single stenoses up to 3 cm in length not involving the very proximal superficial femoral and the distal popliteal artery. Type B lesions are stenoses 3 -5 cm in length, heavily calcified stenoses, multiple lesions (each up to 3 cm) and lesions with no sufficient tibial run-off (the latter are unlikely to meet the criteria of mild ore moderate claudication). Type C lesions are classified as stenoses or occlusions longer than 5 cm and multiple mid-size lesions (3-5 cm). Total common femoral, superficial femoral and popliteal occlusions are classified as type D lesions. There was some dissenting discussion on the definition of type B lesions since interventional radiologists represented by CIRSE wished to express their assumption that even longer lesions up to 10 cm may be justified to be classified as type B instead of type C claiming that the results reported are mainly due to underdeveloped techniques and instruments which have majorly improved in the meantime and no evidence exists comparing efficacy of PTA versus bypass surgery for lesions between 4 and 10 cm.

Other than in the iliac area, less femoral lesions will meet the criteria of type A and B lesions especially if limited to 5 cm in length. Thus, less patients with mild and moderate claudications due to femoropopliteal lesions will become ideal candidates for percutaneous treatment. Moreover - without limiting the importance of the TASC document which certainly means a step forward in the joint approach to peripheral vascular disease - the morphological classification does not take into account some technical considerations that depend on the age and composition of a lesion. Particularly in femoral occlusions, the degree of organization of the occluding thrombus or the composition of the lesion with the original stenosis at proximal and distal end or in the middle are factors which are not well predictable but may influence the technical outcome of the intervention or also its complication rate i.e. distal embolization which might cause a aggravation of symptoms. Other than in the iliac arteries, liberal use of stents and stent grafts may help to overcome a failed balloon angioplasty and to solve the technical outcome but does not achieve an improved long-term efficacy or may start up a life-time dependency on recurrent interventional or surgical procedures. These associated potential drawbacks have to be carefully balanced against the potential benefits and need to discussed in depth with the patient before treatment is performed especially in association with mild or moderate claudication.

These considerations mainly restrict use of endovascular treatment in femoropopliteal lesions to stage II b and II a patients presenting with type A and less pronounced type B lesions.

Assisting forms of treatment

It is widely accepted that well-conducted physical exercise should precede any type of interventional treatment and cessation of smoking is mandatory. Nevertheless, it is also true that in many institutions it is most difficult to find an infrastructure that allows to teach state-of-the-art physical exercise in claudicants and as far as smoking is concerned, there is a major difference between willing

and doing.
Moreover, even with state-of- the-art exercise a young patient will not recover completely from claudications in all his activities including sports. The process will be longer and compromise his or her abilities in their professional lives. It might be therefore discussed whether especially the group of young and active patients should be vigourously put under the axioma of "physical exercise first" or whether in this group of patients, invasive treatment might be offered even as a first approach.
Treatment options with relation to location and lesion
Treatment of femoropopliteal lesions in claudicants have to be seen more critical and less liberal compared to the iliac region. The main reasons are less favorable technical success, higher complication rate and poorer long-term success. There are much more lesions in the femoropopliteal arteries that do not meet the criteria that make them well suitable to endovascular treatment. On the other hand, versatility of endoluminal techniques opens treatment options in many particular lesions and taking clinical symptoms as the only criterion to indicate or to exclude treatment is not justified since depending on the type of lesion a simple and limited intervention will mean a considerable improvement for the patient.

Additional morphological factors (not included into the TASC classfication)
Especially femoropopliteal occlusions might become a source of complications particularly if they happened recently. Simple PTA may result in downward embolization of occlusion material that may aggravate the symtoms or may turn the situation into a limb-threatening situation. Even in short occlusions PTA may be insufficient to reopen the vessel necessitating additional treatment like stent placement which does not receive a better patency compared to balloon angioplasty alone. Reobstruction of stents however is more difficult to treat compared to simple restenosis. Eccentric calcified stenosis is frequently insuffifiently treated. Since stenting is a technical but not necessarily a long-standing solution to such lesions, alternative techniques such as atherectomy may be considered if available. Unfortunately those niche techniques are difficult to place in the market because of the costs involved and some of those well-advanced devices such as the Simpson atherectomy catheter have been withdrawn from the market.
Techniques
Balloon angioplasty
Balloon angioplasty remains the working horse in femoropopliteal lesions. Modern angiographic units allow an inbuilt pretty exact measurement of the true arterial diameter and by use of semicompliant balloons, adaptation to the diameter is well performed. We prefer not to grossly overdilate the artery in order to avoid dissection. Dilation times of 1 to 3 minutes are preferable by using pressure gauges. Balloon lengths of 2 to 4 cm are mainly used. In case of major dissection, the first attempt should be an additional try to improve the result by prolonged balloon dilataion over 4 to 5 minutes and in many cases, the result will be improved by this cost-effective and simple approach.
Stent placement
Use of all kinds of stents should be limited to those cases where balloon angioplasty in all its variations did not achieve a sufficient result. This is particularly true for occluding dissections Other than in the iliac field, a liberal use of stents should not be applied.
The stented segment should be as short as possible. Balloon-expandable stents normally allow to cover only short segments and might be therefore preferred for those lesions. In longer segments or in parts where bending of the artery is an issue self-expanding stent is of advantage if a stent cannot be avoided at all.
The overall results of femoral stenting are disappointing; there are new developments with drug-coated stents on the way that allow to elude drugs from the stent surface such as rapamycin (Sirolimus) or taxol; especially for rapamycin first results from the coronary arteries are very promising but no valid data exist on their use in the femorals yet. Radiation in stents primarily at the time of insertion did not show improved patency but were followed by an increased risk of thrombosis. Afterloading might be therefore a potential tool in the treatment of stent reobstruction.
Stent grafts
Stent grafts still play a limited role in the femoropopliteal field. ePTFE covered self expanding stent grafts like the Hemobahn device (Gore Inc., Flagstaff AZ) yielded promising results in a multicenter trial even in the femoropopliteal field and stimulated the hope to offer a percutaneous alternative especially for those patients presenting with long femoropopliteal occlusions. But there is also a risk of midterm or late rethrombosis.
Below the inguinal ligament, ePTFE covering should be used exclusively since in animal experiments, it has shown much less tendency to induce neointimal growth compared to Dacron covering. Other than in extraluminal bypasses, trans-covering growth of tissue have been demonstrated probably due to the long-segement wall contact between stent graft and the original vascular lumen (2,3).
A considerable disadvantage of stentgrafts however is the problem that frequently, important collaterals have to be covered by the full body of the stent graft. In case of reocclusion, these collaterals will not be anymore available which might cause aggravation of symptoms. This is particularly true for the popliteal artery, where development of compensating collaterals is limited. Therefore we favor to limit their use to the proximal two thirds of the superficial femoral artery especially in claudicants.
Results
Balloon angioplasty
In femoropopliteal endovascular interventions (taken from 8 publications reporting on 1469 procedures), weighted average technical success was 90%, complication rate was 4.3% and 3-year patency rate was 51% (1).
Long-term patency is positively influenced by a good outflow tract (2-3 lower limb arteries) , absence of diabetes and absence of residual stenosis. The latter would favor the use of stents, but unfortunately, there is no proof that stenting would improve overall patency.
Analyzing subgroups after femoral PTA, Huninck and Wong found different patencies for patients with stenotic and occlusive femoral lesions and good run-off (62% versus 48% after 5 years) as well with those and poor run-off (stenoses: 62% versus 43% after 5 years; occlusions: 43% versus 27% after 5 years) (4).
Stents
Follow-up results from stent implantation into the femoropopliteal arteries did not yield improved results compared to balloon angioplasty alone. In a meta-analysis, Muradin et al found a 3-year patency of 63 to 66% after 3 years for stents compared to 61% for PTA of stenoses. They also found, however, that in patients with more severe disease and more severe lesions, the patients achieved a higher benefit from stenting compared to those less diseased (5). Cejna and coworkers did not found a significant difference between patients with PTA alone and stenting in a randomized trial (6).
Endoluminal radiation therapy with afterloading or beta-irradiation as well as drug-eluding stents may change the overall-results in the future. Until now, stenting in the femoral arteries should be used as a bail-out therapy in case of PTA failure. Failure, however, needs to be defined strictly as severe dissection refractory to prolonged balloon dilatation, antegrade dissection with increasing obstruction or severe residual obstruction. Minor irregularities of the wall are not enough to justify stenting since treatment of restenosis is more difficult to treat compared to those after PTA alone.
Stent grafts
Few data exist on the usefulness of stent grafts in the femoropopliteal arteries. In a multicenter trial using the Hemobahn endoprosthesis, Lammer and co-workers achieved a primary patency of 90% after 6 and 79% after 12 months with 80 limbs treated. Secondary patency was 93% at 12 months after treatment (7).

These encouraging results are contrasted by many single center experiences where endografts showed a high rate of thrombosis which was frequently due to development of stenoses adjacent to the stent graft.

Complications

Nature and quality of complications in femoropopliteal arteries do not differ principally from the aortoiliac area. They include dissection, perforation and embolization of occluding material. With stents, risk of early thrombosis was a problem in the very beginning but turned out to become rare since combined treatment of modern antiplatelet drugs is administered.

In occlusions, risk of embolization of occluding material is the most potentially dramatic complication. Aspiration embolectomy in combination with selective thrombolysis is the treatment option of choice. Especially in claudicants, the risk needs therefore to be well balanced to the potential benefit.

Adjunctive drug regimen

In iliac and femoral PTA in claudicants, heparinization during the intervention and for 24 hours after - either by low-molecular weight heparin or conventional heparin - is mostly sufficient. A dosage of 100 mg of ASA daily is usually prescribed. After femoral stent placement or in cases with marked irregularities after PTA, heparinzation may be prologated up to 72 hours and an additional platelet inhbitor such as Clopidogrel are recommended for a period of 4 to 6 weeks.

References

1. The TASC Working Group Management of peripheral arterial disease (PAD). Transatlantic inter-society consensus (TASC). J Vasc Surg 31 (2000) S1-S296
2. Schurmann K, Vorwerk D, Uppenkamp R, Klosterhalfen B, Bucker A, Gunther RW. Iliac arteries: plain and heparin-coated Dacron-covered stent-grafts compared with noncovered metal stents--an exp erimental study. Radiology 203 (1997) 55-63
3.Cejna M, Virmani R, Jones R, Bergmeister H, Losert U, Xu Z, Yang P, Schoder M, Lammer J. Biocompatibility and performance of the Wallstent and several covered stents in a sheep iliac artery model. Vasc Interv Radiol. 12 (2001) 351-8.
4. Hunink M, Wong J, Donaldson M, Meyerovitz M, de Vries J, Harrington D Revascularization for femoropopliteal disease. A decision and cost-effectiveness analysis. JAMA 274 (1995) 165-171
5. Muradin G, Bosch J, Stijnen T, Huninck M Balloon dilation and stent implantation for treatment of femoropopliteal arterial disease: meta-analysis. Radiology 221 (2001) 137-145
6. Cejna M, Schoder M, Lammer J. [PTA vs. stent in femoro-popliteal obstruction] Radiologe. 39 (1999) 144-50
7. Lammer J, Dake M, Bleyn J, Katzen B, Cejna M, Piquet P, Becker G, Settlage R Peripheral arterial obstruction: prospective study of treatment with a transluminally placed self-expanding stent-graft. International trial study group. Radiology 217 (2000) 95-104

33.5

When to stop or stent

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Technically, there is no limitation for endovascular repair either for a stenosis either for a thrombosis. It is always possible to go through, to perform an angioplasty, to implant a stent or a stentgraft, to use other debulcking devices. The Task classification about lesions and indications for PTA is old and do not follow the new endovascular possibilities. However, the problem remains the indications, the benefit compared to the risk for the patient and the cost of the procedure. Patients with rest pain or gangrene have to be revascularized to salvage the limb. All local techniques performed to restore the flow can be done if the physicians know how to perform them. The cost of these procedures should be evaluated to the surgical repair or the amputation management. For patients with claudication, endovascular repair is in competition with the medical management; extra-cost, complications and added value have to be justified. Complications at long term are also challenging such as restenosis rate or stent fracture and interfere with the decision to continue or to stop the procedure. In our practice, it is more difficult to stop for a physician than to continue because it is considered as a failure. However to avoid complications should be the main objective when we have decide to try an endovascular repair, even if our technique failed revascularization. Finally, SFA endovascular treatment is always moving with new technologies, but research should not be considered as the current practice.

Special Session
Renal Artery Intervention

38.1

Who should undergo renal artery intervention?

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The most frequent form of hypertension is essential hypertension while renal function loss is mostly caused by chronic kidney disease. Renal artery stenosis can also cause these diseases, but more frequently is found as an incidental finding, probably not being the cause.

The clinical features suggestive of a renovascular cause are:

- Abrupt onset of hypertension in patients
- Absent family history of hypertension
- Resistance to drug therapy > 3 drugs
- Malignant hypertension
- Unexplained renal failure
- Deterioration of plasma crectine level after ACI-I or angiotension II receptor blocker therapy
- Asymmetric kidney length on imaging
- Unexplained aorta pulmonary oedema or congestive heart failure
- Abdominal bruits.

When the diagnosis renal artery stenosis is made, the stenosis can be caused by fibromuscular dysplasia (FMD) or atherosclerosis (ostial). The stenosis should be more than 50%. Pressurements have not yielded uequivocal results and cannot be relied on to assess the haemodynamic meaning.

The long majority of patients with FMD or arthritis can be treated succesfully with PTA, either curing these patients or diminishing the need for medical treatment.

Patients with renal artery stenosis based on atherosclerotic disease should be treated when:

- recurresnt flash pulmonary oedema is present
- severe hypertension is resistant to all medical therapy
- patients requiring ACE-I or AII-RB therapy develop significant uraemia
- patients develop dialysis dependent renal failure
- patients with acute occlusion of the renal artery.

Presently several studies are ongoing addressing the quenstion which patients with deteriorating renal function and renal artery stenosis should be treated. Fast deterioration and solitary kidney possibly are important predictors for a good clinical result after treatment, but results of these trials are awaited.

Special Session
Renal Artery Intervention

38.4

Medical Therapy of renal insufficiency pre/post intervention

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Acute renal failure occurs in up to 15% of patient undergoing intravascular intervention procedures wit 0.7% of patients requiring dialysis treatment, however sensitive test of kidney function identify mild and transient changes in almost all patients undergoing iodinated contrast examinations. The development of ARF results in prolonged hospitalization, considerably increased cost and occasionally death. In one study Contrast nephrotoxicity was reported to be the third most common cause of hospital acquired acute renal failure.

The level of preexisting renal function is the single biggest contributory factor to the development of acute renal failure post contrast. The development of dialysis requiring acute renal failure in patients with normal renal function has been estimated to be less than 1 in 7000. Other risk factors associated with the development of acute renal fauilure post contrast would include a history of diabetes, age greater than 75, periprocedural volume depletion, heart failure, concomitant use of nonsteroidal antinflammatory drugs or diuretics, intra-arterial injection and volume of contrast utilized.. Contrast-medium-induced nephropathy is usually transient with serum creatinine peaking at 3 days after administration and returning to baseline within 10 days. Thirteen to 50 % of patients requiring dialysis after exposure to contrast medium may depend on dialysis permanently.

The mechanism of ARf post contrast injection is poorly understood but is believed to include hameodynamic effects, direct contrast medium tubular cell toxicity, and and endogenous biochemical disturbance.

It is important to appreciate that not all renal failure post renal artery intervention is mediated by contrast nephrotoxicity. Renal arteries may also acutely occlude post procedure, but more commonly atherembolic material may dislodge from the target artery and embolise distally to the kidney producing deterioration in kidney function

It is important to estimate the risk of contrast induced nephrotoxicity and this can be done simply using validated prediction models. Factors incorporated in these models include systolic blood pressure, requirement for inotropic agents, use of intrarterial baloon pump, severity of heart failure, age >75, haematocrit, volume of contrast used and serum creatine, Patients with a high score using these models can have a risk of renal failure of 12% compared to 0.04% amongst those with the lowest score.

A wide variety of therapeutic strategies have been employed to prevent post contrast ARF including saline hydration, N-acetylcysteine, aminophyline, sodium bicarbonate and endothelin antagonists. IV fluid hydration has shown the most consistent beneficial effect. It is not clear what is the best regimen for hydration. It is apparent however that iv hydration is superior to po fluids. It is also apparent the 0.9% saline result in less of a rise in serum creatinine when compared to 0.45% saline. There is also some suggestion that the use of sodium bicarbonate may have beneficial effect in reducing nephrotoxicity although this is less certain.

N-acetylcysteine has the potential to reduce the nephrotoxicity of contrast through antioxidant and vasodialtory effects. In an initial trial serum creatinine rose by 44umol/l in 2% of patients who received N-acetylcysteine compared to 21% who received placebo. Since then a number of other trials have addressed this question which have shown varying results. A recent metaanalysis did however confirm a benefit. There is also some debate about the appropriate dose. It is clear however that N-acetylcystein is not toxic. It is therefore our policy to administer N-acetylcysteine in a dose of 600mg bd for 24 hours before and after any contrast procedure in patients with risk factors for contrast nephrotoxicity

Not all renal failure post renal artery intervention is mediated by contrast nephrotoxicity. The syndrome of cholesterol embolisastion syndrome needs to be also considered in all cases of acute renal failure post contrast injection, even in circumstances when the renal arteries have not been specifically canulated. Contrast nephrotoxicity will most commonly recover while cholesterol embolisastion syndrome is much less likely to recover completely and may go on to end stage renal failure. The reported incidence of cholesterol atheromembolization as an acute complication of renal artery angioplasty and stenting is low one to 2 percent. However the true incidence is likely to be much higher, because reported cases are biopsy proven and associated with systemic manifestations.

Renal dysfunction after renal artery procedures may be as a result of a number of different mechanisms. Renal arteries may also acutely occlude post procedure, but more commonly atherembolic material may dislodge from the target artery and embolise distally to the kidney producing deterioration in kidney function. Recently some evidence has emerged suggesting that distal protection devices may prevent distal embolisastion which may preserve renal function post renal intervention procedures. In studies by Holden et al 47 renal arteries were treated in 37 patients. Using the Angioguard system to protect distal renal arteries. These authors noted a 95% improvement or stabilization in renal function following renal angioplasty and stent placement. The distal protection basket contained macroscopic or microscopic contents in 30 of 46 cases (65%). This material included fresh thrombus, chronic thrombus and atheroma. The authors state that these results are superior to either what is reported in the literature or there own historical series. There is no doubt that development of renal protection devices is early in the evolution of this technology and will improve with time.

The ideal renal stent -protection system is not yet available. Future strategies to reduce renal damage will likely include reduction in protection device profile, modification of the angioplasty stent design, and use of short guide wires.

The current literature pertaining to contrast nephrotoxicity, cholesterol embolisastion and renal protection peri renal interventional procedures will be discussed in detail

Special Session
Thoracic Stent Grafts

39.1

Preprocedure imaging & patient selection for TAA

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Choice of imaging modality

CT: If patients are being considered for endovascular repair of the thoracic aorta, the main method of preprocedural imaging is CT. Although the newest multi slice CT scanners provide the optimal imaging quality of the thoracic aorta, adequate information for patient and device selection can still be achieved by older types of scanners such as single slice helical CT scanners. Assessment should involve scrutiny of both the axial images and the images obtained after multiplanar reconstruction. In general, the axial images are the most useful images for assessment of aortic diameters and the multiplanar reconstructions are used for assessment of aortic length.

MRI/MRA: Although CT is the main imaging method used by most interventionalists for assessment prior to TEVAR, many operators use MRI and MR angiography as their preferred imaging modality. Particular advantages of MR include the improved visualisation of the origin and course of dissection flaps in patients with aortic

dissection, the lack of ionizing radiation and the absence of necessity for iodinated contrast medium. In many centres, the issue of which modality to use depends on local availability of equipment and radiological expertise.

Other imaging methods: Conventional angiography and transoesophageal echography may be required for assessment in selected patients. In the early years of thoracic endografting, conventional angiography was performed in most patients and the images were studied in combination with the axial CT slices. As CT technology has advanced, the multiplanar reconstructions now produce images that rival or in some cases exceed the quality of images achieved by angiography. As a result the information regarding lesion length and aortic arch anatomy, previously provided by angiography can now be achieved by multiplanar CT. Angiography is used as a problem solver if the findings from CT are inconclusive Conventional angiography may be useful in two situations: a. to provide additional information in a few patients with challenging anatomy when the CT information, particularly with respect to the aortic arch anatomy is suboptimal, and b. to image the access vessels if they are considered to be borderline for passage of the stent-graft delivery system on the CT images.

Duplex ultrasound of the carotid arteries should be performed if the aortic lesion is close to the aortic arch and it is likely that it will be necessary to cover the left subclavian artery. Duplex ultrasound may also be used instead of angiography to image the access arteries - i.e. the iliac and femoral arteries.

Transesophageal echocardiography is not used routinely in our institution for assessment. Some operators find this technique useful in patients with dissection, particularly with regard to the location of the main communication between the true and false lumens.

Aims of preprocedural imaging:

The aims of pre procedural imaging can be divided into two sections:

(i) The assessment of the aorta for the landing zones, the length of aorta to be treated and any tortuosity of the aorta which might give rise to problems advancing the device to the implantation site.

(ii) The adequacy of the access vessels, mainly the iliac arteries and common femoral arteries.

Aorta

It is necessary to have regions of normal aorta above and below the lesion to be treated to land the stent graft so that a seal can be achieved between the stent graft and the normal aortic wall. These areas are known as the proximal and distal landing zones. The landing zones should be of adequate length and diameter to be considered suitable for stent-grafting.

Landing zone length: The length of these landing zones should be at least 15mm, although more than 20mm is optimal. If either the proximal or distal landing zone is considered to be too short, it is possible to increase the length of the landing zones.

(a) Proximal landing zone: If the lesion is close to the left subclavian artery, it is possible to increase the length of the proximal landing zone by placing the proximal end of the stent graft across the origin of the left subclavian artery. Although there is a potential for left arm ischaemia as a result of this technique, in practice, the risk is negligible unless there is disease of the left vertebral artery. If coverage of the left subclavian artery is intended, preprocedural imaging of the carotid and vertical arteries by duplex ultrasound should be undertaken to ensure that the left vertebral artery is not an essential component of the patient's cerebral circulation. Similarly, if the patient has a LIMA graft, coverage of the left subclavian artery is contraindicated. In some patients, even if the left subclavian artery is covered, the distance between the origin of the left common carotid artery and the aortic lesion to be treated is still less that 20mm. In this situation, the proximal landing zone can be increased by performing elective left common carotid artery bypass. In the unusual situation of there still being an inadequate proximal landing zone despite bypass of the left common carotid artery, consideration can be given to bypass of both the left common carotid artery and innominate artery onto the upper ascending aorta to create a proximal landing zone.

(b) The distal landing zone: Similar to the above account, if there is less than 15mm between the lowest extent of the aortic lesion and the celiac artery, the distal landing zone length can be increased by performing elective bypass of the celiac artery and also the superior mesenteric artery if required prior to stenting. At the current time, it is not considered to be safe practice to cover either the celiac or superior mesenteric artery with the stent graft without elective bypass of these vessels.

Landing zone diameter: When selecting a device, it is necessary to oversize the device in relation to the landing zone diameter. In patients with aneurysms, devices should be oversized by 15-20%. In patients with dissection, the devices should be oversized by up to 15% in relation to the diameter of the normal aorta (usually taken as the diameter of the aortic arch). In view of this, the size limits of the landing zones are dictated by the available sizes of the stent grafts. The maximum and minimum diameters of the available stent grafts are 46mm and 24mm. Therefore for aneurysms, the upper and lower limits of landing zone diameter are 20mm and 40mm diameter. For dissections, the upper limit diameter of the landing zone is slightly larger at 42-44mm while the lower limit is 22mm diameter.

Lesion length: In addition to assessing images for the presence of an adequate proximal and distal landing zone, the images should be assessed for the length of aorta to be covered by stent grafts. This will vary from a relatively short lesion such as in cases of traumatic transection of the proximal descending aorta to long lesions which may involve the whole of the thoracic aorta and require coverage by stent-grafts extending from the left subclavian artery through the diaphragm to the level of the celiac artery.

Length measurements are generally obtained from the multiplanar reconstructions or from conventional angiographic images using a calibrated pigtail catheter. When estimating the length of the aorta to be treated, the radiologist should take into account the tortuosity of the aorta. If it is necessary to place more than one device because of the long length of aorta to be treated, the operator should also take into account the overlap required between adjacent devices, which is usually around 5cm of each overlapping device.

Access arteries

The iliac arteries and common femoral arteries should be assessed for their diameter, tortuosity and degree of calcification. For this reason, any preprocedural CT scan should include not only the thoracic aorta to be treated but also the abdominal aorta and the iliac arteries. In the absence of adequate CT images of the iliac arteries, these vessels can also be assessed by a separate duplex ultrasound.

Vessel diameter: Delivery systems are by necessity relatively large and therefore require iliac arteries and common femoral arteries of adequate dimension to accept passage of the delivery systems. The size of the delivery system of each manufacturer's device tends to vary with the diameter of the stent graft. For example, the delivery system for the Valiant stent graft (Medtronic, Santa Rosa, CA) for the 24mm device is 22 French, and increases to 25 French for the 46mm device. This variation with delivery system size also occurs with other devices. The size of some manufacturers delivery systems may be apparently smaller than the delivery system of other manufacturers e.g Gore TAG endoprosthesis. However these devices may need to be placed through a sheath. In the case of the Gore endoprosthesis, the rated sheath size is the internal diameter of the sheath rather than the external diameter. For example, the 40mm Gore TAG stent-graft (W Gore, Flagstaff AZ) requires a 24 French sheath. However, this is in fact an inner sheath diameter dimension and corresponds to a 27 French outer sheath diameter.

If the iliac and/or the common femoral arteries are too narrow to accept the passage of the stent-graft delivery systems, the patient can still be treated by TEVAR if the device is passed directly into the common iliac arteries or in the unlikely cases that these vessels are unsuitable (too narrow or aneurysmal), directly into the aorta. This

involves placing a conduit of vascular graft material directly onto the common iliac artery or aorta through a lower abdominal incision. The device is advanced into the iliac artery/aorta through a small incision in the side of the conduit. Although this is an effective method to access the vascular system with the stent-graft, the morbidity of the procedure may be increased by the need for an abdominal incision.

Tortuosity and calcification: An estimate of tortuosity can be obtained using the CT reconstructions. Whether or not tortuosity is a limiting factor to passage of a stent graft depends to a large extent on the presence of calcification. If a vessel is very tortuous but not calcified, it may be expected to straighten by a very stiff guidewire. On the other hand, if there is substantial mural calcification, it is unlikely that the tortuous vessel can be straightened out by a stiff guidewire. Therefore, in cases of suspected vessel tortuosity, an elective angiogram of the iliac arteries should be performed. During this angiogram, a very stiff guidewire such as a Lundquist guidewire (William Cook Europe, Bjaeverskov, Denmark) is passed up the iliac artery to see if the vessel can be straightened out. If the vessel can be straightened out by the guidewire, the patient can be scheduled for the stent graft procedure. If the vessel cannot be straightened out, consideration should be given to inserting the stent graft directly into the common iliac artery or abdominal aorta via a conduit as described in the previous section.

Patient selection

Although factors such as the age of the patient and cardiorespiratory morbidity are major factors in assessing whether patients should be treated by conventional surgery, these factors are less important an issue when decided whether or not to proceed with endovascular therapy. Although most procedures are performed under general anaesthesia, if patient comorbidity precludes general anaesthesia, stent grafts can as easily be inserted under regional anaesthesia or local anaesthesia. In our practice, few patients are excluded from endovascular therapy on the basis of their age or comorbidity

Device selection

There are several devices now available on the market for use in the thoracic aorta. These include the Valiant stent graft (Medtronic), the Gore TAG endograft (W.Gore), the Zenith TX2 (William Cook) and the Relay device (Bolton Medical, Sunrise, FL). All of these devices are relatively new and are undergoing evaluation. At the current time it seems that all devices are suitable for use for most pathologies in the thoracic aorta. There is a slight variation in the sizes of devices available from each manufacturer and also in the delivery system size. These latter characteristics may influence the choice of device for selected patients. For most operators at the current time, in the absence of any hard data, the selection of a particular device is made using individual operator preference.

39.2

Tips for a successful procedure

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Aortic diseases are an important cause of cardiovascular mortality in Occidental countries, and as the population is aging, the incidence is on the rise. Because of the risks and complications associated with aortic surgery, stent-grafting of the aorta is emerging as a new technique in aneurysms of various etiologies. A number of prospective studies using a variety of devices have now been published in the literature, but so far no randomized studies are available. Actually, short-term morbidity and mortality rates, of large series, compare favorably with those from surgery, and stent graft placement is proving to be a safe, minimally invasive, and effective treatment for thoracic aortic diseases.

The success of the endovascular management of thoracic aortic pathology relies in multiple aspects, involving all the steps of the procedure; from clinical indication, preinterventional planning, anatomic suitability, stent-graft placement, to technical aspects regarding the devices.

The enthusiastic interest in endo-grafts has lead to the development of a wide variety of devices. The technical challenges of these stent-grafts include the need 1 / to be of sufficiently small profile to be delivered by small vessels such as femoral arteries 2 / be flexible to cross tortuous vessels, 3 / to accommodate different lengths and diameters, and to anchor the devices without migration inside the aorta.

The precise sizing of the device is certainly one of the most critical points of these procedures. Multidetector computed tomography (MDCT) with 3D reconstructions is probably the best anatomic evaluation method for the aorta, as well as the iliac and femoral arteries (diameter, calcifications, and tortuosity). Magnetic resonance (MR) imaging is also a good alternative, especially when slow flow conditions are suspected (dissection, endoleaks) or in patients with renal failure. However, due to the MR lower spatial definition, its incapacity to show calcifications, its difficult access, and its frequent incompatibility with life support and monitoring equipment, MDCT is preferred. Though angiography using a calibrated catheter is less useful than MDCT, it can help to estimate the lesion length and aortic angulations in some complex cases.

Oversizing by 10 to 15% the diameter measured, is needed to provide good apposition to the aortic wall. As for length, at least 1.5 cm of normal aorta at each extremity of the graft is required to prevent migration. Whenever possible, greater proximal and distal coverage should be performed.

As a whole, when the clinical and anatomic indications are met, the following points must be verified before the stent-graft placement:

The least tortuous and larger iliac artery must be chosen for vascular access.

The aorta at each extremity of the aneurysm must be normal, without thrombus material, for more than 1.5 cm.

The angulations of the aorta and the predictable position of the stent-graft after deployment must be well estimated.

If intentional exclusion of the ostium of the LSA is necessary, complete imaging of the vertebral arteries and collaterals must be done before implantation to avoid major neurological complications. A 5-F 30-cm-long sheath with a distal radio opaque marker can be placed via the left brachial artery to single out the ostium of the left subclavian artery and to allow angiography during the procedure.

If available, transesophageal echocardiography, is very useful to visualize adequately the lesion, which can be difficult by angiography alone. Furthermore, TEE provides useful information after stent-graft insertion, such as stent-graft kinking, perigraft leakage, and heart status.

Proximal or distal stent-graft extensions should be available in the case of suboptimal stent-graft deployment.

Specific anatomical conditions, can lead to specific technical situations, as when iliac or aortic tortuousities may impede stent graft insertion, even if the stent graft is positioned over a very stiff guidewire. In such cases, to facilitate the progression of the stent graft, the"pull & through technique" can be used.

Specific clinical indications also carry technical considerations, as during stent-graft management of Type B dissections. This modality of treatment aims to exclude antegrade blood flow in the false lumen, therefore decreasing pressure and allowing thrombosis of the false channel in order to restore blood flow in the true lumen and its side branches. It should be emphasized that endovascular techniques used to treat aortic dissections are more complex compared with those employed in aneurysmal disease. In acute aortic dissection, the large discrepancy between true and false lumen diameters makes stent graft implantation in a relatively disease-free aorta difficult. In chronic dissections, thickening of the intimal layer may impede adequate stent graft expansion.

Other indications include, intramural haematomas, penetrating aortic ulcers, and aortic traumatic ruptures.

Traumatic ruptures usually involve the aortic isthmus in proximity to

the LSA. When a graft is placed just distal to the LSA origin, it is usually in a relatively straight position. Therefore, the proximal part of the stent may protrude into the aortic lumen on the inner side of the aortic arch and cause type I endoleak, stent graft collapse or migration. Complete apposition of the stent graft on the wall is easier to achieve if the graft presents a proximal bare section placed over the LSA origin. However, some interventional radiologists are reluctant to use grafts with a proximal bare stent or with built-in hooks because of concern that they may erode the friable traumatized aortic wall. Experience shows that this potential risk is limited if the proximal graft is placed in the healthy portion of the aorta.

These emerging techniques, unfortunately are not free of complications. Different problems can overcome during the procedure and in the follow up. In this paper, technical aspects and results of endovascular TAA repairs will be reviewed. We will also examine the advantages and limitations of stent graft treatment.

References

1.Rousseau H, Bolduc JP, Dambrin C, Marcheix B, Canevet G, Otal P. Stent-graft repair of thoracic aortic aneurysms.Tech Vasc Interv Radiol. 2005 Mar;8(1):61-72.

2.Chung JW, Elkins C, Sakai T et al. True-lumen collapse in aortic dissection: part II. Evaluation of treatment methods in phantoms with pulsatile flow. Radiology. 2000 214:99-106

3.Malina M, Sonesson B, Ivancev K. Endografting of thoracic aortic aneurysms and dissections. J Cardiovasc Surg (Torino). 2005 Aug;46(4):333-48.

39.3

Results, morbidity and mortality

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Introduction

A lower incidence of thoracic aortic aneurysms (TAA) in comparison with abdominal aortic aneurysms has resulted in slower development and less wide-spread experience with endovascular procedures to treat TAA. Stent-graft repair of thoracic aortic disease is an appealing alternative to open surgery, because it avoids thoracotomy, aortic cross-clamping, and left-sided heart bypass. The descending thoracic aorta is suitable for this minimally invasive approach because, it usually enables good adaptation of endografts although it may be elongated and tortuous in patients with aneurysm.[1,2]. Aneurysmal disease of the aortic arch and the thoraco-abdominal aortic segment are far more complex to manage by endovascular technique. However, hybrid procedure and branched stent-grafts have made these conditions also accessible for endovascular repair.[3,4] In addition tot degenerative aneurysms, stent-grafts have been used in the management of false and infected aneurysms, chronic and acute dissections and intramural haematomas. The application rate of stent-graft repair in one series on various pathologic conditions of the descending thoracic aorta was as high as 57%.[5] Unlike the situation in endovascular treatment of abdominal aortic aneurysms, which has been subjected to randomized controlled trial, there seems to be consensus that it would be inappropriate for similar trials to be conducted in respect of thoracic disease. A high prevalence of co-morbid factors and a large proportion of patients classified with an American Society of Anaesthesiology (ASA) risk class of 3 and greater implies that open repair is not a reasonable treatment option for a large proportion of patients with thoracic aortic disease.

In this overview we report the experience of the EUROSTAR multicenter Thoracic Registry, which is involved with data recording and evaluation of endovascular repair of thoracic aortic aneurysms, dissections and other conditions. The objective was to assess early and follow-up results in a large patient series to obtain insight about endovascular repair of thoracic aortic disease in Europe.

Patients and Methods

During a five-year period from January 2000 tot July 2005 a total of 581 patients were recruited onto the EUROSTAR Thoracic Registry, by a total of 54 different European institutions. The mean age of the patients was 63.4 years (range 13 to 91 years). There were 447 (77%) males and 134 (23%) females. Fourty-nine percent of the patients had an ASA risk score of 3 or greater, signifying that they were considered to be unfit for open surgical repair. Cardiac and pulmonary diseases were the most frequent. Fifty-seven percent of the patients were current smokers and 69% were hypertensive.

The patients were categorized into 4 groups: (1) degenerative TAA (292 patients, 50%), (2) aortic dissection (188 patients, 32%), (3) traumatic rupture of the thoracic aorta (63 patients, 11%), and (4) false anastomotic aneurysms (26 patients, 4%). When aneurysm was the presenting feature, 227 (70%) were found to involve the proximal third of the descending thoracic aorta, 173 (45%) the middle third and 115 (30%) the distal third. The arch was involved in 61 (16%) of the patients and the ascending aorta in 3 (1%). The mean maximum diameter of the aneurysm was 62.1 mm (SD $\pm$ 16, range 30 - 120 mm). Of the patients classified as aortic dissection 11 (6%) had type A extent, 144 (77%) a type B and 37 (20%) had penetrating ulcers. The entrance tear was within the proximal third of the descending aorta in 138 (73%), the mid-descending aorta in 50 (27%), the lower third of the descending aorta in 25 (13%) and in the arch in 22 (12%).

Emergency procedures were defined arbitrarily as those that were undertaken within 7 days of first presentation. The following commercially available devices were used: Talent (Medtronic/AVE, 393 patients), Excluder (WL Gore & Associates, 124 patients), Zenith (William Cook Europe, 28 patients), and others (36 patients). A single stent-graft was deployed in 301 (52%) of cases, two were deployed in 167 (29%) and three or more in 110 (19%). General anaesthesia was employed in 546 (94%) of the patients. The remainder was treated under either regional anaesthesia or local infiltration anaesthetics. Controlled hypotension was induced in 246 (42%) and cardiac cessation in 29 (5%). The left subclavian artery was over-stented in 146 (25%) of the patients and some form of extra-anatomic bypass was undertaken in 57 (10%) of patients. "Critical" (T8-12) intercostal arteries were covered in at least 25% of patients (data reporting for this field was incomplete).

Patients were followed up at 1, 6, and 12 months and annually thereafter. Satisfactory findings at CT were defined by absence of endoleak, stent-graft migration, kinking, stenosis, thrombosis and aneurysm expansion. In case of dissection additional criteria included complete thrombosis of the false lumen and, in extensive dissection, thrombosis of the proximal segment of the dissection (partial thrombosis). Outcome reporting adhered to the guidelines from the Ad Hoc Committee for Standardized Reporting Practices in Vascular Surgery of the Society for Vascular Surgery / American Association for Vascular Surgery.[6]

Results

Early outcome

Complete technical success, judged from completion angiography, was achieved in 520 (90%) of patients. One-hundred and ninety-nine patients did not require intensive care unit monitoring postoperatively. The 382 patients that were admitted in an intensive care unit spent a mean of 114 hours (range 3 - 1800 hours) in this unit. The hospital admission had a mean duration of 11 days (range 0 - 100). Arterial complications were encountered in 61 (10%) patients. These included rupture of the aorta, thrombo-embolic complications, and ischemia related to exclusion of aortic side-branches. Device-related complications were reported in 51 (9%) of patients. The most common were failure to advance the delivery system and migration of the stent-graft. There was failure to complete the procedure on five occasions. In one case conversion to open repair was carried

out, and in another two the procedure was abandoned due device related complications (inability to deploy device).
The 30-day mortality was 12%, 22% in patients treated for acute symptoms and 7% in patients receiving elective treatment. Of the category with degenerative aneurysms 13% died within the first month and in patients with dissection 10%.
An endoleak was noted on the completion angiography in 54 (9%) of the patients. There were 40 (7%) type 1 endoleaks and 14 (2%) type 2. Another 10 were not characterized. The incidence of type 2 was much lower than that observed following endovascular repair of abdominal aortic aneurysms, but type I endoleaks were also less frequent.
Neurological complications occurred in a total of 54 (9%) of patients. Of these 33 were serious or permanent accounting for 6% of the whole of the treated population. Intracranial strokes occurred just as frequently as spinal cord injury with an incidence of 18 (3%) compared to 15 (2.5%). This finding highlights the risks associated with the manipulation of wires, catheters and introducer sheaths within the arch, which have potential to off-set or even cancel out the benefit of a reduced risk of paraplegia in comparison to open surgery.
An analysis of the risk factors for paraplegia in 13 patients demonstrated the following. The most important result from a clinical prospective is a highly significant increase in the risk of paraplegia, when three or more stent-grafts are used. This applied in nearly 20% of patients and presumably correlates with the length of aorta covered, i.e. the greater length the higher the risk. The risk of paraplegia is higher with endovascular repair of degenerative thoracic aneurysms (4%) compared with the treatment of dissections (1%). The risk of mortality in patients with paraplegia is very high, two-third of the patients died, most frequently within 30 days of operation.
Results at follow-up
Currently follow-up extends to a maximum of 5 years. However, only a few patients were followed up for this period. A total of 108 patients have died, 67 within 30 days of the operation (62%) and 41 after this period. Cumulative 4-year survival in patients with degenerative aneurysm is 66% and with dissection 80%. Overall fourteen have been converted to open repair, three have suffered late rupture of the aneurysm and 8 patients have been lost to follow-up.
The cumulative survival at three years was 73%, the freedom-from-endoleak rate 87%, and the freedom-from-secondary-intervention rate was 83%. These latter outcomes compare favorably with the results observed after abdominal aortic aneurysm repair. The freedom-from-rupture rate was 98.8%, which also is quite low in comparison with abdominal endovascular repair.

Discussion and conclusions

A variety of thoracic aortic pathologies can be treated by endovascular stent-grafting. Frequently endovascular repair is the only feasible option, for instance in patients with complex pathologies, such as aorto-enteric fistula and mycotic aneurysms who also have severe comorbidity. These categories were not included in the current EUROSTAR-analysis. Degenerative aneurysm and dissections establish the most frequent indications for thoracic aortic stent-graft repair. Complete technical success can be achieved in over 90% of the patients. The total incidence of endoleak at the completion of the procedure is lower in thoracic than in abdominal aortic stent-grafting (in thoracic stent-grafting only 9%). The incidence of paraplegia was only 2.5%, which compares favorably with available data on open repair of thoracic aortic pathologies. Deployment of three or more endografts within the aorta is a highly significant risk factor for paraplegia. Late complications are relatively infrequent and a three-year survival of 73% was satisfactory. The durability of endovascular repair of thoracic aortic abnormalities beyond five years remains to be established. However, within this period late device-related complications have been rare. In contrary to expectations migration of stent-grafts was observed in the present series and only one patient to date.
The long-term efficacy of endovascular treatment of TAAs and dissections remains to be demonstrated and lifelong surveillance remains necessary.

References

1. Leurs L, Bell R, Degrieck Y, Thomas S, Hobo R, Lundbom, on behalf of the EUROSTAR and the UK Thoracic Endograft Registry collaborators. Endovascular treatment of thoracic aortic diseases: Combined experience from the EUROSTAR and United Kingdom Thoracic Endograft registries. J Vasc Surg 2004;40:670-80.
2. Katzen BT, Dake, MD, MacLean AA, Wang DS. Endovascular Repair of Abdominal and Thoracic Aortic Aneurysms. Circulation 2005;112:1663-1675.
3. Anderson JL, Adam DJ, Berce M, Hartley DE. Repair of thoracoabdominal aortic aneurysms with fenestrated and branched endovascular stent grafts. J Vasc Surg 2005;42:600-7
4. Greenberg RK, Haddad F, Svenson L, O'Neill S, Walker E, Lyden SP, et al. Hybrid approaches tp thoracic aortic aneurysms. The role of endovascular elephant trunk completion. Circulation 2005;112:2619-26
5. Cambria RP, Brewster DC, Lauterbach R, Kaufman JL, Geller S, Fan C-M, et al. Evolving experience with thoracic aortic stent-graft repair. J Vasc Surg 2002;35:1129-36.
6. Chaikof EL, Blankensteijn, JD, Harris PL, White GH, Zarins CK, Bernhard VM, et al. Reporting standards for endovascular aortic aneurysm repair. J Vasc Surg 2002;35:1048-60.

Special Session Intermittent Claudication 3

40.3

Emerging Technologies

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Purpose

Despite recent advances in stent technology, neointimal hyperplasia still represents the main obstacle of peripheral recanalization procedures in the infrainguinal vascular territory. Each year an overwhelming number of experimental and clinical studies aim at finding new strategies for the prophylaxis of restenosis after balloon angioplasty and stent placement. The purpose of this lecture is to provide an overview on emerging treatment modalities that have the potential to revolutionize endovascular treatment of peripheral arterial disease.

Systemic Therapy

Systemic antirestenotic therapy basically adresses the multiple cellular and molecular events which were identified by previous experimental work as potential factors in the development of restenosis. Although the majority of clinical studies in this field concentrate on the coronary vasculature, the pathophysiology and procedures have enough similarities to be translated to restenosis in patients with chronic limb ischemia. Among the substances explored for systemic antirestenosis therapy were antiplatelet and anticoagulant drugs, statins, calcium channel blockers, ACE inhibitors, vitamins, antiproliferative drugs and others. Many early trials on systemic therapy with statins, oral ACE inhibitors or vitamins have generated controversial reports, ranging from beneficial outcome to even worsening of restenosis development. Tranilast is an antiproliferative substance that has been evaluated more extensively. In the PRESTO trial, the effect of Tranilast was tested in patients after percutaneous coronary intervention. No differences in major adverse cardiovascular events and angiographic endpoints were found in patients treated with the study drug versus placebo (1). Better results were achieved with Cilostazol, a phosphodiesterase 3-inhibitor with antiproliferative properties, after coronary stent implantation. Patients treated with the drug showed a larger minimal lumen diameter at 6 months when compared to the placebo group (2). A substance with a proven

potential to counter restenosis is rapamycin, which has been mainly used for drug-coating on stents. Recently, in coronary trials, systemic application of rapamycin was studied as an adjunct to angioplasty and stenting. The Oral Sirolimus to Inhibit Recurrent In-stent Stenosis (OSIRIS) and Oral Rapamycin to Prevent Restenosis in Patients Undergoing Coronary Stent Therapy (ORAR) showed beneficial effects in restenotic and de novo lesions, respectively (3, 4). The ORBIT trial assessed the potential of oral Rapamycin to achieve low rates of repeat target lesion revascularization (TLR) in de novo native coronary artery lesions, and showed equally low rates of restenosis for a lower and higher doses of oral rapamycin (5). Dose levels and duration of treatment did not influence restenosis outcome; and an early loading dose was considered as critical, thus supporting results from experimental research (6). Further studies are now needed to find the optimal drug and shed light on parameters like timing of initiation of therapy, dosage of the drug, and duration of treatment, which might all influence the ability to counter restenosis.

Radiation Therapy

Brachytherapy

In vascular brachytherapy ionizing radiation is brought to the vessel by temporary placement of a beta- (P-32, Y-90, Sr-90) or gamma-emitter (Ir-192) through a delivery catheter. On the cellular level, radiation has shown to inhibit restenosis by killing or inactivation of target cells, suppression of extracellular matrix synthesis, and inhibition of negative remodeling (7). In most clinical trials of peripheral artery brachytherapy Iridium-192 was used, primarily because gamma particles have a greater penetrating capability and can pass through the larger vessels of the peripheral arterial system with adequate levels of radioactivity. Despite a considerable range of studies supporting the concept of brachytherapy for restenosis reduction after femoropopliteal angioplasty (8, 9), there is still no widespread acceptance of this technology for routine clinical use. Major drawbacks are the need for large delivery systems (8-9-F) and the fact that, due to special shielding requirements, the patient has to be transported to a secondary location with the delivery catheter in position, which poses the risk of thrombosis at the treatment site.

Radioactive Stents

The IRIS trials assessed safety and feasibility of ^{32}P radioactive beta-emitting stents for patients with symptomatic de novo or restenotic native coronary lesions. Stents with low-to-intermediate activity proved to be save with a high short-term success rate, but, at 6-month coronary angiography revealed an intralesion restenosis of up to 40%, both within the stent and at the edges (10). A succeeding study (Milan Dose-Response Study) characterized safety and efficacy of ^{32}P radioactive beta-emitting stents with higher activities. At 6-month neointimal hyperplasia was reduced in a dose-related manner, but, in all different dose groups intralesion restenosis was high due to late lumen loss at the stent edges, which was referred to as „candy wrapper effect" (11). A further increase of radioactivity combined with less injury outside the stent has not shown to prevent edge restenosis. There are other radioisotopes with more promising physical properties like Re-188 which might solve the problem (12), however, this notion has yet to be confirmed by clincial studies.

Stent-based Technology

Biodegradable Stents

Stents - that successfully avert vessel recoil after angioplasty - often aggravate tissue proliferation and consecutive restenosis due to the constantly exerted radial force. In this situation a bioabsorbable stent might be an alternative. Theoretically such a device could act as a temporary scaffolding for the artery, but avoid the negative long-term effects (13). Absorbable stents made from polymers were already employed in the coronary circulation, but due to a rather low radial force their ability to prevent recoil was inferior when compared to metal stents (14). Biodegradable stents made of a magnesium alloy provide a radial force comparable to conventional metal stents, and the slow degradation of the magnesium alloy appears not to elicit a significant inflammatory reaction. First clinical results with absorbable metal stents were reported for use in the peripheral vasculature (15): Twenty patients with Rutherford class 4 and 5 disease due to lesions in infrapopliteal arteries were treated with this type of stent. Preliminary data after 3 months showed a primary clinical patency of 89.5%. No major amputation was necessary, yielding a limb salvage rate of 100%. Although the long-term outcome of the absorbable metal stent has yet to be demonstrated by controlled and randomized trials, this first clinical experience portrays a promising performance.

Passive Stent Coatings

The number and/or thickness of struts and differences in the angular burden of the stent cross section have been identified as factors influencing neointima development and restenosis (16). However, when taking into account that sufficient scaffolding is critical to adress recoil and negative remodelling, it becomes clear that there are limitations of variation in stent design. Surface characteristics of stents, on the other hand, might directly influence biocompatibility and thus restenosis rates (17). Passive, i.e. inert coatings, like chromium, titanium, platinum and gold were thought to prevent corrosion, enhance biocompatibility and improve long-term outcome, but many of these have failed clinically (18). Early experimental studies with polymer coatings on stents have shown their potential to induce an inflammatory response and limit long term patency (19). Carbon coating on coronary stents has generated low restenosis rates (20), and in a pilot trial by Rand et al. carbofilm-coated stents recently showed a positive patency trend when used for direct treatment of high-grade lesions in the infrapopliteal arteries (21). An international randomized multicenter trial which is currently ongoing will have to show if there is a definite role for these devices in peripheral arterial interventions.

Active Stent Coatings

Active stent coatings (e.g. radioisotopes, antiproliferative drugs or gene-carrying vectors) are supposed to directly address the problem of smooth muscle cell proliferation with consecutive restenosis. The advantage of drug-eluting stents is that they bring high concentrations of the substance to the target tissue; the desired effect is increased while adverse events are avoided. Stent-based local delivery of rapamycin and paclitaxel has demonstrated to reduce in-stent neointimal hyperplasia in clinical studies with treatment of de-novo coronary and in-stent restenosis (22, 23). While the first part of the SIROCCO trial showed a trend to reduce binary restenosis in the superficial femoral artery with rapamycin eluting nitinol stents (24), the results of the extension trial in a larger number of patients (SIROCCO II), did not show statistical significance in any of the preselected endpoints and variables (25).

Catheter-Based Technology

Sonotherapy

In vitro studies have indicated that low-frequency, noncavitational ultrasound energy may have an impact on smooth muscle cell migration, -adhesion and -proliferation (26). Following promising results in a first clinical trial with intracoronary sonotherapy, a randomized study, the EUROpean Sonotherapy Prevention of Arterial Hyperplasia (EURO-SPAH) was initiated. The EURO-SPAH Trial was a multicenter, double blind, randomized study investigating the efficacy of sonotherapy to reduce in-stent late lumen loss. Sonotherapy was not able to prevent stent loss, and the study merely characterized the feasibility and safety of this trechnique (27).

Photodynamic Therapy

Photodynamic therapy refers to the interaction of a photosensitizing drug, light, and tissue oxygen (28). Photosensitizing agents, many of which are porphyrins or chemicals of similar structure, can be given either locally or systemically. When activated by light (e.g. red light from a laser), the drug generates a highly reactive form of oxygen (singlet oxygen) that triggers apoptosis in vascular smooth muscle cells, and reduces the number of proliferating cells in the vessel wall. A small clinical study assessed the ability of photodynamic therapy to prevent restenosis in patients who had previously undergone

angioplasty for superficial femoral artery disease, and who had experienced restenosis within 6 months of the procedure. After a mean follow-up period of 48 months, only one of eight lesions treated developed symptomatic restenosis (29). More recently the potential of photodynamic therapy was evaluated for the prevention of restenosis after coronary-stent placement. At 18 month follow-up no adverse events were observed, and no in-stent restenosis was detected. It was concluded that photodynamic therapy is safe and may be a valuable tool to inhibit in-stent restenosis (30). At this point, however, larger randomized trials are lacking and the value of the procedure to counter restenosis in the femoropopliteal level remains unclear.

Cryoplasty

Cryoplasty is a combination of balloon dilatation with simultaneous cooling of the treatment site. By inflating a special balloon with nitrous oxide instead of saline / contrast, a heat sink of -10°C is achieved at site of angioplasty. Theoretically two major obstacles of conventional angioplasty are addressed by this technique: First, dissection or instant recoil and, second, late restenosis due to vessel shrinkage and neointima formation. The temporary freezing of the artery at the treatment site is considered to change the biologic response to angioplasty and result in a more positive healing process (31). Three main effects are supposed to facilitate the beneficial outcome: (i) controlled stretching of the vessel due to a change of plaque microstructure; (ii) alteration of the morphology of collagen fibers with temporary loss of elasticity, resulting in a reduction of elastic recoil; and (iii) apoptosis of vascular smooth muscle cells and consecutive reduction of neointima formation. From a prospective, nonrandomized multicenter registry quite encouraging results were reported recently (32). Cryoplasty was used in a cohort of 102 patients with femoropopliteal lesions. Primary endpoints were acute technical success, overall procedural success, and freedom from target lesion revascularization at 9 months. The initial technical success was high (85.3%), and there was a low rate of dissection (6.9%). The overall procedural success including stent placement for cryoplasty failure was 94.1%. There was a 9-month clinical patency rate of 82.2% for both stenoses and occlusions, the primary patency rate, assessed by duplex US at 9 months, was 70.1%. Overall the results indicate that cryoplasty may be a safe and effective way to treat atherosclerotic lesions in the infrainguinal arteries. The freezing induced change of the cellular response to angioplasty seems to have the potential to enhance long-term results, however, more research is needed.

Balloon Coating

The concept of catheter-based local drug delivery using a balloon is not new. The early technique with direct infusion of a drug into the vessel wall with a porous balloon-catheter raised some concern, because the procedure itself may induce significant vessel trauma, inflammation and restenosis. Just recently the concept of local balloon-based drug delivery was readopted in a study with paclitaxel-coated angioplasty balloons in a porcine model of coronary stenting. The paclitaxel coating resulted in a dose-dependent reduction of in-stent restenosis, and there was no evidence of a significant inflammatory response in the proximity of the stent struts (33). These data were confirmed in a randomized, double blinded multicenter trial initiated to evalulate paclitaxel eluting balloon catheters in the setting of coronary in-stent restenosis (34). Another multicenter study used paclitaxel-coated balloons for peripheral angioplasty. The first analysis of a portion of the data revealed that at 6 months the drug-coated balloons had been significantly more effective to prevent restenosis than the non-coated balloons (35). The scientific rationale for a balloon- rather than stent-coating is the notion that it theoretically allows more active substance to come into contact with the vessel wall, since on stents the drug is restricted to the area of the struts.

References

1. Holmes DR Jr, Savage M, LaBlanche JM, et al. Results of Prevention of REStenosis with Tranilast and its Outcomes (PRESTO) trial. Circulation. 2002;106(10):1243-50
2. Douglas JS Jr, Holmes DR Jr, Kereiakes DJ, et al. Coronary stent restenosis in patients treated with cilostazol. Circulation. 2005 Nov 1;112(18):2826-32
3. Hausleiter J Kastrati A, Mehilli J, et al.. Randomized, Placebo-Controlled Trial of Oral Sirolimus for Restenosis Prevention in Patients With In-Stent Restenosis. The Oral Sirolimus to Inhibit Recurrent In-stent Stenosis (OSIRIS) Trial Circulation 2004;110:790-795
4. Rodriguez AE, Alemparte MR, Vigo CF, et al.. Pilot study of oral rapamycin to prevent restenosis in patients undergoing coronary stent therapy: Argentina Single-Center Study (ORAR Trial). J Invasive Cardiol. 2003;15(10):581-584
5. Waksman R, Ajani AE, Pichard AD, et al.. Oral Rapamycin to inhibit restenosis after stenting of de novo coronary lesions: the Oral Rapamune to Inhibit Restenosis (ORBIT) study.J Am Coll Cardiol. 2004;44(7):1386-1392
6. Jahnke T, Schäfer F, Bolte H, et al.. Short-term Sirolimus for inhibition of neotintima formation after ballon-mediated vessel injury in rats: Is there a window of opportunity for systemic prophylaxis of restenosis ? J Endovasc Ther. 2005 Jun;12(3):332-42
7. Diamond DA, Vesely TM. The role of radiation therapy in the management of vascular restenosis. Part I. Biologic basis. J Vasc Interv Radiol. 1998 Mar-Apr;9(2):199-208
8. Zehnder T, von Briel C, Baumgartner I, et al.. Endovascular brachytherapy after percutaneous afterpercutaneous transluminal angioplasty of recurrent femoropopliteal obstructions. J Endovasc Ther 2003; 10:304-311
9. Pokrajac B, Potter R, Wolfram RM, et al.. Endovascular brachytherapy for restenosis prevention after femoro-popliteal angioplasty: the Vienna-3 multicenter trial. Radiother Oncol 2004; 71(suppl 1):104
10. Fischell TA, Carter A, Foster M, et al.. Lessons from the feasibility radioactive (IRIS) stent trials. In: Waksman R, ed. Vascular Brachytherapy. 2nd ed. Armonk, NY: Futura Publishing Co; 1999:475-481
11. Albiero R, Adamian M, Kobayashi N, et al.. Short- and intermediate-term results of (32)P radioactive beta-emitting stent implantation in patients with coronary artery disease: The Milan Dose-Response Study.Circulation. 2000 Jan 4-11;101(1):18-26.
12. Tepe G, Dietrich T, Grafen F, Brehme U, Muschick P, Dinkelborg LM, Greschniok A, Claussen CD, Duda SH. Reduction of intimal hyperplasia with Re-188-labeled stents in a rabbit model at 7 and 26 weeks: an experimental study.Cardiovasc Intervent Radiol. 2005 Sep-Oct;28(5):632-7
13. Zidar J, Lincoff A, Stack R (1994) Biodegradable stents. In: Topol EJ (ed) Textbook of interventional cardiology, 2nd edn. Saunders, Philadelphia, pp 787-402
14. Tamai H, Igaki K, Kyo E, et al.. Initial and 6-month results of biodegradable poly-l-lactic acid coronary stents in humans Circulation. 2000 Jul 25;102(4):399-404
15. Peeters P, Bosiers M, Verbist J, et al.. Preliminary results after application of absorbable metal stents in patients with critical limb ischemia. J Endovasc Ther. 2005 Feb;12(1):1-5
16. Kastrati A, Mehilli J, Dirschinger J, et al.. Intracoronary stenting and angiographic results: strut thickness effect on restenosis outcome (ISAR-STEREO) trial.Circulation. 2001 Jun 12;103(23):2816-21
17. Sprague EA, Palmaz JC. A model system to assess key vascular responses to biomaterials. J Endovasc Ther. 2005 Oct;12(5):594-604
18. Kastrati A, Schomig A, Dirschinger J, et al.. Increased risk of restenosis after placement of gold-coated stents: results of a randomized trial comparing gold-coated with uncoated steel stents in patients with coronary artery disease. Circulation. 2000 May 30;101(21):2478-83
19. Goodwin S.C., Yoon HC, Chen G, et al.. Intense Inflammatory Reaction to Heparin Polymer-Coated Intravascular Palmaz Stents in Porcine Arteries Compared to Uncoated Palmaz Stents; Cardiovasc Intervent Radiol (2003) 26:158-167

20. Antoniucci D, Bartorelli A, Valenti R, et al.. Clinical and angiographic outcome after coronary arterial stenting with the Carbostent. Am J Cardiol 2000; 85:821-825
21. Rand T, Basile A, Cejna M, et al.. PTA versus carbofilm-coated stents in infrapopliteal arteries: pilot study. Cardiovasc Intervent Radiol. 2006; 29(1):29-38
22. Liistro F, Stankovic G, Di Mario C, et al.. First clinical experience with a paclitaxel derivate-eluting polymer stent system implantation for in-stent restenosis: immediate and long-term clinical and angiographic outcome. Circulation. 2002;105(16):1883-1886
23. Moses JW, Leon MB, Popma JJ, et al.. Sirolimus-eluting stents versus standard stents in patients with stenosis in a native coronary artery. N Engl J Med. 2003;349(14):1315-1323
24. Duda SH, Pusich B, Richter G, et al.. Sirolimus eluting stents for the treatment of obstructive superficial femoral artery disease: six-month results. Circulation. 2002;106:1505-1509
25. Duda SH, Bosiers M, Lammer J, et al.. Sirolimus- eluting versus bare nitinol stent for obstructive superficial femoral artery disease: the SIROCCO II Trial. J Vasc Interv Radiol. 2005;16: 331-338
26. Lawrie A, Brisken AF, Francis SE, et al.. Ultrasound enhances reporter gene expression after transfection of vascular cells in vitro.Circulation. 1999 May 25;99(20):2617-20
27. Serruys PW, Hoye A, Grollier G, et al.. A European multi-center trial investigating the anti-restenotic effect of intravascular sonotherapy after stenting of de novo lesions (EUROSPAH: EUROpean Sonotherapy Prevention of Arterial Hyperplasia). Int J Cardiovasc Intervent. 2004;6(2):53-60
28. Mansfield R, Bown S, McEwan J. Photodynamic therapy: shedding light on restenosis. Heart. 2001 Dec;86(6):612-8
29. Mansfield RJ, Jenkins MP, Pai ML, et al.. Long-term safety and efficacy of superficial femoral artery angioplasty with adjuvant photodynamic therapy to prevent restenosis. Br J Surg. 2002;89(12):1538-9
30. Usui M, Miyagi M, Fukasawa S, et al.. A first trial in the clinical application of photodynamic therapy for the prevention of restenosis after coronary-stent placement. Lasers Surg Med. 2004;34(3):235-41
31. Gage A, Fazekas G, Riley E. Freezing injury to large blood vessels in dogs. Surgery 1967;61:748-54
32. Laird J, Jaff MR, Biamino G, et al.. Cryoplasty for the treatment of femoropopliteal arterial disease: results of a prospective, multicenter registry. J Vasc Interv Radiol. 2005;16(8):1067-73
33. Scheller B, Speck U, Abramjuk C, et al.. Paclitaxel balloon coating, a novel method for prevention and therapy of restenosis. Circulation. 2004;110(7):810-4
34. Scheller B, Hehrlein C, Bocksch W, et al.. Randomised trial for the treatment of in-stent restenosis by a paclitaxel coated balloon catheter - PACCOCATH ISR., Congress of the European Society of Cardiology, September 2005 Stockholm, Sweden
35. Tepe G. Drug-coated Balloons for Prevention of Restenosis in the SFA and Popliteal Arteries, 18th Annual International Symposium on Endovascular Therapy, January 2006, Miami Beach, Florida, USA

Special Session
AAA Stent Grafts

42.1

Implications of EVAR and DREAM trials

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EVAR offers a significant benefit over open repair

The outstanding finding of EVAR 1 is the consistent 3 percentage points aneurysm-related mortality benefit up to 4 years [1-3]. The operative mortality benefit of EVAR (1·7% versus 4·7% for open repair) was highly significant (p=0.009). During follow up, the trial was powered to show a significant difference in all-cause mortality. However, the statistical advice was carefully to define aneurysm-related mortality as the mortality measure which would be more sensitive than all-cause mortality in the mid-term. Moreover, if the trend in favour of EVAR was to be maintained in terms of aneurysm-related mortality, it is possible that a result could be achieved in terms of all-cause mortality in longer follow-up.

At the mid-term point, the benefit in aneurysm-related mortality was superior in EVAR by the same 3 percentage points and this was significant. All-cause mortality also showed a 3-point difference at 4 years but this was not significant. The consistent EVAR 1 mortality trend across the board is a 3-point benefit in favour of EVAR.

The increased interventions associated with EVAR do not impact on mortality

It is accepted that there is an increase in small reintervention needs after EVAR compared with open repair. Such events have not translated into significant mortality manifestations.

The implication is that any patient being offered EVAR must know that they require careful follow-up for life and it is accepted that open repair will have significantly less follow-up. The patient who wishes to cut loose from hospital follow up, and at the same time accepts a significantly higher early mortality, will opt for open repair. Time will tell if patients who have an average age over 70 prize the mortality benefit ahead of the risk of reintervention.

EVAR 2 indicates that improving fitness for very sick patients should be the focus instead of rapid deployment

Contrary to expectations, EVAR 2 shows that EVAR does not improve survival compared with no treatment intervention in patients unfit for open repair [4]. Why is that? Essentially the rupture rate of the follow-up group was much less than had been modelled from the hard data of the UK Small Aneurysm Study, in which similar patients had 50% mortality in 2 years.

We should remember that the prevailing attitude has been to deploy EVAR as soon as possible to reduce the risk of rupture. However, in the patients who were so unfit that it was impossible to proceed at once or for those who waited until the growth rate was fast or aneurysm tender, the operative mortality of these crossovers was remarkably lower compared with the patients who proceeded to EVAR straight away. In addition, the aneurysm-related mortality curves were noted to cross over at 2 years but as only one third of the patients in either group were alive at 4 years, it is unlikely that sufficient numbers of patients in this trial will survive to realise any potential long-term benefit, should it exist. Thus there has emerged a signal that improving fitness rather than rapid deployment of EVAR should be the focus.

It is too early to judge the cost effectiveness of EVAR

The recent publication in Belgium of a health and technological assessment of elective endovascular aortic repair (EVAR) has appalled many EVAR enthusiasts by concluding that, "The introduction of EVAR (and the rest of the world, for that) was a failure." The report determined that EVAR compared with open surgery, "is not cost effective", and concluded that, "we advise against introduction of EVAR in routine healthcare."

In the United States the rumours are that the governmental Agency for Healthcare Research and Quality is preparing a report that reviews whether to recommend that the Centers for Medicare & Medicaid Services stop the reimbursement of EVAR for high-risk patients following the EVAR 2 trial results.

However, EVAR is being written off prematurely in these quarters based on scientific ignorance. The EVAR 1 trial has a clear report of cost difference. The DREAM trial claims to have a 'snap-shot' cost effectiveness result. This is an erroneous concept: it is simply not possible to have a meaningful 'snap-shot' guesstimate. And guesstimate is the best description.

At this stage leading health economists around the EVAR trials are modelling the factors driving cost effectiveness that will point to the

range of possibilities for the future. The reality will lie somewhere in that range. Time must elapse for clarity on the size of the clinical benefit - to see if this is maintained, increases or decreases with time. A wand cannot be waved to make these years pass instantly for convenience.

What factors will swing the balance? Industry has a major part to play with innovators. It will be a kiss of death for stent graft costs to hike upwards at this crucial moment. Higher stent graft costs could wreck cost-effectiveness prospects if further modelling studies show a close call.

Innovation should be directed at reducing reintervention and expensive surveillance needs. If in time these factors escalate or continue at current rates this could be detrimental in terms of the cost effectiveness of EVAR.

Alternatively, breakthroughs of technology could reduce reintervention rates and swing the cost effectiveness result in a favourable direction.

In the meantime, patients can enjoy a 3% operative and aneurysm-related mortality benefit at four years with less pain, shorter hospital stay, less infection risk and less intensive care. It will be a travesty for patients if EVAR were to be washed away at this stage based on modelling studies. It follows that patient perception of EVAR is an important factor for this patient-friendly treatment. The current cost difference is surely affordable for these advantages.

References

1. Brown LC, Epstein D, Manca A, Beard JD, Powell JT, Greenhalgh RM. The UK EndoVascular Aneurysm Repair (EVAR) Trials : Design, Methodology and Progress. Eur J Vasc Endovasc Surg 2004; 27: 372-81.
2. The EVAR Trial Participants. Comparison of endovascular aneurysm repair with open repair in patients with abdominal aortic aneurysm (EVAR trial 1), 30-day operative mortality results: randomised controlled trial. Lancet 2004; 364: 843-48.
3. The EVAR Trial Participants. Endovascular aneurysm repair versus open repair in patients with abdominal aortic aneurysm (EVAR Trial 1): randomised controlled trial. Lancet 2005; 365: 2179-86.
4. The EVAR Trial Participants. Endovascular aneurysm repair and outcome in patients unfit for open repair of abdominal aortic aneurysm (EVAR Trial 2): randomised controlled trial. Lancet 2005; 365: 2187-92.

42.2

Will emergency EVAR replace open surgery?

Session AAA stent-grafts

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Introduction

While an immense increase in the expertise with endovascular abdominal aortic aneurysm (EVAR) in elective cases was observed during the last decade, only a limited number of centers have thus far published their experience with endovascular repair in emergency AAA (eEVAR). The present overview will include institutional data from the Catharina Hospital Eindhoven, as an example of initial experience with this new treatment approach. Subsequently the results of a multicenter study organized in cooperation with Medtronic® will be presented to demonstrate differences between an initial institutional and a multicenter study, i.e. generalisability of emergency endovascular aneurysm repair.

Only modest improvements have been observed in the outcome of ruptured abdominal aortic aneurysms (rAAA) with conventional surgery.[1] Meanwhile institutional reports on emergency endovascular aneurysm repair have suggested that a substantially lower 30-day mortality and morbidity rates can be achieved than with open repair.[2-8] However, the improved outcomes in these reports may reflect selective patient recruitment with patients selected for eEVAR constituting a lower risk category as they would need to be stable for preoperative imaging and have a suitable anatomical configuration for EVAR. Thus, the favorable outcomes observed in the previous studies may simply reflect selection bias.

Several other questions regarding the use of eEVAR in rAAAs remain. Among these uncertainties, the applicability rate of eEVAR is a key factor. In particular the anatomy of the infrarenal neck and the patency of the iliac arteries may preclude successful endovascular repair. Furthermore, the infrastructural requirements such as the availability of rapid preoperative imaging and around the clock interventionists experienced in emergency endovascular aneurysm repair needs to be assessed.

In the two series that will be discussed below the mortality rate of eEVAR in all patients, who are candidates for endovascular treatment and the effect of a preferential eEVAR policy on the mortality in an unselected group of patients with rAAA will be the primary outcome event. Only by analyzing the entire patient cohort with rAAA advantage of eEVAR in reducing the early mortality can be demonstrated.

Patients and Methods

Series from the Catharina Hospital Eindhoven, the Netherlands

The study group was treated between 2001 and 2004 and consisted of 44 patients with ruptured AAAs, preferentially treated by EVAR (25 patients) or, if this was not possible because of anatomy or extreme hemodynamic instability, by open surgery (19 patients). This group was compared to a control group of 82 patients, all operated before 2001, when no endovascular treatment was available for emergency patients.

The New ERA multicenter study

In the New ERA study, which was a prospective multicenter European and Canadian study, sponsored and supported by Medtronic®, 10 centers participated. Vascular surgeons and interventional radiologists had considerable experience in the diagnosis and open and endovascular treatment of rAAA. Patient data and procedural details were recorded in a structured Case Report Form (CRF) and periodically monitored on-site by representatives of the organizing company. All adverse events including device- and procedure-related events and death were reviewed by an independent Adverse Event Advisory Committee. The preferential treatment in this study was EVAR, with open surgery only selected as treatment when anatomic criteria precluded effective exclusion of the aneurysm, or if the patients were in profound hypovolemic shock, that did not allow CT-examination.

Study endpoints

Study endpoints in the institutional and in the multicenter study included operative mortality, defined as death within the first 30 days or during the same hospitalization and major morbidity. Secondary endpoints included death from all causes and major morbidity within three months after the procedure.

Results

Institutional series

No differences in risk factors, age of the patient, proportion with cardiac or pulmonary disease or the presence of hypovolemic shock and diameter of the aneurysm was noted between the study group and the control group. EVAR was applicable on the basis of anatomy or hemodynamic conditions in 66% in this study. Because of logistics (non-available interventionist) 56% of the patients were in fact treated by EVAR in the study group.

Operating time in the study group was considerably less compared to the control group with routine open repair (156 minutes versus 200 minutes). Most importantly, the 30-day mortality was 32% in the study group with preferential EVAR, compared to 56% in the control group with routine conventional open repair.

New ERA multicenter study

Of all hundred patients included in this study 49 underwent emergency EVAR, 51 open repair. Demographic details (age, cardiac, pulmonary and other risk factors) were comparable for the patients receiving eEVAR and open repair. CT-scanning as preoperative imaging technique was possible in 88% of the patients who

received eEVAR and 86% of he patients with open repair. Anatomical characteristics differed between endovascular and open repair patients in that the aneurysm neck was not suitable in 75% of the patients with open repair, while it was suitable for EVAR in 100% of the patients with endovascular repair. With this observation, neck anatomy was the most frequent cause for a patient to be excluded from endovascular repair.

The number of eEVAR-patients endoleaks at the completion angiogram was 22%. The main differences between the eEVAR at open repair group regarded the replaced blood volume (1300 vs 2400 ml), duration of intensive care unit stay (5.8 vs 9.4 days) and the period on mechanical ventilation (71 vs 165 hours).

The 30-day mortality in patients receiving eEVAR was 35% and in patients with open repair 39%. This difference was not statistically significant. In addition the 3-month all cause mortality, the spectrum of causes of death and the frequency in nature of primary complications were comparable between the groups with eEVAR (60%) and open repair (58%).

Discussion and conclusions

The proportion of patients with anatomic dimensions allowing endovascular repair reported in previous studies varied from 28 to 83%.[6-11] In the new ERA study half of the patients underwent emergency endovascular repair. Adverse anatomy appeared to be the most frequent reason for selecting open repair. Logistic factors, such as unavailable endovascular expertise, precluded eEVAR also in a number of patients and organizational issues need to be resolved before emergency EVAR can be implemented in majority of European institutions. In this regard on rota calls including interventional radiologists and vascular surgeons should be considered.

Preoperative CT-examination was performed in 87% of the new ERA patients in an almost equal proportion of the two treatment groups. Hemodynamic status, i.e. severe or moderate instability on average was comparable in the two treatment groups. Thus, CT-examination is possible in the fast majority of patients with rAAA.

The 30-day mortality in the new ERA trial was considerably higher compared to several published single institutional series in which this rate in emergency EVAR patients varied from 8 to 14%.[2-11] In addition, our own institutional series suggested a significant impact of eEVAR by reducing in-hospital mortality from 56 to 32% in the entire population treated for rAAA. The effect of eEVAR, although still favorable, was less obvious in the New ERA multicenter study. There may be several explanations for this difference. First, selection bias seems a likely explanation of the seemingly favorable results observed in the single center studies. In particular the number of patients undergoing endovascular treatment was small and the outcome in patients with open surgery for their ruptured aneurysm in the same period often was not reported in most literature series. Second, the presence of severe or multiple co-morbidities may cause different outcomes between series. Notably, medical eligibility for open repair may be lower in patients receiving eEVAR, as patients with quite severe co-morbidities may not have been accepted for open repair. Nevertheless, the 35% mortality rate in the eEVAR group and a 37% mortality in the overall study group, still compares favorably with the often observed 40 to 50% perioperative mortality in open repair series.

In conclusion: Questions that were answered in the present study included that eEVAR appeared to be a feasible method for most dedicated vascular centers to treat rAAA, and a good outcome may be anticipated for the majority of patients. Availability and the number of endovascular teams with experience in emergency endovascular repair need to improve to include the majority of patients with a ruptured infrarenal abdominal aneurysm in a preferential treatment by EVAR-protocol. In a well-organized setting the advantages of less blood loss, avoiding of laparotomy, shorter time in the intensive care unit and on mechanical ventilation should translate into a further decrease of the perioperative mortality.

References

1. Bown MJ, Sutton AJ, Bell PRF and Sayers RD. A meta-analysis of 50 years of ruptured abdominal aortic aneurysm repair. Br J Surg. 2002;89:714-730.
2. Ohki T and Veith FJ. Endovascular grafts and other image-guided catheter-based adjuncts to improve the treatment of ruptured aortoiliac aneurysms. Ann Surg. 2000;232:466-479.
3. Greenberg RK, Srivastava SD, Ouriel K, Waldman D, Ivancev K, Illig KA, Shortell C, Green RM. An endoluminal method of hemorrhage control and repair of ruptured abdominal aortic aneurysms. J Endovasc Ther 2000;7:1-7.
4. Hinchliffe RJ, Yusuf SW, Marcierewicz JA, et al. Endovascular repair of ruptured abdominal aortic aneurysm - a challenge to open repair? Results of a single centre experience in 20 patients. Eur J Vasc Endovasc Surg. 2001 ;22 :528-534.
5. Peppelenbosch N, Yilmaz N, van Marrewijk C, Buth J, Cuypers Ph, Duijm L and Tielbeek A. Emergency treatment of acute symptomatic or ruptured abdominal aortic aneurysm. Outcome of a prospective intent-to-treat by EVAR protocol. Eur J Vasc Endovasc Surg. 2003 ;26 :303-10.
6. Lachat ML, Pfammatter Th, Witzke HJ, et al. Endovascular repair with bifurcated stent-grafts under local anaesthesia to improve outcome of ruptured aorto-iliac aneurysms. Eur J Vasc Endovasc Surg 2002 ;23 :528-536.
7. Sambeek van MRHM, Dijk van LC, Hendriks JM et al. Endovascular versus conventional open repair of acute abdominal aortic aneurysm: feasibility and preliminary results. J Endovasc Ther. 2002;9:443-448.
8. Verhoeven ELG, Prins TR, Dungen van den JJAM, et al. Endovascular repair of acute AAAs under local anesthesia with bifurcated endografts: a feasibility study. J Endovasc Ther. 2002;9:158-164.
9. Reichart M, Geelkerken RH, Huisman AB, Det van RJ, Smit de P and Volker Eph. Ruptured abdominal aortic aneurysm: endovascular repair is feasible in 40% of patients. Eur J Vasc Endovasc Surg. 2003 ;26 :479-486.
10. Hechelhammer L, Lachat ML, Wildermuth S, Bettex D, Mayer D and Pfammatter T. Midterm outcome of endovascular repair of ruptured abdominal aortic aneurysms. J Vasc Surg 2005;41:752-7.
11. Veith FJ, Ohki T, Lipsitz EC, Suggs WD, Cynamon J. Treatment of ruptured abdominal aneurysms with stent-grafts: a new gold standard? Semin Vasc Surg 2003;16:171-5.

Special Session
AAA Stent Grafts

42.4

How to treat type 2 endoleaks

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Type 2 endoleaks are common after EVAR and most series record an incidence of around 20%. Undoubtedly the rate of type 2 endoleak is influenced by the method of surveillance imaging. Doppler ultrasound has been shown to be less sensitive than dual-phase CT scanning in the detection of sidebranch endoleak. Dual or triple-phase CT scanning will find more type 2 endoleaks than single-phase arterial CT follow up. Many authors advocate triple-phase CT follow-up to detect all endoleaks. The later phases are almost solely performed to find low flow type 2 endoleaks.

Patent aneurysmal sidebranches are the norm before endovascular abdominal aortic aneurysm repair and it is has been previously suggested that pre-operative sidebranch embolisation may eliminate post-procedural type 2 endoleak. Our own published experience has shown that this is ineffective.

There is some controversy regarding when to treat type 2 endoleaks. Aggressive policies of embolisation of all type 2 endoleaks persisting beyond six months have been suggested. Many authors advocate

treatment only if the endoleak persists beyond 6 months and there is evidence of sac growth of more than 5mm. The value of 5mm is based on the perceived observer error in measuring aneurysms of 5 or 6cm and this is the generally accepted value for diagnosing actual diameter growth. It is important that the baseline study for comparison is the first post-operative CT scan and not the pre-operative one. If there was some delay between the diagnostic CT scan before EVAR and the operative procedure then there will have been some natural growth of the aneurysm. This could be mistaken for post-procedural aneurysm growth and hence we view the first CT scan after EVAR as the baseline.

Categorisation of endoleaks at CT may be difficult and, if endoleak is present with patent sidebranches, then it is possible that the sidebranches are the outflow for a graft-related endoleak. This must be considered for all persistent or late "type 2" endoleaks. The distinction requires careful review of the CT dataset and plain radiographs. The flow direction in branch vessels at ultrasound may be useful in the differentiation between isolated type 2 endoleak and a mixed graft-related and sidebranch endoleak. Catheter angiography may be required in a small number of cases if uncertainty remains. It has been suggested that embolisation of sidebranches in a mixed type 2/graft-related endoleak may increase the risk of rupture as the outflow for a graft-related endoleak is lost.

The literature on embolisation of type 2 endoleaks records several approaches. Trans-arterial embolisation of the fourth lumbar arteries via the ilio-lumbar artery and of the inferior mesenteric artery via the arc of Riolan are well documented. This approach may fail if the vessels are not embolised up to the sac margin. Failure may also occur if the endoleak pathway is more complex and several vessels are involved. This is the reason that direct CT-guided sac puncture is more popular with coil and glue embolisation of the "nidus" in the aneurysm sac. The intra-sac injection of thrombin and Onyx have also been reported.

Operative approaches include laparoscopic or open surgical clipping of aortic sidebranches. Open conversion has also been utilised in this setting.

Prevention of death from rupture is the aim of EVAR and it must be remembered that isolated type 2 endoleak was not shown to be an independent risk factor for late rupture in the EUROSTAR analysis. It would be wrong to suggest that type 2 endoleak is never the cause of sac growth and we must accept that rupture associated with type 2 endoleak is theoretically acceptable and has been very rarely reported. Analogous situations are the sidebranch endoleaks after open surgical ligation and bypass of abdominal aortic and popliteal aneurysms. There is a low incidence of aneurysm growth due to patent sidebranches in both these settings and aneurysm rupture has also been reported.

However the strategies to diagnose and treat type 2 endoleaks are expensive and expose the patient to risks. Multi-phase CT scanning increases the radiation burden to the patient with an increased risk of inducing fatal cancers. Treatment of type 2 endoleaks exposes the patient to the documented risks of paraperesis, colon ischaemia, muscle necrosis, acute renal failure and stroke from transbrachial procedures. Aortic sac infection is also a theoretical risk. I would also speculate that there is a publication bias against the reporting of complications following attempted type 2 endoleak embolisation.

The cost of EVAR in the EVAR1 trial was greater than open repair. The cost of surveillance and secondary interventions is an important part of this additional expense.

The unanswered questions concern when to intervene if persistent type 2 endoleak is documented after EVAR. I would suggest that we have so far over-intervened for type 2 endoleak and that the threshold should be much higher before secondary intervention is performed for persistent type 2 endoleak.

Conclusion:

Type 2 endoleak is common. The diagnosis of type 2 endoleak carries risk to the patient. The treatment of type 2 endoleak exposes the patient to risks of sepsis, neurological and colonic ischaemia and muscle necrosis. An aggressive approach to the diagnosis and treatment of type 2 endoleak is expensive and may tip the financial scales against EVAR. Isolated type 2 endoleak has not been shown to be an independent risk factor for late rupture in the EUROSTAR database of several thousand patients. A much more conservative approach to the diagnosis and management of type 2 endoleak is justified. Routine multiphase CT is not justified. For most patients the additional radiation burden yields no additional information and, in some, a type 2 endoleak may be diagnosed and then ignored. If type 2 endoleak is found then the physician must convince himself that the benefit to the patient in treating this outweighs the risks of the intervention. Our own approach when dealing with type 2 endoleak discovered during routine surveillance is to make sure that there is no evidence of an associated graft-related endoleak and assess for migration at the attachment sites or modular overlap zones. We now adopt a very conservative approach if there is no evidence of a graft-related problem and reintervention for type 2 endoleak in our centre is now very rare.

Special Session
Iliofemoral DVT

43.1

Limitations of current management strategies

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Learning Objectives:

To understand the limitations of current management strategies for the iliofemoral DVT.

To be able to triage patients to the most appropriate therapy

Introduction:

Most commonly the patient presents with a painful swollen leg.

The following is a common pathway for patients with this complaint:

Clotting profile and factor assay

Lower limb ultrasound

If positive

Immediate loading dose of Heparin or Low MW fraction.

Compression stockings

Elevation of the limb

Commencement of oral anticoagulant (Warfarin)

If negative

Reassured and discharged

Later presentation with swollen painful leg with or without venous stasis ulceration.

Diagnosis: Post thrombotic syndrome.

Even in premier centres it is surprising how infrequently the ultrasound examination does not include the iliac veins or the IVC. In May-Thurner syndrome with venous thrombosis the leg veins may be normal on ultrasound and if the ultrasound is used as the primary exclusion of DVT, then the opportunity to completely cure the condition may be lost.

Heparin is used most commonly as a precursor to Coumadin therapy but there is probably much to be gained from a single dose of a thrombolytic drug in the emergency department.

In the setting of an acute iliofemoral DVT it is usually easy to remove the thrombus by either pharmacological, mechanical or combination therapy. In the more chronic setting when all three components of Virchow's triad are present and the thrombus is partially or completely cross-linked removal of the thrombus is much more difficult and maintenance of flow sometimes impossible.

There is a considerable difference of opinion about the appropriate treatment for iliofemoral DVT.

Physicians who generally see the patients early in their disease are

more concerned with the immediate risks of pulmonary embolism. Standard medical treatment of a deep venous thrombosis is anticoagulation, elevation of the limb and compression stockings. This treatment results in a significant on-going morbidity with partially or completely occluded iliac and femoral veins, deep venous insufficiency, leg swelling and ulceration. This is called the post-thrombotic syndrome and affects up to 25% of patients treated medically for iliofemoral DVT.

Several studies have shown that there are often anatomic abnormalities which contributed to iliofemoral DVT particularly in the left common iliac vein but are not treated by conventional medical therapy. A randomised trial of surgical thrombectomy and temporary arteriovenous fistula compared to conventional anticoagulation in1997 showed a benefit for the surgical grouping terms of leg swelling, venous ulceration, patency of the iliac vein and deep venous reflux. Surgery is however rarely performed for iliofemoral DVT now but should be considered in selected cases.

As a result of this observation Iliofemoral DVT is considered by interventional radiologists to be a precursor to post-thrombotic syndrome and deep venous insufficiency and they offer two main options, thrombolysis and thrombectomy alone or in combination with angioplasty and stenting of anatomic abnormalities. The ultimate aim is to remove as much of the thrombus as possible and maintain a patent iliofemoral vein with normal deep venous valve function. Prevention of pulmonary embolism is achieved by use of retrievable IVC filters.

Percutaneous delivery of venous valves is feasible but still in a research and development phase.

As yet production of a percutaneous arteriovenous shunt is not performed although the technology to do this exists.

As the interventional radiologist sees the failures of medical therapy they are somewhat sceptical about the effectiveness of medical therapy. For best results the interventional radiologist has a relatively small window of opportunity which is about 5-7 days. Often the patient presents later than this and the thrombus is cross-linked with fibrin and usually tightly adherent to the vein wall.

The physician on the other hand sees the techniques of interventional radiology as high risk and mostly unnecessary.

In a disagreement between physicians and interventional rdiologists, for every cerulea phlegmasia dolens raised by the interventional radiologist there is usually an anticoagulant related cerebral haemorrhage to counter it.

Even in conditions considered to be contraindications for thrombolysis such as post-partum venous thrombosis it is possible to safely perform catheter directed thrombolysis if the process is carefully managed. Several new devices have been developed which effectively sequester the thrombolytic drugs from the general circulation and provide mechanical disruption of the thrombus at the same time. These devices may provide a wider application of thrombolytic therapy to post-surgical patients fro example.

The lack of consultation between the "Thrombosis Physician" and the interventional radiologist is probably the major problem to be solved. Unfortunately there is no high quality long-term randomised study of best medical versus interventional therapy for iliofemoral DVT. It is not even clear exactly how long the follow-up for such a trial would need to be. Several studies have used a 10 year period of follow-up but a clinical trial of that length might be prohibitively expensive and suring such a period there would be almost certainly significant improvements in current threapy.

Recently a research consensus panel of SIR was convened on venous thromboembolism and it is hoped that a formal clinical trial of medical versus thrombolysis and thrombectomy will result.

Conclusion:

The major limitations of current treatment of iliofemoral DVT are:

1. Referral of patients with iliofemoral DVT is usually late or after medical therapy has failed.
2. Multiple mechanical devices are available but there is no reliable data to help make the decision on which to use.
3. There is no real consensus on what dose and duration of thrombolytic drug to use.
4. There are wide differences in opinion on what is the true incidence of late morbidity from iliofemoral DVT.

References

1. Jackson LS, Wang XJ, Dudrick SJ, Gersten GD. Catheter-directed thrombolysis and/or thrombectomy with selective endovascular stenting as alternatives to systemic anticoagulation for treatment of acute deep vein thrombosis. Am J Surg. 2005 190:864-868
2. H.-S. Kwak, Y.-M. Han, Y.-S. Lee, G.-Y. Jin, and G.-H. Chung. Stents in Common Iliac Vein Obstruction with Acute Ipsilateral Deep Venous Thrombosis: Early and Late Results. J. Vasc. Interv. Radiol., 2005; 16: 815-822.
3. Comerota AJ, Throm RC, Mathias SD, Haughton S, Mewissen M. Catheter-directed thrombolysis for iliofemoral deep venous thrombosis improves health-related quality of life. J Vasc Surg. 2000 32:130-137.
4. Juhan CM, Alimi YS, Barthelemy PJ, Fabre DF, Riviere CS. Late results of iliofemoral venous thrombectomy. J Vasc Surg. 1997 25:417-422

Comerota AJ, Gale SS. Technique of contemporary iliofemoral and infrainguinal venous thrombectomy. J Vasc Surg. 2006 43:185-191.

5. Plate G, Eklof B, Norgren L, Ohlin P, Dahlstrom JA. Venous thrombectomy for iliofemoral vein thrombosis--10-year results of a prospective randomised study. Eur J Vasc Endovasc Surg. 1997 14:367-374
6. Acharya G, Singh K, Hansen JB, Kumar S, Maltau JM. Catheter-directed thrombolysis for the management of postpartum deep venous thrombosis. Acta Obstet Gynecol Scand. 2005;84:155-158
7. Vendantham S, Rundback JH, Comerota AJ et al Development of a Research Agenda for Endovascular Treatment of Venous Thromboembolism: Proceedings from a Multidisciplinary Consensus Panel. J. Vasc. Interv. Radiol.,2005; 16:1567-1573

43.2

Thrombolysis

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Systemic anticoagulation remains the therapy of choice among physicians for deep venous thrombosis (DVT). While effective in reducing continued clot propagation none of the anticoagulating agents used can directly activate thrombolysis. Studies have shown that in the majority of patients treated with anticoagulation alone, the DVT persists. While the bodies natural fibrinolytic system can lyse smaller venous thrombi such as isolated popliteal or calf vein DVT, complete endogenous thrombolysis of the larger femoral and iliac thrombi is a relatively rare occurrence. Consequently the thrombus organizes and leads to permanent occlusion of the vein.

The major focus of current treatment in patients with DVT is the prevention of the dreaded consequence of pulmonary embolus. The long term sequlae of DVT in the lower extremities is poorly understood, and often ignored, by most physicians. Patients who develop chronic venous insufficiency can be as disabled as patients with arterial disease yet aggressive treatment of DVT is rarely pursued. The complacency regarding late complications of venous insufficiency results in most patients receiving anticoagulation with the hope that symptomatic improvement will result from the development of venous collaterals. Over the long-term patients who develop postphlebitic syndrome become a significant socioeconomic burden as a result of their disability and frequent hospitalizations. Surgical options are limited. Despite early favorable reports for venous thrombectomy for acute DVT, most vascular surgeons have abandoned the procedure due to relatively high rethrombosis rates. Cross-over femoral bypass

which is typically reserved for patients with severe venous outflow obstruction, requires reinforced polytetraflouroethylene (Gortex, W.L. Gore, Flagstaff, AZ), combined with a arteriovenous fistula to maintain brisk flow. Unfortunately this operation is associated with relatively high rethrombosis rates due to the low flow rates, and is technically demanding due to the difficulty in handling thin-walled, compliant veins.

Over the last 20 years catheter-directed thrombolysis (CDT) has become well established in treating dialysis access fistulae, arterial thromboses, and upper extremity deep venous thrombosis (e.g. effort vein thrombosis). The rational for CDT is to rapidly remove the thrombus and thereby alleviate painful limb edema, preserve valve function, prevent pulmonary emboli, and prevent post-phlebitic syndrome. In a review by Comerota involving nearly 600 patients with DVT, 63 % of patients treated with systemic thrombolysis had complete or partial lysis of the DVT compared to 18 % of patients treated with anticoagulation alone. This is supported by as yet unpublished data from the national venous registry. Recent data from our institution has shown that early thrombolysis does indeed preserve valve function, based on serial duplex examinations. We currently recommend an aggressive approach to lower extremity DVT with CDT and endovascular stenting of residual lesions.

CDT for iliofemoral DVT

The main advantages of a catheter-based system as opposed to systemic delivery is to provide superior efficiency of lysis while also minimizing the risk of systemic fibrinolysis and subsequent hemorrhage. This modality also provides access for venography, and adjunctive therapeutic techniques such as balloon angioplasty and stent placement.

Patient selection

Patients under consideration for CDT should have lower extremity DVT documented by ultrasound and/or ascending venography to assess the degree of involvement of the calf veins, femoral and iliac veins, and IVC. Ideally CDT should be performed within 4-6 weeks of the onset of symptoms. Many patients are referred to us following a few weeks of attempted anticoagulation with persistent severe symptoms. When patients present over 2 months following symptom onset, we reserve thrombolysis for those patients with definite iliac vein involvement. These patients do not clear the thrombus as well as the more acute presenters, and the benefits in those patients with iliac vein involvement is primarily due to stent placement, a procedure which we reserve for lesions above the inguinal ligament. Contraindications to CDT are patients who have contraindication to anticoagulation, bleeding disorders, pregnancy or recent delivery, metastatic disease involving the central nervous system, or who are within 1 year of a hemorrhagic stroke. Recent surgery is a relative contraindication; we generally do not treat patients within 7 days of a major operation.

Technique

The procedure is performed entirely in the angiography suite. The patients are carefully monitored and given intravenous sedation. Vascular access is either via the right internal jugular vein (supine) or ipsilateral popliteal vein (prone). The right internal jugular vein access can be difficult because of buckling of the catheters into the right atrium and ventricle, or the inability to successfully cannulate an iliac vein that is occluded flush with the IVC. The popliteal approach is often technically easier, and is our access route of choice assuming that the patient can tolerate a prolonged period in the prone position. The vein is cannulated using ultrasound guidance (Site-Rite II, Dymax Inc, Pittsburgh, PA), and a single wall puncture is made with a 5 Fr microaccess set (Cook Inc, Bloomington, IN). After sheath placement, a baseline venogram is performed to assess the state of the femoral and iliac veins, and the cava. The thrombosed veins are probed using a steerable guidewire (Glidewire, Medi-Tech Inc., Watertown, MA) and catheter under fluoroscopic control. After passage of the wire, a catheter is advanced across the occluded or stenosed segment and venography repeated to confirm patency of the veins above the clot. The catheter is then exchanged for a multi-sidehole catheter and wire combination, using a system with an infusion length crossing the lesion. Due to the recent withdrawal of Urokinase (Abbott Laboratories, Chicago, IL) by the Federal Drug Administration we have changed our strategy and are now using recombinant tissue Plasminogen Activator as the lytic drug of choice. Urokinase was considered to be the optimum non-coronary lytic agent due to itâ€™s reliability, predictability and wide margin of safety, however, there were issues regarding possible viral contamination of this drug which has resulted in it no longer being available. Streptokinase is hampered by immunogenic complications and relatively high bleeding complications. Tissue plasminogen activator was used almost exclusively for bolus infusions for myocardial infarctions in the US, however, is now being widely used for a variety of non-coronary indications, and appears to have a low incidence of complications, and high degree of efficacy.

rt-PA is administered via a multi-sidehole infusion catheter and the current dosing strategy is included. A number of trials are underway to establish the optimum dosing and dilution, and the manufacturing company is committed to devising easier mixing and administration methods.

Activase dosing for DVT

A. Reconstitution

10 mg Activase (Genentech Inc., S. San Francisco, CA) vial mixed with 10 ml of sterile water, concentration is 1mg/ml. Can use 5 vials of Cath-flo instead.

B. Storage and Handling

Freshly reconstituted Activase (1mg/ml) is stable at room temperature for up to 24 hours.

Reconstituted Activase may be aliquotted (2 or 5 mg quantities) in plastic syringes and frozen at â€“20 degrees C for up to 6 months with preservation of activity.

C. Dilution

Dilute only in normal saline (0.9 % NaCl)

10 mg reconstituted Activase (10mlâ€™s of above mixture) mixed with 990 mlâ€™s normal saline (0.01 mg/ml).

D. Acute DVT

If patient is already on coumadin continue it, or if not commence on day 1 of therapy.

Overnight continuous infusion techniques using multi-sidehole catheter.

No bolus.

Infuse 25-50 ml/hr (0,01 mg/ml) = 0.25-0.5 mg/hr.

Sub-therapeutic heparin through arm I.V. (300 U/hr maintenance).

Check fibrinogen every 12 hours, and maintain at > 100 mg/dL.

Repeat venogram next morning, if complete lysis achieved, bolus with therapeutic heparin.

Venous sheaths can be removed almost immediately following completion.

Use of short acting 2b3a inhibitors (tirofan; Aggrastat, Merck) with Activase have been done successfully without incident instead of using heparin. Aggrastat is administered through a separate I.V. access according to body weight.

Patients are kept in a step-down unit (not an ICU) where the nurses are trained in managing vascular access sheaths and are familiar with heparin and rt-PA infusions. The next day patients are restudied in the angiography suite, if the thrombus is resolved with excellent venographic flow, the procedure is terminated and the patient is maintained on anticoagulation. More commonly, there is an underlying anatomic defect present in the iliac vein that requires adjunctive treatment.

Angioplasty alone in the large veins is often inadequate to support patency of the treated segment, due to elastic recoil. Stents are usually required to achieve a satisfactory result. The basic principle of stent placement is to provide as large a lumen as possible to provide for continuous flow.

After successful reconstruction, all patients are administered

anticoagulation therapy with warfarin, to achieve an INR of between 2 and 3 times normal for a minimum of 6 months. All patients undergo a baseline Doppler examination of the lower extremities, which is repeated at 2 weeks, 3,6, and 12 monthly, and annually thereafter. The Doppler is used to evaluate venous patency and venous valvular insufficiently.
Prophylactic IVC filters are not placed.
Results
Seventy-two patients with symptomatic iliofemoral DVT have undergone treatment at our institution (34 men, 38 women)(mean age 53 yrs). 52 (75 %) had been previously treated with anticoagulation for a mean of 10 days without symptomatic relief before endovascular intervention. Iliofemoral DVT was present in 56 %, iliac thrombus alone in 44 %. The commonest presenting symptom was lower extremity edema and pain (98 %), with 5 patients presenting with phlegmasia. 52 patients had less than 4 weeks of symptoms, 20 patients had thrombus of greater than 4 weeks duration.
Technical success, defined as successful crossing of the lesion with a guidewire and catheter combination was achieved in 65 cases (90 %). The remaining 7 chronically occluded cases could not be accessed for treatment. Thrombolysis was performed in 59 of 65 patients (86 %), the other 6 patients undergoing primary stenting (14 %). The average thrombolytic dose was 3.5 million units of urokinase, and is now 0.5 mg/hr of rt-PA infused over a mean of 30 hours. 19 limbs (32 %) with complete lysis required no further intervention, 46 (68 %) patients underwent adjunctive endovascular therapy because of residual underlying stenosis > 50 %. Mean follow-up to date is 25 months (range 1-48 months). 6 patients have died, and 4 are lost to follow-up. Clinical and Doppler ultrasound evaluation has shown a primary patency rate of 95 % in technically successful cases. Complete resolution of leg edema and pain was seen in 90 % of patients, partial benefit was seen in 5 %. 2 patients (5 %) have developed recurring symptoms and are being managed with anticoagulation and compression stockings.
Complications
There were no major complications, including pulmonary emboli or death. Minor risks included venous access hematoma (1 %) and anaphylactoid reactions to the urokinase (0.5 %). We have not seen stent migration or embolization, however, the interventionalist must be prepared to deal with these problems.
Summary
The combination of catheter-directed thrombolysis and endovascular stenting is a new and promising approach for treating acute and chronic thrombotic iliofemoral venous occlusions. In acute DVT thrombolysis provides more complete lysis that systemic infusions, and reduces complications. The majority of chronic patients treated had DVT limited to the iliac veins and required stenting. Early aggressive therapy may spare the patient from the life-long disability associated with the post-phlebitic syndrome, by preserving valve function and eliminating the venous outflow obstruction. Immediate postthrombolysis venography can evaluate the underlying vein and assess the need for adjunctive stent placement. Longer term follow-up is necessary to evaluate the rate of recurrent DVT, and the frequency of chronic venous insufficiency compared to patients treated with anticoagulation alone.

References

1.Scully MF, Lane DA, Sagar S, Thomas DP, Kakkar VV. Intermittent plasminogen-streptokinase treatment of deep vein thrombosis. Thromb Haemost 1977;37(1):162-9.
2.Schulman S, Lockner D, Granqvist S, Bratt G, Paul C, Nyman D. A comparative randomized trial of low-dose versus high-dose streptokinase in deep vein thrombosis of the thigh. Thromb Haemost 1984;51(2):261-5.
3.Persson AV, Persson CA. Thrombolytic therapy for deep vein thrombosis. Am J Surg 1985;150(4A):50-3.
4.Scheffler P, Donecke P, de la Hamette D, Berberich R, Kramann B, Wenzel E. [Use of streptokinase and urokinase in deep venous thrombosis and pulmonary embolism: indications and clinical experience]. Z Gesamte Inn Med 1987;42(17):492-8.
5.Meissner AJ, Misiak A, Ziemski JM, Scharf R, Rudowski W, Huszcza S, Kucharski W, Wislawski S. Hazards of thrombolytic therapy in deep vein thrombosis. Br J Surg 1987;74(11):991-3.
6.Hirsch DR, Reis SE, Polak JF, Donovan BC, Goldhaber SZ. Prolonged bleeding time as a marker of venous clot lysis during streptokinase therapy. Am Heart J 1991;122(4 Pt 1):965-971.
7.Comerota AJ, Aldridge SC. Thrombolytic therapy for deep venous thrombosis: a clinical review. Can J Surg 1993;36(4):359-64.
8.Goldhaber SZ, Polak JF, Feldstein ML, Meyerovitz MF, Creager MA. Efficacy and safety of repeated boluses of urokinase in the treatment of deep venous thrombosis. Am J Cardiol 1994;73(1):75-79.
9.Semba CP, Dake MD. Iliofemoral deep venous thrombosis: aggressive therapy with catheter- directed thrombolysis. Radiology 1994;191(2):487-94.
10.Semba CP, Dake MD. Catheter-directed thrombolysis for iliofemoral venous thrombosis. Semin Vasc Surg 1996;9(1):26-33.
11.Semba CP, Murphy TP, Bakal CW, et al. Thrombolytic therapy with use of Alteplase (rt-PA) in peripheral arterial occlusive disease: review of the clinical literature. JVIR in press.
12.Martin M, Heimig T, Fiebach BJ, Riedel C. Fibrinolytic treatment with ultra-high streptokinase infusion via the dorsalis pedis vein offers no advantage over systemic infusion via the brachial vein in patients with deep vein thrombosis of the leg. Vasa 1996;25(3):275-8.
13.Verhaeghe R, Stockx L, Lacroix H, Vermylen J, Baert AL. Catheter-directed lysis of iliofemoral vein thrombosis with use of rt- PA. Eur Radiol 1997;7(7):996-1001.

43.3

Mechanical thrombectomy

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Learning Objectives:
To learn which patients with Deep Venous Thrombosis (DVT) are most likely to benefit from pharmaco-mechanical thrombectomy (PMT); how I perceive and perform it.
Topics
1. Indications for Rx
2. Patient selection
3. Diagnosis
4. Access site
5. Device options
6. Thrombolysis options
7. Initial planning
8. When to finish
9. Post procedure follow up
10. Complications, common mistakes
11. Financial implications
12. Literature review

1. Indications for Rx:

Definite:
1. Acute arterial or venous thrombosis with a threatened limb
2. Phlegmasia Cerulea Dolens

Probable:
1. Thigh (femoral) vein DVT
2. Axillo-subclavian DVT

I do not treat:
1. Below knee DVT
2. Life expectancy less than 2 weeks

2. Patient Selection:

The ideal patient is young, fit and has no prior history. In reality, few patients are like this. Most are old, and medically compromised. Apart

from that, there are no hard and fast rules, and the major advantage of PMT is that the usual rules of thrombolysis do not apply; for instance recent GI bleed/major operation is not a contraindication for the use of the pharmaco-mechanical method of treatment (at least a far as I am concerned!)

The Venous Registry (Mewissen, USA,1999) demonstrated that patients derived the most benefit from Catheter Directed Thrombolysis with a clot history of less than 10 days and this has been my experience. The exception is in patients in whom PMT is merely a prelude to placing venous stents, and there are certainly cases like this. I have also treated much older clot, but chronically scarred and thrombosed veins shrink down and PMT really only opens up a 5-10mm wide channel, and one might as well proceed directly to stenting without bothering with PMT.

3. Diagnosis

4. Access Site

Straightforward; US, CT, MRV. I only perform Venography when I am about to intervene. I do not use intravascular ultrasound, although it certainly has its proponents; largely in iliac vein stenosis uncomplicated by venous thrombosis.

I always perform an US the day of the procedure (you need a good machine with Color if available) and the critical element is to decide where to puncture. In practical terms I scan the groin and assess the common femoral vein, (superficial) femoral vein, and Greater Saphenous Vein. If thrombus involves the confluence of all three of these, then you need to puncture at least as low as the popliteal. At this stage, turn the patient over and look at the popliteal; if it is clear then you can go in here. If there is clot at this level then you need to go lower. I quite like the short saphenous vein provided the calf veins are clear. If there is extensive clot in the calf veins then this is the one area where I believe catheter directed thrombosis (CDT) still has a role. In these unusual circumstances I then puncture the posterior tibial vein at the ankle with a 4 F sheath and use a 50 cm long 4F MDT catheter to drip rtPa in at 1mg/hr with an initial spray of 5mg. I drip this overnight starting the case at about 5pm and bring the patient back the following a.m. early. I have only had to do this once in over 40 cases of PMT.

I almost never go from the contralateral side (unless the patient cannot lie prone) and again, rarely from the jugular unless performing an IVC recanalisation. Traversimg valves is a tedious and unrewarding experience. I hate clichés but "Go with the flow".

The vast majority are therefore from an ipsilateral popliteal approach.

5. Device Options

Although I have used most of the different PMT devices, the one with which I have by far the most experience is the Bacchus Trellis® device (www.bacchusvascular.com).

Local conditions often dictate to an extent on how one practices IR, and I find it difficult to get patients into ICU for thrombolysis; and equally I find it impossible to gain acceptance on the ward with indwelling sheaths and thrombolysis. I have therefore switched largely to one session treatments. The Trellis® is designed for this.

6. Thrombolysis Options

Although we have access to Urokinase, I learned to use tPa in 1992 and never really got comfortable with Urokinase. I think tPa works slightly faster but may cause more bleeding if used over a prolonged period. For this reason, it is better suited to PMT- i.e. short sharp shock rather than dribble drip.

With the Trellis device the total does administered over each segment is of the order of 3-6mg. Only a tiny fraction of this ever even has the **potential** to become systemic. Initially I used to check FDPs and Fibrinogen but they were always normal and I soon abandoned this. (One less thing to remember; another cost saving!!). I have only ever used tPa which is available in 10mg vials. (If you came here to learn about Tenectplase or others I am sorry go have a glass of vino and visit the Colisseum)

7. Initial planning

Assuming a popliteal vein puncture I use a 5F Angiodynamics micropuncture set and then insert a 5F sheath. Initial venography will determine the length of clot to be treated. If in doubt I advance a 65cm Kumpe catheter (Angiodynamics) up to the groin over a wire and then repeat the venogram. The Trellis then comes in 2 shaft (80/120cm) lengths and 2 treatment lengths (15 and 30cm). I insert a 9F sheath and then begin treatment.

VIDEO presentation:

(of the Trellis® you eejit, not me surfing or golfing, this is CIRSE come on be serious)

A stent is almost always required, particularly for the caval and ilio-femoral region. Use large stents-20mm in the IVC, 16mm in the CIV and so on.. I use self expanding stents mainly and Wallstents (Boston Sci) are the only ones that are big enough and long enough for my purposes. They continue to expand and therefore SHORTEN overnight, so if stents overlap, make sure they overlap by at LEAST 2 cm. Infra-inguinal stents can be used, but patency diminishes (personal experience, venous registry).

8. When to finish

I will not finish until I have rapid in line flow which clears in less than 3 seconds on a 20cc hand injection from a popliteal injection. If I do not adhere to this my results have been poor. Rapid cephalad flow is the SINGLE biggest determinant of procedural success.

I have never had a bleeding complication from PMT. I have never had a clinically evident PE either. The design makes embolisation unlikely.

I personally "Perclose" (Abbott Vascular) the puncture site; apply a bandage, and then apply a thigh high 20mm compression stocking and walk the patient back to the ward. I use little sedation- or even reverse- if possible to achieve this. I encourage them to leave the hospital that day if possible.

9. Post procedure follow-up:

CD US on day 1 . **No exceptions**. If it has re-thrombosed then go back in immediately- do not wait. Repeat CDUS at 1 month, 3 months and 6 months. The presence of stents makes iliac veins in particular easy to identify. MR Venography is NOT useful due to signal dropout but CT Venography is.

10. Complications, common mistakes

Not allowing for stent shortening

Not pursuing it until I have rapid flow

Using stents that are too small

Stopping because of patient discomfort (especially chronic IVC)

Not performing PMT the next day when Day 1 CDUS showed acute occlusion.

Not extending my stent low enough into infra inguinal segment if necessary.

11. Financial implications

The device costs about €1200. 10mg tPa is cheap. The various wires and catheters are not expensive. Stents are about €1000 each and I use two on average. Follow up US *3_say €500. Total cost maximum: €5,000.

Traditional CDT requires an admission to ICU, and although this cost varies it will be at least €2500 per day. The average length of time used in treatment in most CDT series is of the order of 30-40 hours, so this is at least 2 days in ICU. There are more sheaths, more wires and probably the same number of stents. Follow up - similar. Minimum cost: €8,000.

References

Radiology. 1999 Apr;211(1):39-49. Erratum in: Radiology 1999 Dec;213(3):930.
Mewissen MW, Seabrook GR, Meissner MH, Cynamon J, Labropoulos N, Haughton SH.
Catheter-directed thrombolysis for lower extremity deep venous thrombosis: report of a national multicenter registry.
AJR Am J Roentgenol. 2000 Sep;175(3):732-4.
Mesenteric and portal venous thrombosis treated by transjugular mechanical thrombolysis.
Sze DY, O'Sullivan GJ, Johnson DL, Dake MD.
J Vasc Interv Radiol. 2000 Jul-Aug;11(7):823-36.

Endovascular management of iliac vein compression (May-Thurner) syndrome.
O'Sullivan GJ, Semba CP, Bittner CA, Kee ST, Razavi MK, Sze DY, Dake MD.
J Vasc Interv Radiol. 2000 Nov-Dec;11(10):1297-302.
Patel NH, Stookey KR, Ketcham DB, Cragg AH.
Endovascular management of acute extensive iliofemoral deep venous thrombosis caused by May-Thurner syndrome.
J Vasc Interv Radiol. 2005 Jun;16(6):815-22.
Kwak HS, Han YM, Lee YS, Jin GY, Chung GH.
Stents in common iliac vein obstruction with acute ipsilateral deep venous thrombosis: early and late results.
J Vasc Interv Radiol. 2004 Jun;15(6):565-74.
Vedantham S, Vesely TM, Sicard GA, Brown D, Rubin B, Sanchez LA, Parti N, Picus D.
Pharmacomechanical thrombolysis and early stent placement for iliofemoral deep vein thrombosis.
J Vasc Surg. 2002 Jan;35(1):8-15.
Raju S, Owen S Jr, Neglen P.
The clinical impact of iliac venous stents in the management of chronic venous insufficiency.
Radiology. 1994 May;191(2):487-94.
Semba CP, Dake MD.
Iliofemoral deep venous thrombosis: aggressive therapy with catheter-directed thrombolysis.
Techniques in Vascular & Interventional Radiology. (2000): 3,1; 45-53
G.J. O'Sullivan
Endovascular Management of Chronic Iliac Venous Occlusion
Tech Vasc Interv Radiol 2004 Jun;7(2):79-85
Murphy KD

Special Session
Controversies in Non-Vascular IR

44.1a

Cutting needles are all you need for percutaneous biopsy ?

Pro: Cutting needles

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In the early years of percutaneous biopsy, biopsy with thin needles (20-25 gauge) was the norm. Thin needles obtained a cytologic aspirate which is often sufficient to confirm or refute a diagnosis of malignancy, but which often is not able to provide a specific histologic diagnosis. Factors that influence the accuracy of fine needle biopsy include: whether or not a cytopathologist is present at the time of biopsy to advise until a specific diagnosis is reached, the experience of the cytopathologist and the type of lesion being biopsied. Very scirrhous lesions, such as pancreatic cancer can be difficult to aspirate with a fine needle, and accuracy consequently suffers. Similarly, very vascular lesions can also be difficult to aspirate because of blood contamination. As you may expect there is a wide reported accuracy varying from 65% to almost 90%.
In recent years, spring activated cutting needles have been developed to obtain core biopsies. These are now available in 20 gauge sizes. Therefore, the distinction between fine needle aspiration biopsy and core biopsy (large gauge biopsy) is less distinct. Traditionally, large gauge biopsy was considered to be biopsies obtained with 12 - 19 gauge needles. These are usually of a TRU-CUT type. Now that a spring activated 20 gauge TRU-CUT biopsy needle is available, small 20 gauge TRU-CUT cores can be obtained from most lesions in the body, with the advantages of:
1. Obtaining a core of tissue.
2. A complication rate that is similar to fine needle biopsy.
We have been using 20 gauge TRU-CUT needles for most abdominal biopsies over the last four to five years. From a total of 145 abdominal biopsies the accuracy of 20 gauge TRU-CUT core biopsy was 95.8%. In a subgroup of 37 patients with pancreatic masses, the diagnostic accuracy of 20g trucut biopsy was 89.5%. In situations where a cytopathologist is not in attendance for fine needle aspiration biopsy a TRU-CUT biopsy with a 20 gauge spring activated needle can increase the yield from biopsy as it preserves the architecture of the lesion and often allows percise cystologic diagnosis of tumor type.

44.1b

Cutting needles are all you need for percutaneous biopsy ?

Pro: Fine Needles

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Introduction
Percutaneous biopsy has emerged as an invasive procedure of choice for the diagnosis of a great number of malignant and benign diseases. Increased expertise of cytopathologists and operators and advances in imaging technique guidance has mainly contributed to the growing acceptance of the method.
The use of various needle sizes, tip design and sampling mechanism has been reported in percutaneous biopsy.
It is well known for someone who is involved in such procedures, that there is a wide variety of needles that could be used in percutaneous biopsies and sometimes this variety could be confusing to the operator.
It is noteworthy that the existence of such broad spectrum does not only serve for commercial purposes. Each needle could be useful, depending on the kind, the topography and the size of lesion, as well as on the correlation to nearby organs and the risk of possible complications.
The ideal biopsy needle should maximize the specimen obtained, in order to increase the diagnostic accuracy of the method and minimize the complication rates, thus making the procedure safer for the patient.
Biopsy needles
Percutaneous biopsy needles are generally divided into two main categories:
A. **Aspirating needles**, which are used to obtain cytologic specimens and in some cases tissue fragments for histologic sample. Aspirating needles are 19G or less in diameter, i.e. 21G or 22G. Usually they have the Ciba type design, although other types of tip design also exist.
B. **Cutting needles**, which are used to obtain and provide core specimens, are convenient for histologic examination. The most widely used cutting needles consist of a variety of versions of the Tru-Cut needle, which have been placed into a handle with a spring loaded mechanism which fire the inner notched stylet and the outer cutting cannula in rapid succession at the press of a button . The diameter of these needles range from 19G to 18G while they are available in 16G or in 14G.
Concerning the diameter, 19G is the borderline between aspirating and cutting needles.
Every system has advantages and disadvantages taking into account the target lesion.
Techniques of aspirating needles
Single pass and multiple passes are routinely used with the aspirating needles. For the optimal sampling in a biopsy, the coaxial technique is used.
Coaxial technique consists of insertion of a thin inner needle through a larger outer needle placed at the edge or within the lesion. This technique presents numerous advantages over the single needle technique with the main advantage being the ability for multiple sampling from the biopsy site with the inner needle. On top of that, additional material could be aspirated from the outer needle at the end of the procedure. Moreover, this technique reduces the number of insertions in various

organs and subsequent normal tissue traumatization. Another advantage of the technique is the ability to reposition the needle in cases where correction of its course is needed.
In order to obtain more sampling material, suction is generated by a syringe, applying back and forth movements, rotation of the needle and multiple needle passes. Careful sampling from multiple different parts of the lesion should be made, in order to minimize the possibility to take sample from necrotic material, cavitated lesion areas or reactive zone of the tumor. For example and as a recent study has shown, the majority of lung carcinomas contain a reactive zone of variable thickness, representing about 10% of the total tumour diameter [8], reinforcing the concept that multiple sampling should be done in several parts of a lesion and also make sure that the wall of a necrotic or cavitary lesion should be carefully sampled.
All the aforementioned techniques improve the yield of the method.
Ideally the tissue specimen is stained and examined by a cytopathologist at the time of the procedure. This practice enables rapid assessment of the specimen and in cases of non-diagnostic material, repeated sampling with a larger aspirating needle or, if necessary, with cutting needle biopsy can be performed immediately.
Advantages of aspiration needles
- Less traumatic
- Less major complications
- Ability to penetrate in deeper locations
- They are more flexible and present a better control along the needle track

They usually provide adequate material for cytologic examination, immunocytochemistry evaluation and in some cases for histologic examination.
Disadvantages of aspiration needles
Small amount of sampling material which in certain cases is inadequate to establish diagnosis from the histologic examination, especially in
- Lymphoma
- Majority of benign lesions
- Malignant cases, where precise determination of the cell type is of crucial importance for the clinical management.

CONCLUSION
Percutaneous biopsy is a well-established technique for the diagnosis of a great number of malignant and benign diseases. Technical improvements of guidance, needle design and pathological techniques may contribute to push back any technical limitations therefore to decrease the rate of biopsies technically impracticable, as well as the rate of complications and their severity.
Both biopsy techniques are complementary. The final decision to use one or the other depends on personal experience, the risk of complications and the availability of the pathologist on - site.
In cases of suspected lymphoma or benign lesion, the use of core needle is recommended as first line approach as well as in cases of absence of pathologist on site. When there is a strong suspicion of malignancy and the cytopathologist is readily available, fine needle aspiration is primarily suggested.
In every case the risks must be carefully weighted against the benefits.

References

1. J.S. Klein and M.A. Zarka , Transthoracic needle biopsy. Radiol. Clin. North Am. 38 (2000), pp. 235-266.
2. E.H. Moore , Technical aspects of needle aspiration lung biopsy: a personal perspective. Radiology 208 (1998), pp. 303-318.
3. J. Greif, S. Marmur, Y. Schwarz, A. Man and A.N. Staroselsky , Percutaneous core cutting needle biopsy compared with fine-needle aspiration in the diagnosis of peripheral lung malignant lesions: results in 156 patients. Cancer 84 (1998), pp. 144-147.
4. J. Greif, S. Marmor, Y. Schwarz and A.N. Staroselsky , Percutaneous core needle biopsy vs. fine-needle aspiration in diagnosing benign lung lesions. Acta. Cytol. 43 (1999), pp. 756-760.
5. A.N. Staroselsky, Y. Schwarz, A. Man, S. Marmur and J. Greif , Additional information from percutaneous cutting needle biopsy following fine-needle aspiration in the diagnosis of chest lesions. Chest 113 (1998), pp. 1522-1525.
6. T.C. McLoud , Should cutting needles replace needle aspiration of lung lesions?. Radiology 207 (1998), pp. 569-570.
7. D.F. Yankelevitz, M. Vazquez and C.I. Henschke , Special techniques in transthoracic needle biopsy of pulmonary nodules. Radiol. Clin. North Am. 38 (2000), pp. 267-279.
8. L.J. Layfield, K. Liu and J.J. Erasmus , Radiologically determined diameter, pathologic diameter, and reactive zone surrounding pulmonary neoplasms: implications for transthoracic fine-needle aspiration of pulmonary neoplasms. Diagn. Cytopathol. 21 (1999), pp. 250-252.
9. R.J. Zarbo and C.M. Fenoglio-Preiser , Inter-institutional database for comparison of performance in lung fine-needle aspiration cytology: a College of American Pathologists Q-Probe Study of 5264 cases with histologic correlation. Arch. Pathol. Lab. Med. 116 (1992), pp. 463-470.
10. J.H. Austin and M.B. Cohen , Value of having a cytopathologist present during percutaneous fine-needle aspiration biopsy of lung: report of 55 cancer patients and meta-analysis of the literature. Am. J. Roentgenol. 160 (1993), pp. 175-177.
11. A.R. Padhani, W.W. Scott, Jr., M. Cheema, D. Kearney and Y.S. Erozan, The value of immediate cytologic evaluation for needle aspiration lung biopsy. Invest. Radiol. 32 (1997), pp. 453-458.

44.2a

TIPS or Endoscopic treatment for variceal rebleeding?

Pro: Endoscopic treatment

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Portal hypertension is a major complication of cirrhosis, and responsible for major complications such as massive gastrointestinal haemorrhage, ascites and hepatorenal syndrome.
Bleeding from oesophageal or gastric varices remains one of the most challanging emergencies in internal medicine, and potentially requires the input of a number of specialists in providing optimal patient care. In contrast to most other types of upper gastrointestinal haemorrhage, which tend to stop spontaneously, only 50% of variceal bleeding episodes stop without any further intervention. General management includes care in a high dependency area, effective resuscitation, early diagnosis and treatment. Antibiotic prophylaxis is essential. Protection of the airway may be important to reduce the risk of pulmonary aspiration. Specific pharmacotherapy with intravenous terlipressin (a vasopressin analogue which can be administered in boluses rather than by infusion) is widely used, as it is the only pharmacological agent shown to reduce mortality. It may also have beneficial effects in preventing or reversing hepatorenal syndrome, which is a potentially catastrophic complication. The favoured endoscopic therapy fro oesophageal varices is endoscopic variceal ligation (EVL), which is more effective and less associated with oesophageal ulceration than sclerotherapy. Endoscopic therapy is less successful in bleeding oesophageal varices, where injection of tissue-glue is generally favoured. Endoscopic therapy is generally used in addition to pharmacotherapy.
After first-line endoscopic and pharmacological therapy, 10-20% of bleeding remains uncontrolled.
Predictive factors of failure to control bleeding are active bleeding at endscopy,-oozing or spurting, severity of liver disease, portal venous pressure $\geq$ 20mmHg, and bacterial infection.
The overall risk of rebleeding is 8-20%, with the highest risk in the first 5 days.

During the weeks after EVL, recurrent variceal haemorrhage may occur from varices and EVL ulcers, though the latter are less common than with endoscopic sclerotherapy. The mortality rate in these patients is high. Balloon tamponade can achieve transient haemostasis in most cases, although airway compromise and subsequent rebleeding are considerable problems. Definitive treatment options include pharmacologic therapy, endoscopic therapy, surgical shunt, and TIPS. Factors such as local expertise and availability may be important in deciding which therapy to use.

A diagnostic endoscopy to confirm the source and cause of the rebleeding is essential. The source of rebleeding may be ulceration related to endoscopic therapy

At endoscopy, therapeutic endoscopic techniques such as sclerotherapy or EVL may be attempted for a second to control the haemorrhage, if the varices apppear amenable and there are no obvious local endoscopic complications. Failure to control haemorrhage within a total of 2 sessions of endoscopic therapy, or continued or recurrent bleeding is an indication for further therapy, such as TIPS or, if this is not available, a staple transection of the oesophagus. In this circumstance, TIPS can be placed in > 90% of patients and has a > 90% success rate and is generally the treatment of choice. A difficulty with TIPS in the acutely bleeding patient is that the mortality is high, especially in patients with higher Child-Pugh scores, who have developed sepsis, require inotropic support or ventilation, or have declining renal or liver failure. This group of patients has a very high mortality, and is difficult to study in controlled clinical trials.

It is crucial to perform TIPS at an appropriately early stage before potentially lethal complications such as aspiration pneumonia, infection, renal or multi-organ failure occur. Although TIPS may be associated with a reduced risk of rebleeding, TIPS was not associated with a reduction in mortality, which is primarily related to the severity of the underlying liver disease. TIPS is advantageous compared with surgical portal decompression or oesophageal transection, because of the lack of necessity for general anaesthesia and a lower procedure-related risk, especially in patients with advanced liver disease.

TIPS does bring its own potential problems, especially hepatic encephalopathy, but its utility in patients with failed endoscopic therapy for variceal haemorrhage is clear.

Frequently, encephalopathy can be successfully managed by oral lactulose, temporary protein restriction and attention to other factors which may contribute to encephalopathy or liver function. Occasionally refashioning of TIPS to a narrower diameter is required.

TIPS, as a first line treatment of prevention of rebleeding, appears to offer a reduced risk of rebleeding compared with endoscopic therapy, but does not appear to offer a survival advantage and is associated with a much higher rate of potentially disabling encephalopathy.

TIPS has a greater and earlier role in the management of gastric than oesophageal varices, in which endoscopic therapy is much less successful compared with oesophageal varices.

The prevention of recurrent variceal haemorrhage after the cessation of the initial episodes offers several options such as non-selective beta-blockade, EBL, sclerotherapy and TIPS. TIPS is associated with a lower rebleeding rate compared with endoscopic therapy, but encephalopathy is commoner. Given that a small number of patients have a level of encephalopathy which is disabling, many hepatologists currently the endoscopic option, which has a proven track record of success.

It is also worth commenting that such patients should be under the care of a specialist in liver disease. Consideration of referral for liver transplantation is important in patients with critical advanced liver disease.

In summary, TIPS is the rescue therapy of choice in patients who have failed endoscopic and pharmacological therapy. It is widely used when variceal haemorrhage perisists after 2 sessions of endoscopic therapy, usually combined with pharmacotherapy.

44.3a

Pro: Is Colonic stenting before colon resection necessary?

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Introduction

Acute obstruction of the large bowel usually requires urgent surgical treatment. It is caused by a number of benign and malignant diseases, but by far the most frequent etiology is colorectal carcinoma . Eight to 29 % of these patients present with acute obstruction and have a poor prognosis. Other causes include malignant infiltration from adjacent malignant tumor or metastatic involvement. Benign conditions such as diverticulitis are less frequent.

Patients with acute obstruction generally have a poor prognosis because of the poor general condition related to dehydration and electrolyte imbalance. The conventional treatment in these patients usually consists of a multistage (two to three) surgical intervention with an initial defunctioning colostomy to relieve acute large bowel obstruction. According to a recent German multicenter study the rates of mortality and morbidity in emergency operations for colonic cancer are approximately 12 % and 39 % respectively, decreasing to 3.5 % and 23 % when the patients are treated electively [1]. A further single center study showed even more dramatic results when comparing emergent surgery versus elective operation in colorectal carcinoma: Mortality was reduced from 34% to 7% and postoperative morbidity from 64% to 24% [2]. Furthermore, it has been shown that the best oncologic approach to obstructing carcinoma of the colon is primary resection without colostomy [3]. Finally stoma complications following colostomy particularly in elderly patients are quite significant and may add to a reduced quality of life [4].

Therefore, self-expanding metallic stents have been used for several years now at many centers for rapid relief of obstruction to allow the patient to be prepared for an elective tumor resection with primary anastomosis thereby obviating a temporary or permanent colostomy.

Methods of Stent placement

The diagnosis of acute colonic obstruction is made by plain film radiography and an enema with water soluble contrast medium. Colonoscopy and biopsy can help to determine the exact location and nature of the obstruction. Other diagnostic and staging procedures such as abdominal ultrasound, computed tomography etc. may be delayed until after stent placement. The stenosis can be negotiated with radiological techniques alone or with combined endoscopic-radiological methods. With the patient in supine or oblique decubitus position and under adequate sedation with midazolam and analgesia the stricture is negotiated with stearable or hydrophilic guidewires in combination with torque-control angiographic catheters. For stent placement a superstiff guidewire has to be used. As most colonic cancers are located in the rectosigmoid region these stenoses can usually be negotiated with interventional catheter techniques alone. However, we have found it convenient to use a combined endoscopic-fluoroscopic approach particularly for lesions beyond the distal descending colon. The endoscope is helpful as a stiffening tool for managing the rectosigmoid curvature, to straighten out kinks and to deal with elongation of bowel. It serves as a guiding tool, especially in lesions proximal to the descending colon and around the splenic flexure. If both, the facilities and the expertise of fully trained interventional radiologists and gastroenterologists are available, this combination would seem optimal for treating obstructing lesions throughout the colon.

Immediate post procedural care consists of recording vital signs, treatment of electrolyte imbalance and intravenous administration of fluids. Patients are then prepared for elective one-stage surgery receiving adequate bowel preparation for usually 2-5 days. Plain films of the abdomen are routinely obtained after 24 to 48 hours to assess adequate position and expansion of the stent and resolution

of the radiological signs of ileus.

Results and Discussion

The placement of self-expanding metallic stents for preoperative decompression of acute colon ileus as a minimally invasive and low risk alternative to emergent surgery with a high technical (63 - 100%) and clinical (84 - 100%) success rate as has been shown by several authors. Two review articles by Mauro et al [5] and Zollikofer et al [6] compiling a total of 117 and 140 patients respectively found the clinical success to be 89% to 96%. The technical success rate for crossing the lesion with a guidewire and successive stent placement was 90% and 89 % respectively. Khoth et al [7] reported a preoperative success of 85%, where 95% of the patients had a one-stage surgery. The majority were treated with Wallstents (mainly of the esophageal, vascular or ,,Enteral" type) with initial success rates of 96% to 100 %. No significant difference in the results between Z-stents or the large caliber Wallstents could be found in the above mentioned reviews.

Experience with stenting of obstruction in inflammatory stenosis due to diverticulitis is still limited but seems feasible. Three of the four patients which we stented for acute diverticulitis, with short stenotic lesions, had fast relief of obstruction, whereas a fourth patient with a long segment stenosis had no significant improvement.

The overall rate of severe complications ranges from 0 % to 32 % (mean 10 %) but is usually less than 10% in experienced hands [5-7]. Perforation caused by guidewire manipulation usually has no sequelae, whereas perforation caused by balloon dilatation before or after stent placement prove to be more severe, requiring surgery in the majority of cases. Therefore, we never use balloon dilatation before stent placement, and only rarely following implantation if the stent does not expand adequately. Stent migration occurs in 0 % to 26 % (mean 6.5 %). It seems directly related to the stent diameter and the severity of the stenosis. To keep the migration rate as low as possible stent diameters of not less than 22-25mm and a length of at least 6cm seem advisable. Prophylactic stenting for subacute ileus with incomplete obstruction or non-circular lesions should be avoided.

Inadequate bowel decompression is usually related to stent malpositioning, incomplete expansion or stent migration [5-7]. This may be corrected by additional stent placement.

Most recently a new type of flexible colonic nitinol stent with a diameter of 25mm and lengths of 6, 9 an 12cm has become available (Wallflex™ Enteral Stent, Boston Scientific) replacing the "old Enteral" Wallstent. It has blunt edges which should prevent the danger of perforation, a problem which could occur with the old model. The increased diameter, flared end and improved flexibility and expanding force may also reduce the risk of stent migration

Preoperative stenting to decrease the high complication rate of emergent surgery for diverticulitis with severe colonic obstruction can probably be done safely, provided the inflammatory tumor obstruction of the bowel lumen is short (≤ 5cm) and elective surgery after treatment with antibiotics is performed in due course.

Cost-effectiveness and evidence based treatment to day is a mayor issue to day and naturally also applies to colonic stenting. Targownik et al [8] in their recent report have calculated cost effectiveness in a decision analysis concerning two different strategies of treating acute left-sided malignant obstruction: Emergent colonic stenting followed by elective surgical resection and primary anastomosis versus emergent surgical resection followed by diversion (mostly Hartmann's procedure) or primary anastomosis. They found that in the colonic stent group there were 23% fewer operative procedures per patient (1.01 vs 1.32), a 32% reduction in temporary stoma requirement (7% vs 43%) and a lower procedure mortality (5% vs 11%). With an overall reduction in cost of 8.5% the authors concluded that stenting followed by elective surgery appears more effective and less costly.

In a retrospective study at our own institution comparing a cohort of 27 patients undergoing preoperative stenting with a group of 18 patients having surgery only, a cost saving of 21.9% could be calculated. This was mainly due to shorter hospitalization time and lower surgical fees. 86% of the patients who underwent surgery after stent placement had a primary anastomosis and only 14% needed a temporary colostomy. In addition postoperative complications were significantly higher in the surgery only group (61% vs 22%) which was also reflected in only three reinterventions in the stent group (11%) versus nine (50%) in the surgical group.

Preoperative colonic stenting is safe and cost-effective

In summary, the preoperative use of self expanding metallic stents in obstructive colorectal cancer, particularly of the descending and sigmoid colon, is a cost-effective, minimally invasive alternative to emergent surgery. It buys time for improving the patient's overall condition and staging of the disease enabling the performance of elective one-stage surgery with tumor resection and primary anastomosis after appropriate bowel cleansing, which is much more comfortable for the patient than emergent surgery. Lower rates of mortality and morbidity can be expected. Therefore, preoperative stenting in acute leftsided colonic obstruction should be the first line treatment instead of conventional staged surgical procedures.

References

1. Riedl S, Wiebelt H. Postoperative Komplikation und Letalität in der Therapie des Kolon-Karzinoms. Chirurg 1995; 66(6): 597-606
2. Smothers L et al. Emergent surgery for colon carcinoma. Dis Colon Rectum 2003 ;46 : 24-30
3. Fielding LP, Wells BW. Survival after primary and after staged resection for large bowel obstruction caused by cancer. Br.J.Surgery 1974; 61: 16-18
4. Londono-Schimmer EE, Leong APK, Phillips RKS. Life table analysis of stomal complications following colostomy. Dis Colon Rectum 1994; 37: 916-920
5. Mauro MA, Koehler RE, Baron TH. Advances in gastrointestinal intervention: the treatment of gastroduodenal and colorectal obstructions with metallic stents. Radiology 2000; 215: 659-669
6. Zollikofer CL, Jost R, Schoch E, Decurtins M Gastroduodenal and Colonic Stents: Review Article. Semin Intervent Radiol 2001;18:265-280
7. Khot UP, Lang AW, Murali K, Parker MC. Systematic review of the efficacy and safety of colorectal stents. Brit J Surg 2002; 89(9): 1096-1102
8. Targownik LE, Spiegel BM, Sack J, Hines OJ, Dulai GS, Gralnek IM, Farrell JJ Colonic stent vs. emergency surgery for management of acute left-sided malignant colonic obstruction: a decision analysis. Gastrointest Endosc 2004; 60: 865-874

Special Session
Vascular Imaging 1: Imaging of the Legs

50.1

Tips to improve MRA

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Vascular imaging 1: Imaging of the legs

Tips to improve MRA

Since its first description in the early nineties, contrast-enhanced MR angiography has shown an exciting evolution and plays now a dominant role in state-of-the-art vascular imaging.

Because of its non-invasiveness and high diagnostic accuracy, contrast-enhanced MR angiography has caused a revolution in the diagnostic and post-treatment work-flow for patients suffering from arterial diseases of the lower extremities.

Despite the broad clinical use of this technique for imaging the arteries of the legs, the method is not without limitations or problems.

Thus this presentation should be focused on state-of-the-art imaging of the arteries of the legs by means of contrast-enhanced MR angiography and should discuss different techniques and tricks to increase diagnostic

accuracy and to avoid non-diagnostic examinations.
Although contrast-enhanced MR angiography became the leading MR angiography technique for the arteries of the body within a very short time after its first publication, its use for the peripheral arterial tree was hampered for different reasons. In the beginning, multiple acquisitions including multiple contrast bolus injections were needed for the imaging of the entire peripheral arterial tree combined with increased acquisition time and increased background noise for the second and the third acquisition due to the repeated injection (so called "MultiStation" protocols). The availability of so called "moving-table" or moving-bed" techniques represented a real breakthrough for the establishment of contrast-enhanced MR angiography in the clinical routine for the management of patients suffering from peripheral arterial disease. With such techniques, more than one field-of-view can be imaged during the injection of one large single contrast bolus.
However, even using such automatic techniques for moving-bed or moving-table imaging, which are provided by different manufacturers, imaging of the complete peripheral arterial tree with homogeneous accuracy in all levels is still challenging due to the anatomical differences among the peripheral vasculature. The calf and pedal region is the target region for most of the research on peripheral MR angiography due to its special anatomical issues. The reason for that is the small calliper of the calf arteries and the complex anatomical situation for the pedal arteries with their in-plane orientation. Thus, many institutions use modified techniques combining moving-bed techniques with multistation protocols (so called "hybrid techniques"). Additionally to the general idea of combining a moving-bed acquisition with a single station contrast-enhanced MR angiography of the calf arteries prior or after the moving-table scan many different techniques and innovations have been reported recently. To improve the visualization of the distal arteries, the research groups try to optimize all the parameters which determines the quality in contrast-enhanced MR angiography. Thus, most of research is focused on reducing the acquisition time, to increase the spatial resolution, to increase anatomical coverage and to reduce venous overlay.
Within this presentation, the recently published techniques dedicated to increased diagnostic accuracy should be presented.
In contrast-enhanced MR angiography image acquisition is limited to a small time window during the arterial first pass of the extracellular contrast agent. However, since three field-of-views are acquired for peripheral MR angiography during the injection of one large single contrast bolus, the acquisition is to long with respect to the arterial first-pass. Thus, venous overlay is a significant problem especially for the third (calf) region. This problem is of increased importance in patients with advanced stages of peripheral arterial occlusive disease (pAOD IV). Different approaches to reduce venous overlay exist and should be combined for optimized imaging. First, hybrid techniques combining fast 2D acquisitions of the arteries of the pelvis and the thigh with high-resolution scans of the crural and pedal arteries during a second contrast injection provide a high spatial resolution with no venous overlay in the third field-of-view. Since subtraction techniques are used, the venous enhancement due to the previously administered contrast agent is not a major issue. With such technique, even the pedal arteries can be visualized [1].
Using parallel imaging techniques, acquisition time can be further reduced, but this reduction is combined with an even reduced signal-to-noise (SNR) ratio. However, such techniques can be used to achieve higher spatial resolution within the same acquisition time [2 - 4].
Additionally, a midfemoral venous compression was introduced to slow down the circulation time and thus to decrease venous overlay. In this technique, veins at the mid-thigh are compression by means of an inflatable cuff, and significantly reduced venous overlay has been reported recently [5 - 6].
Another approach to achieve increased spatial resolution is the use of blood pool agents, since the long circulation time allows a long acquisition time with high resolution [7 - 8]. However, complex discrimination between arteries and veins is mandatory using such agents, which might be time consuming.
One research group reported recently the possibility of intra-arterial administration of gadolinium during contrast-enhanced MR angiography to achieve a more exclusive arterial enhancement combined with a maximum of resolution [9 - 10].
Due to the increased number of patients suffering from peripheral arterial occlusive disease, the demand for a robust, reliable, diagnostic and non-invasive diagnostic tool is of high demand. Although contrast-enhanced MR angiography of the peripheral arteries was established as the diagnostic method of first choice within only a few year, the performance of peripheral MR angiograms of high diagnostic quality is still a challenging procedure. Thus, many different groups focus their research on further technical improvement of this exciting technique to overcome existing limitations. Above mentioned new developments, new technical innovations as well as some Tricks and Tips should be presented and demonstrated by typical examples within this overview. Furthermore, future trends and still existing problems of this fast evolving non-invasive technique should be discussed.

References

1. Schmitt R, Coblenz G, Cherevatyy O, Brunner H, Frohner S, Wedell E, Karg G, Christopoulos G. Comprehensive MR angiography of the lower limbs: a hybrid dual-bolus approach including the pedal arteries. Eur Radiol. 2005 Dec;15(12):2513-24.
2. Hu HH, Madhuranthakam AJ, Kruger DG, Glockner JF, Riederer SJ. Continuously moving table MRI with SENSE: application in peripheral contrast enhanced MR angiography. Magn Reson Med. 2005 Oct;54(4):1025-31.
3. Bezooijen R, van den Bosch HC, Tielbeek AV, Thelissen GR, Visser K, Hunink MG, Duijm LE, Wondergem J, Buth J, Cuypers PW. Peripheral arterial disease: sensitivity-encoded multiposition MR angiography compared with intraarterial angiography and conventional multiposition MR angiography. Radiology. 2004 Apr;231(1):263-71;
4. De Vries M, Nijenhuis RJ, Hoogeveen RM, de Haan MW, van Engelshoven JM, Leiner T. Contrast-enhanced peripheral MR angiography using SENSE in multiple stations: feasibility study. J Magn Reson Imaging. 2005 Jan;21(1):37-45.]
5. Herborn CU, Ajaj W, Goyen M, Massing S, Ruehm SG, Debatin JF. Peripheral vasculature: whole-body MR angiography with midfemoral venous compression--initial experience. Radiology. 2004 Mar;230(3):872-8.
6. Zhang HL, Ho BY, Chao M, Kent KC, Bush HL, Faries PL, Benvenisty AI, Prince MR. Decreased venous contamination on 3D gadolinium-enhanced bolus chase peripheral mr angiography using thigh compression. AJR Am J Roentgenol. 2004 Oct;183(4):1041-7
7. Goyen M, Edelman M, Perreault P, O'Riordan E, Bertoni H, Taylor J, Siragusa D, Sharafuddin M, Mohler ER 3rd, Breger R, Yucel EK, Shamsi K, Weisskoff RM. MR angiography of aortoiliac occlusive disease: a phase III study of the safety and effectiveness of the blood-pool contrast agent MS-325. Radiology. 2005 Sep;236(3):825-33.
8. Li W, Tutton S, Vu AT, Pierchala L, Li BS, Lewis JM, Prasad PV, Edelman RR. First-pass contrast-enhanced magnetic resonance angiography in humans using ferumoxytol, a novel ultrasmall superparamagnetic iron oxide (USPIO)-based blood pool agent. J Magn Reson Imaging. 2005 Jan;21(1):46-52
9. Goyen M, Edelman M, Perreault P, O'Riordan E, Bertoni H, Taylor J, Siragusa D, Sharafuddin M, Mohler ER 3rd, Breger R, Yucel EK, Shamsi K, Weisskoff RM. MR angiography of aortoiliac occlusive disease: a phase III study of the safety and effectiveness of the blood-pool contrast agent MS-325. Radiology. 2005 Sep;236(3):825-33.
10. Li W, Tutton S, Vu AT, Pierchala L, Li BS, Lewis JM, Prasad PV, Edelman RR. First-pass contrast-enhanced magnetic resonance

angiography in humans using ferumoxytol, a novel ultrasmall superparamagnetic iron oxide (USPIO)-based blood pool agent J Magn Reson Imaging. 2005 Jan;21(1):46-52

Special Session
New IR therapies for Cancer

51.1

Principles of cancer treatment

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Principles of treatment - HEPATOCELLULAR CARCINOMA
The policy of universal vaccination at birth against the hepatitis B virus is starting to decrease the incidence of hepatocellular carcinoma (HCC). In Taiwan for example, among 6-14 year old children, the incidence has fallen from 0.7/100,000 (1981-86, prior to universal vaccination) to 0.57/100,000 (1986-90) and then to 0.35/100,000 since 1990 (Chang et al., *N Engl J Med* 1997; 336:1855-59). However, it will be many decades before this approach has a major impact on the adult incidence rate. Furthermore, hepatitis C virus infection and alcohol abuse related HCC will remain so that development of early diagnosis and effective treatment will continue to be challenges for many years to come. At the time of writing the only treatment that is widely accepted to be curative for HCC is surgical removal. Unfortunately, however, most patients will not be able to undergo conventional resectional surgery because of poor underlying liver function, extensive bilobar disease (and/or invasion of the major vessels), extrahepatic metastasis, or coexistent serious medical conditions. Even where resection is successful, recurrence occurs in over 50% of cases. The establishment of liver transplantation has overcome the problem of poor underlying liver function and among patients with small tumours (<5cms), in the absence of vascular evasion, 5 year survival rates of over 75% can be anticipated. However, results of transplantation for patients with large symptomatic tumours tend to be much poorer. Expense and lack of donors will seriously limit the role of transplantation in most areas of the world where HCC is common, as will the sheer number of patients involved.
Patients with decompensated cirrhosis (Child's grade C) are generally not offered 'active treatment' as their survival is related to the underlying liver disease rather than the tumour. Whilst there are currently a large number of experimental approaches to the treatment of unresectable HCC, most patients with adequate liver function and no extrahepatic metastases will receive thermal ablation (such as Radio Frequency Ablation, (RFA)), percutaneous ethanol injection (PEI), 'Transcatheter *A*rterial oily *C*hemoembolisation' (TACE) or some form of systemic therapy. PEI is simple, cheap and safe treatment for small tumours (<3cms in diameter) and is probably equivalent to surgical resection, but the procedure becomes much less effective and requires multiple sessions for larger tumours. In the latter group, (up to 5cm) radiofrequency ablation is increasingly being used. It is quick and effective but tumours that are close to the capsule or to large blood vessels are not appropriate; in the best hands results probably now approach those achieved by surgical resection. TACE is a complicated procedure that relies on a combination of intra-arterial chemotherapy, a drug carrier (usually lipiodol), and subsequent embolisation with one of several possible agents. This is the only procedure for which there is evidence from prospective randomized controlled trials, for improved survival in a small subset of highly selected patients. Although HCC is sensitive to cytotoxic agents, and complete remissions may occasionally be obtained, there is no evidence that overall survival is improved and this approach is now generally confined to clinical trials.
Keys to progress are early diagnosis and development of new systemic agents that can impact on advanced disease and prevent recurrence once local control has been achieved. Particularly with newer targeted therapies, assessment of response is proving problematical. Novel serological biomarkers and molecular imaging - both for diagnosis and monitoring the efficacy of new therapies are being intensively investigated, as are more imaginative designs for clinical trials.

51.2

Drug Eluting Particles

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Transarterial chemoembolization (TACE) is an effective option for HCC patients diagnosed at intermediate stage. Improved survival is due to the achievement of an objective treatment response reflected by extensive tumor necrosis. However, this beneficial effect in survival may be partially offset by the induction of side effects known as post-TACE syndrome. This usually resolves but in some instances the impairment of quality of life may counteract the expansion of life expectancy. In addition, since the tumor recovers again its arterial supply through newly developed collaterals, the response to treatment is lost during follow-up and TACE has to be repeated several times per year. According to these concepts, the strategy to improve the impact of TACE on survival should be based on the development of new strategies that, while increasing the antitumoral effect with longer duration of the response to treatment, would have a better tolerance with a low rate of side effects. Ideally, this enhanced initial effect should translate in a further delay in tumor progression after initial positive response and ultimately, into an improved survival.
Drug eluting beads is a promising tool to perform TACE. They combine several advantages by fulfilling most of the aims depicted before. The injection of homogeneously calibrated spheres that slowly release doxorubicin induce a very pronounced antitumoral effect that is recognised by major tumor necrosis on follow-up CTs. At the same time, the side effects due to the passage of chemotherapy to the systemic circulation are significantly diminished, and this allows an optimal tolerance to repeated treatment. Indeed, pharmacokinetic data show that the passage of chemotherapy to the systemic circulation is negligible even if using high doses and hence, chemotherapy related side effects are abolished.Future trials should compare this novel approach vs conventional TACE where obstruction is achieved by gelfoam injection and chemotherapy is emulsified in lipiodol. End-point of these studies should be time to progression and optimally survival. Other parameters such as initial response rate or quality of life should be considered less robust and amenable of several biases.

51.3

Interstitial radiotherapy

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Patients with cirrhosis of the liver, mainly of post-necrotic origin (virus B or C), have a high probability of presenting hepatocellular carcinoma (HCC) in the course of their disease. With a variable incidence according to the geographical zone, HCC is one of the most frequent primary tumors in the world. When the tumor has not spread out of the liver and has particular morphological characteristics, the patient can receive a curative treatment (e.g. transplant), but this occurs in less than 10% of cases. In patients with tumors of the gastrointestinal tract, the presence of hepatic metastases is a highly unfavorable prognostic factor. Without treatment, the possibility of survival at five years is null. Surgery, as in the case of HCC, is the best therapeutic option for such cases.
It is clear, therefore, that only a few patients with liver tumors (maybe

under 15%) can receive curative therapy. In the last few years a great variety of treatments have been used with varied results, among which we can highlight ablative percutaneous treatment (with radiofrequency or alcohol), intravenous or intraarterial chemotherapy, and embolization with particles. In recent years mixed techniques have been applied, such as radiofrequency associated with embolization or embolizing particles loaded with drugs that are slowly delivered to increase exposure of the tumor to the drug.
A relatively new option is the application of radiotherapy using embolizing particles and is called "Selective Internal Radiation Therapy" (SIRT). The efficiency of radiotherapy in the treatment of hepatic tumors is well known, but it is also known that the healthy hepatocytes are very sensitive to radiation. If this reliable therapeutic modality (radiotherapy) is to be applied, its effects on non-tumor tissues will therefore have to be decreased considerably.
The application of particles loaded with Ytrium 90 (Y90), a pure ß emiter, is an interesting possibility, because theoretically they will be deposited in the tumoral areas (hypervascular areas) and they will leave the healthy parts of the liver theoretically undamaged, since the non-tumor hepatic tissue will receive blood not only through the artery but also through the porta..
The application of intra-arterial radiotherapy with Y90 can be performed using two types of device now available on the market: TheraSpheres® (not sold in Europe) and SIR-Spheres® (on the market in Europe). The latter are particles of resin 35µ in diameter, which release ß radiation with a half-life of 64 hours and a maximum penetration of 11mm. The approximate number of particles used in each treatment is 50-60x10^6, and when diluted in water, they occupy a vial of approximately 2-3ml.
Treatment with SIRT is a clear example of the multidisciplinary approach because the selection and care of the patient, the calculation of the dose for each patient, the detailed anatomical study and the follow-up of the patient's progress, as well as the management of any complications, must be carried out by a team made up of oncologists, heptatologists, surgeons, specialists in nuclear science and interventional radiologists (IR). The IR plays an essential part because he or she has the special task of administering the treatment.
It is known that what could be called "normal vascular anatomy" is present in 60% of cases. However, 40% of patients will have aberrant hepatic arteries originating outside the hepatic artery, and a high percentage will have non-hepatic arteries which originate in the hepatic artery. Clear examples of this are the gastroduodenal and right gastric artery. The IR should ensure that the treatment only reaches the tumoral area, and avoid including in the treated area regions like the stomach, while making sure that the whole tumor receives a sufficient quantity of particles and therefore a high enough dose of radiation. It is therefore easy to imagine that a high degree of precision is needed in both the anatomical study and the ligation (embolization) technique used on the extrahepatic vessels.
Until now, the criteria for inclusion that have been used for SIRT treatment are: patients who had tumors that would not respond to other treatment or who had suffered relapse after treatment with known efficacy (e.g. chemoembolization), and who had good liver function (Child A, Bil<2g/dl).
The results are still preliminary but in HCC, responses have been observed in approximately 20% of cases, and control of the disease has reached 100%. Different clinical studies has been carried out valuing the efficacy of SIRT in patients with hepatic metastases of colo-rectal origin that had not responded to or had relapsed after previous treatment. There were responses in 89% of cases, with a mean survival of 21 months.
The complications related to the treatment can be divided into those that affect the liver and the extrahepatic complications. To avoid the administration of radioactive particles to extrahepatic territory that is highly sensitive (lungs and stomach), a simulation previous to the treatment will be carried out, by injecting macroaggregates of albumin loaded with Tecnetium 99. By this method, the liver-lung shunt can be assessed which, if greater than 20%, would contraindicate treatment with SIRT. Cases have been described of gastric ulcers caused by the passing of particles into the gastric area, as well as cholecystitis caused by entry of particles into the cystic artery.
One important complication is affection of the non-tumorous hepatic parenchyma by radiation. Cases of veno-occlusive disease, of radiation hepatitis and hepatic fibrosis have been described. With the objective of adjusting the therapeutic doses as accurately as possible and avoiding, as far as possible, the presence of liver and lung complications, careful dosimetric studies should be carried out.

51.4

Combined therapies

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Hepatocellular carcinoma (HCC) is the fifth most common cause of cancer, and its incidence is increasing worldwide because of the dissemination of hepatitis B and C virus infection. Patients with cirrhosis are at the highest risk of developing HCC and should be monitored every six months to diagnose the tumor at an asymptomatic stage. Accurate prognosis estimation at diagnosis is crucial for the therapeutic management of HCC patients. The Barcelona-Clinic Liver Cancer (BCLC) group has developed a system that stratifies patients into four categories, depending on the performance status, the severity of liver dysfunction caused by the underlying cirrhosis, and the kind of tumoral involvement, simultaneously setting prognosis and guiding treatment. In the BCLC staging classification, early stage includes patients with performance status of 0, Child-Pugh class A or B cirrhosis, and an asymptomatic single tumor smaller than 5 cm or as many as three lesions smaller than 3 cm each. These patients should be considered for any of the available radical treatment options. These include surgical resection, liver transplantation, and percutaneous techniques of tumor ablation. Indication to surgical resection is currently restricted to patients with solitary HCC and extremely well-preserved liver function, who have neither clinically significant portal hypertension nor abnormal bilirubin. Cadaveric liver transplantation is limited by the shortage of donors and living donor liver transplantation is still at an early stage of clinical application. As a result, percutaneous ablation plays a key role in the therapeutic management of early stage HCC.
Several methods for percutaneous treatment have been developed and tested clinically over the past years, including intratumoral injection of ethanol or acetic acid, and thermal ablation with radiofrequency, laser, microwaves, or cryosurgery. Percutaneous ethanol injection has been the most widely used technique. Several series have provided indirect evidence that ethanol injection therapy improves the natural history of HCC. Patients with early stage HCC may achieve a 5-year survival of 32-47%. The major limitation of ethanol injection is the high local recurrence rate, that may reach 33-43%. Radiofrequency (RF) ablation has emerged as the most powerful alternate method for percutaneous ablation, and is challenging the role of ethanol injection as the percutaneous treatment of choice for patients with early-stage tumors.
Patients with multinodular HCC with neither vascular invasion nor extrahepatic spread are classified as intermediate stage according to the BCLC staging system, provided that they have a performance status of 0 and Child-Pugh class A or B cirrhosis. Transcatheter arterial chemoembolization is the accepted palliative treatment option for patients intermediate stage HCC. Recently, following advances in RF technology, RF ablation has also been used to treat patients with intermediate-stage tumors. Preliminary reports showed that RF ablation performed after balloon catheter occlusion of the hepatic artery or transarterial embolization or chemoembolization resulted

in increased volumes of coagulation necrosis, enabling successful destruction of large HCC lesions.

This article reviews the current status of percutaneous, image-guided RF ablation in the management of HCC, by discussing the clinical results in the treatment of early and intermediate stage HCC.

CLINICAL RESULTS

Treatment of early stage HCC

Patients classified as early stage according to the BCLC staging classification, that are not candidates for surgery, qualify for percutaneous ablation. In most early clinical experiences with RF ablation, patients were treated in the framework of feasibility studies, aimed at analysing safety, tolerability, and local therapeutic effect of the treatment. One of the recommendations of the European Associaton for the Study of the Liver is to compare newer methods of tumor destruction, such as RF, with the well-established ethanol injection technique through randomized trials assessing not only initial tumor response, but also survival outcomes. We performed a prospective randomized study aimed at comparing the efficacy of RF ablation with that of ethanol injection. Primary end-point of the study was overall survival. Secondary end-points were local recurrence-free survival and event-free survival (i.e., survival free from local recurrence, new HCC tumors, and extrahepatic metastases). Fifty-two patients with 69 HCC tumors were treated with RF ablation, while 50 patients with 73 HCC tumors received ethanol injection. No statistically significant differences between RF and ethanol injection groups were observed with respect to baseline characteristics, except for patients age and albumin concentration. Despite statistical analysis of overall survival rates did not demonstrate a significant difference between RF ablation and ethanol injection, a trend towards increased survival in the RF ablation group was observed. In addition, 1- and 2-year local recurrence-free survival rates were significantly higher in the RF group (98% and 96%, respectively) than in the ethanol injection group (83% and 62%, respectively, p=0.002). One- and 2-year event-free survival rates were also higher in RF-treated patients (86% and 64%, respectively) than in ethanol injection-treated patients (77% and 43%, respectively, p=0.012). RF treatment was confirmed as independent prognostic factor for local recurrence-free survival by multivariate analysis (adjusted RR=0.20, p=0.015).

Recently, the long-term survival outcomes of patients with hepatic cirrhosis and early-stage HCC who received percutaneous RF ablation as the sole first-line anticancer treatment were reported. A series of 187 patients with Child-Pugh class A or B cirrhosis and either single HCC 5 cm in diameter or smaller or as many as three HCCs each 3 cm or smaller were treated in a prospective clinical trial. All patients were free from tumor vascular invasion and extrahepatic metastases. The follow-up period ranged 3-78 months (mean, 24 months ± 21). At the end of the study, 140 patients were alive, and 47 patients were dead. The cause of death was liver failure with tumor progression (23 patients), liver failure without tumor progression (14 patients), variceal bleeding (5 patients), and others (5 patients). The overall survival was 97% at 1 year, 89% at 2 years, 71% at 3 years, 57% at 4 years, and 48% at 5 years. Survival of Child-Pugh A patients (n = 144; 76% at 3 years and 51% at 5 years) was significantly better than that of Child-Pugh B patients (n = 43; 46% at 3 years and 31% at 5 years, p = 0.0006). A subgroup of 116 patients with Child-Pugh class A cirrhosis and solitary HCC had 3- and 5-year survival rates of 89% and 61%, respectively.

These data must be compared with those obtained in patients with early-stage tumors who received other potentially curative treatments. Liver transplantation was shown to be the only treatment option that consistently provided 5-year survival rates in the range of 71-75%. Surgical resection or early stage HCC resulted in 5-year survival rates in the range of 41-51%. Resection achieved substantially higher survival rates only when patients with a solitary tumor and extremely well preserved liver function - who had neither clinically significant portal hypertension nor abnormal bilirubin (also defined as Child-Pugh "hyper A") - were selected. Unfortunately, such criteria are met by less than 5% of HCC patients. Long-term survival of patients who received ethanol injection therapy ranged 32-47%, with the higher rate obtained in patients with Child-Pugh class A and a solitary tumor. Therefore, long-term survival rates of RF ablation-treated patients compares well with those reported for matched patients who underwent resection or ethanol injection.

Treatment of intermediate stage HCC

In the West and Japan, HCC is detected at an early stage in about 30% of the patients. In fact, despite surveillance programs, most tumors are still diagnosed at a later stage, when radical treatment options can not be performed. The accepted treatment for HCC patients not suitable for radical treatments is transarterial chemoembolization . In fact, chemoembolization was shown to improve survival of patients in the intermediate stage, who have preserved liver function and asymptomatic, multinodular tumors without vascular invasion and extrahepatic spread. Patients with advanced or end stage HCC are mostly treated with symptomatic treatment.

Recently, following advances in RF technology, RF ablation has also been used to treat patients with intermediate stage tumors. However, results obtained by RF ablation alone were not entirely satistactory. Of interest, recent studies have proved the influence of perfusion-mediated tissue cooling on the area of thermal necrosis achievable with RF treatment. RF application during vascular occlusion produced larger areas of coagulation necrosis than RF with unaltered blood flow. Assuming that the volume of thermal necrosis produced by RF treatment is strongly dependend on blood flow, and considering that in HCC blood flow is mainly sustained by the hepatic artery, we performed a multicenter clinical trial aimed at investigated whether interruption of the tumor arterial blood supply by means of occlusion of either the hepatic artery with a balloon catheter or the feeding arteries with gelatin sponge particles could increase the extent of RF-induced coagulation necrosis. A series of 62 consecutive patients with a single, large HCC ranging from 3.5 to 8.5 cm in diameter (mean, 4.7 cm) accompanying cirrhosis underwent RF ablation after occlusion of the tumor arterial supply. The RF energy was delivered by using an expandable electrode needle at the time of balloon catheter occlusion of the hepatic artery (n = 40), at the time of occlusion of the HCC feeding arteries with gelatin sponge particles (n = 13), or 2-5 days thereafter (n = 9). Two patients underwent liver resection after the thermal ablation; the remaining 60 patients were followed up for a mean of 12.1 months (range, 3-26 months). During the follow-up, 49 (82%) of the 60 treated HCC nodules showed stable complete response, while the remaining 11 (18%) nodules showed local progression. Histopathologic analysis of one autopsy and of the two surgical specimens revealed more than 90% necrosis in one specimen and 100% necrosis in two. No fatal or major complications related to the treatment occurred, despite the more aggressive RF treatment protocol.

Results of this study provide evidence that areas of coagulative necrosis that are much larger than those previously reported can be created if RF thermal ablation is performed in HCC nodules after occlusion of their arterial supply. The results achieved with this technique were confirmed by two recent studies. Despite these encouraging preliminary results, there are no reports showing that RF ablation - performed alone or in combination with intra-arterial procedures - results in improved survival in patients with intermediate stage HCC. A randomized trial comparing an optimized RF technology with chemoembolization would be needed to establish the potential role of the technique in this patient population.

CONCLUSION

In view of the limited number of HCC patients who can profitably receive liver transplantation or surgical resection, percutaneous techniques play a central role in the therapeutic management of patients with early stage tumors. RF ablation appears to be superior to the other interventional methods of tumor destruction, and can therefore be currently considered as the first-line percutaneous

treatment of choice. Ethanol injection - as well as transarterial chemoembolization - still have a valuable complementary role in patients with early-stage HCC. In fact, appropriate use of each treatment technique can only be done when the therapeutic strategy is tailored to the individual patient and to the features of the disease. Further studies are warranted to define the potential role of RF ablation in the treatment of selected patients with intermediate stage tumors.

Special Session
Uterine Fibroid Embolisation

52.1

Work up & embolization technique

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UAE - WORK UP AND TECHNIQUE

Pre procedure:

Work up patients will require full consultation with clinical history. This consultation is very important, Radiologists will see patients from a different perspective to the Gynaecologist and often Radiologists themselves will be administering the anaesthetic. It is very important to check that the patient is not hypertensive, as post embolisation pain can exacerbate labile hypertension. The blood pressure should be properly controlled in the weeks prior to the procedure. Afro-Caribbean patients are particularly liable to have hypertensive problems. In 1300 patients the only intensive care unit admission that the author has experienced is a patient who with no previous history of hypertension developed hypertensive encephalopathy. This patient made a full recovery with no sequelae but that is obviously a situation which needs to be avoided. The Radiologist should inquire about any allergic history so that you are not confronted with a patient on the table who at that point tells you they have a latex allergy. It is vital to inquire whether the patient has any coagulopathy, history of DVT or pulmonary embolus. There is a small incidence of pulmonary embolus and the author knows of at least two deaths world wide. If patients do have a coagulopathy and such a history it is probably advisable, particularly from a medico legal point of view, to put the patient on low molecular heparin before the procedure. Obviously early mobilisation eg. catheter out within 3 hours, patient up and about after 4 hours and mobilisation during the procedure together with TED stockings is important. The patient should have a full blood count and any anaemia corrected and diabetes, sickle cell etc. excluded.

The author's protocol is to not routinely to take a vaginal swab. A high percentage will be positive and there is no evidence to suggest that treatment in that situation would be prophylactically effective.

It cannot be over emphasised that all women regardless of age should have an FSH estimation. 2-3% of women will become menopausal or peri-menopausal before the age of 45, some women who are having irregular periods and suspect they are in fact pre-menopausal may not disclose this to you. It is thus vital you have a base line FSH level should the patient claim that a subsequent menopause is due to the procedure. Another very important precaution which maybe overlooked is the exclusion of cervical carcinoma. Following embolisation cellular material is extruded over the cervix and cervical smears may become significantly inaccurate. This occurs for a period of time after the embolisation, the length of which is unknown. It is thus vital that any women should have had a cervical smear within 1 year of the procedure and we included this in our information leaflet. The jury is still out on whether GNRH analogue therapy reduces the effectiveness of embolisation due to vasoconstriction, the author however advises that GNRH therapy should have been stopped at least 8 weeks before the embolisation is carried out to avoid any possibility of any deleterious impact on the efficacy of the procedure.

All our patients receive a fact sheet on embolisation a separate sheet giving details on what they will experience in hospital and post procedurally and all are required to complete a detailed medical questionnaire prior to the embolisation. This questionnaire includes details of any psychiatric history and in particular any history of previous surgery, particularly myomectomy.

The patient should have a full consultation with the radiologist, the procedure should be explained and a fact sheet and information leaflet provided describing what the patient can expect during their in-hospital stay and during the convalescence period. The information sheet should give the radiologists contact details, in the authors case this includes the home and mobile phone numbers so that the radiologist can be contacted in an emergency. The information sheet should also contain a description of the post embolisation syndrome and the fact that infection maybe a complication of fibroid embolisation and that if a patient has a temperature over 38º and particularly if they feel nauseated, have severe abdominal pain and particularly if associated with apparent discharge they should contact the radiologist. If an MRI scan is available it is useful to go over the scan with the patient so that they can see their problem. It is also particularly important to counsel patients with regard to pregnancy if they wish to preserve their fertility. If they have multiple large fibroids it should be explained that there is a significant risk of miscarriage and infertility and that whether the patient has a myomectomy or a fibroid embolisation they may not be able to get pregnant. Often patients are in their late 30's or 40's fertility rates are reduced and miscarriage rates significantly increased in this group of patients. It is important that the patient does not have an unrealistic expectation with regard to pregnancy.

A full diagnostic work up is vital and not infrequently the radiologists will find that the diagnostic work up from the referring hospital is inadequate. Ideally the radiologist should be experienced in trans-abdominal and trans-vaginal scanning and should scan the patient himself and if possible the patient should have an MRI scan. It is of vital importance that the radiologist considers the question of endometrial carcinoma. If the patient has inter menstrual bleeding then they should be investigated for endometrial carcinoma. If they are post menopausal the radiologists needs to pay particular attention to the thickness of the endometrium on the MRI scan and ultrasound. Adenomyosis needs to be excluded and any ovarian pathology. It is very important that a full clinical history is taken by the radiologist. Patients may be referred to a radiologist for fibroid embolisation because of non-dysmenorrhoeic pelvic pain in conjunction with other fibroid related symptoms is wrongly ascribed to fibroids. It is rare for fibroids to cause pain except when there is red degeneration. The author knows of at least one case involving fibroid embolisation where the main complaint was of pelvic pain which in fact was due to caecal carcinoma. Dermoids are another catch and should be excluded.

The question of exclusion of uterine sarcoma is a difficult one there is no accurate tests for uterine sarcoma. Some MRI appearances may suggest it. A minority may be associated with an increase of LDH. Rapid growth of a fibroid is not an indication of sarcoma, as fibroids often grow in rapid spurts, obviously post menopausally such a growth spurt would arise suspicion. Percutaneous or trans-vaginal biopsy maybe simply carried out and is often reassuring to the radiologist and patient. This reassurance maybe false as very well differentiated sarcomas may mimic leiomyomas

Technique:

Vessels not grossly dilated should be catheterised with micro catheters to avoid vasospasm and embolise under free flow conditions. Ovarian failure is a complication of fibroid embolisation and this maybe due to over embolisation or forcing particles into the uterine artery under pressure, with reflux into the ovarian arteries. It is thus always safer to embolise to the distal oscillation end point

under free flow conditions. If it is necessary to enter the vessel with a 4 French guiding catheter placed in the origin of the uterine artery, insert micro catheter and immediately withdraw guiding catheter to minimise spasm. If uterine artery origin difficult may need Rim catheter, if ovarian artery difficult, may need MIK catheter. If vessels very torturous use long floppy guide wire through Renegade. If spasm occurs 300 micro grams GTN. To avoid clogging use Renegade micro catheter plus dilute PVA if using standard non spherical particles. Inject using 5ml aliquots through Renegade catheter, to avoid dissection or perforation be gentle do not force. If dissection occurs wait if it does not resolve pull out and postpone study. Examples of anatomical pit falls to be presented.

Ovarian artery embolisation is not a difficult procedure. The question of whether consent should be obtained for ovarian artery embolisation in all patients prior to UAE is debatable. The object of ovarian artery embolisation is to only embolise the branch vessels of the ovarian artery to the fibroids which can usually be seen quite clearly on the selective arteriogram. The author is only prepared to embolise one ovarian artery except under very special circumstances (eg in a pre-menopausal patient). Catheterisation of the ovarian arteries is usually simple using a Sidewinder 1 catheter but if there is a problem use a MIK catheter. In all cases the ovarian artery should be initially catheterised with the guiding catheter a Renegade then passed down the ovarian artery and the guiding catheter removed from the origin so that free flow in the ovarian artery is obtained. Only small amounts of particles are usually necessary eg. 0.25 - 0.75 of a ml. and usually 0.2 - 0.3. Often although a fibroid or fibroids are supplied by one or other of the ovarian arteries, the branches of the ovarian artery to the fibroids can be embolised from the uterine artery by refluxing the particles under a little pressure through the utero-ovarian anastomosis into the branch vessels that supply the fibroids.

Choice of particles, the author uses conventional PVA 355 - 500 microns. Spherical PVA may be inferior to conventional PVA or Embospheres or Beadblock. Dilution of conventional PVA important to insure correct penetration of particles. End point of conventional PVA and Embospheres was considered to be different ie conventional PVA distal oscillation of contrast Embospheres, pruned tree. The author doubts whether this distinction is valid. Vessel occlusion is never the end point. Some radiologists advocate embolisation beyond the cervico-vaginal branch. No evidence.

In some cases where there are single fibroids these maybe supplied from one uterine artery only, in which case unilateral embolisation only may be required.

52.3

Long term results & fertility issues

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Introduction

From the beginning of the clinical application of uterine embolization for fibroids, there has been great interest in understanding the long-term outcome and pregnancy outcomes. Our knowledge in these areas is growing. In the past two years, there have been several new studies published that provide additional insights into these questions.

Long-term outcome

There have been few long-term studies until recently. There are now several that merit review.

The first five-year outcome study from UFE was published this fall by Spies et al (1). Among 200 patients enrolled, 181 completed 5 year follow-up. Of these, 73% remained improved, while 20% had recurrent symptoms, with 13.7% undergoing hysterectomy. Patient satisfaction remained high for most patients.

Marret and coworkers have recently published an analysis of recurrence after embolization (2). Among 61 patients with a median of 30 months follow-up, 15 patients either failed to improve after treatment or required further therapy, for a 17.2% recurrence rate. An increase number of fibroids and fibroid size were predictors of failure. Using imaging obtained over 3 years after post-embolization, Pelage explored recurrence from a different perspective, and studied the mechanisms underlying recurrence after initially successful treatment (3). Among 20 women, there were three recurrences by 3 years after therapy. In each of these 3, there was incomplete infarction of the dominant fibroid identified using a contrast enhanced MRI. Those portions of the fibroids that were uninfarcted grew over the follow-up interval. In each of these cases, the recurrent fibroid was smaller than it was originally, but still resulted in symptoms. The authors note that this argues against using volume reduction as determined by ultrasound as a key indicator of outcome, as it may mask uninfarcted fibroids that are at high risk of recurrence.

At the time of the writing of this summary, a 5 year outcome from a group of patients treated with Spongel authored by Katsumori and co-workers is in press, scheduled for publication in March of 2006 in the American Journal of Roentgenology. The details of that study will be included in this presentation.

Pregnancy after UFE

From the earliest days, a number of potential problems that might be caused by uterine embolization have been theorized. These include the potential for misembolization to the ovaries (with subsequent harm to their function), the potential for endometrial or myometrial injury after embolization (which might impact the implantation of an embryo), reduced uterine vascular flow from occlusion of the uterine arteries (with the potential of placental insufficiency), and weakening of the wall of the uterus (which may predispose uterine rupture during labor). We will address each of these issues in turn.

While it is clear that ovarian dysfunction may occur after embolization, it is most common in women over the age of 45 (4, 5). There have been studies investigating the impact of embolization on follicle stimulating hormone (FSH) levels in the past (6-8) and a new study by Tropeano and colleagues confirms those earlier findings (9). They studied a group of 20 regularly cycling women aged 33-39 with pre-treatment cycle day 3 FSH levels of < 10 mIU/ml. They found no change in mean cycle day 3 FSH or E2 levels at 3, 6 or 12 months after embolization. Healey studied both patients undergoing embolization and simple hysterectomy (with preservation of ovaries) and found that neither procedure had changes in FSH, E2, or luteinizing hormone (LH) levels 3 and 6 months after treatment (10). While not definitive statements on ovarian function, from a practical perspective it is unlikely that there is a clinically important impact on ovarian function in most women under 40.

As to whether there is injury to the myometrium or endometrium, it is not often clinically apparent. Myometrial injury is certainly rare. In our experience, this is detectable by MRI is less than 1 in 500 patients. Endometrial atrophy is also likely to be rare, although its true incidence is unknown. Walker and Pelage noted a 13% rate of chronic vaginal discharge in their study of 400 patients and endometrial atrophy may have been one cause (11). However, most of these patients had ongoing passage of fibroid debris so the incidence of endometrial injury could not be determined. These authors used a very aggressive embolization technique including placing a coil at the end of the procedure in each uterine artery. This complication is likely to be rare with current technique.

There have been no published reports of placental insufficiency to date after embolization and I am aware of only one anecdotal report of uterine rupture occurring during labor (12).

From our limited knowledge as discussed above, it appears unlikely that there is commonly an injury to any of the structures involved in conception, implantation or fetal growth. Having said that, it is important to review the results of pregnancy that have been reported to date.

Pregnancy after UFE

Our understanding of pregnancy after embolization is increasing. Goldberg recently compared the outcomes from case reports of pregnancies after uterine embolization to those from published series of laparoscopic myomectomy patients (LM) (13). In this review, they reported that the UFE patients were more likely to have pre-term delivery and malpresentation. However, the two groups were not comparable, as pointed out by the authors. The LM patients were younger, had smaller fibroids, and were more likely to be nulliparous. The LM procedures were more likely to be performed for intramural and serosal fibroids, while the UFE procedures also were performed for submucosal fibroids, which are known to impact fertility. Because of the multiple confounding variables that might impact the pregnancy outcomes of myomectomy and embolization, the conclusions from such a comparison are not reliable.

The pregnancy outcomes from the Ontario Multi-Center Trial on Uterine Embolizaton were published in early 2004 (14). Among the 555 women enrolled in that multi-center study, 21 women became pregnant, with 3 having two pregnancies. The range of ages of the patients at the time of delivery was 29-42 years, with a mean age of 36. Of a total of 24 pregnancies, 23 were spontaneous and one the result of in vitro fertilzation. There were also 4 miscarriages and 2 elective terminations. Of 18 live births, 14 were full term and 4 were pre-term. There were no antenatal complications among the pregnancies leading to delivery, but there were 3 cases of abnormal placentation (2 placenta previas and 1 placenta accreta). The 2 cases of placenta previa had minor episodes of hemorrhage early in the third trimester that necessitated pre-term delivery. The patient with placenta accreta had a significant hemorrhage at the time of cesarean section, which necessitated hysterectomy.

Carpenter and Walker also have reported on 29 pregnancies in 671 women (15). Data were presented on 26 completed pregnancies. Among these, there were 7 miscarriages, 2 terminations and 1 ectopic pregnancy. Of 16 deliveries, there were 4 preterm deliveries and 2 others with premature rupture of membranes. There were 14 of 16 delivered by cesarean section and there was post-partum hemorrhage in 3 patients. Based on these findings, the authors concluded there was a higher than normal cesarean delivery rate, although there was no analysis of potential confounders for cesarean such as prior myomectomy.

The data to date do suggest that pregnancy with subsequent delivery is quite possible after UFE, but still are too few to allow any conclusion regarding the safety of pregnancy after embolization. Further, the relative likelihood of conception and subsequent uncomplicated delivery after UFE or myomectomy is not known. Caution is suggested in counseling patients in this regard; until more is known, patients seeking to become pregnant may be best treated with myomectomy. However, for those with prior myomectomy, very extensive or difficult to remove fibroids, or who are poor surgical candidates, embolization may be a safer approach. The decision for therapy must be individualized for each patient based on her level of interest in pregnancy, age, extent of disease, potential complicating factors and her preferences. This decision is best made after consultation with both a gynecologist and an interventional radiologist experienced in embolization.

Conclusions

As with most therapies in medicine, our knowledge of uterine embolization and its impact on fertility and pregnancy grows with each passing year. However, we are far from understanding all the dynamics associated with pregnancy and UFE- for that matter we do not yet understand the true nature of fibroids in the context of implantation and pregnancy. Considerable addition research is needed before we can determine the best method to improve the chances of successful pregnancy in women with fibroids.

References:

1. Spies J, Bruno J, Czeyda-Pommersheim F, Magee S, Ascher S, Jha R. Lon-term Outcome of Uterine Artery Embolization of Leiomyomas. Obstet and Gynec 2005;106:933-9.
2. Marret H, Alonso AM, Cottier JP, Tranquart F, Herbreteau D, Body G. Leiomyoma recurrence after uterine artery embolization. J Vasc Interv Radiol 2003;14(11):1395-9.
3. Pelage J, Guaou Guaou N, Jha R, SA A, JB S. Long Term Imaging outcome after embolization for uterine fibroids tumors. Radiology 2004;230:803-809.
4. Chrisman HB, Saker MB, Ryu RK, Nemcek AA, Jr., Gerbie MV, Milad MP, et al. The impact of uterine fibroid embolization on resumption of menses and ovarian function. J Vasc Interv Radiol 2000;11(6):699-703.
5. Spies J, Myers ER, Worthington-Kirsch R, Mulgund J, Goodwin S, Mauro M. The FIBROID Registry: Symptom and quality-of-life status 1 year after therapy. Obstet and Gynec 2005;106:1309-18.
6. Ahmad A, Qadan L, Hassan N, Najarian K. Uterine artery embolization treatment of uterine fibroids: effect on ovarian function in younger women. J Vasc Interv Radiol 2002;13(10):1017-20.
7. Spies JB, Roth AR, Gonsalves SM, Murphy-Skrzyniarz KM. Ovarian function after uterine artery embolization for leiomyomata: assessment with use of serum follicle stimulating hormone assay. J Vasc Interv Radiol 2001;12(4):437-42.
8. Tulandi T, Sammour A, Valenti D, Child T, Seti L, Tan S. Ovarian Reserve After Uterine Artery Embolization For Leiomyomata. Fertility and Sterility 2002;78:197-198.
9. Tropeano G, Di Stasi C, Litwicka K, Romano D, Draisci G, Mancuso S. Uterine artery embolzaiton for fibroids does not have adverse effects on ovarian reserve in regularly cycling women younger than 40 years. Fertil Steril 2004;8:1055-61.
10. Healey S, Buzaglo K, Seti L, Valenti D, Tulandi T. Ovarian function after uterine artery embolization and hysterectomy. J Am Assoc Gynecol Laparosc 2004;11(3):348-52.
11. Walker WJ, Pelage J. Uterine artery embolisation for symptomatic fibroids:clinical results in 400 women with imaging follow up. Brit J of Obstet and Gynaec 2002;109:1262-1272.
12. Pelage J. Uterine rupture during labor after uterine embolization. In; 2004.
13. Goldberg J, Pereira L, Berghella V, Diamond J, Darai E, Seinera P, et al. Pregnancy outcomes after treatment for fibroimyomata: Uterine artery embolization versus laparoscopic myomectomy. Am J Obstet Gynecol 2004;191:18-21.
14. Pron G, Mocarski E, Bennett J, Vilos G, Common A, Vandergurgh L. Pregnancy after uterine artery for leiomyomata: The Ontario Multicenter Trial. Obstet and Gynec 2005;105:67-76.
15. Carpenter TT, Walker WJ. Pregnancy following uterine artery embolisation for symptomatic fibroids: a series of 26 completed pregnancies. BJOG 2005;112:321-325.

Special Session
Vascular Imaging 2: Plaque Imaging

53.1

Clinical importance of Assessing Plaque Vulnerability. Role of Imaging

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Atherosclerosis is a pathology involving the metabolism and the immune and vascular system producing alterations which lead to the formation of vulnerable plaques. Atheromatous vulnerable carotid plaque rupture is responsible for the majority of ischaemic strokes in the developed world. Plaque rupture has been associated with plaque morphology, plaque components' properties, inflammation and local stress concentration. In 1995, Stary et al, for the American Heart Association, defined different atherosclerotic subtypes, the purpose being to pathologically identify plaque more likely to cause symptoms. Complicated plaque was defined as

that with surface rupture or intraplaque or associated intraluminal hemorrhage and was defined as type VI disease. The presence of these features is associated with increased risk of thromboembolism and subsequent symptoms. In addition, it has been shown that the stepwise progression of atheroma, either with or without symptoms, in its latter accelerated phase is often associated with intraplaque hemorrhage, thus providing further evidence of the importance of this form of complex plaque in atherosclerotic disease. A means of identifying type VI complicated plaque in vivo may therefore provide a surrogate marker of plaque activity and an improved method of patient stratification and management. In randomized trials (NASCET and ECST), the selection of patients for carotid endarterectomy (CEA) has been considered primarily on measurement of stenosis by angiography, so that the potential therapeutic benefit of carotid endarterectomy (CEA) depends critically on this parameter in order to measure stroke risk; on the other hand, many data show that several patients may undergo to procedure for no benefit with significant risk of complication and expense. According to the results of these trials (NASCET and ECST), the use of carotid endarterectomy (CEA) for the treatment of symptomatic internal carotid artery (ICA) stenoses >50%, is beneficial on the long-term in the prevention of cerebro-vascular events when compared to medical therapy alone. However, the benefits deriving from the endovascular or surgical treatment of critical asymptomatic stenoses remains controversial. For instance, in the Asymptomatic Carotid Atherosclerosis Study (ACAS), the majority of the patients with different grades of stenoses of the internal carotid artery (ICA) ($\geq$ 60%) remained asymptomatic and the benefits deriving from carotid endarterectomy, particularly in women, was not demonstrated. These results suggest that other variables such as plaque composition may influence the clinical evolution of an internal carotid artery stenosis. Many studies suggest that stroke risk is mostly due to plaque thromboembolic potential, which is only indirectly linked to the degree of stenosis. Considering this concepts we must identify the plaque characteristics that more directly relate to thromboembolic potential. Hystopathologic studies report that plaques that present a high component of fibrous tissue seem to be more stable than plaques containing a large bulk of friable atheroma with a high hemorrhagic component, this statement has not jet been confirmed in vivo, because it was not possible to identify the alteration of the plaque component was necessary to obtain techniques to visualize morphology and composition and correlate these features with the patient's clinical presentation. The evaluation of the risk related to the plaque may be performed assessing clinical, biological and Imaging data. In the routinary clinical evaluation, the use different diagnostic tools, such as color-Doppler US, multi-detector CT, MR with dedicated micro-coils, allow the identification of those morphological plaque characteristics which are to be considered at risk (vulnerable plaque). The spatial distribution of specific plaque components, like the necrotic core and the foamy cells, leads to the rupture of the fibrous cap producing a symptomatic stenosis. Several in vivo internal carotid artery imaging studies, demonstrate how the plaque's surface and characteristic structures are associates to the development of thrombo-embolic events. However, the majority of these studies lack a sufficient standard histopathological correlation. Calcification is in this sense an important structural characteristic of the advanced atherosclerotic plaque and is easily detected by multi-detector CT. Most studies regarding plaque calcification are centered on the coronaries and the aorta, although the role of calcification in plaque stability is still unclear. The objective of our retrospective study is to assess plaque calcification as a marker of plaque stability. MRI with dedicated micro-coil can visualize carotid plaque structure and quantify differences in morphology and composition that are not observable with the use of other modalities. The possibility of identifying the clinical and imaging factors and the inflammatory markers of plaque vulnerability, along with the recent development of new therapeutic options, may bring to a new concept of patient at risk for thromboembolic events leading to an improved prevention of cerebrovascular events. The results of the most important studies suggest that in vivo plaque characterization is achievable with dedicated high resolution micro-coil, in order to improve the resolution needed to differentiate the different components of the plaque. The ability to identify plaque components will permit studies that could shed light on how plaque composition modifies the risk of neurological events over and above that conferred by geometric descriptors, such as diameter stenosis. Presently, the management of symptomatic internal carotid artery (ICA) stenoses is mainly determined by the angiographic degree of the stenosis, in the next future this condition will probably drastically change and in consequence also the indication the treatment. A multimodal assessment of plaque vulnerability involving the combination of systemic markers, new imaging methods that target inflammatory and thrombotic components, and the potential of emerging therapies may lead to a new stratification system for atherothrombotic risk and to a better prevention of atherothrombotic stroke.

References

1. North American Symptomatic Carotid Endarterectomy Trial Collaborators. Beneficial effect of carotid endarterectomy in symptomatic patients with high-grade carotid stenosis. N Engl J Med. 1991; 325: 325-445.
2. MRC European carotid surgery trial: interim results for symptomatic patients with severe (70-99%) or mild (0-29%) carotid stenosis: European Carotid Surgery Trialists' Collaborative Group. Lancet. 1991; 337: 1235-1243.
3. The Asymptomatic Carotid Atherosclerosis Study. Endarterectomy for asymptomatic carotid artery stenosis. JAMA. 1995; 273: 1421-1428.
4. Barnett HJM, Ramsay RW, Eliasziw M, Fleming L, Sharpe B, Gates P, Meldrum H. Causes and severity of ischemic stroke in patients with internal carotid artery stenosis. JAMA. 2000; 283: 1429-1436.
5. Inzitari D, Eliasziw M, Gates P, Sharpe BL, Chan RKT, Meldrum HE, Barnett JM, Chan RKT. The causes and risk of stroke in patients with asymptomatic internal-carotid-artery stenosis. N Engl J Med. 2000; 342: 1693-1700.
6. Rothwell PM, Gibson R, Warlow CP. Interrelation between plaque surface morphology and degree of stenosis on carotid angiograms and the risk of ischemic stroke in patients with symptomatic carotid stenosis. Stroke. 2000; 31: 615-621
7. Rothwell PM, Warlow CP. Low risk of ischemic stroke in patients with reduced internal carotid artery lumen diameter distal to severe symptomatic carotid stenosis. Stroke. 2000; 31: 622-630
8. Eliasziw M, Streifler JY, Fox AJ, Hachinski VC, Ferguson GG, Barnett HJM. Significance of plaque ulceration in symptomatic patients with high-grade carotid stenosis. Stroke. 1994; 25: 304-308
9. Lusby RJ, Ehrenfeld WK, Stoney RJ, Wylie EJ. Carotid plaque hemorrhage: its role in the production of cerebral ischemia. Arch Surg. 1982; 117: 1479-1488
10. Imparato AM, Riles TS, Mintzer R, Baumann FG. The importance of hemorrhage in the relationship between gross morphologic characteristics and cerebral symptoms in 376 carotid artery plaques. Ann Surg. 1983; 197: 195-203.
11. Feeley TM, Leen EJ, Colgan M-P, Moore DJ, Hourihane DO, Shanik GD. Histologic characteristics of carotid artery plaque. J Vasc Surg. 1991; 13: 719-724.
12. Bluth EI. Evaluation and characterization of carotid plaque. Semin Ultrasound CT MR. 1997; 18: 57-65.
13. Seeger JM, Klingman BS. Relationship between carotid plaque composition and neurologic symptoms. J Surg Res. 1987; 43: 78-85.
14. Bassiouny HS, Davis H, Massawa N, Gewertz BL, Glagov S, Zarins CK. Critical carotid stenosis: morphologic and chemical similarity between symptomatic and asymptomatic plaques. J Vasc Surg. 1989; 9: 202-212.
15. Hatsukami TS, Ferguson MS, Beach KW, Gordon D, Detmer P, Burns D, Alpers C, Strandness DEJr. Carotid plaque morphology

and clinical events. Stroke. 1997; 28: 95-100.
16. Gomez CR. Carotid plaque morphology and risk for stroke. Stroke. 1990; 21: 148-151.
17. Asdente M, Pavesi L, Oreste PL, Colombo A, Kuhn W, Tremoli E. Evaluation of atherosclerotic lesions using NMR microimaging. Atherosclerosis. 1990; 80: 243-253
18. Merickel MB, Berr S, Spetz K, Jackson TR, Snell J, Gillies P, Shimshick E, Hainer J, Brookman JR, Ayers CR. Noninvasive quantitative evaluation of atherosclerosis using MRI and image analysis. Arterioscler Thromb. 1993; 13: 1180-1186..
19. Gortler M, Goldman A, Mohr W, Widder B. Tissue characterization of atherosclerotic carotid plaques by MRI. Neuroradiology. 1995; 37: 631-635.
20. Toussaint J-F, Southern JF, Fuster V, Kantor HL. T2-weighted contrast for NMR characterization of human atherosclerosis. Atheroscler Thromb Vasc Biol. 1995; 15: 1533-1542.
21. Wildy KS, Yuan C, Tsuruda JS, Ferguson MS, Wen N, Subramaniam DS, Strandness DEJ. Atherosclerosis of the carotid artery: evaluation by magnetic resonance angiography. J Magn Reson Imaging. 1996; 6: 726-732.
22. Toussaint J-F, LaMuraglia GM, Southern JF, Fuster V, Kantor HL. Magnetic resonance images lipid, fibrous, calcified, hemorrhagic, and thrombotic components of human atherosclerosis in vivo. Circulation. 1996; 94: 932-938
23. Shinnar M, Fallon JT, Wehrli S, Levin M, Dalmacy D, Fayad ZA, Badimon JJ, Harrington M, Harrington E, Fuster V. The diagnostic accuracy of ex vivo MRI for human atherosclerotic plaque characterization. Arterioscler Thromb Vasc Biol. 1999; 19: 2756-2761
24. Soila K, Nummi P, Ekfors T, Viainte M, Kormando M. Proton relaxation times in arterial wall and atheromatous lesions in man. Invest Radiol. 1986; 21: 411-415Wagner R, Brown DG. Unified SNR analysis of medical imaging systems. Phys Med Biol. 1985; 30: 489-518.
25. Hatsukami TS, Ross R, Polissar NL, Yuan C. Visualization of fibrous cap thickness and rupture in human atherosclerotic plaque in vivo with high-resolution magnetic resonance imaging. Circulation. 2000; 102: 959-964
26. Bassiouny HS, Yashuhiro S, Mikucki SA, McKinsey JF, Piano G, Gewertz BL, Glagov S. Juxtalumenal location of plaque necrosis and neoformation in symptomatic carotid stenosis. J Vasc Surg. 1997; 26: 585-594
27. Yuan C, Mitsumori LM, Reinecke D, Udovich K, Chiu W, Xiang Q, O'Brien K. Magnetic Resonance Imaging Techniques Which Identify and Distinguish Between Lipid- and Calcium-Rich Regions: Proceedings of the Fifth Scientific Meeting and Exhibition; 1997 April 12-18; Vancouver, Canada. Berkeley, California: International Society of Magnetic Resonance in Medicine; 1997: 790.

53.2

MR imaging

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The unstable carotid artery plaque:state of the art and new perspectives

Background and purpose

Atherosclerosis is a diffuse, chronic inflammatory disorder that involves the vascular, metabolic, and immune systems and leads to plaque instability. The traditional risk assessment relies on clinical, biological, and conventional imaging tools. Ischemic strokes and transient ischemic attacks (TIAs) are frequently caused by cerebral embolism from an atherothrombotic plaque, or thrombosis at the site of plaque rupture. Although the degree of lumen obstruction is a relevant marker of the risk of stroke, the role of the unstable plaque has opened new avenues in the field of atherothrombotic stroke. The instability is dictated in part by plaque morphology, which, in turn, is influenced by pathophysiologic mechanisms at the cellular and molecular level. However, these tools fall short in predicting near-future events in patients with unstable carotid artery disease. In current clinical practice, anatomic imaging modalities, such as intravascular ultrasound and high-resolution magnetic resonance imaging can identify several morphologic features characteristic of the unstable plaque, but give little or no information regarding molecular and cellular mechanisms.

Summary of Review

This review is dedicated to factors involved in carotid artery plaque instability and to new magnetic resonance imaging methods that target this condition . Our aim is to describe: 1) conventional pathologic and imaging markers predictive of plaque instability; 2) the role of relevant biological, genetic, and mechanical factors; 3) the potential of High Resolution and Molecular Magnetic Resonance Imaging (HRMRI); and 4) current and emerging treatments.

Plaque composition can be determined in vivo using a combination of pulse sequences that produce bright-blood and dark-blood images, and plaque can be accurately classified according to a modified AHA classification scheme .Several plaque components have a characteristic appearance and can be assessed qualitatively. MRI-based tissue quantification was demonstrated to be accurate. Furthermore, multi-contrast MRI was used to identify fibrous cap rupture, allowing a plaque stratification according to complicated and non-complicated subtypes.

The use of gadolinium contrast agent may further enhance differentiation between plaque components such as the fibrous cap and necrotic core : Fibrocellular tissue within an atheroma selectively enhanced 29% after administration of gadolinium-based contrast agent . Moreover, detection of other plaque characteristics, such as increased neovascularization, was possible using gadolinium contrast agent.

Differentiation between complex atherosclerotic plaques and mural thrombosis remains difficult because of the components (e.g., platelets, fibrin, and red blood cells) of thrombus and the resultant complex MR signal characteristics on T1-, T2, and proton density-weighted images of arterial thrombi.

Thrombus MR imaging showed time-dependent changes on T2W and T1W images in an animal model of carotid artery thrombus. These changes reflected the thrombus organization as shown by histologic analysis . MRI can detect carotid artery plaques that are at high risk for rupture and distal embolization. MRI is able to identify complicated plaques by directly visualizing the thrombus inside the carotid artery. Specifically, magnetic resonance direct thrombus imaging (MRDTI) has the ability to discriminate between the different stages of thrombus and hemorrhage formation. The ability of multi-contrast-weighted MRI to further characterize the location of hemorrhage (intraplaque versus juxtaluminal) in advanced atherosclerotic lesions has also been established

Conventional imaging technologies are based on anatomical, physiological, or metabolic heterogeneity to provide image contrast. Conversely, the emerging field of **molecular imaging** uses targeted and "activatable" imaging agents to exploit specific molecular targets, pathways, or cellular processes to generate image contrast.. Molecular imaging is a multidisciplinary field that aims to provide disease-specific molecular information through diagnostic imaging studies. The primary advantage of magnetic resonance imaging (MRI) as a molecular imaging system is its ability to provide soft tissue and functional information by exploring proton density, perfusion, diffusion, and biochemical contrasts. This feature allows co-registration of molecular information with anatomical information within a single imaging mode. A number of paramagnetic- (e.g., gadolinium) and superparamagnetic- (e.g., iron oxide) based molecular imaging agents have been tested for preclinical and clinical molecular imaging applications. Identification of high-risk atherosclerotic lesions and high risk patients prior to development

of vascular disease is an important goal. In this context, molecular imaging may provide functional information about biological processes in atherosclerosis. Targeted MRI agents have largely been based on either superparamagnetic iron oxide nanoparticles or gadolinium chelates. Superparamagnetic iron oxide nanoparticles exert strong and reversible relaxation effects on their surrounding environment. Several forms of such iron oxides are in use, with some preparations under clinical investigation.

Gadolinium has also been used in the development of targeted MRI contrast agents, but its lower intrinsic relaxivity often necessitates larger-sized nanoparticleconstructs, such as polymerized liposomes, dendrimers, orperfluorocarbon nanoparticles. Nonetheless, these agents have been successfully used to specifically image angiogenesis, progenitor cells, and thrombosis in vivo. An exhaustive description of molecular imaging markers is beyond the scope of this review; however, some challenging applications and recent clinical data suggest a growing interest in the future assessment of vulnerable plaque with these methods.

Baseline carotid MRI scans were obtained and nanoparticles were then administered. Within 24 to 48 hours, areas of inflammation within the atherosclerotic plaques became enhanced compared to the baseline images. Histopathological correlation demonstrated a focal iron signal in areas of MRI plaque signal loss. Molecular imaging of microthrombus within the fissures of unstable atherosclerotic plaques has been demonstrated with fibrin-targeted nanoparticles . This molecular imaging approach might assess the responsiveness of individual patients to anti-thrombotic therapies.

Conclusion:

A multimodal assessment of plaque instability involving the combination of systemic markers, high resolution MRI, and molecular MRI that targets inflammatory and thrombotic components, and the potential of new drugs that target plaque stabilization, may lead to a new stratification system for atherothrombotic risk and to a better prevention of atherothrombotic stroke.

References

1. Bamford J, Sandercock P, Dennis M, Burn J, Warlow C. Classification and natural history of clinically identifiable subtypes of cerebral infarction. Lancet. 1991; 337:1521-1526.
2. Albers GW, Amarenco P, Easton JD, Sacco RI, Teal P: Antithrombotic and thrombolytic therapy for ischemic stroke. Chest 2001; 119:300S-320S.
3. Barnett HJ, Taylor DW, Eliasziw M, Fox AJ, Ferguson GG, Haynes RB, RankinRN, Clagett GP, Hachinski VC, Sackett DL, Thorpe KE, Meldrum HE, Spence JD. Benefit of carotid endarterectomy in patients with symptomatic moderate or severe stenosis. North American Symptomatic carotid Endarterectomy Trial Collaborators. N Engl J Med. 1998. 12; 339 (20): 1415-25.
4. European Carotid Surgery Trialists Collaborative Group. Randomised trial of endarterectomy for recently symptomatic carotid stenosis: final results of the MRC European Carotid Surgery Trial (ECST). Lancet. 1998; 351: 1379-1387.
5. Faxon DP, Fuster V, Libby P, Beckman JA, Hiatt WR, Thompson RW, Topper JN, Annex BH, Rundback JH, Fabunmi RP, Robertson RM, Loscalzo J; American Heart Association. Atherosclerotic Vascular Disease Conference: Writing Group III: pathophysiology. Circulation. 2004 1;109(21):2617-25.
6. Hennerici MG. The unstable plaque. Cerebrovasc Dis. 2004 ; 17 (S3) : 17-22.
7. Hollander M, Hak AE, Koudstaal PJ, Bots ML, Grobbee DE, Hofman A, Witteman JCM, Breteler MMB. Comparison between measures of atherosclerosis and risk of stroke , The Rotterdam Study. Stroke. 2003; 34: 2367-2373.
8. Farb A, Burke AP, Tang AL, et al. Coronary plaque erosion without rupture into a lipid core: a frequent cause of coronary thrombosis in sudden coronary death. Circulation. 1996; 93: 1354-1363.
9. Meairs S, Timpe L, Beyer J, Hennerici M: Acute aphasia and hemiplegia during karate training. Lancet; 2000; 356:40
10. Rothwell PM, Villagra R, Gibson R, Donders RC, Warlow CP. Evidence of a chronic systemic cause of instability of atherosclerotic plaques. Lancet. 2000. 1;355 (9197): 19-24.
11. Fisher M, Paganini-Hill, Martin A, Cosgrove M, Toole JF, Barnett JM, Norris J. Carotid plaque pathology thrombosis, ulceration, and stroke pathogenesis. Stroke.2005; 36: 253-257.
12. Sitzer M, Muller W, Siebler M, Hort W, Kniemeyer H-W, JanckeL, Steinmetz H. Plaque ulceration and lumen thrombus are the main sources of cerebral microemboli in high-grade internal carotid artery stenosis. Stroke. 1995; 26: 1231-1233.
13. Rothwell PM, Gutnikov SA, Warlow CP. European Carotid Surgery Trialist's collaboration. Reanalysis of the final results of the European Carotid Surgery Trialist's Collaboration. Stroke. 2003. 34(2): 514-23.
14. Nandalur KR, Baskurt E, Hagspiel KD, Phillips CD, Kramer CM. Calcified carotid atherosclerotic plaque is associated less with ischemic symptoms than is noncalcified plaque on MDCT. AJR Am J Roentgenol. 2005. 184 (1): 295-8.
15. Shaalan WE, Cheng H, Gewertz B, McKinsey JF, Schwartz LB, Katz D, Cao D, Desai T, Glagov S, Bassiouny HS. Degree of carotid plaque calcification in relation to symptomatic outcome and plaque inflammation. J Vasc Surg. 2004. 40 (2): 262-9.
16. Kolodgie FD, Gold HK, Burke AP, Fowler DR, Knuth HS, Weber DK, Farb A, Guerrero LJ, Hayase M, Kutys R, Narula J, Finn AV, Virmani R. Intraplaque hemorrhage and progression of coronary atheroma. N Engl J Med. 2003;349: 2316-2325.
17. . Imparato AM, Riles TS, Mintzer R, et al. the importance of hemorrhage in the relationship between gross morphologic characteristics and cerebral symptoms in 376 carotid artery plaques. Ann Surg. 1983; 197: 195-203.
18. Montauban van Swijndregt AD, Elbers HR, Moll FL, et al. Cerebral ischemic disease and morphometric analyses of carotid plaques. Ann Vasc Surg. 1999; 13: 468-474.
19. Spagnoli LG, Mauriello A, Sangiorgi G, Fratoni S, Bonanno E, Schwartz RS, Piepgras DG, Pistolese R, Ippoliti A, Holmes DRJr. Extracranial thrombotically active carotid plaque as a risk factor for ischemic stroke. JAMA. 2004; 20; 292 (15): 1845-52. 27
20. De Graba TJ, Siren AL, Penix L, Mc Carron RM, Hargraves R, Sood S, Pettigrew KD, Hallenbeck JM. Increased endothelial expression of intercellular adhesion molecule-1 in symptomatic versus asymptomatic human carotid atherosclerotic plaque. Stroke. 1998; 29 (7): 1405-10.
21. Nuotio K, Lindsberg PJ, Carpen O, Soinne L, Lehtonen-Smeds EM, Saimanen E, Lassila R, Sairanen T, Sarna S, Salonen O, Kovanen PT, Kaste M. Adhesion molecule expression in symptomatic and asymptomatic carotid artery stenosis. Neurology. 2003; 24:60 (12): 1890-9.
22. Johnson JL, Jackson CL, Angelini GD, George SJ. Activation of matrix-degrading metalloproteinases by mast cells in atherosclerotic plaques. Arterioscler Thromb Vasc Biol. 1998; 18: 1707-1715.
23. Morgan A, Rerkasem K, Gallagher P, Zhang B, Morris G, Calder P, Grimble R, Eriksson P, McPheat W, Shearman C, Ye S. Differences in matrix metalloproteinase-1 and matrix metalloproteinase-12 transcript levels among carotid atherosclerotic plaques with different histopathological characteristics. Stroke. 2004;35:1310-1315.
24. Johnson JL, George S, Newby A, Jackson CP. Matrix metalloproteinases-9 and -12 have opposite effects on atherosclerotic plaque stability. Atherosclerosis. 2003;169:199.
25. Molloy KJ, Thompson MM, Jones JL, Schwalbe EC, Bell PR, Naylor AR, Loftus IM. Unstable carotid plaques exhibit raised matrix metalloproteinase-8 activity. Circulation. 2004;110:337-343.
26. Levitt NC, Eskens FA, O'Byrne KJ, et al. Phase I and pharmacological study of the oral matrix metalloproteinase inhibitor, MMI270 (CGS27023)
27. Ardissino D, Merlini PA, Ariens R, Coppola R, Bramucci E, Mannucci PM. Tissue-factor antigen and activity in human coronary atherosclerotic plaques. Lancet. 1997; 349: 769-771
28. Toschi V, Gallo R, Lettino M, Fallon JT, Gertz SD, Fernandez-Ortiz

A, Chesebro JH, Badimon L, Nemerson Y, Fuster V, Badimon JJ. Tissue factor modulates the thrombogenicity of human atherosclerotic plaques. Circulation. 1997; 95: 594-599.
29. Cipollone F, Fazia M, Mincione G, Iezzi A, Pini B, Cuccurullo C, Ucchino S, Spigonardo F, Di Nisio M, Cuccurullo F, Mezzetti A, Porreca E. Increased expression of transforming growth factor-β1 as a stabilizing factor in human atherosclerotic plaques. Stroke. 2004;35:2253-2257.
30. Jander S, Sitzer M, Schumann R, Schoeter M, Siebler M, Steinmetz H, Stoll G. Inflammation in high-grade carotid stenosis: a possible role for macrophages and T cells in plaque destabilization. Stroke. 1998; 29 (8): 1625-30.

53.3

Endovascular Ultrasound

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Plaque imaging: Endovascular ultrasound

Technique of IVUS imaging

Endovascular or intravascular ultrasound (IVUS) imaging is performed by using a miniaturized 10-40 MHz US probe that is attached to the tip of a catheter. There are basically two different types of US transducers, mechanically and electrically driven. The catheter is usually a rapid change type with a channel for guide wire only in the distal part of the catheter facilitating easier removal and change of the imaging catheter. High frequency e.g. 40 MHz imaging catheters are used for small arteries, such as coronaries and infrainguinal arteries and low frequency 10-20 MHz catheters for large caliber arteries, such as aorta and iliac arteries.

For imaging the catheter is advanced beyond the planned imaging segment of the vessel over a guide wire. Image registration is done during pull back of the imaging catheter. Pull back is currently done mainly by motor driven devices that facilitate constant speed. Longitudinal position of the imaging probe inside the vessel is verified by fluoroscopy and by spot images during fluoroscopy. During analysis also side branches can be used to localize imaging level. It is to be noted that IVUS provides basically only axial information without any possibilities for directional fixation.

Especially for scientific purposes two-and three dimensional reconstructions are needed and there are numerous softwares to reconstruct longitudinal 2D and 3D data from the original axial US data. These reconstructions preclude motorized pull-back device and use automated, although usually manually aided edge detection systems for identification of the inner lining of the vessel and various layers of the arterial wall.

IVUS morphology of arterial wall

IVUS morphology of the arterial wall is mainly due to the different cellular composition of the anatomical layers in the arteries. In particular the concentration and organization of elastin and collagen has been shown to explain IVUS finding. Categorically, there are two basic types of human arteries presenting with different IVUS finding. In normal elastic arteries the wall tends to be homogeneous because elastin appears in media, whereas in muscular arteries there is hypoechoic media that coincides with the arterial smooth muscle cells. In other words, arterial wall of muscular artery has a three layered structure: a distinct complex of hyperechoic intima and hypoechoic media, plus mainly indistinct hyperechoic adventitia. Examples of muscular arteries are coronary, internal carotid, and femoral arteries and examples of elastic arteries are common carotid artery and aorta.

IVUS morphology of atherosclerotic plaque

Histopathological studies have shown that IVUS finding has good correlation on histological structure of the plaque. This is true especially for differentiation between lipid rich and fibrotic components of the plaque, as well as calcifications. Intravascular US depict the fibrous cap as hyperechoic surface and hypoechoic deeper portions of the plaque. It is possible to differentiate between soft, lipid rich lesions appearing as mainly hypoechoic in comparison with the adventitia, from dense, fibrocalcified lesions appearing as dense or denser than adventitia. A fully developed calcification shows as a very bright with an acoustic shadow. Studies have revealed that intravascular US is very sensitive imaging modality for revealing even tiny calcification in the plaque. However, it is difficult to differentiate between very fibrotic portions of the plaque from calcification. Moreover, IVUS can not differentiate between lipid rich parts of the plaque from possible necrotic core since both appears hypoechoic in US.

Mainly studies on coronary arteries have clarified IVUS characteristics of stable, mature plaques and those of plaques that are in danger for rupture with potentially serious clinical consequencies. Categorically, stable plaques exhibit with a hyperechoic thick fibrous cap and a small lipid core, while vulnerable plaques have a thin fibrous cap and a large hypoechoic lipid core. Coronary artery IVUS studies on patients with myocardial infarction have demonstrated also IVUS features of ruptured plaque, responsible for abrupt closure of the artery.

IVUS measurements of atherosclerosis

There is a large number of various measurements that have been applied for quantitation and characterization of atherosclerotic process at IVUS. Free lumen area, and the vessel area that is defined as the area bounded by the external elastic membrane are basic parameters, as well the minimum and maximum plaque thickness. Based on these measurements, parameters such as lesion atheroma area, lumen area stenosis percentage, and atheroma burden can be calculated. Serial measurement of the plaque area and/or volume (plaque burden) can be used as a primary efficacy parameter in pharmacological intervention trials on atherosclerosis. Finally, an important parameter is the remodelling index. Arterial remodelling is an important phenomenon that is basically the change in vessel area as the atherosclerotic process develops. Remodelling can be positive, that is compensative increase of vessel area or negative that is shrinkage of the area during development of the lesion. The impact of remodelling is not fully understood yet but it might be an important predictor of clinical consequencies of the lesion as well as long term patency after endovascular intervention.

Role of IVUS in atherosclerosis imaging in near future

There are a number of important clinical trials, most of which are on coronary atherosclerosis that have used IVUS imaging successfully to test the study hypothesis. The trials have e.g. shown the beneficial effect of statin therapy on coronary and femoropopliteal atherosclerosis. Many of these studies have been published during recent years and there is ongoing even larger number of coronary artery atherosclerosis progression-regression trials utilizing IVUS.

IVUS imaging is an invasive modality and although associated only on risk that is comparable with introduction of diagnostic or microcatheter across the lesion there lacks evidence for instance about its safety in imaging symptomatic carotid plaques. On the other hand, less invasive or totally non-invasive imaging modalities, MR and CT are rapidly developing for plaque imaging. Because of its excellent spatial and time resolution it seems clear that IVUS remains as a golden standard for vascular wall and plaque imaging during next few years and it has an important role in atherosclerosis progression-regression trials in coronary arteries. However, in peripheral arteries other imaging modalities may mostly replace IVUS in plaque imaging during the following years.

References

1. Manninen HI, Räsänen H et al. Human carotid arteries: Correlation of intravascular ultrasound with angiographic and histopathologic findings. Radiology 1998;206:65-74.
2. Manninen HI, Vanninen RL. et. al. Intravascular Ultrasound and magnetic resosnce imaging in the assessment of atherosclerotic lesions in rabbit aorta. Correlation to histopathologic findings. Invest Radiol 1998; 33:464-71.
3. Räsäsnen HT, Manninen HI et al. Mild carotid artery

stherosclerosis: assessment by 3-dimensional time-of-flight magnetic resonance angiography, with reference to intravascular ultrasound imaging and contrast angiography. Stroke 1999;30:827-33.
4. Manninen HI, Räsäsnen HT et al. Stent placement versus percutaneous transluminal angioplasty of human carotid arteries in cadavers in situ: distal embolization and findings at intravascular US, MR imaging and histopathologic analysis. Radiology 1999;212:483-92.
5. Manninen HI, Räsänen HT. Intravascular ultrasound in interventional radiology. Eur Radiol 2000;10:1754-62.

53.4

Optical Coherence Imaging

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Optical Coherence Tomography

Intravascular optical coherence tomography (OCT) is a new and promising imaging modality providing histology-like information of both vessel morphology and geometry. Based on the principles of interferometry, OCT uses the back-reflection of low coherent infrared light to create cross-sectional images with a spatial resolution of 10 to 20 µm (1-4). This is at least an order of magnitude higher than the resolution of intravascular ultrasound (IVUS), the current standard of reference for in vivo characterization of the vessel wall and lumen. Studies using IVUS to characterize different plaque types have shown high accuracy, especially in detecting calcified lesions. The discrimination of fibrous and lipid-rich plaques with IVUS, however, is limited (5, 6). In an ex vivo study, Yabushita et al. were the first to describe different OCT signal characteristics for fibrous, lipid-rich, and fibrocalcified plaques in coronary artery specimens (7). Initial studies in vivo suggest that OCT can also identify high-risk lesions such as thin cap fibroatheroma, with high sensitivity and specificity (8). As the peripheral arteries of the lower limb represent a heterogeneous group in terms of vessel size, patterns of atherosclerosis, therapy strategies and outcome (9), exact knowledge of the composition and geometry of atherosclerotic lesions will become crucial, especially with the introduction of new interventional techniques, such as cutting balloon angioplasty, intravascular cryo-ablation or improved intravascular atherectomy and thrombectomy (10). Studies of our group showed high agreement of OCT with histopathology in the differentiation of normal vessel wall layers as well as atherosclerotic plaques in below-the-knee arteries ex vivo. We were able to demonstrate high correlation with IVUS concerning quantitative measurements of vessel dimensions (11, 12). Sensitivity and specificity for OCT criteria were 86% and 86% for fibrous plaques, 78% and 93% for lipid-rich plaques, and 84% to 95% for calcified plaques (overall agreement, 84%) Interobserver and intraobserver reliabilities of OCT assessment were high (K values of 0.84 and 0.87, respectively). Analyzing vessel area (VA), lumen area (LA), and plaque area (PA), a high and significant correlation between vessel parameters derived by IVUS and those derived by OCT (r=0.80-0.95) were shown. OCT overestimated VA by only 1% and underestimated LA by only 2% compared to IVUS. Plaque area was underestimated by 4%.

Beside the ultra-high resolution, additional advantages of OCT in comparison to IVUS are the low susceptibility to metallic artifacts and the small size of the imaging probe, measuring only 0.014-0.019 inches in diameter. This makes OCT an interesting means for online guidance of interventional procedures and direct therapy stratification.

However, there are also limitations of this evolving technique. One is the restricted ability to look through hemoglobin-rich blood. To temporarily block blood flow, a combined low-pressure occlusion balloon and flushing device has been developed, which buries some risk for vessel wall trauma. The other limitation of OCT is the penetration depth of only 1.5-2.0 mm in non-transparent tissue.

This lecture will provide an overview on the current status and future potentials of OCT in the diagnosis and treatment of cardiovascular disease. Detailed information on OCT signal characteristics of different plaque types will be given as well as sources of misinterpretation. As the first commercially available intravascular OCT system (Lightlab Imaging, Westford MA, USA) has received CE-certification for coronary applications in April 2005, initial experience on the safety and feasibility of OCT in vivo will be reported. Different strategies for achieving temporary ischemia to obtain artifact-free OCT images without interferences will be discussed.

The ability of OCT to accurately characterize atherosclerotic plaques may hold promise for a better understanding of the progression or regression of atherosclerosis. Additional information on plaque composition and monitoring of reaction to different therapeutic approaches in real-time may lead to more sophisticated and individually tailored treatment strategies for vascular disease in the future. Moreover, OCT provides the unique ability for online guidance of interventional procedures. This may significantly improve long-term results by minimizing vessel trauma. Pressure within the balloon could gradually be increased, leading to a smoother and more lesion-adapted approach. OCT has been successfully used to monitor a cutting balloon procedure (13). With OCT, exact positioning of the blades of the cutting balloon as well as control of the procedural success in real-time is possible. Up to now, it is still unclear whether stents may have a significant benefit in femoropopliteal revascularization. Maximum length of the stented vessel segment, stent fractures, overlapping stents and surface coating continue to be the focus of discussion. Current trials comparing PTA to primary stenting in the superficial femoral artery show a tendency towards better patency rates of primary stenting, at least for occlusions (TASC C lesions) (14, 15). In the near future, OCT may play an important role in the optimization of stent placement. Areas of insufficient stent expansion and stent malapposition, associated with increased thrombosis rates, can be directly detected and re-treated. This is especially important with the advent of new bioresorbable stents, not exactly visible with angiography or IVUS. OCT can accurately provide information about the size and symmetry of stent expansion and guide/facilitate the implantation of multiple stents in a row. To date, OCT is the only imaging technique able to image the degradation process of biodegradable stent-struts over time. Although the incremental value of OCT has to be determined in further studies and technical advances have to be made, OCT has the potential to contribute to a better understanding of the dynamic process of atherosclerosis and lead to an improvement of interventional procedures with better long-term results.

References

1. Fujimoto JG, Boppart SA, Tearney GJ, Bouma BE, Pitris C, Brezinski ME. High resolution in vivo intra-arterial imaging with optical coherence tomography. Heart 1999; 82:128-133.
2. Fujimoto JG, Brezinski ME, Tearney GJ, et al. Optical biopsy and imaging using optical coherence tomography. Nat Med 1995; 1:970-972.
3. Huang D, Swanson EA, Lin CP, et al. Optical coherence tomography. Science 1991; 254:1178-1181.
4. Tearney GJ, Brezinski ME, Bouma BE, et al. In vivo endoscopic optical biopsy with optical coherence tomography. Science 1997; 276:2037-2039.
5. Kimura BJ, Bhargava V, DeMaria AN. Value and limitations of intravascular ultrasound imaging in characterizing coronary atherosclerotic plaque. Am Heart J 1995; 130:386-396.
6. Regar E, Serruys PW. Ten years after introduction of intravascular ultrasound in the catheterization laboratory: tool or toy? Z Kardiol 2002; 91 Suppl 3:89-97.
7. Yabushita H, Bouma BE, Houser SL, et al. Characterization of

human atherosclerosis by optical coherence tomography. Circulation 2002; 106:1640-1645.
8. Jang IK, Tearney GJ, MacNeill B, et al. In vivo characterization of coronary atherosclerotic plaque by use of optical coherence tomography. Circulation 2005; 111:1551-1555.
9. Aronow WS. Management of peripheral arterial disease. Cardiol Rev 2005; 13:61-68.
10. Bates MC, Aburahma AF. An update on endovascular therapy of the lower extremities. J Endovasc Ther 2004; 11 Suppl 2:II107-127.
11. Meissner OA, Rieber J, Babaryka G, et al. [Intravascular Optical Coherence Tomography: Differentiation of Atherosclerotic Plaques and Quantification of Vessel Dimensions in Crural Arterial Specimens.]. Rofo 2006; 178:214-220.
12. Meissner OA, Rieber J, Babaryka G, et al. Intravascular Optical Coherence Tomography: Comparison with Histopathology in Atherosclerotic Peripheral Artery Specimens. J Vasc Interv Radiol 2006; in press.
13. Ito S, Itoh M, Suzuki T. Intracoronary imaging with optical coherence tomography after cutting balloon angioplasty for in-stent restenosis. J Invasive Cardiol 2005; 17:369-370.
14. Galaria, II, Surowiec SM, Rhodes JM, Shortell CK, Illig KA, Davies MG. Implications of early failure of superficial femoral artery endoluminal interventions. Ann Vasc Surg 2005; 19:787-792.
15. Surowiec SM, Davies MG, Eberly SW, et al. Percutaneous angioplasty and stenting of the superficial femoral artery. J Vasc Surg 2005; 41:269-278.

Special Session
Controversies in Vascular IR

54.1b

Contra: Stenting of the SFA is the future

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Introduction

Over the past two decades, metallic stents have revolutionised the treatment of peripheral vascular disease. Stent placement minimises the effects of elastic recoil and vessel remodelling after PTA and has led to demonstrably superior patency rates, particularly in high flow vascular territories such as the iliac arteries. However, while stenting has been accepted in the management of some peripheral vascular lesions, it has as yet failed to become established in the management of femoropopliteal disease. Prospective studies comparing femoral angioplasty with stenting have not demonstrated any clinically important long-term advantage following stent placement. Furthermore, comparison between bare metal and drug eluting stents in the superficial femoral artery (SFA) has yielded no convincing data to support the routine use of this expensive technology.

SFA angioplasty

The SFA remains the most challenging territory for vascular intervention and there are several fundamental reasons for this. Our understanding of the flow dynamics, biomechanics and pharmacology of the SFA is incomplete. The limitations of SFA angioplasty are well recognised and successive attempts to improve patency rates by various forms of adjuvant therapy have failed to significantly increase objective patency or clinical outcomes. Furthermore, many of the basic questions concerning SFA angioplasty remain unanswered despite the numerous published studies in the radiological literature. Criteria used for the selection of patients for femoral PTA differ between countries and institutions, often making comparison between published data difficult. At the same time, many of the basic procedural aspects of SFA intervention such as optimum balloon inflation time, balloon sizing and adjunctive therapy have received scant attention. Despite these ambiguities and uncertainties, high procedural success rates, exceeding 90%, are widely reported in the treatment of stenotic and occlusive femoropopliteal disease. Long-term primary patency rates for femoropopliteal PTA are very acceptable and range from 50-86% after one year to 41-58% at five years following treatment (1-7). The approach to follow-up and re-intervention after SFA angioplasty differs widely between institutions. The strategy of close surveillance and early reintervention using balloon angioplasty has received limited attention but this approach could potentially offer a superior and cost-effective alternative to the use of stents or surgical bypass. Therefore, from the outset, it is clear that attempting to compare outcomes after stenting in the SFA with historical controls is difficult. Only randomised controlled studies can be used to establish outcomes after stenting in comparison to conventional PTA. Yet another important consideration in this debate is the relationship between vessel patency and symptomatic improvement. The primary role of SFA angioplasty is to re-establish equilibrium between demand and supply in the ischaemic limb. Objective measures of vessel patency do not necessarily equate to clinical success. Many patients experience symptomatic and quality of life improvement despite SFA restenosis or re-occlusion. Factors which influence this process include collateralisation, medical treatment, lifestyle modification, and exercise programmes. Vessel patency is not ,therefore, the sole determinant of clinical success in the treatment of femoropopliteal disease (3,8).

Stenting in the SFA

The first reports of stenting for femoropopliteal disease appeared in the early 1990s. Predictably, very encouraging technical results were reported and early follow-up data suggested that SFA stenting offered a reliable solution to the problem of long term patency in the SFA. It soon became clear that while early patency rates were improved, no clear advantage to standard interventional techniques could be demonstrated in the long term. Most of the published data relates to small cohort studies using a variety of different stents in patients selected according to differing criteria. In a prospective study of the Wallstent in SFA intervention, Sapoval concluded that self-expanding stents did not reduce the reocclusion rate after PTA. Furthermore this group of investigators found that secondary procedures in the presence of restenosis did not significantly improve patency rates. The diameter of the treated vessel also seemed to be significant and those vessels with diameters of less than 5mm had much reduced long-term patency (9). Strecker reported disappointing overall primary patency rates of 51% and 48% at 2 and three years respectively for flexible tantalum stents in femoropopliteal lesions (10). A number of similar cohort studies found that mid and longer-term patency rates for femoral stents were lower than anticipated and that restenosis was more likely in the presence of longer lesions, distal disease and small diameter vessels (9,11-13).

There is very little randomised data comparing stenting with PTA in the femoral arteries. In a randomised study by Cejna et al, initial success rates for were significantly better after stenting in comparison to PTA. However, cumulative primary patency rates at 2 years showed no improvement in the stented group (14). These results were confirmed by two further reports by Grimm and Vroegindeweij which failed to show any benefit of balloon expandable stents in randomised groups (15,16). The potential problems and limitations of balloon expandable stents within the SFA has prompted other investigators to evaluate self-expanding stents within the SFA. In a non-randomised study by Do et al, neither clinical status nor ABI was found to be significantly improved by use of the Wallstent in femoropopliteal lesions (17). Whether or not any particular stent material or design might offer better patency has not been addressed by any comparative studies, although a recent uncontrolled study by Jahnke suggests that nitinol coil stents may offer higher patency rates than those previously reported (18).

The reported results of femoropopliteal stenting do not, therefore, support the widespread use of this technique and this is supported by two major systematic reviews (19,20). The suggestion that more severe SFA disease may respond more favourably to stenting has yet

to be confirmed and current evidence-based guidelines recommend the use of stenting as a bailout procedure only (21).

Stent-grafts and drug-eluting stents

The problems of early thrombosis and significant restenosis in SFA stents have prompted further research into the potential applications of covered stents and drug-eluting devices for use in the SFA. Metallic stents act as a chronic stimulus to neointimal hyperplasia and little is understood of the optimal characteristics for stent construction which are necessary to minimise this effect.

Covered stents using Dacron and ePTFE have been used in an attempt to simulate surgical in-situ femoral grafts. Dacron stent-grafts appear to be unsuitable in femoropopliteal lesions because of significant problems due to postimplantation syndrome and unacceptable occlusion rates (22). ePTFE stent-grafts have shown better patency rates but there is as yet very limited prospective data comparing these relatively expensive devices with balloon angioplasty (22,23).

The emergence of drug-eluting stents for use in the SFA has prompted understandable excitement as our search for the holy grail in the face of restenosis continues. Drug-eluting stents offer a new perspective. Stents are an ideal platform for local drug delivery, because they provide permanent scaffolding and can act as a drug reservoir, achieving an effective local concentration of the drug over a predetermined time period. The basic components of a drug-eluting stent are the carrier stent made of nitinol or stainless steel, the coating matrix, and the bioactive agent with its particular release characteristics. To date, all clinical studies have used commercially available stent designs as the drug carrier. The SIROCCO trials have investigated the use of sirolimus coated nitinol SMART stents in SFA disease (24). While early results showed better patency in drug-eluting stents compared to bare stents, this was not statistically significant at 2 years. Stent design may have a crucial role here. The self-expanding nitinol coil design, with its promising patency rates, may be intrinsically better suited to maintaining patency and countering restenosis in the SFA territory. However, such a design provides a much less efficient drug-delivery platform due to the spacing of the stent loops. Nitinol stents with a mesh design theoretically allow a more concentrated delivery of drug to the vessel wall, but may provide a degree of mechanical stimulation that is disadvantageous after the period of drug elution has ceased. Currently available stent designs are unlikely to provide the optimal approach to drug delivery in the SFA.

The future

The use of metallic stents has an established role in bailout following suboptimal angioplasty or in the presence of dissections that do not respond to balloon dilatation (21). To date, there is no good scientific evidence to suggest that more widespread use of femoropopliteal stents will significantly improve long-term patency rates after intervention. More specifically, there is no logical argument to support use of stents in the treatment of focal SFA disease where the objective and clinical results of balloon dilatation are already excellent. Better understanding of patient selection, pharmacological treatment and surveillance strategies may, in fact, offer a superior and cost effective means of managing restenosis. It has been calculated that to be cost-effective, a device costing $3000 for use in the SFA would have to produce patency rates of almost 50% in critical ischaemia and 90% in claudicants at 5 years (25). Our collective experience tells us that this is almost certainly unachievable.

In the next few years, studies of drug-eluting stents in the SFA will undoubtedly show excellent short term results, but it seems equally certain that they will only provide limited improvement in the long-term prognosis of what is a diffuse and progressive condition. Stenting is not yet, therefore, the future in the SFA.

References

1) Jeans WD, Armstrong S, Cole SEA, et al. Fate of patients undergoing transluminal angioplasty for lower-limb ischaemia. Radiology 1990;177:559-564
2) Capek P, McLean GK, Berkowitz HD. Femoropopliteal angioplasty: factors influencing long-term success. Circulation 1991;83:70-80
3) Johnston KW. Femoral and popliteal arteries: reanalysis of results of balloon angioplasty. Radiology 1992;183:767-771
4) Matsi PJ, Manninen HI, Vanninen RL, et al. Femoropopliteal angioplasty in patients with claudication: primary and secondary patency in 140 limbs with 1-3 years follow-up. Radiology 1994;1191:727-733
5) Murray JG, Apthorp A, Wilkins RA.Long segment (>) femoropopliteal angioplasty: improved technical success and long-term patency Radiology 1995;195:158-162
6) Galliano A, Mahler F, Probst P, et al. Percutaneous transluminal angioplasty of the arteries of the lower limbs: a 5 year follow-up. Circulation 1984;70:619-623
7) Krepel VM, van Andel GJ, van Erp WF, Breslau PJ. Percutaneous transluminal angioplasty of the femoropopliteal artery: initial and long-term results. Radiology 1985;156:325-328
8) Rutherford RB, Becker GJ. Standards for evaluating and reporting the results of surgical and percutaneous therapy for peripheral arterial disease. Radiology 1991;181:277-281
9) Sapoval MR, Long AL, Raynaud AC, Beyssen BM, Fiessinger J-N, Gaux J-C. Femoropopliteal stent placement: long-term results Radiology 1992;184:833-839
10) Strecker E, Boos I, Göttmann D. Femoropopliteal artery stent placement: evaluation of long-term success Radiology 1997;205:375-383
11) Liermann D, Strecker EP, Peters J. The Strecker stent: indications and results in iliac and femoropopliteal arteries. Cardiovasc Int Radiol 1992;15:298-305
12) Zollikofer CL, Antonucci F, Pfyffer M, et al. Arterial stent placement with use of the Wallstent: midterm results of clinical experience. Radiology 1991;179:449-456
13) Henry M, Amor M, Ethevnenot G, et al. Palmaz stent placement in iliac and femoropopliteal arteries: primary and secondary patency in 310 patients with 2-4 year follow-up. Radiology 1995;196:167-174
14) Cejna M, Illiasch H, Waldenberg P, et al. PTA vs Palmaz stent in femoropopliteal obstructions: a prospective randomised trial - long-term results. Radiology 1998;209:492 (abstract)
15) Grimm J, Muller-Hulsbeck S, Jahnke T, et al. Randomised study to compare PTA alone versus PTA with Palmaz stent placement for femoropopliteal lesions. J Vasc Interv Radiol 2001;12:935-942
16) Vroegindeweij D, Vos LD, Tielbeek AV, Buth J, vd Bosch HCM. Balloon angioplasty combined with primary stenting versus balloon angioplasty alone in femoropopliteal obstructions; a comparative randomised study. Cardiovasc Int Radiol 1997;20:420-425
17) Do-Dai-Do, Triller J, Walpoth BH, et al. A comparison study of self-expandable stents vs balloon angioplasty alone in femoropopliteal artery occlusions. Cardiovasc Int Radiol 1992;15:306-312
18) Jahnke T, Voshage G, Müller-Hülsbeck S, Grimm J, Heller M, Brossmann J. Endovascular placement of self-expanding nitinol coil stents for the treatment of femoropopliteal obstructive disease. J Vasc Interv Radiol 2002;13:257-266
19) Muradin G, Bosch J, Stijnen T, Hunink MG. Balloon dilatation and stent implantation for treatment of femoropopliteal arterial disease: meta-analysis Radiology 2001;221:137-145
20) Lammer J. Femoropopliteal artery obstructions: from the balloon to the stent-graft Cardiovasc Intervent Radiol 2001;24:73-83
21) Tsetis D, Belli A-M. Guidelines for stenting in infrainguinal arterial disease. Cardiovasc Intervent Radiol 2004;27:198-203
22) Jahnke T, Andersen R, Muller-Hullsbeck S, et al Hemobahn stent-grafts for treatment of femoropopliteal obstructions: midterm results of a prospective trial. J Vasc Interv Radiol 2003;14:41-51
23) Bray PJ, Robson WJ, Bray AE. Percutaneous treatment of long superficial femoral artery occlusive disease: efficacy of the Hemobahn stent-graft J Endovasc Ther 2003;10:619-628
24) Duda SH, Bosiers M, Lammer J, et al. Sirolimus-eluting versus

bare nitinol stent for obstructive superficial femoral artery disease: the SIROCCO II trial. J Vasc Interv Radiol 2005; 16:331-338
25) Muradin GS, Hunink MG. Cost and patency rate targets for the development of endovascular devices to treat femoropopliteal arterial disease Radiology 2001;218:464-469

54.2b

Con: Renal Artery stenting is indicated for hypertensive patients

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Controversions in vascular IR
Renal artery stenting is indicated for hypertensive patients: contra
In 99% of the patients with hypertension the cause for this disease is unknown and is called essential. Renal artery stenosis is quite prevalent and was found in > 40% in post mortum studies of patients aged more than 75 years. So essential hypertension and renal artery stenosis will frequently coincide without having a causal relation. This can explain why treatment results of these patients are frequently dissapointing.
Furthermore the aim of treating these patients with hypertension is not to get a better control of their hypertension but to improve their prognosis. So after treatment the number of heart attacks, strokes and reno/pheripheral vascular disease should diminish.
The hypertension is just an intermediate marker of disease. So stent placement should lead to improved cardiovascular outcomes. When stent placement has this effect, on top of the effect caused by good medical treatment with a.o. statins, then stent placement should be pursued.
What has been proven up to now in randomized trials? There have been 6 randomized trials in this field of which 4 are relevant for our question. In one it was shown that the use of a stent better keeps the vessel open than PTRA alone.
In 3 other randomized trials PTRA (without stent) was compared with antihypertensive treatment. Two meta analysis of these 3 trials showed that a large improvement in renal function or hypertensive can be ruled out, a moderate but clinically worthwhile benefit, however cannot be ruled out, because the total size of the group (n = 210) was too small to make a certain statement. Furthermore, the follow-up of 1 year was too short to make any statement about improved cardiovascular outcomes. So renal artery stenting is not indicated for hypertensive patients and should be considered an experimental treatment only done in a trial setting. These trials should include many more patients (> 1000) and should have a longterm follow-up to assess whether cardiovascular outcomes improve.

54.3a

Pro: Fertility is preserved after UAE

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Pro- UFE does not harm fertility or future pregnancy
Introduction
I will be honest- I hate these pro and con sessions. I think they are designed for entertainment rather than enlightened discussion. There are relatively few controversies in Interventional Radiology that can be clearly divided into black and white. The only one that comes to mind in a clinical context is the controversy of bland embolization versus chemoembolization for hepatic neoplasms. Perhaps we could get a heated discussion about choice of embolic material for UFE, although that discussion is not so current this year.
So when asked to take a side on the issue of subsequent pregnancy after UFE, I was hesitant. I felt I was in a better position to argue both sides rather than just one. I have opinions that are very divided on this issue. Having said that, I think a discussion on why UFE may not be bad for pregnancy would be useful, if for no other reason than gynecologists worldwide have twisted our hesitancy to recommend UFE for women seeking to become pregnant into a belief that it is impossible to become pregnant after UFE. I have even had one gynecologist who told a patient who wanted to become pregnant that she could not have UFE, because it makes pregnancy impossible, so he recommended a hysterectomy instead!
So it is with reluctance but also with a sense of duty to our patients that I will attempt to discuss why a patient can become pregnant after UFE. I apologize in advance that some of the material that follows has been presented elsewhere in this syllabus, but there are only so many ways to present the same data from the literature.
Pregnancy after UFE
Our understanding of pregnancy after embolization is limited but increasing. One of the early reports was published by Ravina in 2000, in which there were 12 pregnancies among 184 women undergoing UFE. There were 5 miscarriages (in 3 women), 7 deliveries of 8 babies (one twin pregnancy). There was one fetal death from sepsis delivered by a patient with AIDS. The other delivered babies were normal. There were 4 cesarean sections.
McLucas also reported on 17 pregnancies in 14 women among 52 women under 40 interested in becoming pregnant . He estimated a pregnancy rate of 33%. There were 10 term pregnancies and 5 miscarriages, with 2 ongoing pregnancies at the time of publication.
The pregnancy outcomes from the Ontario Multi-Center Trial on Uterine Embolization were published in early 2004 . Among the 555 women enrolled in that multi-center study, 21 women became pregnant, with 3 having two pregnancies. The range of ages of the patients at the time of delivery was 29-42 years, with a mean age of 36. Of a total of 24 pregnancies, 23 were spontaneous and one the result of in vitro fertilzation. There were also 4 miscarriages and 2 elective terminations. Of 18 live births, 14 were full term and 4 were pre-term. There were no antenatal complications among the pregnancies leading to delivery, but there were 3 cases of abnormal placentation (2 placenta previas and 1 placenta accreta). The 2 cases of placenta previa had minor episodes of hemorrhage early in the third trimester that necessitated pre-term delivery. The patient with placenta accreta had a significant hemorrhage at the time of cesarean section, which necessitated hysterectomy.
Carpenter and Walker also have reported on 29 pregnancies in 671 women . Data were presented on 26 completed pregnancies. Among these, there were 7 miscarriages, 2 terminations and 1 ectopic pregnancy. Of 16 deliveries, there were 4 preterm deliveries and 2 others with premature rupture of membranes. There were 14 of 16 delivered by cesarean section and there was post-partum hemorrhage in 3 patients. Based on these findings, the authors concluded there was a higher than normal cesarean delivery rate, although there was no analysis of potential confounders for cesarean such as prior myomectomy.
Goldberg recently compared the outcomes from case reports of pregnancies after uterine embolization to those from published series of laparoscopic myomectomy patients (LM) . In this review, they reported that the UFE patients were more likely to have pre-term delivery and malpresentation. However, the two groups were not comparable, as pointed out by the authors. The LM patients were younger, had smaller fibroids, and were more likely to be nulliparous. The LM procedures were more likely to be performed for intramural and serosal fibroids, while the UFE procedures also were performed for submucosal fibroids, which are known to impact fertility. Because of the multiple confounding variables that might impact the pregnancy outcomes of myomectomy and embolization, the conclusions from such a comparison are not reliable.
The Unknowns
Now that we know that women can become pregnant after embolization, what don't we know? Here are a few of the many holes in our knowledge
1.We don't know who will be become pregnant.

We often assume that our therapy is not as effective for improving fertility chances as surgery, but we have no proof either way. This is because we also do not know who will become pregnant after myomectomy. The primary reason we recommend myomectomy in many patients currently is that there are too many unknowns with UFE at this stage- myomectomy may not be perfect but it is at least a procedure with which most gynecologists are comfortable.

Therefore, there is a need for substantial additional research on the exact impact that fibroids have on pregnancy, what role fibroid size and location have on pregnancy, and which subgroups might be better treated with one or the other of the available to improve pregnancy outcomes.

2.We don't know which patients are poor candidates for myomectomy or for UFE.

There is little study on the outcomes of myomectomy based on extent of fibroid disease. While it is likely that increased fibroid load may negatively impact the outcome in terms of fertility outcomes after surgery, we have little data to support that view. We also have no data to support our current belief that for patients with extensive fibroids or who had prior myomectomy, UFE may be better.

3. We don't know whether UFE or myomectomy has less impact on uterine structure and function, endometrial viability, or ovarian function.

This clearly needs to be established before we can begin large studies comparing fertility outcomes for the two procedures. In the general population of patients of reproductive age, pregnancy is a relatively rare event and a more direct way to begin to study of the relative fertility impact is to evaluate these parameters in patients after treatment. This will allow us to understand whether there is a systematic advantage of one or the other of these approaches in patients in their reproductive years.

These are just the first of many unknowns that need to be explored before we can take a firm pro or con position for UFE in women seeking to become pregnant. So if I must take a position, I would like to be pro research so that we may base our decisions on more complete knowledge.

References

1. Ravina J, Vigneron N, Aymard A, Le Dref O, Merland J. Pregnancy after embolization of uterine myoma: report of 12 cases. Fertility and Sterility 2000;73:1241-1243.
2. McLucas B, Goodwin S, Adler L, Rappaport A, Reed R, Perrella R. Pregnancy following uterine fibroid embolization. Int J Gynaecol Obstet 2001;74:1-7.
3. Pron G, Mocarski E, Bennett J, Vilos G, Common A, Vandergurgh L. Pregnancy after uterine artery for leiomyomata: The Ontario Multicenter Trial. Obstet and Gynec 2005;105:67-76.
4. Carpenter TT, Walker WJ. Pregnancy following uterine artery embolisation for symptomatic fibroids: a series of 26 completed pregnancies. BJOG 2005;112:321-325.
5. Goldberg J, Pereira L, Berghella V, Diamond J, Darai E, Seinera P, et al. Pregnancy outcomes after treatment for fibroimyomata: Uterine artery embolization versus laparoscopic myomectomy. Am J Obstet Gynecol 2004;191:18-21.

Special Session
Radiation Protection for Interventional Radiologists

55.2

Strategies to reduce doses in the IR suite

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Why radiological protection in interventional radiology?

Radiological protection (RP) is a key point for interventional radiology (IR) practices. Staff and patient doses are the highest in X ray imaging. Radiation injuries could be produced if high standard equipment and procedures are not used. The International Commission on Radiological Protection (ICRP), the United States Food and Drug Administration and the World Health Organisation have published recommendations on how to avoid radiation injuries and to improve the level of safety in IR.

The frequency and complexity of fluoroscopically guided invasive procedures have increased substantially in recent years. Reports of patient skin injuries in IR are fully documented in the scientific literature. Research into new methods for patient dose monitoring, especially that focused on preventing deterministic effects has been developed in the last years. Information on peak skin dose (PSD) at the operator console would be desirable. Mapping skin doses is useful to determine the probability of a possible injury and its extent, to detect areas of overlapping radiation fields and to provide the possibility of obtaining a permanent register of the most exposed patient skin areas. This is essential for the follow-up of patients with multiple fluoroscopy interventions.

The European Commission and some individual Countries from the European Union have made during the last years a significant effort in regulation and in some focussed research programmes to promote a high standard of quality and RP for IR.

Strategies to reduce patient and staff doses in the interventional X ray suites maintaining enough image quality and obtaining enough diagnostic information to carry out IR procedures will be reviewed.

International and European recommendations

Patient and staff doses during interventional fluoroscopically guided procedures will depend on the existing X rays system and its particular setting and the operational procedures (including the proper use of RP tools). The record and follow up of patient and staff dose values are essential. Comparison of local dose values with reference levels (indicative of good practice) will allow optimisation techniques and improvement in radiation safety. Quality assurance programmes, including initial and continuous training programmes in RP are another key aspect to be considered.

ICRP recommended in its report on "Avoidance of radiation injuries from medical interventional procedures" (2000) several practical aspects: All departments performing interventional procedures should know the output parameters of their X ray system and the typical doses delivered to patients and staff. All patients should be informed of the likelihood of radiation effects as part of informed consent. Frequent patient dose audits should occur when digital techniques are introduced in an operational facility. Industry should promote tools to inform about the exposure parameters and the resultant patient doses. The exposure parameters and the resultant patient doses should be standardized, displayed and recorded. A second, specific, level of training in radiation protection, additional to that undertaken for diagnostic radiology, is desirable. Specific additional training should be planned when new x-ray systems or techniques are implemented in a centre.

Concerning personnel dosimetry, ICRP states that the high occupational exposures in interventional radiology require the use of robust and adequate monitoring arrangements for staff. A single dosimeter worn under the lead apron will yield a reasonable estimate of effective dose for most instances. Wearing an additional dosimeter at collar level above the lead apron will provide an indication of head (eye) dose. Consequently, it is recommended that interventional radiology departments develop a policy that staff should wear two dosimeters.

The Council Directive 97/43/ Euratom on health protection of individuals against the dangers of ionizing radiation in relation to medical exposure, states in its article 4 that "the optimization process shall include … the assessment and evaluation of patient doses …" and that "appropriate quality assurance programmes including … patient dose assessments shall be implemented" (art.8). Acceptance test and periodic quality control of the X ray systems is an essential part of any quality assurance programme.

The International Electrotechnical Commission (IEC) published a

standard on "Particular requirements for the safety of X-ray equipment for interventional procedures", which includes general safety and RP aspects. In addition, IEC is working on a standard (drafted under the name "DICOM-DOSE") written in concert with DICOM WG-02. It is proposed that all irradiation events (fluoroscopy runs and image acquisition series) be archived, irrespective of the storage of the images produced by that irradiation. This information will be stored in a "Radiation Dose Structured Report" (RDSR). The RDSR could be archived in the RIS, or PACS, or be transferred to a "Radiation Safety Reporting System". This RDSR will facilitate the patient dose audit and the possibilities to optimise the procedures.

Practical advices to reduce patient doses

Staff and patient doses are correlated during interventional practice but they are not directly proportional. If interventionists are properly trained in RP, occupational doses will be low even for complex procedures because protection tools will be properly used. But still in these cases if patient dose reduction is achieved, consequent staff dose reduction will also be produced.

If is possible to give some practical advices for the proper management of patient doses in the IR suites.

1. Keep the x-ray tube at the practicable maximum distance from the patient.
2. Keep the image detector (image intensifier or flat detector) as close to the patient as is practicable for the procedure.
3. Reorient the X ray beam avoiding overlapping irradiated areas in the skin of the patient.
4. Use appropriate collimation of the X ray beam.
5. Thicker tissue masses absorb more radiation, thus much more radiation must be used when steep beam angles are employed. Try to avoid these projections or reduce the fluoroscopy time and image acquisition in these cases.
6. Use magnification only when needed. For most of the systems, magnification involves an increase in patient skin dose rate.
7. Use low fluoroscopy modes when practicable (typically these modes will have high filtration and pulsed fluoroscopy modes).
8. Use only the number of series (and frames per series) required for the procedure.
9. Give attention to the dosimetric indications in the X rays system (typically dose area product and cumulative skin dose).

Practical advices to reduce staff doses

1. One of the most important radiation protection measures is to increase one's distance from the radiation source (the patient in the catheterisation laboratory).Working at 80 cm from the isocentre instead of 40 cm can decrease scattered dose to approximately a quarter of the original dose.
2. Use a ceiling suspended screen and other structural or personal shielding tools available, such as a lead apron and thyroid collar, when possible.
3. Minimise the use of fluoroscopy and use low fluoroscopy modes (for example, pulsed fluoroscopy) when possible.
4. As scattered dose during image acquisition is much higher than during fluoroscopy, acquire only the necessary number of frames per series and limit the number of series.
5. As dose levels are more important for large patients and during angulated projections, staff should be better protected in these cases.
6. 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.
7. Collimation of the radiation field (and generally all other factors reducing patient dose) decreases the level of scattered dose.

In addition, a final general recommendation: be aware of the RP of your patient and you will also be improving your own occupational protection.

Quality indicators

A simple test to evaluate if a basic radiation safety programme exists in an interventional suite, could be to give a positive answer to the following questions:

a) Could your laboratory report patient dose values from the last year?
b) Do you have a procedure for the clinical follow-up of high doses to patients?
c) Do you know the results of your X ray system QCs?
d) Are you following your staff dose values?
e) Do you have a continuous training programme in RP?

Conclusions

In most cases, published papers on skin radiation injuries have always been associated with lack of quality control in the X-ray systems or a lack of training in RP of the specialists performing the procedures.

The new development in X ray systems (dynamic flat detectors, DICOM implementation, on line patient dose records, etc) should improve the radiation safety in the IR suites maintaining a high standard of image quality. A close collaboration between interventionalists, medical physicists and industry will be necessary to profit the technological advances offered by the industry.

The knowledge of typical dose rates for each X-ray system in use in interventional laboratories is essential in order to optimise protection of patients and staff. Typical values for the different fluoroscopically guide procedures should be obtained in the different laboratories and national and European patient dose surveys will help in the quality and safety of the interventional radiology practice as already done in the RAD-IR study in USA.

The European Coordination Action SENTINEL with members from 20 European Countries, funded in part by the European Commission, has a workpackage on IR and can help in the improvement of the radiation safety aspects in these procedures.

References

1. Balter S, Schueler BA, Miller DL, Cole PE, Lu HT, Berenstein A, Albert R, Georgia JD, Noonan PT, Russell EJ, Malisch TW, Vogelzang RL, Geisinger M, Cardella JF, St George J, Miller GL 3rd, Anderson J. Radiation doses in interventional radiology procedures: the RAD-IR Study. Part III: Dosimetric performance of the interventional fluoroscopy units. J Vasc Interv Radiol. 2004 Sep;15(9):919-26.
2. European Commission. Council Directive 97/43 Euratom on health protection of individuals against the dangers of ionizing radiation in relation to medical exposure, and repealing Directive 84/466 Euratom. Off. J. Eur. Commun. L180, 22-27 (1997).
3. European Commission. Guidelines on education and training in radiation protection for medical exposures. Directorate General Environment, Nuclear Safety and Civil Protection. Radiation Protection 116. (Luxembourg: EC) (2000). Available on http://europa.eu.int/comm/energy/nuclear/radioprotection/publication/116_en.htm.
4. International Commission on Radiological Protection. Avoidance of radiation injuries from medical interventional procedures, ICRP Publication 85. Annals of the ICRP 2000;30(2). Oxford: Pergamon Press, 2000.
5. International Electrotechnical Commission. Medical electrical equipment_Part 2-43: Particular requirements for the safety of X-ray equipment for interventional procedures, IEC 60601-2-43. Geneva: Switzerland, IEC, 2000.
6. Koenig TR, Mettler FA, Wagner LK. Skin injuries from fluoroscopically guided procedures: part 2, review of 73 cases and recommendations for minimizing dose delivered to patient. AJR Am J Roentgenol. 2001;177(1):13-20.
7. Koenig TR, Wolff D, Mettler FA, Wagner LK. Skin injuries from fluoroscopically guided procedures: part 1, characteristics of radiation injury. AJR Am J Roentgenol. 2001;177(1):3-11.
8. Miller DL, Balter S, Cole PE, Lu HT, Berenstein A, Albert R, Schueler BA, Georgia JD, Noonan PT, Russell EJ, Malisch TW, Vogelzang RL, Geisinger M, Cardella JF, George JS, Miller GL 3rd, Anderson J. Radiation doses in interventional radiology procedures: the RAD-IR study: part II: skin dose. J Vasc Interv Radiol. 2003;14(8):977-90.
9. Miller DL, Balter S, Cole PE, Lu HT, Schueler BA, Geisinger M, Berenstein A, Albert R, Georgia JD, Noonan PT, Cardella JF, St

George J, Russell EJ, Malisch TW, Vogelzang RL, Miller GL 3rd, Anderson J; RAD-IR study. Radiation doses in interventional radiology procedures: the RAD-IR study: part I: overall measures of dose. J Vasc Interv Radiol. 2003;14(6):711-27.
10. US Food & Drug Administration (FDA). Avoidance of serious X-ray induced skin injuries to patients during fluoroscopically-guided procedures. Medical Bulletin 1994;24(2):7-17.
11. Vano E, Arranz L, Sastre JM, Moro C, Ledo A, Garate MT, et al. Dosimetric and radiation protection considerations based on some cases of patient skin injuries in interventional cardiology. Br J Radiol 1998;71:510-6.
12. Vano E, Geiger B, Schreiner A, Back C, Beissel J. Dynamic flat panel detector versus image intensifier in cardiac imaging: dose and image quality. Phys Med Biol. 2005:50(23):5731-42.
13. Vano E, Gonzalez L, Beneytez F, Moreno F. Lens injuries induced by occupational exposure in non-optimized interventional radiology laboratories. Br J Radiol 1998;71:728-33.
14. Vano E, Gonzalez L, Fernandez JM, Guibelalde E. Patient dose values in interventional radiology. Br J Radiol. 1995;68(815):1215-20.
15. Vano E, Guibelalde E, Fernandez JM, Gonzalez L, Ten JI. Patient dosimetry in interventional radiology using slow film systems. Br J Radiol 1997;70:195-200.
16. Vano E. Radiation exposure to cardiologists: how it could be reduced. Heart. 2003 Oct;89(10):1123-4.
17. World Health Organisation. Efficacy and radiation safety in interventional radiology. Geneva: WHO, 2000.

55.3

Flat panel digital technology in interventional Radiology

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Since the first angiography procedure in the fifties, cardio-vascular imaging has benefited from consistent but relatively modest technological advances. The demand for the highest possible image quality was never as heavy as today.
Nowadays, interventional vascular radiology requires excellent image quality to enable easier diagnosis in more details, while minimizing radiation dose to both patient and staff.
The development of three-dimensional angiographic techniques has created a new focus on the clinical applicability and potential implications of this new technology.
3D rotational angiography, offers the anatomic resolution of digital subtraction angiography, with the complement of the 3D visualization properties previously offered by CT or MR angiography. It also provides more detailed information than does DSA alone in the evaluation of neurovascular lesions, such as cerebral aneurysms. 3D-DSA has taken a prominent role in treatment planning in neurorradiology, by enabling a better study of the morphology of complex vascular lesions.
However, few articles have been published regarding applications in peripheral interventional radiology.
So far, 3D angiography was done using image intensifier detectors (IID). A new generation of angiographic systems, equipped with flat panel detectors (FPD) has been introduced in general angiography imaging with an optimized field of view of 41cm x 41cm, improving image quality.
By converting the incident x-ray photons directly, into digital images at the detector, the all-digital technology replaces the image chain components of the conventional systems.
We present our clinical experience with these emerging technologies, in terms of daily practice. We report as well, the results of a comparison study held on our institution, which pretended to measure both image quality and radiation dose to determine if this new large flat panel technology leads to improved results compared to conventional image-intensifier systems.
The methods used in such study regarding to radiation dose, were as follows; the entrance dose measurement were made using Digital Flat Panel (DFP) angiography system Innova 4100 and LCA conventional Image Intensifier (II) based system, a Calibrated dosimeter was placed on the angiography X-Ray table for each system, the dose was measured using an ionization chamber for 10, 15, 20, 25 and 30 cm of Plexiglas, with the centre of the Plexiglas phantom maintained at the isocenter of the image system gantry. Dose measurements were made for each system in all doses modes available for both fluoroscopy (30 fr/sec) and Digital Subtraction Angiography (DSA) per frame, and for each magnification mode. The methodology employed for dose measurements was the following; fluoroscopic and DSA dose rates compared between Innova 4100 and LCA conventional II based system, the nominal FOVs used was (40, 32/30, 20/21 and 16 cm), skin dose was measured (in mGy/min) on PMMA of varying Equivalent Patient Thickness (EPT) with anti-scatter grid and a Plexiglas phantom was placed at isocenter position.
The image quality was assessed using the new NEMA-SCA&I phantom (new industry approved cardiovascular-benchmark phantom and IQ standard).
The results obtained in terms of dose savings demonstrated that, on fluoroscopy and DSA modes, the DFP system compared favourably to the conventional II system.
In fluoroscopy, the DFP resulted in significantly (up to 42% on normal dose mode) lower entrance exposure dose (75% on low dose mode), compared to the II system. In DSA mode, this same study resulted in a 42% (on normal dose mode) and 72% (on low dose mode) reduction.
Image quality measurements were consistently superior for the Innova 4100 (80% higher resolution in fluoroscopy and 30% in DSA) with significantly more low contrast iodine targets and moving wires detected and a larger dynamic range or working thickness range.
The daily practice based opinion, was that the large DFP system for angiography has higher image quality in fluoroscopy and in DSA compared to a conventional II system.
The overall conclusions of our study were: advantages in image quality were present with low and normal dose mode on the Innova 4100, fluoroscopy and DSA radiation dose levels were significantly lower, that we do not need to position collimation filters any longer (which results in a reduction of time and radiation and in advantages for AVF PTA and distal angioplasty), the visualization of low contrast iodine targets and moving objects was superior with the DFP system through an improved dynamic range, and that we identified an improved resolution with fluoro and record details (in particular for small vessels leading to advantages for distal angioplasty, abdominal angiography and neuroradiology). With the large panel we were able to cover more anatomy with fewer sequences with no distortion across the whole image (which is beneficial for thoracic and abdominal angiography and lower limbs) and through lower volumes and fewer sequences the contrast agent dose was reduced. Therefore, promising vascular 3D imaging as well as soft tissues and bones reconstructions can be pursued to support interventional procedures.
As a general result, better multi-planar cross-sectional and 3D reconstructions (scanner like imaging) can be obtained leading to improved understanding of complex vascular pathologies and their anatomical relationship with surrounding structures.
Newer possible applications are under study, as rotational three dimensional cholangiography, 3D dimensional rotational angiography of transplanted renal arteries, or as an aiding tool during transcatheter arterial embolization of liver malignancies.
The intent of this work we present, is both to provide an overview of the advantages that this system can offer in a daily based clinical practice, to discus the potential limitations in radiology and to introduce the reader to the new clinical applications that this emerging technology will bring into the cath. lab.

References

1. Spahn M, Heer V, Freytag R. Flat-panel detectors in X-ray systems. Radiologe. 2003 may;43(5): 340-50.
2 .Geijer H. Radiation dose and image quality in diagnostic radiology. Optimal of the dose-image quality relationship with clinical experience from scoliosis radiography, coronary intervention and a flat-panel detector. Acta Radiol Suppl. 2002 mar; 43 (427): 1-43.
3. Okusako K, Shogaki M, Yokoyama K et coll. An experience of the clinical study with angiography system using flat panel detector. Igaku Butsuri. 2002; 22(4): 255-63.
4. Gailloud P, Oishi S, Murphy K. Three-dimensional fusion digital subtraction angiography: new reconstruction algorithm for simultaneous three-dimensional rendering of osseous and vascular information obtained during rotational angiography. AJNR Am J Neuroradiol. 2005 Apr;26(4):908-11.
5. Liapi E, Hong K, Georgiades CS, Geschwind JF. Three-dimensional rotational angiography: introduction of an adjunctive tool for successful transarterial chemoembolization. J Vasc Interv Radiol. 2005 Sep;16(9):1241-5.

10.1.1

Complications of internal iliac artery embolisation prior to endovascular aneurysm repair

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Purpose: Coil embolisation of the internal iliac artery (IIA) is used to extend the applicability of endovascular aneurysm repair (EVAR) in cases of challenging iliac anatomy. The aim of this study was to document pelvic ischaemia following IIA embolisation and pool the results of other published studies for comparison.
Materials/Methods: A vascular database and telephone interviews were used to assess 40 patients who had undergone IIA coil embolisation as part of EVAR. A literature search was performed to identify other studies of IIA embolisation and the results pooled with our own.
Results: Buttock claudication occurred in 55% (16 patients) and new erectile dysfunction in 46 % (six patients). Pooled results: buttock claudication occurred in 31% of patients overall (187/614 patients), in 29% of unilateral embolisations (65/222 patients) and in 48% of bilateral embolisations (20/42 patients) (Fisher's exact test, p=0.029). New erectile dysfunction occurred in 19% of patients overall (23/121 patients), in 44% of bilateral embolisations and in 17% of unilateral embolisations (Fisher's exact test, p=0.021).
Conclusion: Pelvic ischaemia occurs frequently, especially when both IIAs are embolised. Branched stent-grafts may prove to be a safer alternative once experience with them increases.

10.1.2

Retrograde aortic dissection: an underestimated complication after supracoronary aortic replacement in patients with Stanford type A aortic dissection

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Purpose: To determine presence and extent of retrograde aortic dissections in patients with Stanford type A dissection treated by supracoronary aortic replacement.
Materials/Methods: Forty-four patients with treated Stanford type A aorta dissection underwent contrast-enhanced electrocardiography-gated multi-detector row helical computed tomography (CT) (slice collimation 16x1.5 mm; 120 kV; 300 mAs; 120 ml Ultravist 300). CT-scans were obtained 10-70 months after supracoronary aortic replacement. The presence and the extent of retrograde dissections into the Valsalva sinus were assessed by two experienced readers. The presence of a retrograde dissection was correlated to the time interval after the operation.
Results: Thirteen patients (30%) showed a retrograde dissection, always into the non-coronary sinus. The Valsalva sinus diameter was significantly larger (47+/-11 mm) in these patients compared with those without retrograde dissection (39+/-8 mm; p<.05). The time interval between the operation and follow-up CT was significantly longer in the group of patients with retrograde dissection (46 versus 22 months).
Conclusion: The presence of retrograde dissections is an underestimated complication after supracoronary aortic replacement. The longer time interval between the operation and the follow-up in patients with retrograde dissections suggests that this complication may develop after failure of the tissue glue used to fix dissected membranes.

10.1.3

Internal iliac artery embolization during endovascular treatment of aortoiliac aneurysms: initial experiences with a nitinol vascular occlusion plug

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Purpose: To evaluate a novel vascular occlusion device for embolization of internal iliac arteries during endovascular repair of aortoiliac aneurysms.
Materials/Methods: Between November 2004 and December 2005, six men (mean age, 73±4 years; range, 66-77) with aortoiliac aneurysms were referred for stent-grafting. Preoperatively, five patients underwent unilateral and one patient bilateral embolization of the internal iliac artery to prevent endoleak. Via an ipsi- or a contralateral femoral approach (6- or 8-F vascular sheath) the embolization procedure was performed using an Amplatzer® vascular plug (AGA Medical Corp., Golden Valley, MN), a self-expandable cylindrical device consisting of a nitinol-based wire-mesh. Technical success, clinical outcome, and complications were evaluated. Six- and 12-month follow-ups were performed by clinical and radiological [(computed tomography- (CTA) and magnetic resonance-angiographies (MRA)] examinations.
Results: Internal iliac artery embolization was technically successful in all cases. Procedure-related complications did not occur. Initial six- and 12-month follow-ups were accomplished in five patients. CTA and MRA did not show retrograde perfusion of the aneurysmal sac. Clinical symptoms--such as buttock claudication, bowel ischemia, or sexual dysfunction--were not observed.
Conclusion: Preoperative internal iliac artery embolization with a nitinol vascular occlusion plug during endovascular treatment of aortoiliac aneurysms appears to be a safe and feasible method.

10.1.4

Endovascular graft infections: an update

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Purpose: To investigate the current frequency of aorto-iliac endovascular graft infections and seek the main factors influencing their development.
Matherials/Methods: To improve our personal experience, a questionnaire was sent to 40 international centers of vascular and endovascular surgery. The literature was also reviewed to collect data on infections developing in endovascular grafts.
Results: We identified 101 cases of infected endovascular grafts (0.46% frequency of endograft infection). In 15 (15%) patients, the infection manifested initially with vague symptoms only, but 86 (85%) patients eventually presented with high-grade infection. Staphylococcus aureus was identified as the cause of most infections (55.4%). The majority (70.3%) of these 101 patients were treated surgically; 25 (24.8%) patients received conservative therapy. Overall mortality was 42.6% (43/101), and operative mortality was 17.8% (18/101). Conservative treatment led to a mortality rate of 64% (16/24). The mean follow-up for all the patients was 32.6 weeks. Possible factors influencing the development of an infection were secondary adjunctive procedures, immunosuppression, treatment of false aneurysms, infected central lines.
Conclusions: Infected endovascular grafts are an urgent problem. Albeit low, the current incidence remains unfortunately stable. No longer limited to the abdominal aorta, endovascular infections involve also thoracic grafts with high mortality.

10.1.5

What proportion of thoraco-abdominal aortic aneurysms could be treated with branched/fenestrated stent grafts? A multidetector computed tomography-angiography study

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Purpose: To estimate the proportion of thoraco-abdominal aortic aneurysms (TAAAs) suitable for branched/fenestrated stent-grafting using current technology.
Materials/Methods: Thirty-nine patients (mean age 67.4) underwent 16 multi-detector computed tomography-angiography. Aneurysms were: Crawford type I (n= 6), II (n=24), III (n=8), IV (n=1). Difficult landing zones (LZ) (<1.5 cm), arch angulation ($\leq 110^0$), thoraco-abdominal aorta angulation ($\leq 90^0$), branch vessel origin stenosis ($\geq$50%), circumferential calcification and thrombus ($\geq 180^0$), iliac tortuosity ($\leq 70^0$), and aortic dissection (AD) were assessed using a scoring system ($\geq$3 components: unsuitable for branched/fenestrated grafts).
Results: Short LZs requiring adjunctive procedures were present in 12.8%; 33.3% had difficult $<110^0$ arch angulation. Significant stenosis was detected in 25.6% of celiac (CA), 28% of renal (RA), 5.13% of superior mesenteric (SMA) and 7.7% of left subclavian (LSCA) arteries. Significant circumferential origin calcification was found in 20.5% of CAs, 10.3% of SMAs, 30.8% of RAs, and 18% of LSCAs. Severe iliac tortuosity was found in 10.6% of patients including one complete occlusion. AD was recorded in 16/39 (13=Type B). Fifty-nine percent of cases had difficulty score $\geq$3.
Conclusion: The high prevalence of adverse anatomic features suggests that a significant proportion of TAAAs may be unsuitable for pure endovascular repair using branched/fenestrated stent-grafts with current technology.

10.2.1

Hemodynamic evaluation of the cirrhotic patient: does it matter where you measure the pressures?

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Purpose: To evaluate if the site of pressure measurement to calculate the portosystemic gradient in patients with biopsy-proven liver cirrhosis has any impact on the final gradient.
Materials/Methods: A retrospective analysis of 158 consecutive transjugular liver biopsies with hemodynamic evaluation from June 2004 to January 2006 in 145 patients was reviewed. A total of 88 men and 57 women [mean age: 53 (11-86 years)] were identified. Indications for transjugular biopsy were: coagulation disorders 39% (n=62), massive ascites 26% (n=41), work-up for organ transplantation 10% (n=16), and other 25% (n=39). Pressures measured included: wedge hepatic vein (WHV), free hepatic vein (FHV), inferior vena cava (IVC) and right atrium (RA). Data were analyzed using the two tailed, paired t-student test.
Results: Thirty-one cirrhotic patients were identified. The mean gradients were: WHV/FHV: 16.35 (± 7.33) mmHg; WHV/IVC: 16.55 (± 7.54) mmHg and WHV/RA: 19.52 (± 8.27) mmHg. The WHV/FHV and WHV/IVC gradients were similar (p= 0.75). Both the WHV/IVC and WHV/FHV were different to the WHV/RA gradients (p=<0.0002) and (p<0.0001), respectively.
Conclusion: WHV/RA gradients were significantly higher than either the WHV/IVC or WHV/FHV gradients. The site of pressure measurement should be specified by the operator as this information may have therapeutic importance.

10.2.2

Transjugular intrahepatic portosystemic shunt creation in Budd-Chiari syndrome: utility of percutaneous ultrasound-guided simultaneous puncture of the portal vein and the inferior vena cava

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Purpose: To evaluate percutaneous, ultrasound-guided, simultaneous puncture of the portal vein and the inferior vena cava (IVC) in transjugular intrahepatic portosystemic shunt (TIPS) creation. Medium-term clinical outcome in patients with severe Budd-Chiari syndrome not responding to the medical therapy will be discussed.
Materials/Methods: Between October 2003 and January 2006, ten patients with refractory ascites (three with variceal bleeding) underwent TIPS creation with percutaneous, ultrasound-guided, direct, simultaneous puncture of the portal vein and the IVC. Shunt patencies were determined by ultrasound, venography or both at one, three, six, and 12 months and every six months thereafter. Shunt stenosis or thrombosis were determined by ultrasound.
Results: A post-TIPS symptomatic improvement was achieved in all the patients. A repeat intervention was done in four patients for stent occlusion. All occluded stents were detected during the first week. No bleeding related to the percutaneous puncture occurred. One patient had a pulmonary edema immediately post-procedure. One patient underwent liver transplantation eight months post-procedure. Follow-up was changed from one month to 26 months in this case.
Conclusion: Direct, simultaneous, percutaneous portal vein and IVC puncture can be accurately done under real-time ultrasound guidance to facilitate TIPS procedure in Budd-Chiari syndrome.

10.2.3

Short- and long-term effects of transjugular intrahepatic shunt on cardiac function

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Purpose: To assess short- and long-term effects of transjugular intrahepatic portosystemic shunt (TIPS) on cardiac function.
Materials/Methods: Eleven patients were imaged on a 1.5-T magnetic resonance (MR) scanner prior, within 24 hours, and three to six months after TIPS. Invasive pressures were recorded during TIPS. MR imaging consisted of a stack of contiguous slices (TR/TE/FA 3.3/1.6/60°) and phase-contrast images at all four valves planes (TR/TE/FA 6.1/2.9/18°). Imaging data were analyzed through time volume curves and first derivatives.
Results: Portoatrial pressure gradient decreased from 19.8+/-2.3 to 6.6+/-2.3 post-TIPS insertion. Central venous, mean pulmonary artery, and pulmonary capillary wedge pressures showed a significant increase immediately post-TIPS (66%, 86%, 112%, respectively). Left and right ventricular enddiastolic volumes were markedly increased (11% and 13%, p<.001) but dropped to baseline at long-term follow-up. Stroke volumes increased by 23% initially and remained slightly elevated (11%, p=.026). At long-term follow-up, left ventricular mass was larger than baseline in all patients with an average increase of 7.9 g (p>.001).
Conclusion: The increased volume load shunted to the heart post-TIPS insertion transiently increased cardiac dimension and function with signs of restrictive cardiac filling. Normalization of these changes after three to six months is coming along with left ventricular remodelling.

10.2.4

Results of a multicenter randomized trial of distal spleno-renal shunt versus transjugular intrahepatic portosystemic shunt to control refractory variceal bleeding in Child's A or B cirrhosis

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Purpose: To compare distal spleno-renal shunt (DSRS) with transjugular intrahepatic portosystemic shunt (TIPS) for prevention of variceal bleeding refractory to endoscopic variceal sclerosis (EVS).
Materials/Methods: Patients with refractory variceal bleeding were prospectively randomized to DSRS or TIPS.
Results: One-hundred forty patients were prospectively randomized to DSRS (73) or TIPS (67). There was no significant demographic difference. Mean and median follow-ups were 43 and 42 months, respectively (range 0-91 months); 96% of scheduled visits were completed. Rebleeding occurred in four (5.5%) DSRS and seven (10.5%) TIPS patients [p=0.27]. By five years, 50% of each group had at least one incidence of encephalopathy without difference in the first clinical event or the overall pattern of occurrence. Radiologic intervention to maintain shunt patency was required in 55 of the TIPS and eight of the DSRS groups [p<0.001]. Shunt thrombosis occurred in two DSRS and 15 TIPS patients [p<0.01]. The two- and five-year survivals were 81% and 64% in the DSRS and 88% and 60% in the TIPS groups [p=0.84].
Conclusion: DSRS and TIPS are equally safe and effective in preventing variceal rebleeding in this patient group, although strict surveillance and a high reintervention rate are necessary to maintain TIPS patency.

10.2.5

Pre-extended hepatectomy portal vein embolization for future liver remnant hypertrophy using n-butyl cyanoacrylate

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Purpose: Pre-extended hepatectomy portal vein embolization for future liver remnant hypertrophy using n-butyl cyanoacrylate.
Materials/Methods: Thirty-three patients (23 men, ten women) aged 37-79 years underwent selective portal vein embolization (two left, 31 right) prior to extended hepatectectomy for the diagnoses of hepatocellular carcinoma (7), colorectal metastasis (12), and cholangiocarinoma (13). Portal vein approach included ipsilateral (21), contralateral (11), and transjugular (1). Fine-needle access was achieved using intraparenchymal carbon dioxide administration as a target. Embolization was performed with n-butyl cyanoacrylate (1-3 cc) diluted with Lipiodol (4:1).
Results: Post-procedure complications included non target embolization (1, .03%) which did not preclude surgery. There was no hemorrhage, death, or portal vein thrombosis. All patients had a 23-hour admission. Two patients demonstrated mild symptoms of post-embolization syndrome. At 4-6 weeks post-embolization, 32 patients (97%) demonstrated increased volume of the future liver remnant from 27 to 39%. The one patient without hypertrophy had a history of diabetes, previous chemotherapy and elevated bilirubin.
Conclusion: Pre-extended hepatectomy portal vein embolization utilizing n-butyl cyanoacrylate is safe and efficacious for stimulating hypertrophy of the future liver remnant and increasing the pool of potential surgical candidates.

10.3.1

Endovascular treatment of acute and chronic thoracic aortic injury

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Purpose: To present medium-term results after endovascular repair of acute and chronic blunt aortic injuries.
Materials/Methods: Between December 1999 and December 2005, 13 patients were endovascularly treated for blunt aortic injury. Ten patients (eight men, two women; mean age 38.7 years) were treated for acute traumatic injury in the isthmus region of the thoracic aorta. Stent-graftings were performed between the fifth hour and the sixth day after injury. Three men (mean age 66 years; range 59-71) were treated due to the presence of symptoms of chronic post-traumatic pseudoaneurysm of the thoracic aorta (mean time after injury 29.4 years, range 28-32). Fifteen stentgrafts were implanted in 13 patients.
Results: In the group with acute aortic injury, one patient died due to failure of endovascular technique. Lower leg paraparesis occurred in one patient, other eight patients are regularly followed (1-72 months, mean 30.2 months) without complications. In the group with post-traumatic pseudoaneurysms, all three patients are alive. One patient suffered postoperatively from upper arm claudication, which was treated by carotido-subclavian bypass.
Conclusion: Endoluminal technique can be successfully used in the acute repair of aortic trauma and its consequences. Medium-term results are satisfactory with low incidence of neurologic complications.

10.3.2

Endovascular treatment of descending thoracic aorta. A new-concept prosthesis for a complex pathology

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Purpose: To report the first experience with a new-concept endoprosthesis for the endovascular treatment (EVT) of descending thoracic aortas in patients with a complex pathology.
Materials/Methods: In a two-year period, 20 endovascular interventions of descending aortas were performed in 17 patients (28-73 years) with a complex pathology (severe tortuosity, no proximal neck, true lumen collapse, global aortic aneurysm). We treated eight cases with a type B dissection (one acute, seven chronic) and nine aneurysms (three degenerative, four pseudoaneurysms following coarctation operation, two post-traumatic). The customized endoprosthesis was a one-piece, long, flexible prosthesis, which adapts to the aortic wall without hooks, and with magnetic resonance compatibility.
Results: There were no conversions to open repair. During the first week post-EVT, there was no death or major adverse cardiovascular event. During the follow-up period (mean 12.5 months), one patient died. Two leaks (12%) without aneurysm diameter progression were recorded. The remaining aneurysms had shrunk (88%). All the patients were free of paraplegia or subclavian steal symptoms (four with a covered subclavia).
Conclusion: The endovascular treatment of descending thoracic aorta disease is a safe and feasible technique. With this new customized endoprosthesis, we were able to treat also cases with a very complex pathology.

10.3.3

Incidental pathology detected on routine computed tomography in relation to endovascular aneurysm repair is a significant problem

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Purpose: The aim of this study was to establish the prevalence of non-aneurysm related findings on computed tomography (CT) scans of patients undergoing endovascular aneurysm repair (EVAR) of abdominal aneurysms in one centre.
Materials/Methods: Reports of all CT scans done on EVAR patients were reviewed to note findings of non-aneurysm-related pathology. Findings were classified into group A) simple benign feature, group B) benign feature that warranted review, and group C) malignant or likely malignant feature.
Results: Two hundred and thirty three patients underwent a total of 1435 CT scans during a median follow-up of 34 months (range 1-112) after EVAR. Number of scans per patient ranged from one to 19 (median 4).
The number of patients according to groups were as follows: group A = 125 (54%), group B = 70 (30%), and group C = 18 (8%). Unexpected features consistent with neoplasia of urological, biliary, pulmonary, colonic, hepatic and skeletal systems were noted.
Conclusion: Potentially serious and unexpected non-aneurysm related pathology was reported in a third of EVAR patients at some stage. Endovascular programs need strategies to react consistently and appropriately to such incidental findings. Failure to do so may have serious consequences and could constitute negligence.

10.3.4

Endovascular repair of abdominal aortic aneurysms: virtual planning

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Purpose: The goal of this study is to assess the feasibility of virtual manipulation of computed tomography-angiography (CTA) and magnetic resonance-angiography (MRA) for planning interventional radiology repair of abdominal aortic aneurysms (AAA).
Materials/Methods: A stereoscopic surgical planning workstation (Dextroscope-Volume Interactions, Singapore) was used. The user interacts using both hands and visualizes volume-rendered reconstructions using a stereoscopic display. During the period December 2003-December 2005, 46 consecutive patients were evaluated.
Results: Virtual interventional planning allowed us to avoid diagnostic angiography and to perform correctly endovascular therapy. This is due to the superior stereoscopic visualization, the easy 3D manipulation, and the accurate/flexible measurement tools available. Seven patients were not eligible for endovascular repair. Until now, in 39 cases the creation of a virtual model of the stent has always been successful.
Conclusion: The interactivity with the single imaging modality and the accuracy of measurement tools has allowed a reliable method for decision-making about endovascular therapy and type of endoprosthesis. We have reduced invasiveness and obtained time- and cost-savings by avoiding the angiography step. The study is now running for a definitive assessment of the protocol and the comparison with other post-processing systems in 100 consecutive cases.

10.3.5

Endoleak classification after abdominal aortic aneurysm stent-grafting: computed tomography-angiography versus contrast-enhanced ultrasonography

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Purpose: To assess the effectiveness of contrast-enhanced ultrasound (CEUS) in the endoleak classification after endovascular treatment of abdominal aortic aneurysm in comparison with computed tomography-angiography (CTA).
Materials/Methods: From 2002 to 2005, 19 patients with 20 endoleaks showed by CTA during follow-up underwent CEUS with a second generation contrast agent (Sonovue®). In six cases, patients were also studied with digital subtraction angiography (DSA).
Results: CEUS confirmed the CTA classification in 16 cases (type II endoleak). On the other hand, two CTA type III endoleaks were classified as type II by CEUS, and two CTA type II endoleaks were classified as type I by CEUS. In those cases with conflicting classification, DSA confirmed CEUS results.
Conclusion: CEUS is more accurate than CTA in the classification of endoleaks. As it shows the flow in real time, CEUS allows a better attribution of the endoleak origin and, subsequently, a more precise therapeutic planning. Type II endoleaks could be monitored with ultrasound, deferring use of CTA studies, with consequent reduced costs and exposure to radiation.

10.4.1

Transcather embolization of male varicocele with Fibro-Vein mousse infusion: experience with 340 patients

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Purpose: The aim of our study was to evaluate efficacy and safety of the Fibro-Vein mousse in the treatment of male varicocele.
Materials/Methods: From January 2000 to December 2006, 340 patients (mean age: 28.2 years; range 15-44) were treated by sclerotization of the pampiniform plexus venous dilatation. The patients had infertility (86), pain (190), or both (44); the diagnosis was routinely obtained by physical examination and Doppler-ultrasound. Phlebography was performed under local anesthesia with access through the basilic vein using 4-F Simmons II catheters. Patients' embolization was always perfomed with mousse Fibro-Vein at 3% and air (ratio 1:4). Follow-up was routinely perfomed by Doppler-ultrasound and clinical examinations.
Results: A technical success was obtained in all but 28 patients (8.2%); of the 86 (25.2%) patients with infertility, 35 (52.3%) become again fertile; of the 190 (56%) patients with pain, 175 (92%) had pain relief, of the 44 (13%) patients with pain and infertility, 38 (86%) had pain relief and improvement of sperm count alteration, while six (13.6%) patients had pain relief but still sperm count alteration.
Conclusion: Treatment of male varicocele by Fibro-Vein mousse and air is a safe and very effective technique that allows an easy pampiniform plexus sclerotization.

10.4.2

Incidence of large perforating collaterals between the incompetent great saphenous vein and the femoral vein

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Purpose: To evaluate the prevalence of large communicating perforator veins between the incompetent great saphenous vein and the femoral vein.
Materials/Methods: Between July 2002 and January 2006, a total of 155 previously uninstrumented great saphenous veins were treated by endovenous ablation (either radiofrequency or laser) in an angiography suite. Standard technique included contrast evaluation of the great saphenous vein (GSV) after access was obtained. The presence or absence of a large collateral between the GSV and the femoral vein was noted.
Results: Forty-six cases were not evaluable. Overall, a collateral was present in 64 of 109 veins (59%). Incidences were similar in men (17 of 30; 57%) and women (48 of 78; 62%), and between right (28 of 48; 58%) and left (37 of 60; 62%) limbs.
Conclusion: A large collateral between the GSV and the femoral vein is present in over 50% of limbs treated. This potentially has significant implications as new procedures for ablation of the incompetent GSV are developed.

10.4.3

Transjugular pelvic vein embolisation in the pre-operative management of patients with pelvic vein reflux undergoing leg vein surgery

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Purpose: Vulval varices are often associated with pelvic vein reflux. We present our experience of transjugular embolisation in a group of patients with significant pelvic vein reflux awaiting surgery.
Materials/Methods: Patients presenting with varicose veins and vulval varices routinely undergo transvaginal sonography; 216 patients with pelvic vein reflux underwent pelvic vein embolisation. Ultrasound was repeated after six weeks to assess outcome.
Results: The mean age was 42 years. Symptoms and signs at presentation included: *de novo* varicose veins (48%), recurrent varicose veins (37%), pelvic pain (23%), and cyclical symptoms (8%). Two-hundred and seven (96%) patients had at least one ovarian vein embolised and 184 (85%) at least one internal iliac vein; 209 (97%) had uncomplicated successful embolisation. Six had persistent pelvic reflux, four had *de novo* reflux, and three had early recurrent reflux. All but one of these patients underwent successful repeat embolisation. Two patients suffered pulmonary embolisation of coils, one being symptomatic requiring radiological retrieval. One patient suffered symptomatic perineal phlebitis, successfully treated by foam sclerotherapy. All patients at final follow-up had successfully embolised pelvic veins.
Conclusions: Transjugular pelvic vein embolisation is a relatively safe and effective treatment for pelvic vein reflux associated with vulval varices prior to surgery.

10.4.4

Percutaneous bioprosthetic valve placement for treatment of deep vein insufficiency: a safety clinical study

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Purpose: A one-year feasibility study was conducted to determine the safety of the bioprosthetic venous valve (BVV).
Materials/Methods: Fifteen patients with symptomatic deep chronic venous insufficiency were treated percutaneously with small intestinal submucosa (SIS)-covered BVVs. Single BVV was deployed into femoral vein. Pre- and post-deployment exams required clinical examination, intravascular ultrasound, duplex ultrasound, and descending venography at three, and 12 months.
Results: Successful placement of 15 BVVs was achieved without tilting or migration. Eleven valves (73.4%) were patent and four occluded (26.6%). Four BVVs (26.6%) partially functioned showing moderate leak on venograms and duplex ultrasound at 12 months. Three-oversized BVVs overexpanded (20% resulting in leaflets attachment to the vein wall. SIS leaflet pliability has been limited by adverse reaction and healing responses in four valves (26.6%). Twelve of the 15 patients (80%) had immediate and three-month clinical improvement of their symptoms. Clinical improvement was seen in nine patients (60%) at 12-month follow-up. None of the patients symptoms got worse.
Conclusion: Percutaneous BVV showed promising short-term results with clinical improvements in the majority of patients. The valve biomaterial needs to be modified to prevent leaflet stiffness and to improve longevity of the BVV.

10.4.5

Primary bilateral varicocele sclero-embolization: preliminary report on the effect on birth rate

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Purpose: Varicocele is a widespread disease and is alleged to be among the first causes of couple infertility. Since the late ,90s, supported by recent urologic reports that underline the importance of bilateral treatment, we are performing primary bilateral treatment to improve spermatic parameters. A retrospective analysis of treated cases was performed to compare birth rate of bilateral versus monolateral sclerosing treatment.
Materials/Methods: From 1995, more than 1200 patients were mainly treated by transbrachial approach (91.5%). Sclerotizations were performed by tetrasodium decilsulphate; digital subtraction angiography facility with pulsed X-rays were used (92%). All the patients underwent clinical, ultrasound and Color Doppler-ultrasound studies prior and after (one, six, 24 months) the percutaneous treatment.
Results: Overall techical success was 93% (transbrachial 97.5%, transfemoral 87%). Bilateral treatment was performed by transbrachial approach in 73% of cases (transfemoral in 18%). Mean X-rays exposition was 6.5 min. Birth rates at six and 24 months were 32% and 64% versus 21% and 38% of monolateral treatment. No minor or major complications related to the procedure were encountered.
Conclusion: Primary bilateral sclerosing treatment for varicocele proved to strongly improve pregnancy rates as compared with monolateral treatment, without any difference in minor complications.

10.5.1

Does interventional radiology have a future as a clinical speciality? A survey of general practitioner perceptives

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Learning Objectives: To determine the perception of interventional radiology as a clinical speciality in the eyes of primary care physicians.
Background: Interventional radiology is evolving rapidly and interventionalists perform varied procedures, contributing to patients' clinical management. There is concern that interventional radiologists (IRs) may be perceived by general practitioners (GPs) to be inadequately qualified to assess patients and hence unable to provide a clinically-based secondary care service.
Clinical Findings or Procedure Details: A web-based and postal questionnaire survey amongst GPs in the locality of London and surrounding counties was conducted. Seventy replies were received. Questions encompassed personal demographics, willingness to refer medical problems directly to IRs, and determination of GPs awareness of common interventional procedures and who performs them. Results and comments were tabulated and analysed, and feedback given to GPs, as required.
Conclusion: Significant numbers of GPs are unaware of service availability in their locality. A point of worry is IRs cannot provide full secondary care management of patients. However, most GPs are happy to refer directly to IRs if reassured about operator clinical expertise and shortened waiting lists. IRs have also been advised to discard the 'Radiologist' title if interventional radiology were to become a more clinically-based speciality.

10.5.2

Porcine transfer study: does virtual reality simulator training compare to porcine training in endovascular novices?

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Purpose: To compare learning endovascular interventional skills by training on pig models versus virtual reality simulators.
Materials/Methods: Twelve endovascular novices participated in a study consisting of a pig (P-Lab) and virtual reality laboratory (VR-Lab). Subjects were experience-stratified and randomized into alternative training groups. Following didactic instruction, all attempted an iliac artery stenosis revascularization in each laboratory. Onsite proctors evaluated their performances using a Task Specific Checklist and a Global Rating Scale (yielding a Total Score). Participants completed two training sessions using their group's assigned method(s) and were then re-evaluated.
Results: VR-Lab Total scores were higher than P-Lab scores (β=6.659, p<.0001). Total scores improved with additional sessions in either the P-Lab (β=2.552, p=.0010) or VR-Lab (β=2.435, p=.0032). Cummulative P-Lab sessions increased P-Lab Total scores (β=4.074, p<.0001) but had no effect on VR-Lab Total scores. VR-Lab sessions raised VR-Lab Total scores (β=3.029, p=.0015) and P-Lab Total scores (β=1.814, p=.0452).
Conclusion: Training sessions in the VR-Lab and the P-Lab resulted in improved Total Score performances. General interventional skills learned in the virtual environment may be transferable to the real catheterization laboratory as modelled by the P-Lab. The VR-Lab may be useful for safer, faster and more economical training and evaluation of interventional skills.

10.5.3

How do patients perceive the benefits and risks of peripheral angioplasty?

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Learning Objectives: For patients to give their informed consent they should understand the benefits and risks of the procedure involved.
Background: Two-hundred and fifty-two patients undergoing peripheral angioplasty were surveyed. Thirty patients formed a pilot-study, leaving 222 study patients. Patients were randomly assigned into two groups, one aided by the use of a recognized "Risk-Assessment-Chart" questions regarding the risks and benefits of the procedure were posed. Patients were asked to express their likelihood of benefit and complication in terms of a percentage.
Clinical Findings or Procedure Details: One-hundred eighty-eight (85%) patients thought that they would have at least 75% (3 in 4 chance) of benefiting from angioplasty. Over a third thought they would definitely (100%) benefit; 115 (52%) patients thought the test would be painful; 70 (32%) patients thought there would be no radiation exposure; 36 (16%) patients realized there was a chance of uncontrolled bleeding; 177 (80%) patients thought the test was easier than they had originally thought. The use of the "risk-chart" significantly altered patients perceptions (t-test, p=0.044)
Conclusion: The risk assessment tool appeared to influence the patient's perception of risk and benefit and, as such, might be useful in the consent process.

10.5.4

Deriving metrics for objective assessment in interventional radiology using cognitive task analysis

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Purpose: With reducing invasive diagnostic imaging, interventional radiology (IR) requires an alternative to training in patients. Simulator models could provide training, but require clear performance objectives (metrics) for assessment. In this study we derived metrics for IR procedures.
Materials/Methods: Video recordings of six procedures were systematically analysed by an interventional radiologist (AEH) and, using a proprietary software (Observer Plus), by an occupational psychologist (SJ) during several formal interviews with experienced operators. From these data, a hierarchical task analysis was performed for each procedure studied (arterial/venous needle puncture, nephrostomy, ultrasound/computed tomography-guided biopsy, percutaneous transhepatic cholangiogram). Three experts graded each procedure step using a visual analogue scale to determine skill threshold, range and level of criticality.
Results: The structure of tasks, cues and actions required for performance were identified and graded to show the more critical procedure steps (metrics) which could be used for procedure assessment. There was a significant (p<0.001) correlation between raters indicating agreement on the key procedure steps.
Conclusion: Metrics for assessment of IR training can be derived by psychologists working with expert operators. Metrics incorporated into simulator models could be validated as a component of a broader IR training and certification programme.

10.5.5

Radiation exposure of the interventional radiologist during different procedures

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Purpose: Hand or eye radiation doses of the interventional radiologist might accumulate with time. Our aim was to specify radiation exposure during interventional procedures.
Materials/Methods: Online measurements of radiation doses were done using the Unfors EDD-30 dosimeter, by attaching the sensor to the operator's hand or next to the eye. Maximum dose-rate and skin-dose were related to fluoroscopy time and patient's area-dose-product in diagnostic angiography, percutaneous transluminal angioplasty and stenting, liver interventions [percutaneous transhepatic cholangiodrainage (PTCD)/radiofrequency], transarterial chemoembolisation (TACE) and vertebroplasty.
Results: Maximum skin-dose (max. dose rate, fluoroscopy time) in particular cases was up to 736 µSv (122 mSv/h, 21') in complex diagnostic angiographies+interventions (including recanalisation and thrombolysis), 276 µSv (12 mSv/h, 18.1') in TACE, 4048 µSv (350 mSv/h, 27') in PTCD, 130 µSv (6.9 mSv/h, 12.3') in RFA of liver metastases using CT-fluoroscopy, 606 µSv (38 mSv/h, 6.5') in vertebroplasty using CT-fluoroscopy. Dosimeter alerts with acoustic signals when critical dose rates are exceeded.
Conclusion: Online measurement evaluates the range of radiation exposures of the various procedures. Different doses might be explained by the procedures' complexity and fluoroscopy times. Proximity between the interventionalist's hand and the radiation field in different procedures obviously is the key issue to limit radiation dose.

10.6.1

Treatment of plicature-induced transplant renal artery stenosis by primary stenting: technical results and clinical outcome

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Purpose: To evaluate technical feasibility and clinical results of stenting of plicature-induced transplant renal artery (TRA) stenosis.
Materials/Methods: Over an eight-year period, stent placement was considered in ten patients to manage plicature-induced TRA stenosis. All cadaveric arteries were anastomosed in an end-to-side fashion to the common iliac artery via an aortic patch. Patients suffered from severe hypertension (n=2), impaired renal function (n=1), or both (n=7). In all the patients, stent implantation was performed immediately after complete post-percutaneous transluminal angioplasty recoil of post-anastomotic arterial plicature. Palmaz (n=4), Herculink (n=4), or Tsunami (n=2) stents were placed to straighten and keep the stenotic area open.
Results: Stent placement was 100% successful. The renal artery peak blood flow velocity fell from 324+/-65 to 154+/-18 cm/s. The mean systolic blood pressure fell from 175+/-32 to 135+/-18 mm Hg. Allograft function improved in seven patients (serum creatinine from 3.2+/-1.1 mg/dl to 1.5+/0.4) and stabilized in three. During the follow-up period (three months-eight years, median 52 months), asymptomatic, <50%-intrastent stenoses were left untreated in three patients. Redo-transplantation was performed in one patient because of recurrent glomerulonephritis.
Conclusion: Stents revealed to be very useful in managing plicature-induced TRA stenoses. Medium-term patency and clinical outcome are promising.

10.6.2

Renaissance trial: a prospective, multicenter trial to confirm the safety and efficacy of the Express® SD stent for treating renal artery stenosis

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Purpose: The Renaissance trial was designed to study the safety and effectiveness of the Express™ SD renal stent in treating renal artery disease.
Materials/Methods: Renaissance is a prospective, single-arm, multi-center study involving 100 patients with renal artery disease in 14 sites in the United States. The primary efficacy endpoint was the binary restenosis rate at nine months compared to the 40% pre-specified benchmark representative of percutaneous transluminal renal angioplasty (PTRA), as evaluated by an independent core laboratory.
Results: The nine-month binary restenosis rate was 21.3%, which was significantly superior to the OPC rate of 40% ($p<0.0001$). Study results showed a high technical and procedural success (99%) and a significant improvement in renal function (peak systolic velocity and renal-to-aortic ratio). The study demonstrated an excellent correlation (87%) between ultrasound and angiography for significant restenosis.
Conclusion: Stenting with the Express® SD is a safe and effective way to treat renal artery stenoses, and provides superior results compared to those from balloon angioplasty alone. This multi-center study validates duplex-ultrasound as an accurate non-invasive method for surveillance of restenosis after renal artery stenting.

10.6.3

The role of interventional radiology in the management of kidney transplant complications

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Purpose: To review the role and the effectiveness of interventional radiology in the management of complications in renal transplantation.
Materials/Methods: Between 1996 and 2005, 40 complications in 38 patients with kidney transplantations (28 men and ten women aged 35-65 years) were treated by radiological procedures: 12 renal artery stenoses and one native external iliac artery stenosis [treated by 12 percutaneous transluminal angioplasty (PTA) and one primary stenting], 12 ureteral obstructions, eight ureteral leaks (nephrostomies, in two cases associated with ureteral stenting) and six lymphoceles (percutaneous ultrasound-guided catheter drainage), one embolization of a non-functional kidney.
Results: Primary technical success was 80% (32/40 cases). Success was obtained with a second interventional procedure in 4/40 cases (two lymphoceles, one ureteral fistula, and one renal artery stenosis) with a secondary success rate of 90%. We observed one peri-procedural complication (renal artery post-PTA dissection during a restenosis treatment). Five cases (one renal artery post-PTA dissection, one ureteral obstruction, one ureteral leak and two lymphoceles) needed surgical correction.
Conclusion: Interventional radiology should be the first therapeutic approach in the management of renal transplantation complications. Surgery has to be considered only if minimally-invasive procedures are unfeasible or ineffective.

10.6.4

The benefit of stent placement and blood pressure and lipid-lowering for the prevention of progression of renal dysfunction caused by atherosclerotic ostial stenosis of the renal artery. The STAR-study: baseline data and early technical results

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Purpose: Atherosclerotic renal artery stenosis (ARAS) is associated with a progressive loss of renal function and is one of the most important causes of renal failure in the elderly. The additional effect on preserving the renal function of endovascular stent placement, as compared with the medical therapy alone, is unknown. This randomised trial compares the effects of renal artery stent placement together with medication versus medication alone on renal function in patients with ARAS.
Materials/Methods: Patients with an ARAS ≥50% and renal failure (creatinine clearance <80 ml/min/1.73 m^2) were randomly assigned to either stent placement with medication or to medication alone. Medication consisted of statins, anti-hypertensive drugs, and antiplatelet therapy. The primary outcome is a decrease in creatinine clearance >20% at two-year follow-up compared with baseline.
Results: Inclusion of patients has just been completed. This study presents the preliminary results of the 140 randomized patients (mean age 67 years (SD, 9), 63% men). Besides the baseline data, we will discuss the early technical outcomes comparing both groups.
Conclusion: This is the first randomized trial assessing the effect of additional stent placement on medication in patients with ARAS with renal function as a primary outcome.

10.6.5

Incidence and percutaneous management of arterial emboli occurring during hemodialysis graft recanalization

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Purpose: To determine the incidence and management of arterial emboli resulting from hemodialysis graft recanalization.
Materials/Methods: Between August 1997 and December 2005, 900 patients (349 men, 551 women) with thrombotic occlusions of hemodialysis grafts were treated with mechanical thromboaspiration (817), „lyse and wait" technique (55), and Urokinase (28). The incidence of arterial emboli--according to the thrombectomy method--was analyzed by chi-square test.
Results: Arterial emboli were documented in 26 (2.9%) patients. One patient complained of finger pain which subsided immediately. The incidence of arterial emboli, according to the thrombectomy method, are as follows: mechanical thromboaspiration (24, 2.9%), „lyse and wait" technique (two, 3.6%) and Urokinase (0, 0%) (p=0.449). Arterial emboli were retrieved by occlusion balloon (12), sheath-assisted suction (2) and backbleeding technique (3). One patient, unsuccessfully treated with angioplasty, was successfully managed by surgery. No intervention was undertaken in the remainder (8). Subsequent fistulograms demonstrated complete (n = 2) resolution of the untreated emboli. No complication related to arterial embolectomy occurred.
Conclusion: Arterial emboli are not a rare occurrence during percutaneous thrombectomy and, in the majority of cases, they can be easily retrieved by percutaneous technique. Conservative management appears to be indicated in asymptomatic patients.

10.7.1

Inflammation slows endothelialization in restenosis

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Purpose: Stents are most often implanted at sites of advanced macrophages rich atheromatous lesions. The objective of the present study is to test the hypothesis that macrophages inhibits reendothelialization of stent material surfaces.
Materials/Methods: Human aortic endothelial cells (HAEC) were seeded and grown to confluence on a firm collagen gel for 24 hours. Then, either non-treated human monocytic leukemia cells (naTHP-1) or THP-1 activated (aTHP-1) with 50 nM of 12-O-tetradecanoylphorbol-13-acetate (TPA), were added to the HAEC cultures. After 48 hours, flat 1.2x1.2 cm square Elgiloy® coupons were implanted on the endothelized surface and migration rate of HAEC onto the Elgiloy® surface was measured and compared after ten days.
Results: Control HAEC migrated uniformly from the periphery to the center to cover the entire metal coupon, for a mean distance of 6 mm. HAEC migration rate in the presence of aTHP-1 significantly decreased relative to control. HAEC incubated in the presence of aTHP-1 migrated for a mean distance of 2.4 mm (r 1.8-2.9) ($p< 0.0001$).
Conclusion: These results indicate that stent implantation in the presence of activated macrophages, such as found in vulnerable atherosclerotic plaques decrease endothelial cell migration onto a prosthetic material surface.

10.7.2

Structural characteristics of a composite material stent knitted with a metallic wire and a non-metallic fiber: comparison with a metallic stent

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Purpose: With metallic stents, conformability/trackability and mechanical strength are difficult to be maintained, since these parameters are mainly determined by material physical properties rather than by stent design. These structural parameters are instead compatible in composite knitted stents produced with different materials. Our aim was to compare the structural characteristics of a composite material stent knitted with a metallic wire and a non-metallic fiber with metallic stents.
Materials/Methods: A metal wire (stainless steel or Ni-Ti) and a non-metal fiber (aramid yarn fiber) are knitted in the same textile as an UltraFlex stent. Parameters such as radial force and lateral elasticity for mechanical strength, and kinking resistance and strengthening force for conformability and trackability were compared between the composite stent and similar textile metallic stents.
Results: Radial force and lateral elasticity were ≤70% than those of similar structural metallic stents. Apparent kinking at hair-pin shaped bending was not observed in composite stents, and their strengthening force was less than 50% as compared with metallic stents.
Conclusion: A composite knitted stent produced from metal and non-metal materials has comparable mechanical strength and superior conformability or trackability with similar structural metallic stents.

10.7.3

Magnetic resonance-labeled mesenchymal stem cells for therapeutic angiogenesis

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Purpose: Mesenchymal stem cells (MSCs) have been shown to produce multiple angiogenic factors. We sought to determine the feasibility of using magnetic resonance (MR) to monitor delivery and tracking of MSCs labeled with ferumoxides (Feridex, Berlex Labs) in a model of hindlimb ischemia.
Materials/Methods: MSCs were isolated/expanded from bone marrow aspirates of New Zealand White rabbits (NZW) and MR-labeled using magnetoelectroporation; $1.0x10^{8}$-MR-labeled MSCs were delivered via intramuscular injections into the medial left limb, as the left superficial femoral artery was occluded the prior day. On days 1, 8, and 14, MR imaging was performed on a 3T-XMR scanner (FGRE, FSE, and IRON pulse sequences) to evaluate MSC engraftment. Angiograms were performed and the animals sacrificed on day 15.
Results: The viability of cells after magnetoelectroporation was 70%. The injection sites appeared as hypointense foci on the FGRE/FSE sequences, and as hyperintense foci on the IRON sequence. These foci persisted on days 8/14 MR images. Day 15 angiograms showed the popliteal artery was reconstituted via a robust collateral arterial network. Histology is pending.
Conclusion: MR imaging, combined with magnetoelectroporation labeling techniques, can be used to monitor intramuscular delivery and persistence of cellular therapies into skeletal muscle.

10.7.4

Comparison between the Sirolimus-eluting, biodegradable, poly-L-lactic acid, vascular stent and a stainless steel stent in a porcine model

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Purpose: To evaluate technical feasibility and biocompatibility of new biodegradable, Sirolimus-eluting, poly-L-lactic acid (S-PLLA) stents in porcine restenosis models.
Materials/Methods: Polytetrafluoroethylene-aorto-biiliac grafts were implanted in nine pigs. The lower edge of both iliac arteries was graft-inverted to produce downstream anastomosis irregularities. Six balloon-expandable S-PLLA-stents, six unloaded PLLA-stents, and six stainless steel stents (MS) were randomly implanted at both iliac anastomotic sites. After six weeks, the stented segments were explanted and processed for histology to measure intimal thickness, mean luminal diameter, vascular injury, and inflammation scores.
Results: No limb ischemia was observed. Luminal diameter of S-PLLA-stents (3.74±0.15; 4.03±0.13 mm) was comparable with MS (3.98±0.15; 4.29±0.18), but significantly higher then in PLLA-stents (2.86±0.56, p=0.001; 3.46±0.39, p=0.013). Intimal thickness was significantly lower in S-PLLA-stents (0.09±0.02) than in PLLA-stents (0.31±0.15, p<0.001) and MS (0.19±0.04, p=0.004). Vascular injury scores demonstrated a mild vascular trauma for all stents. A mild inflammatory reaction was noted around S-PLLA-stent struts. This was comparable with MS, but significantly lower than PLLA-stents.
Conclusion: With Sirolimus, a significant reduction of inflammatory and neointimal response was seen. No difference was found between luminal diameters of S-PLLA stents and MS. Results have to be evaluated at 12-month follow-up to assess patency and biodegradation process.

24.1.1

Effectiveness of uterine artery embolization in patients desiring future pregnancy

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Purpose: To evaluate the effects of uterine artery embolization (UAE) on fertility.
Materials/Methods: UAE was performed in 592 patients; infertility secondary to myomata was present in 105 (17.7%) of them, with limitations to myomectomy due to fibroid size, number, and location. In 56/105 women, uterine-to-ovary arterial anastomoses were found, which required technical maneuvers to prevent ovarian failure due to inadvertent embolization.
Results: Follow-up ranged from one to 36 months. There were no cases of hysterectomy. Seventy patients are still under birth control (recommended for 12 months after UAE). In 35 patients only, UAE was performed more than one year ago. Eight of them (22.8%) concieved 14-22 months after UAE: in one case, miscarriage occurred, one patient terminated her pregnancy, three patients are still pregnant, and three delivered (including the patient with AV fistulas). One patient delivered biamniotic twins and in all cases a caesarean section was performed.
Conclusion: UAE can be the method of choice in patients desiring future pregnancies, particularly when myomectomy cannot be performed.

24.1.2

Safety of uterine artery embolization in large-sized fibroids

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Purpose: To evaluate the safety of uterine artery embolization in large-sized uterine fibroids.
Materials/Methods: Fifty-two women (aged 23-54 years, mean 40.6 years) underwent uterine artery embolization for large-sized uterine fibroids. Enhanced-magnetic resonance was performed before, and two weeks and six months after the procedure. The fibroid size ranged from 10 to 30 cm. Embolization was performed with polyvinyl alcohol particles or Embospheres®. At discharge, a questionnaire was administered to every patient to evaluate the embolization symptoms. All women were followed-up for at least 30 days after the procedure.
Results: Uterine artery embolization was performed successfully in every patient. Two major complications occurred, consisting in the expulsion of the fibroid. One of them required hysterectomy. No permanent sequelae were observed in the other patient. Complications in the remaing 50 patients were minor and will be presented.
Conclusion: Uterine artery embolization for large-sized fibroids is a safe procedure.

24.1.3

Fluoroscopically-guided placement of Essure™ fallopian tube microinserts for permanent birth control in women status-post uterine artery embolization for fibroid disease

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Purpose: To present the use of Essure™ fallopian tube microinserts, placed under fluoroscopic guidance, as a means of permanent birth control in women who have had uterine artery embolization (UAE) for fibroid disease.
Materials/Methods: Women who continue to have regular menses three-six months after UAE and express a desire for permanent birth control are offered placement of Essure™ fallopian tube microinserts as an outpatient procedure under fluoroscopic guidance.
Results: Of ten women treated to date, placement of bilateral Essure™ microinserts was successful in eight. The other two patients had no definable fallopian tube filling at pre-insertion hysterosalpingography, and are presumed to be already sterile. The presence of treated fibroids causes sufficient distortion of the uterine cavity that placement of the device under hysteroscopic control would almost certainly be impossible. All procedures were done on an outpatient basis with no need for sedation or systemic analgesia.
Conclusion: Placement of Essure™ fallopian tube microinserts is technically feasible and efficacious in women who have had UAE for fibroid disease.

24.1.4

Outpatient uterine artery embolization for fibroids

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Purpose: To evaluate if uterine artery embolization (UAE) can be performed as an outpatient procedure without increased risks.
Materials/Methods: UAE was performed in 162 patients during a 19-month period. Polyvinyl alcohol particles were used in 153 cases, microspheres in nine. In 103 patients, UAE was performed as an inpatient procedure and in 59 as an outpatient procedure. These last patients were discharged 6-9 hours after embolization. Analgesic, anti-inflammatory, antibiotic, and antiemetic medications were administered before, during, and after UAE. At discharge, a questionnaire evaluated post-embolization symptoms. The follow-up was made by telephone calls for at least 30 days after the procedure. A retrospective comparison assessed post-embolization symptoms of both inpatient and outpatient procedures.
Results: None of the patients discharged 6-9 hours after the procedure was rehospitalized. At first follow-up, the reported symptoms were: pelvic pain, nausea/vomiting, haemorrhage, and abdominal distension. These symptoms were controlled with the medications prescribed at discharge. All women were satisfied with their early discharge. There was no difference in post-embolization symptoms between inpatients and outpatients.
Conclusion: With a close follow-up and specific medications, UAE can be safely performed as an outpatient procedure.

24.1.5

Flouroscopic times and radiation doses during uterine fibroid embolisation: lessons learned from the UK fibroid registry

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Purpose: To report the range and the factors influencing flouroscopic times (FT) and radiation doses (RD) during uterine fibroid embolisation (UFE).
Materials/Methods: The study population comprised all 460 patients whose entry into the UK fibroid registry included data on radiation exposure. A number of factors were studied for their influence on FT and RD.
Results: Forty-two operators contributed between one and 63 patients; 98% of procedures were performed by radiologists. Overall, median FT and RD were 16.4 mins and 5113 cGycm^2, respectively . FT and RD were inversely related to operator experience (i.e. the number of UFEs performed over a two-year period). Median FT and RD for those performing less than ten procedures were 20.5 mins and 6800 cGycm^2 versus 15.0 mins and 5235 cGycm^2 for those performing more than 25 procedures. Median FT and RD were lower in 2004 than 2005. FT and RD were marginally higher for UFE performed with bilateral femoral access.
Conclusion: FT and RD during UFE vary widely. Data support the existence of a learning curve; FT and RD were lower for more experienced operators and, overall, are falling with time. Surprisingly, FT and RD were slightly higher for UFE performed with bilateral femoral access.

24.1.6

Endocrine and reproductive aspects of uterine fibroid embolization

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Purpose: To evaluate safety of uterine fibroid embolization (UFE) in women of reproductive age.
Material/Methods: Ninety-two premenopausal women with intramural fibroid/s were treated with UFE from 5/2000 to 1/2006. Seventy patients, who met inclusion criteria (age <40 years, follicle-stimulating hormone (FSH) <10 IU/l, regular menstrual cycles), were prospectively followed regarding ovarian and reproductive functions.
Results: Bilateral uterine artery embolization was successful in 62 cases (89%); utero-ovarian anastomoses were detected in 25 (36%). The average patients´ age was 33 years, pre-procedural FSH concentration 6.7 (3.17-9.85) IU/l, and length of follow up 19.9 months. After six months, the average FSH was 6.8 (3.76-14.11); seven cases of FSH elevations >10 IU/l and six of transitory amenorrhoea were observed. Hysteroscopy revealed a normally responding endometrium in 88% of women but major intrauterine abnormalities in seven cases. Thirteen pregnancies occurred so far: five term deliveries, five miscarriages, one pregnancy termination; two women are pregnant now. One case of severe post-partum haemorrhage (without hysterectomy) was the only perinatal complication.
Conclusion: The risk of post-UFE ovarian failure in younger women with normal ovarian reserve is low. But in some cases, UFE could seriously affect the uterine cavity and diminish the chance of women for good reproductive outcome.

24.1.7

Early efficacy of uterine fibroid embolization in fibroids with bulk-related symptoms

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Purpose: A growing body of evidence supports the efficacy of uterine fibroid embolization (UFE) in managing the symptoms of fibroids, especially in cases with menorrhagia. To determine the efficacy of UFE in treating bulk-related symptoms, we compared the outcome in this group with the overall outcome in our prospective series of patients.
Material/Methods: From December 2002, 50 consecutive women (20 with bulk-related symptoms) with symptomatic uterine fibroids previously studied by magnetic resonance imaging (MRI) underwent transcatheter UFE. The mean size of the fibroids was 81.2 mm in diameter (range 40-150 mm). Patients were followed up clinically at regular intervals and underwent MRI at three, 12, and 24 months. Efficacy was evaluated.
Results: The procedure was carried out successfully in all cases. Immediate complications were observed in 10% of cases and late complications in 6%. Mean hospital stay was 1.34 days. Outcome was considered satisfactory in all but two cases. In the subgroup of 20 patients with bulk-related symptoms, symptoms had disappeared in 18/20 (96%) at three-month follow-up. No correlation with size reduction was observed.
Conclusion: UFE for the treatment of symptomatic fibroids appears to be an effective therapeutic option with a high clinical success rate in patients with bulk-related symptoms.

24.1.8

Randomised comparison of uterine artery embolisation with surgical treatment in patients with fibroids (REST trial): one-year results

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Purpose: To compare uterine artery embolisation with surgical treatment in women with fibroids (REST trial).
Materials/Methods: Women with symptomatic fibroids that would justify surgery were recruited. The primary outcome was quality of life assessed using the Short Form-36 (SF-36) questionnaire. Follow up was assessed at 12 months. Analysis was on an-intention-to-treat principle. Between November 2000 and May 2004, 157 patients were randomised on a 2:1 basis between uterine artery embolisation (n=106) and surgery (n=51). Ninety-five percent (149 of 157) of patients underwent their allotted treatment.
Results: There was no statistically significant difference in any of the eight components of the SF-36 scores at one year. The length of hospital stay and time to performing routine tasks was significantly shorter in those having UAE. Symptom scores were significantly better in the surgical arm. There were 33 (31%) serious adverse events (which included treatment failures) in the UAE arm and nine (18%) in the surgical arm at latest follow up (56 months).
Conclusion: Surgery and UAE provide a successful treatment for a majority of women with symptomatic fibroids. Faster recovery following UAE must be weighed against the need for further treatment, in a minority of patients following UAE.

24.1.9

Location of trisacryl-gelatin microspheres in fibroids according to size

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Purpose: Histologically evaluate the influence of trisacryl-gelatin microspheres (TGMS) sizes on their location in uterus and tumor area.
Materials/Methods: Patients were embolized with TGMS before myomectomy (MM n=44) or hysterectomy (HM n=7). TGMS sizes in MM were 500/700 µm (n=33), 700/900 µm (n=10), or 900/1200 µm (n=1). In HM, sizes were: 500/700 µm (n=6), 700/900 µm (n=1). Tumour size, presence/absence of TGMS in specimens, intra/extra TGMS tumoral location, and depth in tumor were studied. The Statview software was employed.
Results: TGMS were present in 42/51 specimens. Their presence significantly decreases with size (p=.0001, Chi2 test). In MM, 75% of TGMS were located intra-tumorally; 500/700-µm TGMS represented 99% of intratumoral TGMS and their median depth was 2000 µm (min-max 50-22000). Depth was correlated to tumour size (Rho= .481, p=.0004, Sp). TGMS were intra-tumorally absent in tumors sized <2.1 cm (p<.0001, Chi2 test). In HM, 18% of TGMS was located intra-tumorally (p<.0001, Chi2 test versus MM group); 96% of them were 500/700-TGMS and were located at a median depth [1200 µm (min-max 300-3200)] (p= .0252 MW versus MM group).
Conclusion: TGMS measuring 500/700 µm are more likely to be found in specimens and have a higher fibroid penetration rate than larger ones.

24.2.1

Cryoplasty in arterial restenosis

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Learning Objectives: To assess whether cryoplasty is of benefit in high-risk patients.
Background: Cryoplasty has been proposed as a method of inhibiting restenosis secondary to neointimal hyperplasia. Its benefit should be greatest in patients at high risk of restenosis.
Clinical Findings or Procedure Details: Between May 2004 and June 2005, ten patients with restenosis following ilio-femoral endovascular treatments underwent 12 cryoplasty procedures. Indications were grafts at risk (n=5), in-stent restenosis (n=5), and cryoplasty failure (n=2). Cryoplasty was performed in accordance with manufacturer's instructions using 6- or 8-mm balloons. All patients had Doppler-ultrasound evaluation at one, three, six, and 12 months. All procedures had angiographically successful immediate outcome with <30% residual stenosis. Non flow-limiting dissection was evident in two cases. In six procedures (50%), restenosis was evident as early as 1-3 months post-procedure. Whilst in the other six, there was progressive restenosis appearing between 6-12 months. Five cryoplasty procedures have needed endovascular re-intervention due to symptomatic high-grade restenosis and a sixth is awaiting surgery.
Conclusion: The results of cryoplasty in high-risk patients are disappointing with half the procedures failing within three months and all of them within the first year. Evidence to support its use in peripheral arterial lesions is lacking.

24.2.2

Absorbable metal stents in patients with critical limb ischemia. One-month interim results of AMS-INSIGHT 1 study: a randomized trial with absorbable metal stents

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Purpose: A novel absorbable metal stent (AMS) technology is currently under investigation in patients with critical limb ischemia within a prospective, multicenter, randomized clinical trial.
Materials/Methods: Fifty-seven patients enrolled at investigational sites in Belgium, Netherlands, Austria, and Germany with stenosed or occluded infrapopliteal lesions (Rutherford's categories 4 and 5) were randomized to either treatment with Biotronik´s AMS stent or percutaneous transluminal angioplasty (PTA) only. Safety and efficacy data were collected and assessed in respect to adverse events, limb salvage, and procedural success.
Results: Sixty-six infrapopliteal lesions were treated in 57 patients. Procedural success rate was 97% (31/32 lesions) in the AMS group and 88% (30/34 lesions) in the PTA-only group. Limb salvage rate was 0.93 in both groups. A total of 13 adverse events occurred. Ankle brachial index (ABI) improved in both groups from an average of 0.8 (AMS) and 0.7 (PTA) pre-procedure to 0.9 (AMS) and 1.0 (PTA) one day post-procedure and 1.0 (AMS) and 0.9 (PTA) one month post-procedure.
Conclusion: Final conclusion must await completion of patient recruitment and collection of additional 1-month follow-up data. Patency will be determined using quantitative analysis of the six-month angiogram post-intervention.

24.2.3

Evaluation of stent fractures after lower limb artery stenting with special regard to the stent types and the clinical impact

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Purpose: The aim of our study was to evaluate the prevalence and the clinical impact of stent fractures in iliac, femoral, and popliteal arteries. We also searched for stent fracture risks based in the patients.
Materials/Methods: Four-hundred and five stents were placed in 168 patients (104 Wallstent-Uni, 92 Self Xpert, 79 Luminexx, 62 Dynalink, 29 Absolute 0.35, 24 Smart Control and others) in 68 months. Stents were placed in the femoral (232), in iliac (127), and the popliteal (46) arteries. Mean follow-up time was 12.7 months (range: one day-68 months). Follow up was performed using colour-coded duplex-sonography, plain x-ray and, in case of restenosis, also digital subtraction angiography.
Results: Fifty-seven stent fracures (two Wallstents, 55 Nitinol-stents) were detected (41 minor, six moderate, eight severe fractures). Eighteen fractures were located in the iliac, 31 in the femoral, eight in the politeal arteries. There was no significant difference in the fracture rates dependent on the stent length and the number of overlapping stents. The fracture rate increased with the calcification degree of the artery wall and with eccentric calcifications.
Conclusion: Stenting of iliac, femoral, and popliteal arteries is still a safe procedure and the clinical impact is low.

24.2.4

Interim results of the below-the-knee CHILL study

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Purpose: To establish safety and effectiveness of cryoplasty in the treatment of below-the-knee arterial obstructive lesions in patients with critical limb ischemia.
Materials/Methods: The below-the-knee CHILL study is a prospective, multi-center, post-market study designed to evaluate the PolarCath Peripheral Dilatation System as primary treatment of infrapopliteal obstructive lesions in patients with critical limb ischemia. The system combines vessel wall freezing and balloon dilatation. The primary endpoints are initial technical success, and absence of major amputation six months post-treatment. Secondary endpoints include adverse events and absence of major amputation 12 months post-treatment. A total of 111 patients were enrolled at 16 sites.
Results: The primary technical success rate was 97%, with only one (1%) Grade-C dissection. No major complications occurred. Currently, 98 subjects have been enrolled for six months or more. Four amputations have been reported, yielding a six-month absence of major amputation rate of 95.9%. Twelve-month data will be available at the time of the meeting.
Conclusion: Cryoplasty therapy has been demonstrated to effectively treat intrapopliteal obstructive arterial lesions, and to yield excellent limb salvage rates at six months.

24.2.5

Intravascular ultrasound-guided fenestration of vascular dissections by using the Pioneer™ catheter: a novel therapeutic catheter technique

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Purpose: Evaluation of feasibility and effectiveness of intravascular ultrasound (IVUS)-guided needle insertion to gain controlled target lumen reentry in the treatment of peripheral occlusive disease and aortic dissection.
Materials/Methods: Between May 2004 and February 2006, 13 consecutive patients (eight men; mean age, 64 years) with peripheral ischemia were treated by using the Pioneer™ catheter. This dual-lumen catheter combines a 20-MHz IVUS-transducer with a pre-shaped, sheathed 24-gauge nitinol needle; using this device, real-time IVUS-guided targeting of the desired lumen is possible. After successful reentry, a 0.014" guidewire may be delivered into the target lumen. Seven patients underwent treatment due to aortic dissections and six for peripheral occlusive disease. Technical success, outcome, and complications were evaluated.
Results: Using the Pioneer™ catheter our technical succes rate was 100%. Time of recanalization/fenestration ranged between 25 and 57 minutes. Procedure-related complications did not occur. In 12 cases, a significant improvement of clinical symptoms was observed; one case with ischemic paraplegia required subsequent surgery. Three patients had to undergo reintervention during their follow-up.
Conclusion: The Pioneer™ catheter is a reliable device which may be helpful to achieve target lumen reentry in subintimal recanalization procedures of peripheral occlusive disease and in fenestration approaches of aortic dissections.

24.2.6

Percutaneous treatment in iliac artery occlusions: long-term results

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Purpose: To evaluate long-term outcomes after recanalization of chronic iliac artery occlusion with primary stenting and underline predictive factors of clinical success.
Materials/Methods: From January 1995 to August 2005, 228 consecutive patients (mean age, 68.2 years) with occlusive iliac artery disease underwent recanalization with primary stenting. Pre-procedure evaluation included: Fontaine classification, color-Doppler-ultrasound, digital subtraction angiography (DSA) findings, and ankle-brachial pressure index (ABI). The mean ABI at hospitalization was 0.52 (range: 0.23-0.72). Follow-ups included ABI measurements, vascular clinical control, color-Doppler-ultrasound, and--from September 2000--multislice computed tomography angiography at one, three, six months and every year thereafter. In case of significant ABI reduction (>0.15) or worsening of clinical conditions, a DSA was performed.
Results: Technical success was 98.7%. A clinical improvement was recorded in all the patients in whom a technical success was achieved. Primary patencies were 87.3, 83.3, 61.4, and 49.6% at three, five, seven, and ten years; secondary patencies were 98.7, 98.2, 69.3, and 55.7%, respectively.
Conclusion: Primary stenting is safe and effective in case of chronic occlusions; long-term results of primary and secondary patencies are similar to traditional surgery.

24.2.7

Twelve-month results of FAST: femoral artery stenting trial

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Purpose: Whether stenting in peripheral arterial occlusive disease is superior to percutaneous transluminal angioplasty (PTA) remains unclear. We report on a multi-center, randomised trial to evaluate PTA versus stenting in superficial femoral artery (SFA) lesions.
Materials/Methods: Two-hundred and fifty patients with Rutherford grade 2 and a SFA lesion no longer than 10 cm were randomised (1:1) to PTA or stenting with a nitinol stent (Luminexx). Primary endpoint was 12-month restenosis rate (duplex sonography).
Results: There was no significant difference in age and risk factors. Mean improvement of ankle-brachial index at rest was 0.12 (PTA) versus 0.18 (stenting) (p=0.091). Success rates were 79% (PTA) and 93% (stenting). A cross-over rate for PTA group was 11%. Binary restenosis in the intention-to-treat analysis was 33.8% (PTA) versus 25.5% (stenting) (p=0.085). Target lesion revascularization (TLR) in the PTA arm was 12.4% compared with 6.5% in the stent arm. In the per-protocol analysis, binary restenosis was 41.5% in the PTA arm versus 24.5% in the stent arm (p=0.018).
Conclusion: In this six-month interim analysis, improved outcomes (in terms of binary restenosis and post-stenting TLR) were observed. Final 12-month analysis will be available at the congress.

24.2.8

Long-term results after infrapopliteal angioplasty

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Purpose: To evaluate short- and long-term results in patients who underwent infrapopliteal angioplasty.
Materials/Methods: We retrospectively evaluated all the patients who had undergone infrapopliteal angioplasty from 1997 to 1999. Patients with acute (<2 weeks) limb ischemia were excluded. Primary end-points were limbs salvage rate and patients survival. Secondary end-points were complication rate, technical success, and walking distance.
Results: One-hundred and twelve patients with a mean age of 72 years (41 women, 71 men) underwent angioplasty. Four patients had severe claudication (category 3), all the others had critical chronic limb ischemia (categories 4 to 6). Complication rate was 2.7%. A technical success was achieved in 92%. The ankle brachial index increased from 0.59 to 0.88 (p<0.001). Mean walking distance at follow up was 284±346 meters. Limb salvage rate was 83.6% after one year and 81.1% after three years. Mean survival rates according to Kaplan-Meier were 79.4%, 69.2%, and 54.2% at one, two, and three years, respectively.
Conclusion: Infrapopliteal angioplasty shows high technical success rates with acceptable complication rates. Clinical long-term success seems favourable. However, survival is limited due to co-morbidities in this patient group.

24.2.9

Flanders experience with endovascular treatments for below-the-knee-lesions in critical limb ischemia-patients: the FEET-BTK study

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Purpose: Presently, endovascular strategies exist for the treatment of infrageniculate peripheral arterial occlusive disease (PAOD). However, beyond technical feasibility, only a limited evidence supports their use for below-the-knee (BTK) interventions. One-year outcomes of excimer laser recanalization, percutaneous transluminal angioplasty (PTA) alone, PTA followed by stenting, and primary stenting for BTK-lesions in critical limb ischemia (CLI)-patients were studied.
Materials/Methods: Between September 2002 and June 2005, 381 patients (299 Rutherford category 4, 76 category 5, six category 6) underwent intervention for 587 BTK-lesions. Follow-up was at least every six months after index intervention: limb salvage data were recorded and duplex ultrasound was performed to measure treated area patency.
Results: One-year primary patency and limb salvage rates of the entire population were 74.9% and 96.9%, respectively. Stratified for the treatment strategy (excimer laser in 63, PTA alone in 64, PTA + stenting in 173 and primary stenting in 81 patients), one-year primary patencies were 76.5%, 74.9%, 73.8%, and 76.3%, while limb salvage rates were 87.5%, 96.0%, 99.3%, and 100% for each modality, respectively.
Conclusion: Endovascular interventions should be the primary treatment for BTK-lesions in CLI-patients, with one-year survival, primary patency, and limb salvage rates that favorably compare with published surgical data.

24.3.1

Percutaneous discectomy under computed tomography and fluoroscopic guidance: six to 24 months of follow up. Report on 50 cases

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Purpose: To report our study on the use of the 1.5-mm Dekompressor probe (Stryker Co., Kalamazoo, MI, USA) on percutaneous discectomies performed under dual guidance [computed tomography (CT) and fluoroscopy] in 50 patients with a follow up of six to 24 months.
Materials/Methods: From September 2003 to May 2005, a prospective review on 50 patients (25 men; median age, 52 years) was performed. Cases were randomly selected among those presenting with a lumbar sciatica from a nonextruded herniated disc resistant to all medical treatments. Pain intensity was measured by Huskisson's visual analogue scale (VAS) with a follow-up after two and seven days, and after one, three, six, 12, and 24 months.
Results: In 11/50 patients, results were not satisfactory: VAS decrease was below 30% in 10/11 patients, and in 1/11 the development of an epiduritis was treated surgically. In 39/50 patients (78%), the benefits obtained allowed the suspension of the medical therapies administered pre-procedurally in 31/39 or their definite reduction in 8/39 patients.
Conclusion: Our study on the use of percutaneous discectomy performed under CT- and fluoroscopy-guidance is encouraging. Inclusion or exclusion criteria should be strictly respected, in particular the preservation of a hydrated disc with a satisfactory volume.

24.3.2

Percutaneous nucleoplasty in the treatment of disc lumbar pain

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Purpose: To assess the effectiveness of percutaneous nucleoplasty in the treatment of lumbar pain due to contained discal herniation.
Materials/Methods: From June 2003 to July 2005, 101 patients with positive visual analogue scale (VAS) (mean score: 8) and lumbar pain were selected. A lumbar magnetic resonance imaging (MRI) revealed a contained discal herniation in all (four patients: L1-L2; 16 patients: L2-L3; 29 patients: L3-L4; 45 patients: L4-L5; seven patients: L5-S1). All the patients were refractory to medical and rehabilitative therapies performed for more than three months. The main principle of this procedure is a bipolar radiofrequency energy emitted by an electrode-needle, with consequent volumetric reduction of the nucleus polposus and elastic return of the anulus fibrosus. The treatment was performed under biplanar fluoroscopic guidance.
Results: Postprocedural evaluation confirmed VAS reduction (mean score: 3). MRI performed at six- and 12-month follow-up demonstrated the complete resolution of the treated discal pathology in all patients. No post-procedural complications or recurrences were observed.
Conclusion: Percutaneous nucleoplasty proved to be an easy, effective, and feasible technique. This minimally invasive procedure is ideal for the treatment of those patients with painful contained discal herniation, refractory to conservative medical therapy and not candidate to surgical treatment.

24.3.3

Radiofrequency ablation in the treatment of osteoid osteoma

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Purpose: To determine the efficacy of radiofrequency ablation (RFA) in the treatment of osteoid osteoma (OO) regarding complication rates and pain relief.
Materials/Methods: In a four-year period, 25 patients (13 males, 12 females, aged from 9 to 45 years) were treated. In 8/25 patients, OOs were localized in the lumbar (5/8) or the thoracic spine (3/8), the other 17 OOs were in the femur (7/17), the acetabulum (2/17) or the radius and the tibia (8/17). In children, RFA was performed under general anaesthesia, while in adults a conscious sedation was obtained. Ablations at a temperature of 90°C lasted 5 to 8 minutes. Primary success rate, complications, disease-free interval, and follow-up were evaluated.
Results: Within the observation period (3-48 months), all of our patients were successfully treated and had no more complaints. Twenty-one of the 25 patients were free of pain after the first ablation, while in four cases RFA was repeated to achieve a complete response. No major complications occurred. In two patients, minor complications (one hematoma, one skin burn of degree 1) were observed.
Conclusions: RFA is a highly effective, efficient, minimally invasive, and safe method for treating OOs.

24.3.4

Polymethyl methacrylate cement compared with Calcibon® in kyphoplasty of painful osteoporotic vertrebral fractures. Three-year outcomes of a prospective cohort study

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Purpose: Calcium-phosphate cements are replaceable by newly formed bone tissue after implantation into bone tissues, e.g. into vertbral bodies. A new calcium-phosphate cement is Calcibon®. It exhibited satisfying vertebral stability in short-term follow-up studies. We report on our three-year outcomes in comparison with polymethyl methacrylate (PMMA) cement.
Materials/Methods: Forty consecutive patients with primary osteoporosis and painful fractures were treated with kyphoplasty. Twenty patients received Calcibon®, the other 20 were treated with PMMA cement. All the patients were administered osteoporosis medical treatment, pain medications, and physiotherapy. Visual analogue score (VAS) range (0-100) and radiomorphological measurements were assessed at baseline, after six, 12 and 36 months.
Results: Pain score (VAS) showed an improvement from 26.9 to 41.5 after six, and to 47.3 after 36 months. In the PMMA group, pain score changed from 25.5 to 46.9 after six, and to 47.3 after 36 month. There were no statistically significant differences between the two groups.
Conclusion: Calcibon® is as effective as conventional PMMA cement in immediate and sustained pain reduction in patients with painful vertrebral fractures. Calcibon® has the potential of being resorbed and replaced by newly formed bone tissue. It can therefore be used in younger patients with type A1.1 traumatic fractures.

24.3.5

Percutaneous vertebroplasty in patients with osteoporotic fractures of the spine: medium-term clinical outcome

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Purpose: To evaluate medium-term clinical outcomes of percutaneous vertebroplasty (PV) for severe back pain due to osteoporotic fractures of the spine.
Materials/Methods: Over a period of 44 months, 80 vertebrae (two cervical, 36 thoracic, 40 lumbar) were treated in 58 consecutive patients (44 women and 16 men; mean age, 70±13 years) with osteoporotic vertebral fractures. PV was performed under computed tomography/fluoroscopic guidance using local anesthesia only. Therapy efficacy in terms of pain relief was assessed at discharge and one year after by administering a standardized questionnaire [pain level at visual analogue scale (VAS), medications, additional treatments].
Results: In 68.4% of patients, a good pain relief was reported, 15.8% had no change, and 15.8% had a pain worsening after a mean observation period of 368 days. This corresponds to a VAS mean pain reduction from 8.7 (before PV) to 5.5 (one day post-PV) and 3.6 (one year after PV); 68.4% of patients reduced or discontinued analgesics, in 26.3% of cases the use of pain killers did not change, and 5.3% of patients had increased the amount of medications one year post-PV.
Conclusion: PV facilitates an effective and minimally invasive treatment of severe back pain due to osteoporotic fractures of the spine.

24.3.6

Plasma radiofrequency-based discectomy (Coblation) for the treatment of cervical herniated nucleus pulposus: feasibility, safety and preliminary clinical results

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Purpose: To assess feasibility, safety, and preliminary clinical results of the percutaneous treatment of cervical herniated discs using plasma radiofrequency-based discectomy.
Materials/Methods: Patients (n=55) with radicular pain due to cervical soft disc herniation were treated over 29 months. Three patients also had a moderate myelopathy. The procedure was performed using the Perc-DC SpineWand (ArthroCare Corp., Sunnyvale, CA) via an anterior approach. Most cases were conducted on an outpatient basis under local anesthesia.
Results: At two and six months, respectively, 44/55 (80%) and 44/52 (85%) patients had 'good' or 'excellent' results. One complication (infectious discitis) occurred within the first month, which was successfully treated. One technical complication (*in-situ* rupture of the device tip) was observed; the patient remained asymptomatic during the two-year follow-up. Patients with clinical myelopathy experienced a regression of cord compression symptoms; two of them showed morphological evidence (magnetic resonance imaging) of reduction of cord compression.
Conclusion: Plasma radiofrequency-based discectomy in the cervical spine was easy to perform, safe, and effective in the short- and middle-term, and was associated with only a minimal discomfort for the patient. It appears to be a minimally invasive, low-risk approach, valuable for use in the early phases of a cervical disc herniation.

24.3.7

Post-vertebroplasty posture, standing, and walking habits measurements in relation to pain scores

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Purpose: To prospectively evaluate the relationship between body posture and pain in patients treated by vertebroplasty.
Materials/Methods: Eleven patients (28 vertebrae; average age: 77.6 years) treated for painful vertebral fractures (21 osteoporotic and seven multiple myeloma) between 3/2005 and 12/2005 were prospectively followed. A baropodometer provided electronic pressure information in two phases: standing and walking. Pain and mobility were scored following a visual analogue scale, according to a validated questionnaire. Height, body centre projection, stability, walking analysis, and pain measurements were compared with post-treatment results from day two to 45 (mean 11 days, SD=4.5). Wilcoxon matched-pairs signed-ranks analysis (n<50) was performed .
Results: As expected, a significant post-treatment pain relief was achieved (p=0.003). No complications were observed. No statistical changes were noted in standing analysis (p=0.19). Important changes were measured for walking habits (p=0.005). Two patients completed the post-treatment walking tests which were unable to perform pre-treatment. Significant posture changes were proven, even when significant height vertebral restoration was not recorded
Conclusion: Vertebroplasty plays an important role in pain relief. Initial data suggest that measurable changes in walking habits (unrelated to vertebral height restoration) induced by pain relief can be obtained. Static measurements are not as affected as walking habits.

24.3.8

„Vertos-II" trial: vertebroplasty versus conservative therapy in patients with osteoporotic vertebral compression fractures

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Purpose: To present an ongoing randomised controlled trial (RCT) comparing clinical outcome and cost-effectiveness of vertebroplasty (VP) versus conservative therapy (CT) in patients with osteoporotic vertebral compression fractures (VCF).
Materials/Methods: In November 2005 a prospective, multicenter, RCT was started in the Benelux. The inclusion criteria are local back pain (six weeks or less), osteopenia, 50 years of age or older, and VCF with bone edema on magnetic resonance imaging. A total of 200 patients will be included, 100 in each arm, randomised for VP or CT. Cross-over is not allowed. Radiological imaging results and standard questionnaires addressing clinical symptoms (Roland), pain medication, Visual Analog Scale (VAS) and quality of life (QUALEFFO) will be compared to baseline. Follow-up is at regular intervals over a one-year period. Cost-effectiveness of both therapies will be obtained and compared. Secondary fractures, necessary additional therapies and complications of both treatments are recorded.
Results: Preliminary results of patients enrolled in the trial between November 2005 and August 2006 will be presented. At that time we expect to have included approximately 100 patients.
Conclusion: Vertos II is the first large West-European multicenter prospective RCT comparing VP and CT in patients with osteoporotic VCF.

24.3.9

Incidence of adjacent and distant fractures during follow-up after computed tomography-guided vertebroplasty

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Purpose: To evaluate the incidence of new vertebral fractures adjacent or distant to pretreated vertebrae and the impact of intradiscal cement leaks.
Materials/Methods: Osteoporotic fractures were treated with vertebroplasty. Incidence and time of new fractures were analysed. New fractures were re-treated with vertebroplasty and included in the follow-up.
Results: Three-hundred seventy-two osteoporotic fractures were treated in 186 patients (125 women; age 70.7±9.8 years). During follow-up (20.2±12.4 months, range 1-45), 65 new fractures occurred in 37 patients (19.9%). Twenty-eight were adjacent to pretreated vertebrae (4.2±5.8 months; range 0.5-22), seven were sandwich fractures (4.2±5.2 months; range 0.3-12), and 30 were in distant vertebrae (3.8±5.3 months; range 0.5-22). New adjacent fractures were located below pretreated vertebrae in 16/28 and above in 12/28. Nine of the 28 adjacent fractures occurred with preexisting intradiscal cement leakages from pretreated vertebrae, 13 occurred without intradiscal leaks. However, 4/7 sandwich fractures occurred in cases with preexisting leaks in adjacent discal spaces.
Conclusion: Intradiscal cement leaks might have a minor influence on the occurrence of adjacent fractures. Intradiscal leaks were present in half of the sandwich fractures. Other biomechanical factors, such as changes in the statics of the spine and hardening of cemented vertebrae might have more impact.

24.4.1

Do device characteristics impact outcome in carotid artery stenting?

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Purpose: To identify those factors negatively impacting carotid artery stenting (CAS).
Materials/Methods: Patient, lesion, or procedure variables in 701 consecutive CAS procedures were analyzed for association with 30-day stroke/death/transient ischemic attack (TIA). Odds ratio [OR (95% CI, p-value)] was calculated to predict adverse outcome.
Results: Thirty-day stroke/death/TIA was 3.7%. OR for basic risk factors (age ≥70, symptomatic, smoking, hypertension, diabetes, peripheral vascular disease, hypercholesterolemia, embolic protection device, predilation, ulceration, calcification, restenosis) were analyzed and found to be non-significant, except for hypercholesterolemia [OR=2.7 (1.0-7.3 p=0.041)]. Symptomatic patients (n=304, 43%) receiving open-cell stents had increased risks for stroke/death/TIA of 3.1 as compared with those receiving closed-cell stents [OR=4.1 (1.4-12.1, p=0.0136)]. Concentric filters implantation in symptomatic cases led to a 3.3 times higher risk for stroke/death/TIA as compared with eccentric filters [OR=3.3 (1.0-10.4, p=0.0525)]. In patients with echolucent plaques (n=486.69%), open-cell stents increased the stroke/death/TIA risk of 3.1 times as compared with closed-cell stents [OR=3.1 (1.2-8.2, p=0.0343)]. Embolic protection with concentric filters in this subgroup increased the risk for stroke/death/TIA of 3.7 times as compared with eccentric filter protection [OR=3.7 (1.3-10.4, p=0.0174)].
Conclusion: In symptomatic patients or with echolucent lesions, closed-cell stent implantation and eccentric filter protection seems superior in this dataset.

24.4.2

Does the embolized debris collected in protection filters during carotid artery stenting correlate with angiographic findings?

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Purpose: Angiographic findings (plaque morphology) are correlated with histopathologic analysis of embolized debris collected in protection filters during carotid artery stent implantation.
Materials/Methods: We prospectively evaluated 40 distal filters devices for cerebral protection in patients undergone carotid artery stenting. Age, presence of symptoms, angiographic findings of the carotid bifurcation, and histopathologic analysis of emboli were correlated. Angiographic findings were based on Wholey's classification: type A=short and regular, type B=irregular and long, and type C=subocclusion or ulcerated. The particles were stained with hematoxylin-eosin for qualitative analysis, subsequently photographed, and their areas were measured (μm^2) by a computer software. The statistical analysis was made using the t-student test and analysis of variance; $p< 0.05$ was significant.
Results: Presence of debris was detected in all but three filters. Collected debris consisted of thrombotic material, foam cells, calcium and cholesterol clefts. The mean area of the debris was 9,261.76 μm^2 (type A lesion); 234,434.34 μm^2 (type B lesion), and 1,411,900.31 μm^2 (type C lesion)
There was a correlation between angiographic findings and the area (μm^2) of embolized debris.
Conclusion: The qualitative analysis of embolized material showed debris dislocated from the atheromatous plaque. Wholey type-C plaques embolized more than type-A plaques.

24.4.3

The relationship between post-carotid artery stenting hypotension and stent type

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Purpose: To assess whether there is a significant difference in the incidence of periprocedural hypotension requiring treatment related to stent type used in the carotid artery for *de-novo* lesions.
Materials/Methods: Between January 1996 and January 2006, 245 patients were treated at a single center by carotid artery angioplasty and stenting. There were 171 patients with *de-novo* lesions and 167 successful procedures. These cases were examined for stent type--balloon-expandable, braided Elgiloy® (Wallstent), or segmental device (nitinol). Those in current use, the Wallstent and nitinol stents were included (n=151). Variables analyzed include patient demographics, procedural parameters and the incidence of periprocedural hypotension. Statistical analysis by unpaired t-test at p=0.05 was used.
Results: There were 39 women (26%) and 112 men. Mean age was 70.5±9.5 (36-88). There were 121 patients who were treated with nitinol segmental stents; 29 received Wallstents (braided Elgiloy®). The 16 patients treated with balloon-expandable stents early in our experience were not included in this analysis. The incidence of periprocedural hypotension was significantly lower for those patients treated with Wallstents: 17.24% versus 32.79% (p=0.05).
Conclusion: Self-expanding nitinol stents are associated with a higher risk of peri-procedural hypotension than braided Elgiloy® stents.

24.4.4

Cerebral ischemia after filter-protected carotid artery stenting is common and cannot be predicted by the presence of substantial amount of debris captured by the filter device

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Purpose: To determine the incidence of new ischemic lesions found at diffusion-weighted magnetic resonance imaging (DW-MRI) after protected carotid artery stenting using a filter device and to determine the potential relationship between these new ischemic lesions and the presence of debris captured by the neuroprotection filter device.
Materials/Methods: A non-randomized cohort of 52 patients underwent protected carotid artery stenting using a filter device. DW-MRI-scans obtained one day before stenting were compared with those obtained one day after stenting. Additionally, the microscopic analysis of debris, captured by the filter device, was assessed.
Results: Neuroprotected carotid stenting was complicated by a transient ischemic attack in three patients (5.6%). In 22 patients (41.5%) new ischemic lesions were found on DW-MRI and in 21 filter devices (39.6%) a substantial amount of atheromatous plaque and/or fibrin was found. No clear relationship between the presence of debris captured by the filter device and new lesions detected by DW-MRI was found (p=0.087; odds ratio 3.067).
Conclusion: Neuroprotected carotid artery stenting will not avoid silent cerebral ischemia. Systematic microscopic analysis of debris captured by the filter device has no predictive value for potential cerebral ischemia after carotid artery stenting.

24.4.5

Strategies for the management of carotid stenting using cerebral protection: our experience in the first 100 patients

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Purpose: To assess the safety and the efficacy of carotid artery stenting (CAS) in patients treated with two types of protection device. We describe endovascular approaches and ways to successful treatement.
Materials/Methods: Between January 2004 and January 2006, 100 patients with internal carotid stenosis (74 primary and 26 restenoses) underwent CAS using self-expandable stents. Two types, proximal or distal, of protection devices were used (86 distal and 14 proximal protection devices). The choice for the appropriate protection device was based on preoperative angiographic examinations performed on a eight-slice multidetector computed tomography scanner. Cerebral magnetic resonance (MR) images with diffusion sequences were obtained the day before and within 24 hours after CAS.
Results: All stent implantations were successful. One patient suffered minor stroke after CAS with a distal protection system. Post-procedural digital subtraction angiography confirmed the optimal calibre of the treated artery. Post-procedural diffusion weighted (DW)-MR showed new hyperintense lesions in 33% of patients.
Conclusion: CAS using a protection device is safe and reduces the risk of peri-procedural embolism. In our study, ischemic lesions were seen on DW-MR after CAS with both protection systems. The detected lesions did not cause neurological deficits.

24.4.6

Sirolimus-eluting stents in the carotid artery. Increased inflammation but persistent prevention of restenosis in follow-up

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Purpose: Stent implantation in the carotid artery (CA) has been shown to be feasible for the treatment of CA stenoses. Although restenosis rate is reported to be much lower than in coronary and peripheral arteries, problems may arise with the increasing number of treated patients.
Materials/Methods: Eight pigs were randomly assigned to receive a nitinol, self-expanding, Sirolimus-eluting stent (SES) and the same stent without Sirolimus-coating in the right or left CA. Angiography and intravascular ultrasound were done after six weeks and at six months.
Results: After six months, the neointima was significantly reduced by SES (5.9±2.5 mm^2 versus 0.7±1.0 mm^2). Interestingly, the positive effect of SES was maintained after six months, whereas there was a significant increase of neointimal formation in the bare stents between six weeks and six months. Despite the Sirolimus coating, inflammation around the stent struts was significantly higher in the SES.
Conclusion: Sirolimus self-expanding nitinol stents may be an effective tool to reduce the restenosis rate in CA in selected cases. Despite an inflammatory reaction around the stent struts, these stents had a persistent positive effect on the restenosis rate.

24.4.7

Endovascular treatment of internal carotid artery stenosis: immediate and five-year follow-up

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Purpose: Internal carotid artery (ICA) stenting is an emerging alternative to endoarterectomy not only in high-risk patients. Few data are available on long-term clinical efficacy of this technique using protection devices, and on restenosis incidence.
Materials/Methods: During the last five years, 512 consecutive patients [557 lesions, 267 (52.14%) symptomatic patients] with stenosis of the ICA were treated with routine use of cerebral protection devices. Pre-procedurally, all the patients underwent Doppler ultrasound (USD), angio-magnetic resonance, and/or angio-volume computed tomography. A neurological examination was performed before and after the procedure.
Results: A technical success was achieved in 557 lesions (100%) and cerebral protection was successfully applied in 542 procedures (97.30%). According to USD criteria, mean carotid artery stenosis was 78±10%. Thirty-day incidence of stroke and death was 1.17%. Follow-ups included clinical, neurological, and USD examinations. A USD control was carried out in all surviving patients (7) showing a restenosis (>80%).
Conclusion: In our experience, ICA stenting seems to be a safe and effective treatment of ICA stenoses with results comparable with the surgical alternative. At five-year follow-up, ICA stenting proved to be durable and effective in the prevention of strokes, with a very low incidence of restenosis.

24.4.8

Carotid RX ACCULINK/ACCUNET post-approval trial to uncover unanticipated or rare events (CAPTURE): status update on 2500 patients

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Background: The „Carotid RX ACCULINK/ACCUNET post-approval trial to uncover unanticipated or rare events" (CAPTURE) post-market approval study was part of the Food and Drug Administration approval of carotid stenting with embolic protection for high surgical risk patients. We report on the outcomes to date with this large cohort size.
Materials/Methods: Enrollment is ongoing at the time of abstract submission. Inclusion/exclusion criteria were for all patients treated with the carotid stent and embolic protection device. The precedent „ACCULINK for revascularization of carotids in high-risk patients" (ARCHeR) trial, which served as the basis for carotid stent approval, reported on patients at high risk for surgical intervention but is the closest comparator for CAPTURE.
Results: To date, data on 1603 CAPTURE patients has been reported orally with the 30-day composite endpoint of death, myocardial infarction and death at 5.1%. Comparable endpoint data from the ARCHeR trial was 8.3%. Updated and detailed data for over 2500 CAPTURE patients will be presented including octogenarian symptomatic and asymptomatic data comparisons.
Conclusions: Comparison between updated CAPTURE outcomes and pivotal ARCHeR trial data will be undertaken with specific assessment of success of the transfer of this technology out of the clinical trial environment using the parameters listed above.

24.4.9

Does residual stenosis influence a long-term in-stent patency after carotid artery stenting?

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Purpose: To evaluate the influence of residual stenosis on long-term in-stent patency after carotid artery stenting.
Materials/Methods: A retrospective analysis of 200 procedures--all done with filter neuroprotection and self-expanding stents--was perfomed. Treated stenoses were >70%. Predilation was performed in 44 cases (22%), postdilation was a standard for all procedures, with the use of 5- and 5.5-mm balloons. In 118 cases (59%) carotid artery lumen was restored after stenting. A residual stenosis up to 20% was noticed in 57 cases (28.5%). In 23 cases (11.5%) residual stenosis was 20-40%. Residual stenoses >40% were not found. Two cases of early stent thrombosis occurred, without additional treatment. All the patients had a six-month follow-up with duplex ultrasound, and 167 (83.5%) patients were examined after one year, with measurement of the smallest stent diameter. There were three restenoses >40% (one retreated). In 144 patients (72%), the stent diameter during follow-up was the same as post-stenting. In 30 cases (15%), it was smaller but without restenosis features. In the remaining 24 patients (12%) the stent diameter was bigger than the original one.
Conclusion: A residual stenosis, even of 20-40%, does not influence long-term in-stent patency. We found no correlation between restenosis frequency and residual stenosis.

24.5.1

The Option vena cava filter: conical, retrievable, self-centering, true 6-French

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Purpose: Evaluation of OPTION vena cava filter (Rex Medical, Conshohocken, PA) in ovine models.
Materials/Methods: Fifty-two sheep were evaluated in three cohorts after Institutional Animal Care and Use Committee approval using the OPTION filter. Filters were placed via femoral (n=47) or jugular approach (n=5) and snared via an 8-F 90-cm sheath after two weeks (n=9), one month (n=12), two months (n=6), and three months (n=2) after implantation. All animals underwent pre- and post-retrieval angiography and gross pathology. The clot challenge group all had autologous 36-hour old clot injected via a bulb syringe immediately after filter deployment. Filters were evaluated for clot trapping and autologous thrombolysis after being survived for 30 (n=3), 60 (n=3), and 90 days (n=3) post-clot challenge. Fourteen filters were permanently implanted, followed by *in-situ* gross pathology at one (n=7) and three months (n=7).
Results: All OPTION filters were placed with less than 4-degree tilt and no migration. Thrombus resorption was 70% at 30, 95% at 60, and 100% at 90 days. All widely patent filters were removed without difficulty. Post-retrieval cavagrams demonstrated no abnormality. Gross pathology was normal without transmural migration of retention hooks.
Conclusion: The OPTION could be safely removed in ovine models after 90 days.

24.5.2

The Recovery inferior vena cava filter. Placement and retrieval experience

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Purpose: To report our experience with the placement and retrieval of the Recovery inferior vena cava filter.
Materials/Methods: One hundred Recovery filters (Bard Canada, Mississauga, Ontario) were placed into 98 patients between April 2000 and December 2005. Twenty-one patients had experienced a complication of anticoagulation, while 34 others had contraindications to anticoagulation. Forty-seven patients had documented acute lower extremity deep vein thrombosis (DVT), 22 had pulmonary embolism (PE) only, 22 had both PE and DVT, and seven filters were placed into patients on a prophylactic basis. Seventy-five filters have been removed using the Recovery Cone (Bard, Canada) via jugular vein access (74 right/1 left). Mean follow-up was 584 days (0-1242).
Results: All 98 patients successfully received filters. All attempted removals (75/75) were technically successful, with a mean filter implantation time of 95 days (1-284) post-insertion. There were two cases of filter migration. There were three incidents of caval thrombosis with the filter *in situ*. One incident of PE while the filters were in place occurred. There was one case of asymptomatic PE that occurred at the time of filter retrieval. There was also one case of filter fracture.
Conclusion: Implantation and retrieval of the Recovery filter is safe and effective.

24.5.3

Günther Tulip retrievable inferior vena cava filters: indications, complications, efficacy and retrieval

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Purpose: To evaluate Günther Tulip (GT) inferior vena cava (IVC) filter placement for indication, efficacy, complications, retrieval, and anticoagulation.
Materials/Methods: A retrospective study of 147 patients (64 men, 83 women) who underwent GT filter placement between 2001 and 2005 was performed. Indications included pulmonary embolism (PE) or deep venous thrombosis (DVT) with a contraindication to anticoagulation (n=68), PE/DVT on anticoagulation (n=49), and prophylaxis for high risk of PE (n=30).
Results: Access sites were transfemoral (n=78) or transjugular (n=69). Filter placement was permanent in 102/147 patients and temporary in 45/147 patients. Complications included pneumothorax (n=4), failure of filter expansion (n=1), asymptomatic IVC perforation (n=1), and breakthrough PE (n=1). Filter retrieval was successful in 36/45 patients (80%) and unsuccessful in 9/45 patients (20%) at a mean time of 33.6 days (range 14-112 days). Reasons for failed retrieval included inability to snare the retrieval hook because of filter tilt (n=2) and adherence of the filter struts to the IVC wall (n=7). Ninety six patients (67%) received anticoagulation. No IVC thrombotic episodes were recorded.
Conclusion: GT filter placement is safe and efficacious. GT filters can be safely retrieved at a mean of 33.6 days. The newly developed Celect filter may extend the retrieval interval.

24.5.4

New optional inferior vena cava filter: ***in-vivo*** **comparative study in an ovine model. Günther Tulip versus Celect**

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Purpose: To compare the Celect inferior vena cava (IVC) filter with the Günter Tulip filter regarding migration.
Materials/Methods: Twelve IVC filters (six Günter Tulip, six Celect) were implanted in six sheep by jugular access. The sheep were anticoagulated by low-molecular-weigh heparin; all sheep were sacrificed after 30 days and the vena cava segment containing the implanted filters was excised *in toto*. The filters *in situ* were immediately sent to the disengaged radial force test. We designed a special machine to measure the force necessary to free the hooks of the vena cava wall.
Results: At autopsy, retroperitoneal hemorrhages, vena cava fractures, or other alterations were nor detected. Filter fractures also were not observed. In five filters (1 Günter Tulip, 4 Celect), the hooks had perforated the vena cava wall. Filters did not migrate; the average radial force needed for filter migration with the Günter Tulip filter was 760 g, for the Celect filter it was 887.5 g.
Conclusion: No significant differences in the disengage radial force test for filter migration between the Celect IVC filter and the Günter Tulip were detected.

24.5.5

Günther Tulip inferior vena cava filter in an ovine model: retrievable force study

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Purpose: To report feasibility and safety of Günther Tulip inferior vena cava filter (IVCF) retrieval after four-week implantation in an ovine model.
Materials/Methods: Ten Günther Tulip IVCF were implanted in ten sheep. All the filters were removed 30 days after implantation. A modified commercial dynamometer was used to evaluate the strength required to remove the filter. The difficulty degree to remove the filter was classified into four levels: N (none difficulty), M (Medium difficulty), G (Great difficulty) and U (impossible to remove). The sheep were sacrificed after filter retrieval and the vena cava segment was extracted for the histopathology study.
Results: The filters did not migrate; filter retrieval attempts were successful in all ten sheep (technical success of 100%). Severe complications during the procedures were not recorded. In all cases, the strength necessary to retrieve the filter was below 500 g (average 325 g). One sheep had small clots and another had clot into the filter legs. At autopsy, complications were not recorded.
Conclusion: The Günther Tulip IVCF is a safe and easy-to-use device; it can be retrieved without difficulty after four-week indwelling time in an ovine model.

24.5.6

Additional clinical experience with a long-term retrieval optional vena cava filter

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Purpose: Insertion of a permanent vena cava filter has been shown to reduce occurrence of pulmonary embolism (PE) despite an increased risk of deep vein thrombosis (DVT) at long-term. Retrievable or optional caval filters offer the ability to be removed or not, according to PE exposure.
Materials/Methods: A bi-centric retrospective study was performed to assess filter efficacy and ability to remove the ALN filter in patients with severe acute venous thromboembolism associated with at least one indication of filter, such as contraindication to anticoagulant (mainly due to haemorrhagic phenomena), acute major surgery, and recurrence of venous thromboembolism despite anticoagulant.
Results: This study included 367 (280 + 87) patients with DVT (26%), PE (13%) or both (61%). After a median follow-up of 12.1 months, two episodes of PE and three filter thromboses occurred. A decision of filter removal was taken for 84 (65+19) patients (22.9%): all filter retrievals were successful without any complication. The median implantation period was 103 days (range: six days- 24 months).
Conclusion: These preliminary results confirm the efficacy of the ALN filter. They also demonstrate the feasibility and safety of retrieval up to 24 months after implantation.

24.5.7

A clinical comparison between two optional caval filters

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Purpose: To compare safety and efficiency of two optional filters.
Materials/Methods: Ninety-three consecutive Günther Tulip (GT) filters (92 patients) were compared with 83 consecutive OptEase (OE) filters (80 patients). Indications were prophylaxis in high-risk patients with anticoagulant contraindications (polytrauma, neurosurgery) (70 GT; 44 OE) or therapeutic (proven deep vein thrombosis/pulmonary embolism and anticoagulation contraindication) (22 GT; 36 OE). Cavographies were obtained at deployment and intended retrieval. Permanent filters were followed with Duplex-sonography and plain films.
Results: All filters were inserted infrarenally as intended without complications. Fluoroscopy times at insertion and retrieval were longer in the GT group. GT dwelling time was 11.0 days (range, 3-27) versus 13.8 (range, 1-34) for OE. GT retrieval rate was 49.5% versus 69.9% for OE. Two GTs could not be retrieved for technical reasons; 14 GTs and two OEs were left in place because of major emboli/thrombi in the filter. Follow-up was 41 [GT, n=19] and 7 [OE, n=8] months. Refractory pulmonary embolism occurred in four GT and one OE patient. One in each group had chronic caval thrombosis. No late migration or filter disintegration occurred.
Conclusion: Both optional filters are safe, although OE handling seems more operator-friendly. Late filter-associated complications are rare with both.

24.5.8

Günther Tulip optional vena cava filter: retrieval after four-week implantation. A preliminary prospective clinical study

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Purpose: To report feasibility and safety of the Günther Tulip inferior vena cava filter (IVCF) retrieval after four-week implantation.
Materials/Methods: From March 2004 to September 2005, a prospective study was carried out in 35 patients requiring IVCF implantation. All the filters were removed 30 days after implantation. A modified dynamometer was used to evaluate the strength required to remove the filter. Follow-up was done at one, three, six, and 12 months by clinical data and imaging tests.
Results: Of these 35 patients undergoing filter retrieval, two experienced extensive IVC thrombosis, as depicted by computed tomography; another patient died due to respiratory and cardiac failure. Filter retrieval was therefore attempted in 32 patients with 31/32 (96.8%) successful cases. In these 31 cases, the strength required for filter retrieval was lower than1000 g while in one case filter removal was not possible. During the following 14-640 days (average 342.5 days) complications were not observed.
Conclusion: The Günther Tulip IVCF is a safe and easy-to-use device and it can be retrieved after four weeks of indwelling time.

24.5.9

The Guenther-Tulip retrievable filter: a method of assessing tilting of the filter

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Purpose: There has been concern regarding the influence of tilting on retrievability of Guenther-Tulip filter (GTF). We, therefore, developed a method of quantitating filter tilting in an experimental model.
Materials/Methods: A model consisting of a flexible plastic tube (26 mm x 21 mm) was used to simulate filter placement. After GTFs were placed with their apices centered in the tube or tilted against the wall at 13 degrees, plain films were taken in anteroposterior (AP), lateral, and 30-degree craniocaudal angled projections. The degree of filter tilt in AP was determined by angling the X-ray tube in the caudocranial direction until the four filter hooks were aligned at the same horizontal plane.
Results: Tilting in transverse plane could be more accurately measured with superimposition of the plain films on the cavograms. When the filter was centered in lumen, there was no significant separation between anterior and posterior limb hooks. When the filter was tilted in 13 degrees, there was more than 5-mm separation.
Conclusion: Post-placement films can accurately determine tilting of GTF. When the filter appears to tilt to the caval wall, contrast cavogram and computed tomography scans should be obtained to evaluate caval penetration prior to filter retrieval.

24.6.1

Blunt splenic injuries: computed tomography-angiographic correlates and efficacy of carbon dioxide-digital subtraction angiography

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Purpose: To evaluate correlation between computed tomography (CT) and splenic angiograms using contrast medium (CM) or carbon dioxide (CO_2) in blunt splenic trauma.
Materials/Methods: A convenient sample of cases of contrast-enhanced CT scans, and digital subtraction angiography (DSA) using CM and CO_2 from 17 cases with splenic injuries and 17 without trauma underwent blinded, retrospective review. CT scans were correlated with angiographic findings of splenic rupture (including active leakage of CM from the splenic arteries into the splenic pulp, early filling of the splenic vein during the arterial phase, intrasplenic hematoma, and "Starry Night".
Results: CT accurately assessed the severity of splenic injury (grades III-V) and helped triage for treatment. Both CM and CO_2-DSA demonstrated one or more of the angiographic findings of splenic rupture. CO_2 identified extravasation in two cases in whom contrast DSA was negative. All patients underwent superselective embolization without complications.
Conclusion: We have demonstrated an excellent CT-angiographic correlates in splenic injuries. CO_2 is more sensitive in detecting extravasation than CM, thus guiding superselective embolization for splenic conservation.

24.6.2

Contrast-induced nephropathy: practical guidance for clinicians

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Purpose: A systematic literature review on contrast-induced nephropathy (CIN) was undertaken as a basis for consensus statements and an algorithm.
Materials/Methods: An international multidisciplinary expert panel reviewed the data generated by a comprehensive literature search on iodinated contrast media (CM) and renal disease/failure/dysfunction. On the basis of this evidence, the group developed ten consensus statements and an algorithm.
Results: Calculate estimated glomerular filtration rate (eGFR) and assess CIN risk:
eGFR >60 ml/min (discontinue metformin)
• No special precautions
eGFR 20-60 ml/min (discontinue non-steroid antinflammatory drugs, other nephrotoxic drugs, metformin)
- Hydration (IV isotonic crystalloid 1-1.5 ml/kg/h for 3-12 hours before and 6-24 hours post-procedure)
- Intra-arterial: iso-osmolar contrast
- Intravenous: iso-osmolar or low osmolar contrast
- Limit contrast volume (<100 ml)
- Consider pharmacological treatment
• Serum creatinine before discharge or within 24-72 h
eGFR <20 ml/min
- Hospital admission
- Nephrology consultation
- Dialysis planning (in case CIN occurs)
- Other strategies as for eGFR 20-60 ml
• Serial serum creatinine and electrolytes
Conclusions: This consensus program is the first attempt to systematically review all relevant information on this common and serious problem. This evidence-based algorithm provides a framework upon which future guidelines and quality programs can be developed.

24.6.3

Carotid artery magnetic resonance imaging plaque characterization in patients with suspected acute transient ischemic attack/ischemic stroke

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Purpose: High-spatial resolution magnetic resonance (MR) of the carotid bifurcation allows classification of atherosclerotic plaque into American Heart Association (AHA) grades. The plaque type may relate to thromboembolic outcome in those with suspected stroke.
Materials/Methods: Seventy-three patients had acute stroke protocol MR/MR-angiography examination with additional 3D black-blood turbo-spin-echo T1-/T2-weighted imaging of the carotid artery bifurcation (T1: TR/TE 800/24 ms; T2: TR/TE 2000/132 ms; 0.490x0.490 mm). Two blinded reviewers performed MR-modified AHA plaque gradings. Clinical outcome was obtained by chart review.
Results: MR plaque characterization was feasible in 55/73 (76%) (30 men, mean age 64.3, SD 16.0). Nineteen had ischemic stroke (IS) with acute diffusion abnormality. Fourteen had a discharge diagnosis of transient ischemic attack (TIA) without diffusion abnormality; 22 had no diffusion abnormality and clinically did not have TIA/IS. Four positive TIA/IS had non-carotid etiology and were excluded. Ipsilateral type-6 plaque (complex with surface defect, thrombus and/or hemorrhage) was found in 14 patients with TIA/IS and in three without TIA/IS, $p<0.001$. Ipsilateral carotid stenosis (70-99%) was found in two: one with ipsilateral TIA/IS and one without TIA/IS. Kappa agreement between reviewers was good.
Conclusion: Findings suggest that TIA/IS is more commonly associated with underlying plaque type rather than severe stenosis.

24.6.4

Use of near-infrared refracted spectroscopy for cerebral monitoring during stenting of supra-aortic trunks

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Purpose: Usefulness of cerebral monitoring by near-infrared refracted spectroscopy (NIRS) during supra-aortic trunks stenting with proximal and distal flow-blockage protection was evaluated.
Materials/Methods: During 29 months, 49 non-consecutive patients underwent stenting monitored by NIRS recording; 38 were protected by flow-blockage (FB): MO.MA devices were used in 28 cases, Corail in three, Guardwire in seven. Eleven patients (control group, CG) were protected by distal filters. In 24/49 patients, diffusion-weighted magnetic resonance (DW-MR) was performed 24 hours pre- and post-procedure. A decrease >20% of baseline at NIRS served as a cut-off value predictive of intolerance to flow-blockage.
Results: Technical success was 100%, no major/minor stroke events occurred, one periprocedural transient ischemic attack after MO.MA system use was reported. Mean occlusion interval was 11 minutes (range 2-28). Four of the 38 FB patients (4/28 post-MO.MA) showed ischaemic intolerance to endoclamping, always anticipated by a decrease >20% of NIRS values. In 45 patients, the procedure was well-tolerated, with NIRS values decreasing <15% in 34 FB and <5% in all CG patients. Neither false-negatives nor false-positives were noticed. DW-MR revealed subclinical microembolic foci in 7/27.
Conclusion: NIRS monitoring is useful for predicting the onset of ischaemic intolerance and allows a safer management of protection devices.

24.6.5

Xper-computed tomography flat-detector dacryocystography: a new technique for morphologic and functional evaluation of the lacrimal outflow system

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Purpose: To assess the utility of a new diagnostic radiographic technique for morphologic and functional evaluation of the lacrimal outflow system in patients with suspected nasolacrimal duct obstructions.
Materials/Methods: Dacryocystography (DCG) was performed in 35 patients by gentle manual injection of nonionic water-soluble contrast medium. Imaging included digital flat-detector DCG (2 frames/sec.) in frontal and lateral views (Alura Xper FD 20 flat detector System, Philips, The Netherlands). Additionally, 3D rotation Xper-computed tomography (CT) scan was performed using C-arm roll movement. Images were analyzed using functional and morphological criteria based on 3D surface shaded and multiplanar reconstructed 2D images.
Results: In four cases, no tear duct obstruction was found. Stenoses in 17 cases and occlusions in 14 were recorded. Soft tissue swelling within the nasolacrimal duct was the most common cause of obstruction. In three cases, an additional dacryocele was depicted. The radiation dose applied was lower as compared with conventional post-DCG CT, providing comparable diagnostic information.
Conclusion: Xper-CT 3D-rotation flat-detector DCG provided detailed imaging of the soft tissue lacrimal outflow system and surrounding bony structures within one diagnostic tour. This new technique combines morphologic and functional diagnostic information that improves planning of interventional procedures.

24.6.6

A prospective comparison of duplex ultrasonography, Captopril renography, magnetic resonance-angiography and computed tomography-angiography in assessing renal artery stenosis

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Purpose: Prospective study comparing diagnostic accuracy for duplex ultrasonography, Captopril renography, computed tomography-angiography (CTA) and 3D, gadolinium-enhanced magnetic resonance-angiography (MRA) in diagnosing hemodynamically significant renal artery stenosis (RAS).
Materials/Methods: The standard of reference was the measurement of trans-stenotic pressure gradients. Fifty-eight hypertensive patients with suspicion of RAS were evaluated, when possible, by all five techniques. Sensitivity and specificity to detect RAS were compared for each technique on both patient- and kidney-basis. Discrepancies were evaluated separately and classified as borderline, method-dependent or operator-dependent.
Results: The prevalence of RAS was 77%. The sensitivity/specificity of ultrasonography, Captopril renography, CTA and MRA in detecting kidneys with RAS were 73/71%, 52/63%, 94/62%, and 93/91%, respectively. Ultrasonography had a significantly lower sensitivity than CTA and MRA ($p<0.001$) but higher than Captopril renography ($p=0.013$). Borderline RAS was the main cause for discrepancies.
Conclusion: MRA and CTA were significantly better than ultrasonography and Captopril renography in detecting hemodynamically significant RAS. Ultrasonography criteria for RAS are questioned. Captopril renography cannot be recommended for detecting RAS.

24.6.7

Evaluation of renal in-stent restenosis using multislice computed tomography: 28 patients

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Purpose: To determine the accuracy of multislice computed tomography (MSCT) for renal artery in-stent restenosis detection.
Materials/Methods: MSCT (16 slices, General Electrics Medical Systems, Waukesha, WI, USA) was performed in 28 patients six months after renal stenting, the day before of control arteriographies. Thirty-six stented renal arteries were imaged with 0.625-mm slices, after bolus detection. Images were evaluated by two vascular radiologists using native images and multiplanar reconstructions.
Results: Angio-computed tomography was able to analyze all renal stented arteries, thus permitting the study of endo-stent lumina and visualization of neo-intimal hyperplasia. With 30% of restenosis threshold (four angiographic restenoses, two occlusions), the following values were recorded: negative predictive values: 92% (reader 1) and 89% (reader 2), sensitivities: 78% and 66%, specificities: 84% and 87%. With 50% of restenosis threshold (two angiographic restenoses, two occlusions), the recorded values were: negative predictive values: 96% and 93%, sensitivities: 75% and 50%, and specificities: 84% and 87%.
Conclusion: Performances of multislice angio-computed tomography represent a fair detection test of in-stent restenosis.

24.6.8

Magnetic resonance imaging assessment of renal perfusion pre- and post-angioplasty and stenting: initial results

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Purpose: To quantitatively evaluate the change in renal perfusion before and after percutaneous transluminal renal artery angioplasty and stenting (PTRAS) utilizing contrast-enhanced perfusion magnetic resonance imaging (CEPMRI).
Materials/Methods: To date, 20 patients with hemodynamically significant renal lesions have been enrolled. A multi-slice saturation-recovery turboflash sequence that facilitates bilateral volumetric renal perfusion analysis was performed at 1.4 second intervals following administration of 0.05 mmol/kg of gadodiamide. Baseline studies were performed immediately prior to intervention. Follow up CEPMRI was performed six weeks after successful PTRAS. Dynamic cortical and aortic signal intensities were plotted as a function of time. Perfusion was then calculated via analysis of the slope of cortical signal intensity normalized to the juxta-renal aorta. Comparative analysis was performed with a paired t-test. Creatinine clearance and blood pressure were assessed pre- and post-procedure.
Results: Preliminary assessment of the first six patients reveals an increase in perfusion from 0.242 +/- 0.162 to 0.330 +/- 0.135. Clinical outcome correlated with those with the greatest improvement in renal perfusion.
Conclusions: CEPMRI demonstrates increased renal perfusion following PTRAS and may be a marker of clinical response. Further data are required to evaluate statistical significance and confirm these results.

24.6.9

Grading of internal carotid artery stenosis: can computed tomography-angiography overcome the confusion?

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Purpose: Exact grading of internal carotid artery stenosis (ICAS) is crucial; different grading methods and divergent results of different modalities, however, often lead to confusion.
Materials/Methods: Sixty-nine consecutive patients underwent multi-detector computed tomography-angiography (MDCTA) and, within 28 days, digital subtraction angiography (DSA). Images of both modalities were interpreted by two radiologists blinded to the results of the other modality. For both modalities, the exact ICAS degree was calculated according to the North American Symptomatic Carotid Endarterectomy Trial (NASCET) and the European Carotid Surgery Trial (ECST) criteria.
Results: The agreement between both grading methods was comparable for MDCTA ($R^2=0.87$) and DSA ($R^2=0.84$); mean differences between ECST and NASCET were 13.9% (CTA) and 12.9% (DSA; $P>0.05$). The corresponding results for inter-modality correlation were almost equal for NASCET ($R^2=0.59$) and ECST ($R^2=0.55$), with mean differences of 13.4% and 13.5%, respectively ($P>0.05$). CTA sensitivity and specificity for occlusions detection was 100% for both modalities and grading systems; for the detection of >70%-stenoses, 90.9% and 54.9% for NASCET, and 94.7% and 46.3% for ECST.
Conclusion: The introduction of MDCTA cannot overcome the confusion in the exact grading of ICAS; the application of both tested modalites and both grading methods results in clinical important differences.

24.7.1

Comparison of „Response Evaluation Criteria in Solid Tumors" and „European Association for the Study of the Liver" criteria: assessment of treatment response following transarterial embolisation or chemoembolisation for unresectable hepatocellular carcinoma

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Purpose: To compare Response Evaluation Criteria in Solid Tumours (RECIST) and the criteria set by the European Association for the Study of the Liver (EASL) and their correlation with alpha-fetoprotein (AFP), in assessing tumour response in hepatocellular carcinoma (HCC).
Materials/Methods: Eighteen consecutive patients underwent transarterial embolisation (TAE) or chemoembolisation (TACE) as part of a randomised trial comparing the two treatments in unresectable HCC. All patients had computed tomography followed by three treatment episodes at three-weekly intervals. Follow-up imaging was performed 2-4 weeks post-embolisation and at three monthly intervals thereafter. Response was determined using RECIST and EASL and correlated with AFP.
Results: Concordance between RECIST and EASL occurred in four patients, with correlation between AFP and tumour response in two.
Of the 14 patients in whom RECIST and EASL were discordant, 13 had a complete/partial response by EASL but stable disease by RECIST. Baseline AFP was elevated in nine patients with discordant responses and correlated with EASL response.
Conclusion: Treatment-induced tumour vascularity reduction is reflected by assessment using EASL criteria and, in most patients, not with RECIST. Consideration should be given to the use of EASL criteria, in combination with AFP, in assessment of response to TAE/TACE, in patients with HCC.

24.7.2

Transcatheter arterial chemoembolization for liver metastases in patients with adrenocortical carcinoma

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Purpose: Distant metastases, namely liver metastases, are the main cause of cancer-related deaths in adrenocortical carcinoma (ACC). Systemic chemotherapy impact on survival is questionable. We evaluated tolerance and efficacy of transcatheter arterial chemoembolization (TACE) for ACC liver metastases.
Materials/Methods: From June 1995 to August 2005, 29 consecutive patients (24 women) with 103 progressive ACC liver metastases were treated with TACE [Cisplatin (1-2 mg/kg)/10 cc iodized-oil/gelfoam pledglets]. Hormonal and morphological responses [evaluated according to the response evaluation criteria in solid tumors (RECIST) and for Lipiodol uptake) were assessed every 1-3 months.
Results: Fifty TACE [(1-5); mean=1.7] were performed. After 2-32 months (mean=9.6) a partial response was obtained on 26 tumours, 13 showed minor responses, 42 were stable, and 22 were progressive. Six patients had a partial response, 16 stable diseases, and seven progressions; 70/103 tumors had Lipiodol fixation >50%. Hormonal secretion decreased in 9/16 patients. Six patients are alive five to 44.5 months after the first TACE (mean=19.6), while 23 died two to 51 months (mean=10.8) post-TACE.
Conclusion: In ACC liver metastases, TACE provides a cumulative response and stabilization rate of 76%. The best responses were achieved in tumors <3 cm, which advocated treatment early in the disease.

24.7.3

Selective internal radiation therapy with Yttrium-90 resin-microspheres in extensive metastatic disease of the liver: clinical results

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Purpose: Selective internal radiation therapy (SIRT) assessment in patients with primary/secondary liver tumors and response determination.
Materials/Methods: Patients with metastases from colorectal cancer (CRC) (18), breast cancer (MBC) (7), and hepatocellular carcinoma (HCC) (5) were included. Tumor response was assessed by tumor-markers and computed tomography over a follow-up to 20 months.
Results: At three-, six-, and nine-month follow-up in 3/17, 5/15, and 5/10 CRC patients, carcinoembryonic antigen levels were higher than pre-treatment. In the MBC group, three and six months post-SIRT, tumor marker levels were higher in 2/5 and 2/2 patients. In 5/5 HCC patients, alpha-fetoprotein decreased three months post-treatment. Using the Response Evaluation Criteria in Solid Tumors, progressive disease (PD) was seen in 4/17, 2/12, and 2/10 patients in the CRC group at three, six, and nine months post-SIRT. In the MBC group, three and six months post-SIRT, 7/7 and 4/5 patients presented without PD; 5/5 HCC patients showed stable disease or partial response at three- and six-month follow-up. Median time to progression was 6.5 months for CRC and 7.5 months for MBC cases. PD was not observed in HCCs. Eighteen patients are still alive.
Conclusion: SIRT is a promising approach for patients with otherwise non-responding primary/secondary liver tumors.

24.7.4

Computed tomography follow-up of lung tumors treated by radiofrequency ablation

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Purpose: To assess different features of lung metastases treated by radiofrequency ablation on follow-up computed tomography (CT).
Materials/Methods: Sixty-six patients with 120 metastatic nodular lesions were included. Multi-tine electrodes were used. CT follow-up was done after 48 hours, and two, four, six, nine, and 12 months later. Forty-three patients (71 lesions) were followed for one year. CT imaging findings were evaluated by two radiologists and documented by consensus.
Results: From the fourth month after treatment, four main CT patterns have been identified: fibrosis, cavitation, nodule, and atelectasy. At the fourth month, 43% of lesions were nodular and 37% of lesions were fibrous. At 12-month follow-up, 70% of lesions were fibrous and 20% were nodular. The recurrences (7%) appeared in cases of a nodular lesion or atelectasy and were always depicted after the fourth month on lesion enlargement.
Conclusion: Four main features of lesions are identified after lung radiofrequency on CT follow-up and the two main features are fibrosis and nodular lesions. Fibrosis and cavitation are two successful evolutions induced by the treatment. In case of a persistence of a nodular lesion or atelectasy a local recurrence is possible and should be identified.

24.7.5

Computed tomography-guided interstitial single fraction high-dose rate brachytherapy of lung tumors: phase-I/II results of a novel technique

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Purpose: To assess safety and efficacy of computed tomography (CT)-guided brachytherapy of lung malignancies.
Materials/Methods: Twenty-seven patients with 58 lung malignancies were included in this prospective phase-I/II trial (21 metastases, six non-small cell lung cancers). Preinterventionally, six patients had vital capacity and forced expiratory volume in one second <80%. Tumors with maximum diameters of 4 cm were treated with one brachytherapy catheter positioned under CT-fluoroscopy. In two tumors (diameters of 5.5 and 6.5 cm), two applicators were used. In two >10-cm tumors, nine and ten catheters were inserted. Treatment planning for 192Iridium brachytherapy employed three-dimensional CT-data acquired after applicator positioning. All procedures were under local anesthesia. CT was performed at six-week follow-up and every three months.
Results: Mean tumor diameter was 2.5 cm (0.6-11). Minimal dose inside the tumor margin was 20 Gy. Minor complications were nausea (n=1) and non-symptomatic pneumothoraces (n=6). One symptomatic pneumothorax required a chest tube (n=1, 3%). One patient developed an abscess at the previous tumor location nine months post-treatment which proved to be a local tumor recurrence. Median follow-up was 7+ months with a local tumor control of 88%.
Conclusion: CT-guided interstitial brachytherapy was effective in treating lung tumors and yielded a low complication rate.

24.7.6

Percutaneous ultrasound-guided radiofrequency ablation of renal tumors: analysis of predictors for complications and technical success

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Purpose: To identify predictors of complications and technical success, medium-term results of ultrasound-guided percutaneous radiofrequency ablation (RFA) of primary renal tumors were statistically analysed.
Material/Methods: Forty-four primary renal tumors measuring up to 5 cm in diameter (14-50 mm; median 25) in 31 patients (24 with sporadic, seven with hereditary tumor; 15 single-kidney) were selected in a group of 37 consecutive patients series. Complications and medium-term local results (median follow-up time: 19 months) were statistically evaluated by possible predictors.
Results: Eight adverse events occurred; three (6.8%) were major complications, successfully treated with interventional radiology procedures in two cases. Exophytic extension of the tumor resulted protective against complications (p=.040). Local success was obtained in 38 lesions after the first RFA and in 39 (88.6%) after a further treatment. The only negative predictor for technical success turned out to be central extension (p=.007); neither exophytic extension, diameter <3 cm (p=.091), nor other variables achieved statistical significance.
Conclusion: Ultrasound-guided percutaneous RFA may be suggested to treat primary non-central renal tumor up to 5 cm in size, also in patients without surgical contraindications, because of its low complication and high technical success rates. Randomized controlled studies versus conservative resection are necessary to investigate comparative results.

24.7.7

Percutaneous transhepatic biliary drainage for the treatment of bile leak following living donor liver transplantation

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Purpose: To evaluate the efficacy of percutaneous transhepatic biliary drainage (PTBD) for the treatment of bile leak after living donor liver transplantation (LDLT).
Materials/Methods: PTBD and a drain catheter interposition across the bile leak was attempted in 20 of 1105 LDLT recipients. Endoscopic treatment had failed in 12 patients with duct-to-duct anastomosis due to persistent leak (n=6), failed negotiation of bile ducts (n=3), and poor general condition (n=3). Balloon-dilation at the anastomotic stricture (n=14), intraperitoneal biloma drainage (n=12), and intraductal stones or foreign body removal (n=4) were also performed. Technical and clinical successes were reviewed retrospectively.
Results: All procedures were technically successful in all patients. Five patients died of multiorgan failure 10-100 days after PTBD. Fourteen of the 15 remaining patients were healthy without bile leak during 86-658 (mean; 259±139) days follow-up period. One patient received orthotopic retransplantation due to procedure-related intrahepatic pseudoaneurysms. Other procedural major complications occurred in two patients: drainage catheter incorporation (n=1) and repeat bile leak due to balloon dilation (n =1).
Conclusion: Although major complication is not rare, PTBD is an effective alternative to treat bile leak after LDLT.

24.7.8

Percutaneous radiofrequency ablation of hepatic metastases in patients with metastatic breast cancer: medium-term results

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Purpose: A subgroup of patients with breast cancer presents with hepatic metastases and no extrahepatic spread. Since the surgical therapy is generally not considered, therapies like radiofrequency ablation (RFA) are gaining importance.
Materials/Methods: Forty-three patients with sole liver metastases from breast cancer were treated by RFA in 72 sessions subsequently/parallel to chemo- and/or hormonal therapy. All procedures were performed under computed tomography-fluoroscopy. Number of lesions, primary success rate, complications, total and disease-free survival were recorded and analyzed. Median follow-up was 37 (range, 2-68) months.
Results: In 43 patients, 111 metastases were successfully treated by RFA with two major adverse events (severe subcapsular bleeding/bile duct occlusion). Sizes ranged from 5 to 85 mm, with a median diameter of 21 mm. During follow-up, 32 patients (74%) remained disease-free in the liver, five patients (12%) developed local tumor recurrence, and nine (21%) developed new hepatic metastases. Nine patients (21%) were re-treated shortly after the initial procedure due to remaining tumor tissue. Thirteen (30%) patients died one to 48 months after RFA.
Conclusion: RFA could be a valuable adjunct to the classic armamentarium of therapies for hepatic metastases of breast cancer and should be investigated in further comparative studies.

24.7.9

Computed tomography-guided percutaneous intervention using a reduced dose radiation: a three-year experience

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Purpose: To evaluate the feasibility of performing computed tomography (CT)-guided procedures using low milliampere/secons (mAs).
Materials/Methods: We performed 332 CT-guided procedures using a low-dose technique: M:188, F:144, range 22-89 years, mean 65 years. Procedures included biopsy n= 228, catheter placement n= 98, and six lung radiofrequency ablations (RFA). Preliminary images were obtained using standard mAs determined by the patient's body habitus. Subsequent CT imaging was obtained using 30 mAs. Patient weight was recorded for each case. Success rates for catheter placement, biopsy, and RFA were calculated. Comparison was made with biopsy results in cases performed over the prior 12 months using standard radiation doses.
Results: Catheter placement success rate was 96.7%. Three patients required higher mAs. The technical success rate for biopsies was 96%. In ten patients, the procedures were completed using higher dose. All lung RFA were successfully performed using low dose. Patient weight was not a statistically significant factor for success. Technical success rates for biopsies performed using standard radiation dose in the 12 months prior to introducing low-dose radiation technique was 84%. The complication rate using low-dose technique was comparable with the standard dose technique.
Conclusion: Low-dose technique results in technical success for percutaneous intervention.

24.8.1

Transient immunosuppression and oxidative stress after ethanol or radiofrequency-ablation of liver tumors

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Purpose: To evaluate the immunological and oxidative status of patients with liver tumors treated with percutanoeus radio frequency ablation (RFA) and ethanol instillation (PEI).
Methods and Materials: 25 patients (mean age 67±10 years) with HCC (n=15); metastases (n=10); median tumor volume 32.3, range 4.9-245.0 ccm) underwent RFA (n=13) or PEI (n=12). Blood samples were taken 0.5h before, 0.5h, 24h and 5 days after ablation. Human leucocyte antigen-DR (HLA-DR) expression on monocytes, lipopolysaccharide (LPS) induced tumor necrosis factor (TNF), plasma interleukin-6 (IL-6), procalcitonin (PCT), peroxide levels were evaluated.
Results: HLA-DR expression (0.5h postop $p<0.05$; 24h postop $p<0.01$; 5 d postop $p<0.001$) and TNF-production (0.5h postop $p<0.01$) significantly dropped following ablation. Plasma IL-6 (24h postop $p<0.001$; 5d postop $p<0.001$) and PCT levels (24h postop $p<0.05$) were significantly enhanced as compared to pretreatment. 5d after intervention the peroxide levels were significantly higher, whereas antioxidative capacity did not change. Significant higher levels of plasma IL-6 (24h postop $p<0.001$), PCT (24h postop $p<0.01$) and peroxide (1h postop $p<0.05$) were observed in the PEI treated group as compared to RFA.
Conclusion: Following tumor ablation, a transient immunosuppression and oxidative stress occured in all cases. PEI had a greater impact on the immune system than RFA.

24.8.2

In vivo **bimodal electric tissue ablation (BETA) creates larger porcine liver ablation zones than standard radiofrequency ablation using a LeVeen needle**

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Purpose: To compare the *in-vivo* effect of bimodal electric tissue ablation (BETA) with standard radiofrequency ablation in porcine liver using a LeVeen needle.
Material/Methods: A Boston Scientific RF3000 radiofrequency ablation machine was modified to allow polarisation of a 3.5cm LeVeen needle during the creation of radiofrequency ablation zones in porcine liver. Having obtained ethical committee approval and in accordance with local legislation and codes of practice, at open surgery a total of twelve standard RF ablation controls and twelve BETA ablation zones were created *in-vivo* in four animals.
Results: The BETA ablation zones were significantly larger than the control zones ($p<0.001$) and were between 50% and 90% wider in diameter than the corresponding RF control. The size of the pig liver was a limiting factor in measurement, as many of the BETA ablation zones extended to the liver margin. Histology of the quality and extent of necrosis in BETA ablation zones confirmed the increased effect.
Conclusion: *In-vivo* bimodal electric tissue ablation (BETA) creates significantly wider ablation zones than standard radiofrequency ablation using the LeVeen needle.

24.8.3

Longterm retrieval of modified Günther Tulip Vena Cava Filters - an animal study

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Purpose: Late complications of vena cava filters like filter migration can be avoided if retrievable filters are beeing used. The recommended time between filter placement and removal is limited. We modified the Günther Tulip Filter in order to allow longterm retrieval and tested this modified filter design in an animal experiment.
Material and Methods: Approval for the animal experiments was granted by and 14 Celect Filters were inserted into the inferior venae cavae of 7 domestic adult sheep vai right jugular approach choosing the inferior vena cava below the renal veins as target area. After 90 days the filters were removed and a cavogram was attained to check for any signs of bleeding. All filters except for two were thus removed before the animals were sacrificed. All venae cavae were prepared, removed and macroscopically examined for perivascular and/or intramural bleeding.
Results: Filter placement was successfully performed in all cases. Control cavograms after 3 months showed no change in filter locations and no thrombi. Neither cavograms after filter removal nor the macroscopic examinaton of the perivascular vena cava tissue showed any significant bleeding.
Conclusion: The modified Günther Tulip Filter design allows for uncomplicated filter removal up to three months after placement.

24.8.4

Catheter and magnetically guided and detached ferromagnetic nanoparticle filaments with heat-induced particle release.

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Purpose: To develop a new technique for guidance and release of magnetized ferromagnetic nanoparticles using a polymerized filament.
Materials/Methods: Ferromagnetic nanoparticles were embedded in temperature sensitive gels to form filaments. Deflection of the filaments was assessed in a magnetic navigation system (MNS) in comparison with dedicated guide-wires. Curvature was measured as surrogate parameter for deflection. In combination with angiograpic catheters the filaments were navigated in different perfused vessel model under the influence of two permanent magnets of the MNS. The magnetic field vector was varied in all three dimensions. After positioning the magnetic colloid-containing filaments were exposed to an electromagnetic field of 45kA/m, 200kHz over a period of 5 minutes for non-invasive heating.
Results: The filaments showed a superior deflectability when compared with the dedicated guide-wires (p=0.0025). The curvature was 0.54±0.12mm^{-1} for the filaments and 0.33±0.21mm^{-1} for the guide-wires respectively. In combination with angiography catheters magnetic guidance and accumulation of specially designed filaments was possible in the perfused vessel model. Inductive heating allowed non-invasive releasing of the nanoparticles in all filaments.
Conclusions: Magnetic guidance and targeting of a specially designed magnetic colloid-containing filament and subsequent disintegration is feasible, offering the potential for controlled local drug release.

24.8.5

Chemoembolization of unresectable hepatocellular carcinoma with doxorubicin loaded microspheres: First results

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Purpose: To evaluate the clinical performance of doxorubicin loaded beads in the primary treatment of HCC by chemoembolisation.
Method and Materials: We investigated 30 patients with unresectable HCC in a single center prospective trial. The patients were treated with transarterial chemo embolisation using drug eluting polyvinylalcohol microspheres loaded with doxorubicin (Gelspheres^{TM}, Biocompatible Ltd, UK). Treatment efficacy was assessed with contrast enhanced CT.
Results: According to the EASL criteria 6 months follow up showed complete response (CR) in 27%, partial response (PR) in 10%, stable disease (SD) in 3% and progressive disease (PD) in 40% of the patients. According to the RECIST criteria we obtained CR in 27%, PR in 13%, SD in pts 3% and PD in 40%. The 30 days mortality of all performed embolisation procedures was 1%. Major adverse events were observed in 2% (temporary liver failure, acute cholecystitis). In 10% the study was terminated prematurely. The overall survival rate at 6 months was 93%. Liver enzymes and CRP showed a substantial increase after the first cycle and a minor in cycle 2 and 3.
Conclusion: Transarterial chemoembolization of patients with HCC with doxorubicin loaded microspheres was safe. The 6 month efficacy favourably compares with the published literature.

24.8.6

Histopathology of Tissue Extracted on the Probe after Radiofrequency Ablation of Liver Malignancy Can Predict Local Progression: *Initial Results*

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Purpose: To evaluate whether histopathologic characteristics of tissue extracted on the probe after radiofrequency ablation (RFA) of liver malignancies can be used as a predictor of local tumor progression (LTP).
Material/Methods: Tissue extracted on the probe after RFA of liver malignancies was collected and evaluated by the study's pathologist. 56 specimens were classified as coagulation necrosis (CN) and 13 as probably viable tumor (V). Clinical and technical information was prospectively collected in a HIPPA registered RFA database. Medical Records and relevant imaging were reviewed to determine LTP.
Results: The groups were demographically comparable. Pre-treatment mean tumor size was significantly larger in the V (3.4cm) than in the CN (2.6 cm) group (p=0.02). Primary LTP occurred in 12/13 (92%) and 17/56 (30%) (p<0.001) and median primary LTP free survival was 5 and 15 months for the V and CN group respectively (p<0.001). Multivariate analysis by Cox regression confirmed that viability is a risk factor independent of tumor size (p<0.001) and the odds of recurrence is six times more in the V when compared with the CN group (hazard ratio: 6.0, 95% CI: 2.5-14.4).
Conclusion: Histopathology of tissue extracted on the probe after liver tumor RFA is an independent predictor of LTP.

24.8.7

An economic evaluation of uterine artery EMbolization versus hysterectoMY in the treatment of symptomatic uterine fibroids: results from the randomized EMMY-trial

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Purpose: To determine if uterine artery embolization (UAE) is a cost-effective alternative to hysterectomy for patients with symptomatic uterine fibroids, we performed an economic evaluation as part of a multi-center, randomized trial.
Material/Methods: 177 patients were allocated UAE (n=88) or hysterectomy (n=89) and followed for 24 months. We performed an intention to treat economic analysis, including: direct medical in-hospital, direct medical out-hospital, direct non-medical and indirect costs. Costs were calculated as volumes x prices and differences in costs were tested (Mann-Whitney U test).
Results: 81 patients underwent UAE; 75 underwent hysterectomy. 19 (23.5%) secondary hysterectomies were performed in the UAE group. The mean total costs per UAE patient were significantly lower than for the hysterectomy patient (€ 8.676 vs. € 13.841; mean difference € 5.165; p= 0.0006). Direct medical in-hospital costs were € 4.991 for UAE and € 6.203 for hysterectomy (mean difference € 1.212; p=0.0004). Direct medical out-hospital and direct non-medical costs were low. Indirect costs differed significantly in favor of UAE (mean difference € 4.069; p=0.001).**Conclusion:** The cumulative costs of UAE are significantly lower compared to hysterectomy at 24 months follow-up. From an economic perspective, therefore, UAE is the superior treatment in women with symptomatic uterine fibroids.

49.1.1

Selective internal radiation therapy in patients with advanced hepatocellular carcinoma

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Purpose: Evaluation of the role of selective internal radiation therapy (SIRT) in hepatocellular carcinoma (HCC).
Materials/Methods: Twenty patients (70% cirrhotics) with advanced HCC (median tumor volume 661 mL, four with lobar portal vein invasion) and preserved liver function (Child's A) without significant extrahepatic disease were included. Previous assessment included MRI/CT and hepatic angiogram (Tc99-albumin). Seven patients underwent single-lobe treatment. Median activity delivered was 2.20 GBq (range 0.75-3.02). Follow-ups were at three-month intervals without further treatments until progression.
Results: Median follow-up was 10.5 months (range: 3-24). All patients were discharged 24 hours post-treatment. Gastrointestinal toxicity was not observed. Response was evaluated in 17 patients who did not show progression in the target lesions, although seven patients (41%) developed new lesions. Disease control and response rates of target lesions were 100% and 18%. Eleven patients died (unexpected liver failure three and five months post-SIRT in two of the first four cirrhotics treated). Activity calculation was subsequently modified and no severe SIRT-induced liver disease was observed thereafter.
Conclusion: SIRT has valuable anti-tumoral effects against HCC. Comparison with transarterial embolization (TAE) is warranted. SIRT may be safely administered to patients not candidates for TAE (lobar portal vein invasion, bulky rapidly growing disease, diffuse tumors).

49.1.2

Treatment of extensive metastatic liver disease with transarterial, intrahepatic administration of Yttrium90 microspheres: toxicity assessment

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Purpose: To analyse the incidence of liver toxicities associated with selective internal radiation therapy (SIRT) in the treatment of otherwise non-responding hepatic metastases.
Materials/Methods: Thirty-nine patients with extensive hepatic metastases qualified for SIRT. Liver toxicities were coded using Southwest Oncology Group (SWOG) criteria. Laboratory (bilirubin, aminotransferases, alkaline phosphatase) and clinical parameters (ascites, encephalopathy, liver failure, hemobilia) were recorded and compared with pre-treatment levels. SWOG criteria grade liver toxicity from 0 to 5, with a clinical significance of a toxicity grade ≥3. Descriptive statistical methods were applied to determine the incidence of liver toxicities.
Results: Twenty-three patients (59%) experienced 34 liver toxicities. At three-month follow-up, 17 grade 0 and 16 grade 1 toxicities were observed. No grade ≥3 toxicity was recorded. At six-month follow-up, six grade 0, 15 grade 1, four grade 2, and one grade 3 toxicities were noted. The most frequent toxicity parameter was an increased aminotransferase level, followed by increased alkaline phosphatase and bilirubin levels. Eight of the 34 toxicities resolved on follow-up, five worsened. A grade 3 toxicity was attributed to tumor progression.
Conclusion: Single-session SIRT is a safe palliative treatment option in patients with extensive hepatic metastases. No life-threatening liver-related toxicity was observed.

49.1.3

Sequential tanscatheter arterial chemoembolization and portal vein embolization before major hepatectomy for patients with hepatocellular carcinoma

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Purpose: To review our experience with portal vein embolization (PVE) after transcatheter arterial chemoembolization (TACE) in patients with hepatocellular carcinoma (HCC) and insufficient future liver remnant (FLR) volumes.
Materials/Methods: From 6/04 to 10/05, six patients (five men; mean age 71 years) with right lobar HCC underwent TACE followed by right PVE±segment IV. TACE was performed for tumor debulking and occlusion of arterioportal shunts that limit regeneration. PVE was performed after TACE (median 24 days) if preoperative 3D computed tomography (CT)-volumetry showed insufficient FLR/Total Estimated Liver Volume (TELV) (<25%: normal underlying liver; <40%: diseased liver). For PVE, microspheres and coils were administered via transhepatic ipsilateral approach until stasis occurred. CT-volumetrics were performed immediately before and four weeks after PVE to assess FLR hypertrophy. Hospital stay and complications after PVE and resection were recorded.
Results: Following PVE, five patients underwent resection. One patient--not resected due to disease progression--was managed with additional TACE. No major complications occurred after TACE, PVE, or resection. After PVE, mean absolute FLR volume and FLR/TELV increased 45.1% and 11.7%, respectively. Median hospital stays were one day for PVE and seven days after resection.
Conclusion: Post-TACE PVE is feasible and effective for patients with HCC requiring curative major hepatectomy.

49.1.4

Treatment of unresectable hepatocellular carcinoma using intra-arterial Yttrium-90: long-term follow-up

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Purpose: To assess safety and efficacy of Yttrium-90 [(Y90) TheraSphere] in patients with hepatocellular carcinoma (HCC).
Materials/Methods: One-hundred sixty patients with HCC underwent 300 Y90 administrations. Patients were stratified by Okuda and Child-Pugh's classifications and had baseline and follow-up liver function tests at 30-90 day intervals. Computed tomography/magnetic resonance imaging evaluated tumor response. Patients were followed for survival from diagnosis of HCC.
Results: There were 118 men and 42 women. The median absorbed dose was 109 Gy. There were 12% grade-3 bilirubin toxicities at three months following last treatment, most of which were attributed to cirrhosis and tumor progression. Fifty-one patients (32%) had branch or main portal vein thrombosis (PVT). Tumor response rate was 72% (European Association for the Study of the Liver criteria). Time from diagnosis to treatment was 58 days. Median survival for Okuda 1 and 2/3 patients was 800 versus 374 days ($p<0.0001$). Median survival for Child A and B/C was 800 versus 374 days ($p<0.0001$). Patients with branch PVT versus no PVT had no difference in survival until eight months post-treatment, after which the curves diverged slowly in favor of no PVT.
Conclusion: Y90 for HCC appears to represent an efficacious therapy with acceptable toxicity.

49.1.5

Transarterial chemoembolization of neuroendocrine hepatic metastases using drug-eluting beads

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Purpose: To assess feasibility, tolerability, and efficacy of drug-eluting beads for transarterial chemoembolization (TACE) in neuroendocrine hepatic metastases.
Materials/Methods: Nineteen patients underwent 31 courses of TACE with beads (GelSphere®) loaded with doxorubicin. Biological tolerabilities were assessed with blood samples. Morphologic response was evaluated with computed tomography (CT) and CT-perfusion studies assessed blood flow (BF), blood volume (BV), and mean transit time (MTT).
Results: Minor post-embolization symptoms occurred. Mean transaminases values increased from 28/34 to 126/151 IU/l within three days post-treatment and were 51/85 UI at day 5. Mean total bilirubin was 11 mmol/l before and 25 mmol/l within three days post-treatment; it returned to baseline at day 5. Two months after TACE, no patients showed a progressive disease, 13 patients showed a partial response [according to the Response Evaluation Criteria in Solid Tumors (RECIST) criteria], five showed a minor response and one had a stable disease. Decreased mean BF and BV were demonstrated three days post-TACE and persisted at two months, with elongation of mean MTT
Conclusion: TACE with doxorubicin-eluting beads is well tolerated and seems to be efficient. Perfusion-CT seems promising in detecting early changes in tumor vascularisation, whereas mere morphological/RECIST criteria may fail to detect early treatment effects.

49.1.6

Transcatheter arterial chemoembolization for advanced hepatocellular carcinoma with inferior vena cava and right atrium tumors

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Purpose: Advanced hepatocellular carcinoma (HCC) with invasion of venous systems usually indicates not only poor prognosis but also a contraindication for transcatheter arterial chemoembolization (TACE). This study is to evaluate the feasibility of TACE for advanced HCC with inferior vena cava(IVC) and right atrium(RA) tumors, and to search for the ideal embolization particle size.
Material/Methods: Twenty-six patients had HCC with invasion into IVC and RA coexisted obvious arteriovenous shunts treated with TACE. The chemoembolization method was Cisplatin, Adriamycin, Mitomycin C mixed with Lipiodol and Ivalon. The Ivalon particle was divided into two groups based on its size: A) >180μm; N=9, B) 47-180μm; N=17.
Results: The overall response rate was 53.8% (14/26). The survival period of the entire group was from 1.5 months to 76.7 months (median=4.2 months). The survival period of the 14 responders was 1.5 to 76.7 months (median=13.5 months), while the 12 non-responders, 2.1 to 24.3 months (median= 3.3 months), ($p<0.002$). In comparison of two particle sizes, the response rate was: group A 12.5% (1/9) and group B 76.5% (13/17), ($p<0.02$). No pulmonary embolism was observed post-chemoembolization.
Conclusion: TACE used smaller embolization particles (47-180μm) is a safe and effective treatment for advanced HCC with IVC and RA tumors.

49.1.7

Preoperative chemoembolization in patients with hepatocellular carcinoma undergoing liver transplantation: influence of emergent versus elective procedures on patient survival and tumor recurrence rate

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Purpose: To compare recurrence rates and survival in patients with hepatocellular carcinoma undergoing orthotopic liver transplantation (OLT) within seven days of chemoembolization (TACE) versus transplantation more than seven days post-TACE
Materials/Methods: One-hundred eighteen patients had TACE before transplantation. Thirty-one were excluded due to macrovascular invasion or benign tumors at explant. There were 47 patients embolized 0-7 days prior to transplant (urgent group) and 40 patients embolized greater than seven days before transplantation (elective group).
Results: For the urgent versus the elective groups, the average model for end-stage liver disease score was 11.9 versus 9.2 ($p=0.02$); Child-Pugh score was 7.5 versus 6.6 ($p=0.01$). Tumor size and number was not different. Necrosis at explant was 51% versus 80.4% ($p=0.0002$) and recurrence rate was 13/47 (28%) in a median of 687 days versus 6/40 (15%) in a median of 229 days in the urgent and elective groups, respectively. Survivals at one, three, and five years were 78%, 65% and 26% (urgent group) and 85%, 66% and 66% (elective group).
Conclusion: Urgent TACE before liver transplantation causes about 50% necrosis. Although survival was similar to elective TACE, patients receiving urgent TACE had a higher recurrence at three or more years post-OLT.

49.1.8

Hepatocellular carcinoma chemoembolization with dendritic cell beads in 42 patients. Safety and efficacy

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Purpose: To evaluate treatment of hepatocellular carcinoma (HCC) with dendritic cell (DC) Beads (Biocompatibles).
Materials/Methods: Forty-two patients (aged 46-81) with confirmed 4- to 8-cm (mean 5.24±1.1) HCCs underwent repeat superselective embolizations. Liver function parameters and tumor response were evaluated by spiral-computed tomography and contrast-enhanced ultrasound (Sonovue, Bracco); pre- and post-treatment α-fetoprotein were recorded.
Results: The treatment did not cause statistically significant changes in liver function. Mean baseline and one-month post-embolization values were: SGOT: 66.82±14.10 and 66.83±14.04 ($p=0.68$); SGPT: 90.13±26.61 and 87.19±24.11 ($p=0.28$).Cholecystitis (n=1; 2%) and liver abscess (n=1; 2%) were the most severe complications. Fever and pain were observed in 75% (n=33) and 100% (n=42), respectively. Median hospitalization was one day.
An overall necrosis of >90% was achieved in 15 cases (35.7%) and <50% in five (11.90%). Repeat embolization at three months (n=31) achieved over 90% necrosis in 11 patients (26.2%) and less than 50% in only one (2.4%). No increases in tumor size were observed; α-fetoprotein levels had significantly statistically reduced post-procedure (1152.38±1164.60 to 153.93±146.63 ($p<0.001$). Overall survival at one-year was 97.61% (one death unrelated to procedure, ie: myocardial infarction).
Conclusion: HCC embolization with the use of DC Beads is safe and achieves high percentages of target tumor necrosis.

49.1.9

Radioembolism (Yttrium-90) of hepatic liver metastases. A preliminary experience

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Purpose: Evaluation of radioembolism with Yttrium-90 (Y-90) in patients with liver metastases not responsive to chemotherapy.
Materials/Methods: In the last 11 months, we treated 29 patients with liver metastases from colon (18), breast (8), stomach (1), esophagus (1) and pancreas (1) neoplasms. Patients underwent a preliminary abdominal computed tomography, a total-body positron emission tomography (PET), and an hepatic angiography followed by single-photon emission computed tomography with marked albumin (technetium-99).
Results: In a period ranging between four and eight weeks, a reduction and/or normalization of tumor markers was obtained in all cases. PET showed a partial and/or total remission of liver metastases. A patient with bilirubin levels of 1.7 mg died for hepatic insufficiency 30 days after treatment. Two patients with above 60% of hepatic involvement died during the follow-up period (4-6 months). A patient underwent a repeat treatment for the onset of new liver metastases.
Conclusion: Preliminary clinical and imaging data confirm radioembolism with Y-90 as a promising treatment option. A wider study population with a longer follow-up would provide more information about disease-free intervals and survivals.

49.2.1

Proximal aneurysm neck expansion following endovascular aneurysm repair: a cause for graft failure?

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Purpose: Following endovascular aneurysm repair (EVAR), neck dilatation is associated with Type I proximal endoleak, aneurysm rupture, and possible death. Our aim was to identify the rate of proximal neck dilatation following EVAR and its relationship to graft migration.
Materials/Methods: Forty-eight patients underwent EVAR between December 1995 and February 1998 and were followed up by computed tomography. Proximal neck diameters (D2) were measured immediately distal to the lowest renal artery pre-operatively and at 24, 36, and 48 months. D2 measurements were compared using the Student t-test. The graft migration degree was determined from bi-planar abdominal films obtained at each time-point.
Results: D2 increased in 71% of patients at 24 months, 73% at 36 months, and 100% at 48 months. The mean increase in D2 was 1.9 mm at 24 months ($p<0.001$), 2.4 mm at 36 months ($p=0.01$), and 3.1 mm at 48 months ($p=0.0004$). Graft migration (>5 mm) occurred in 4%, with a median onset of 30 months (range 12-48). The mean percentage increase in neck diameter in patients with graft migration was 24.3%, versus 10.6% in patients with no graft migration ($p=0.03$).
Conclusion: Proximal neck expansion is common after EVAR, and is associated with migration, potentially leading to failure.

49.2.2

Endovascular repair of traumatic rupture of the aortic isthmus: medium-term results

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Purpose: Our aim was to report medium-term results of the endovascular treatment of traumatic ruptures of the aortic isthmus.
Materials/Methods: Between January 1996 and January 2006, endovascular repair of traumatic aortic ruptures was performed in 40 patients (mean age 40±17 years). Stent-grafts used were 34 Talent (Medtronic), four Excluder (Gore), and two Boston Scientific devices. Mean injury severity score of patients with acute or sub-acute ruptures was 41.7±12.1. Patients were treated 2.3±2.6 months after the injury in the acute and sub-acute group. Follow-up averaged 28.1 months (max. ten years) and was completed in 93.9%.
Results: Stent-graft deployment was 100% successful. Except for one iliac rupture, major periprocedural complications did not occur. Four patients presented primary endoleaks (one type I, one type II, two type IV) all but one (treated by embolization) spontaneously thrombosed within 30 days. No patient died during the follow-up. Early complications included one occlusion of the left-superior bronchus, two brachial pseudo-aneurysms, one acute upper-limb ischemia, and one sub-acute upper limb ischemia. One-year actuarial freedom from complications was 87.1±6.0% and 79.2±9.3% at three and five years.
Conclusion: The endovascular treatment of blunt thoracic aortic traumas is a safe and effective method, without increased medium-term morbidity and mortality rates.

49.2.3

Endovascular repair of thoracic aortic lesions with Medtronic's Talent and Valiant thoracic endografts

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Purpose: To retrospectively overwiev endovascular repair of thoracic aortic lesions--an accepted alternative to open surgical repair--in high-surgical risk patients.
Materials/Methods: Between 2001 and 2006, Medtronic's Talent or Valiant thoracic endoprostheses were used in 93 patients with atherosclerotic aneurysm (n=55), acute aortic dissection (n=10), penetrating aortic ulcer (n=5), intramural hematoma (n=3), transsection (n=9), iatrogenic trauma (n=2), aortobronchial fistula (n=3), and chronic dissection with false lumen aneurysm (n=6).
Results: Devices were successfully delivered in 92 patients (98.9%), while in one patient (1.07%) an external iliac artery rupture occurred. One patient (1.07%) developed hemiplegia after one year and two patients (2.1%) developed a paraparesis following graft deployment. In four patients (4.3%), endoleaks were observed with two of them requiring reintervention.Thirty-day and overall mortality rates were 0.93% and 3.22%, respectively.
Conclusion: The Medtronic's Talent --s a second-generation endograft--performed well. In severely calcified iliac arteries, the large-bore caliber of the device generated problems such as iliac artery rupture and failure to access. The Valiant--as a third-generation endograft--still has a large profile, but displays several advantages, such as a longer length, a controllable delivery system (Xcelerant), no connecting bar, springs sewn to the outside of the graft material, and a shorter proximal tip.

49.2.4

Abdominal aortic aneurysms secrete interleukin-6 into the circulation

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Purpose: Interleukin-6 (IL-6) is central to abdominal aortic aneurysm (AAA) pathology, and patients with AAA have elevated circulating levels. We aimed to directly measure *in vivo* aortic IL-6, testing the hypothesis that aneurysms secrete IL-6 into the circulation.
Materials/Methods: Using flush catheters, we aspirated blood from within the aorta in 27 patients with aneurysms and 15 controls, prior to endovascular abdominal repair or angiography. Blood was sampled from five sequential points within the aorta: arch, descending, proximal and distal abdominal, and common iliac artery. Plasma IL-6 was determined utilising ELISA. C-reactive protein (CRP) was also measured as marker of systemic inflammation.
Results: A significant rise in plasma IL-6 concentration from above to below the aneurysm was observed (p=0.002), which was not seen in the controls or in CRP. IL-6 was higher in the AAA group compared to controls (p=0.004). There was no difference in CRP between the groups (p=0.35).
Conclusion: Endovascular techniques were utilised in a unique manner enabling *in-vivo* measurements within the vasculature. These data support the hypothesis that aneurysms secrete IL-6 directly into the circulation. As IL-6 is an independent risk factor for cardiovascular mortality this may account for the high rate of cardiovascular death in these patients.

49.2.5

Visualization of the artery of Adamkiewicz at electrocardiography-gated multidetector row helical computed tomography in patients with Stanford type A aortic dissection

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Purpose: To assess detectability of the arteria radicularis magna (also called artery of Adamkiewicz) at electrocardiography (ECG)-gated multidetector row helical computed tomography (MDCT) in patients with Stanford type A aortic dissections.
Materials/Methods: Fifty-one patients with a Stanford type A dissection of the aorta underwent contrast-enhanced ECG-gated MDCT of the entire aorta and the iliac arteries (slice collimation 16x1.5 mm; 120 kV; 300 mAs; 120 ml Ultravist 300). The artery of Adamkiewicz visualization, as well as its branching level, side origin, and provenience from the true/false lumen, was investigated by two independent readers.
Results: In 36 (70%) patients, a single artery of Adamkiewicz was visualized from the stem of the intercostal or lumbar artery up to the anterior spinal artery. Two arteries of Adamkiewicz in the same patient were not visualized. Thirty (83%) arteries of Adamkiewicz originated from the left side; 30 (83%) originated between T8 and L1; 23 (64%) originated from the true and 13 (36%) from the false lumen.
Conclusion: MDCT depicts the artery of Adamkiewicz in a high percentage of patients with Stanford type A aortic dissection. This information may help in developing strategies for preventing spinal chord ischemia related to thoracoabdominal endovascular stent-graft treatment or aortic surgery.

49.2.6

Abdominal aortic aneurysm in octogenarians: a single-centre experience

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Purpose: Optimal management of abdominal aortic aneurysms (AAA) in octogenarians remains a challenging surgical problem. Our purpose was to assess 30-day mortality rate in an elderly population with AAA undergoing elective, urgent, or emergent repair.
MaterialsMethods: From January 2004 to November 2005, 59 octogenarians were treated for AAA. In 25.4% (15/59) of them, a ruptured AAA required an emergent open repair; in 23.7% (14/59) of patients, a symptomatic AAA with impending sign of rupture was treated with an urgent endovascular aneurysm repair (EVAR); 30/39 (50.8%) patients were asymptomatic and underwent elective repair (14 EVARs, four open repairs).
Results: In ruptured AAAs, 30-day mortality rate was very high (66.6%, 10/15) as compared with 7.1% (1/14) of symptomatic AAAs with impending sign of rupture, and with 6.6%(2/39) of those with asymptomatic non-ruptured AAAs.
Conclusion: The proper management of AAAs in the elderly is based on the balancing perioperative risks, risks of rupture, and life-expectancy. The introduction of EVAR has considerably changed the balance of risks and benefits for AAA treatment. Our study confirms the high mortality for octogenarians with ruptured AAA, and supports the value of elective EVAR also for urgent cases with symptoms and signs of impending rupture.

49.2.7

Embolization of the internal iliac artery. Cost effectiveness of two different techniques

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Purpose: To compare the cost effectiveness of coils versus Amplatzer occlusion of the internal iliac artery (IIA).
Materials/Methods: Between 2002 and January 2006, 13 patients (mean age 73±13) were referred for stent-grafting of abdominal aortic aneurysm (n= 6); type I distal endoleak (n= 3), isolated iliac aneurysm (n= 3), or rupture of an internal iliac aneurysm (n=1). In all these patients, an extension of the stent-graft was needed because of the absence of a distal neck. Two different approaches were used to occlude the IIA: an Amplatzer in seven patients (group A) and embolization using Detach 0.18 coils in six (group C). Immediate results and direct material costs were assessed retrospectively.
Results: An immediate success was obtained in all cases, and a simultaneous stent-grafting could be performed in 0/6 cases in group C versus 5/7 cases in group A. In all group-A patients, a single Amplatzer was sufficient to obtain occlusion of the IIA (mean cost: 484 €), while in group-C patients, an average of 7±3 coils were used (average cost: 1890±917 €).
Conclusion: The Amplatzer allows single-step procedures when IIA occlusion is needed at a significantly reduced cost.

49.2.8

Suprarenal fixation promotes reduction in sac diameter after endovascular aneurysm repair

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Purpose: To determine whether reduction in sac diameter after endovascular aneurysm repair (EVAR) is influenced by the method of proximal fixation. We compared devices incorporating suprarenal with those utilising infrarenal fixation.
Materials/Methods: One-hundred seventy-two patients underwent elective EVAR at a single-centre between December 1995 and January 2005, including those enrolled into the „EVAR-1" trial. Patients were grouped according to the level of graft fixation: suprarenal (n=99, Group 1) and infrarenal (n=73, Group 2). Maximum sac diameter, D3, was determined by computed tonography at six, 12, 24, 30, 36, 48, and 60 months. Groups were compared using a Mann-Whitney U test (D3) and paired t-test (percentage diameter change).
Results: There was a greater sac diameter reduction in Group 1 than Group 2 throughout the whole follow-up. At 24 months, median diameter decrease in Group 1 was 8 mm as compared with 2 mm for Group 2 ($p< 0.03$). The corresponding percentage change in sac diameter in Group 1 was 15% at 24 months, compared with 6% in Group 2 ($p< 0.01$).
Conclusion: Later generation EVAR devices employing suprarenal fixation show a greater reduction in sac size as compared with earlier infrarenal fixation grafts. This may equate to lower re-intervention rates.

49.2.9

Endoleak, secondary intervention and mortality of endovascular aneurysm repair are improving with time

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Purpose: Recent trials have proven the efficacy of endovascular aneurysm repair (EVAR). However, less is known about temporal changes in conversion rate, endoleak, secondary intervention and post-EVAR rupture. The aim of this study was to perform a meta-analysis to determine how these parameters have changed with time as experience with EVAR increases and new generations of devices become available.
Materials/Methods: A meta-analysis was performed of all publications quoting endoleak, conversion to open repair, post-EVAR rupture and mortality. Data were collected from 165 series with 28,862 patients.
Results: The pooled estimates for type 1 endoleak was 10.5% with an annual rate of 8.4%. The pooled estimate for other endoleaks (types 2, 3 and 4) was 13.7% with an annual rate of 10.2%. The pooled estimates for primary and secondary conversions to open repair were 3.8% and 3.4%. Operative mortality was 3.3% and post-operative rupture 1.3%. A multivariate meta-regression analysis was performed to investigate changes with time. Operative mortality, post-operative rupture and endoleak reduced significantly with time (all $p<0.05$).
Conclusion: This study demonstrates that EVAR has a low overall mortality and post-operative rupture rate and that mortality, post-operative rupture and endoleak are all decreasing with time as surgeons, radiologists and devices improve.

49.3.1

European multicentric prospective study evaluating clinical performance and cost effectiveness of Hemobahn/Viabahn endoprostheses versus by-pass graft surgery in the correction of femoropopliteal lesions (Hemobahn CIRSE study)

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Purpose: To evaluate technical performance, safety, clinical efficacy, and cost effectiveness of expanded-polytetrafluoroethylene (e-PTFE)-covered nitinol stents (W.L. Gore & Associates) versus bypass-graft in the treatment of femoral artery occlusions.
Materials/Methods: This multicenter, prospective, randomized study involved 77 patients (60 men; mean age 64±12 years) who received e-PTFE stents in 44 cases and bypass-grafts in 33. The average lesion length was 11.4 cm. Duplex ultrasound and ankle-brachial index were performed at discharge and at one-, six-, and 12-month follow-ups. The results of both groups were analyzed by an external team. Non inferiority T-test and a Fisher's exact test were done to test for significant differences between the two groups.
Results: The study started in 2001. Recruitment officially ended in June 2005. For the 12-month follow-up, we are waiting for the data from the last 12 enrolled patients. These data should be available and completed by March 2006. Primary patency rates at six months were 73.5% versus 70.4% for the Viabahn and bypass-graft respectively and secondary patency rates were 82.5% and 86.2%, respectively.
Conclusion: Primary implantation of PTFE-covered nitinol stents in superficial femoral arteries is safe and effective. At six months, comparable results were observed in the both groups.

49.3.2

Safety and efficacy of the Express® vascular LD stent in the treatment of iliac artery lesions: the MELODIE experience

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Purpose: MELODIE is a prospective, multicenter, single-arm, long-term safety and efficacy study of the Express® vascular LD stent in the treatment of iliac artery lesions.
Materials/Methods: Eligible patients received ≥1 stent for *de novo*/restenotic lesions ≤10 mm with diameter stenoses ≥50%. Clinical follow-up was at 30 days, and six, 12, and 24 months with six-month angiography and computed tomography-angiography (CTA) at 12 and 24 months. Primary endpoint was the mean percent luminal diameter loss (%LDL) measured independently using quantitative vascular analysis at six months. Efficacy data were compared with a Palmaz stent literature-derived objective performance criterion (OPC). All deaths, revascularizations, and serious adverse events were adjudicated by an independent Clinical Events Committee.
Results: Ten European/Canadian sites enrolled 151 patients (163 lesions, 159 limbs); follow-up compliance was 97.4% (30-day) and 92% (six-month). At six months, angiographic binary restenosis was 5.6%; clinical success 83.1%; hemodynamic success 71.2%; target lesion revascularization 7.6%; there were no device-/procedure-related deaths. The mean %LDL at six months of 16.09±19.1 (n=112) demonstrated non-inferiority (OPC+δ=20%, one-sided z-test).
Conclusions: The Express LD stent is safe and effective in treating iliac artery lesions with marked improvements of clinical and hemodynamic outcome through six months. Twelve-month data will be available in September.

49.3.3

Sirolimus for below-the-knee lesions with critical ischemia: medium-term results of the „Siro-BTK study"

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Purpose: To assess the safety and efficacy of Sirolimus-eluting stents (SES) in the treatment of below-the-knee lesions. The use of drug-eluting stents may offer significant improvements in the treatment of infrapopliteal lesions which are very similar to coronary lesions.
Materials/Methods: Thirty consecutive patients with critical limb ischemia (CLI), category 3 to 6 of Rutherford classification, and multivessel disease of infrapopliteal arteries were treated with SES. Sixty-two arteries were treated with 106 SES.The primary endpoint was clinical improvement and/or healing of ulcers at short- (one month) and medium-term (seven months). The secondary endpoint was primary vessel patency rate (angiographic or duplex assessment). All the patients received Clopidogrel (75 mg daily) or Ticlopidine (150 mg daily) for two months or longer.
Results: Angiographic and procedural success was achieved in all the patients. At seven months (7.7±5.8), it was necessary to amputate one toe in one patient and one mid-foot in another. Limb salvage was obtained in 100% of patients.All surviving patients had a medium-term clinical improvement with 97% of primary patency (56/58 patent arteries).
Conclusion: Treatment of below-the-knee lesions with SES may provide an alternative treatment for patients with CLI.

49.3.4

Clinical outcome of patients surviving more than three years after subintimal angioplasty

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Purpose: To evaluate long-term patency and clinical efficiency of subintimal angioplasty (SAP) of occluded infra-inguinal arteries three years post-procedure.
Materials/Methods: One-hundred eighty-one patients with a median age of 79 years (89 women) underwent attempted SAP (193 limbs) of occluded infra-inguinal arteries during the period 1999-2001. Forty-six percent of patients had diabetes, 95% had critical ischemia (Fontaine classification ≥II). All the patients surviving at least three years post-operatively were followed up with questionnaires, clinical examinations, ankle-brachial index measurements, and Duplex ultrasonographies. All data were collected prospectively.
Results: A primary technical success was achieved in 77% of the limbs treated. Thirty-day mortality was 8%; 113 patients died before three-year follow up. Limb salvage at >3-year follow-up was 79%; 68% of the patients had clinically improved. Patency rate was 40%. TransAtlantic Inter-Society Consensus classification did not affect technical or clinical outcomes.
Conclusion: SAP is a feasible and tempting minimal invasive option for patients with critical limb ischemia. However, elderly patients are burdened by a high mortality and amputation rate and prospective randomised trials are needed to confirm the efficacy of SAP.

49.3.5

Use of a self-expanding nitinol stent (Absolute) in the treatment of atherosclerotic occlusive disease of the superficial femoral artery

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Purpose: To report the results and one-year follow-up of a prospective multicentre study on the placement of a nitinol self-expanding stent in the treatment of atherosclerotic occlusive disease of the superficial femoral artery (SFA).
Materials/Methods: Between July 2004 and September 2005, 101 patients with atherosclerotic occlusive disease of the SFA were treated with a self-expanding nitinol stent (Absolute, Guidant). In the follow-up, clinical assessment and ankle brachial index (ABI) were performed at one, three, six, and 12 months. Any change was documented by color-flow duplex or angiograhy to document restenosis. Plain X-ray of the SFA was performed at 12 months to detect stent fractures.
Results: Procedural success rate was 100%. Primary patency rates at one, three, and six months were 97.9, 96.9, and 95.7%, respectively. Secondary patency rates at one, three, and six months were 99, 97.9, and 96.7%, respectively. Patency rates at 12 months and stent fractures will be reported.
Conclusion: Endovascular treatment of atherosclerotic occlusive SFA disease with the Absolute self-expanding stent has excellent results which are better than historical series with percutaneous transluminal angioplasty alone and compare favoribly to the published results with other nitinol stents.

49.3.6

Long-term results of cutting balloon angioplasty for critical limb ischemia

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Purpose: Endovascular treatments for critical limb ischemia (CLI) remain controversial vis-a-vis their efficacy relative to bypass surgery, and relative to selecting amongst the increasing number of endovascular devices. To address the need for more data, we have analyzed our results of utilizing cutting balloon angioplasty (CBA) as primary treatment.
Materials/Methods: During a period of 48 months, 64 patients (72 limbs) with CLI were treated with CBA for both supra and infrapopliteal obstructive arterial lesions. Primary end-points for initial results were <30% residual stenosis and thrombolysis in myocardial infarction (TIMI) grade 3 flow; for long-term results were absence of amputation, and death.
Results: Initial technical success was 90% overall, and 98% in infrapopliteal lesions; with one major complication (access site bleeding). Thirty-day results: one patient death, one bypass graft, one major amputation. During the followup (1-48 months, mean 24 months): one additional major amputation, six minor amputations, and five deaths. Only 4% of trifurcation lesions required repeat treatment; 20% of femoropopliteal lesions required repeat treatment.
Conclusion: CBA safely yielded very high initial technical success rates with a strikingly low need for repeat treatments, particulary for trifurcation lesions; and yielded amputation-free survival rates equal to bypass surgery.

49.3.7

Stents in infrapopliteal arteries as a bail-out procedure: six-month follow-up results

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Purpose: To evaluate if stent implantation in infrapopliteal arteries can be used as a bail-out procedure in failed percutaneous transluminal angioplasty (PTA).
Materials/Methods: Infrapopliteal PTA was performed in 53 patients (56 limbs, 92 arteries) with chronic critical limb ischemia. All the lesions were classified as type C and D, according to TransAtlantic interSociety Consensus criteria. The group included 47 men and nine women with an average age of 62.7 (42-82) years; diabetes mellitus was present in 92.9% of patients. Only anterior and posterior tibial arteries ("palpable arteries") were evaluated. Stents were implanted in 15 of the 92 arteries in which PTA had failed. After six months, patency rate was evaluated by palpation, ankle-brachial index, and Doppler ultrasound.
Results: In all cases, stent implantation restored the flow in the artery immediately after PTA. Seventy-five arteries were available at six-month follow-up. In the non-stented group, 59/64 (92.8%) arteries were patent, while in the stented group ten of 11 (91%) arteries were patent
Conclusion: At six-month follow-up, the patency rate of infrapopliteal arteries stented for PTA failure did not differ from non-stented arteries with optimal PTA result.

49.3.8

Initial and intermediate term results of use of cutting balloon for claudication

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Purpose: The results on the use of cutting balloon angioplasty (CBA) for femoropopliteal versus trifurcation lesions in claudicants has not been previously reported. Points to be analyzed included the benefit and safety of treating trifurcation lesions in claudicants.
Materials/Methods: During a 48-month period, 56 patients (64 limbs) were treated with CBA as initial treatment for claudication (77 femoropopliteal lesions, 50 trifurcation lesions).
Results: Claudication grade was improved by at least 1 Rutherford category in 86% of the patients immediately following the procedure. During the followup period (1-48 months, mean: 24 months), 75% remained at least one category improved. The femoropopliteal lesions required repeat treatment in 20% of incidences; only 4% of the trifurcation lesions required repeat treatment.
Conclusion: CBA was followed by a lower incidence of restenosis in the trifurcation lesions. In patients with claudication due to both femoropopliteal and trifurcation lesions the lower incidence of restenosis in the trifurcation lesions resulted in retained improvement in claudication despite restenosis in the femoropopliteal segments.

49.3.9

Drug-coated balloon angioplasty prevents restenosis.Six-month angiographic follow-up of the Thunder trial

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Purpose: Drug-eluting stents have been proven to reduce the restenosis rate in the coronary arteries. Unfortunately, drug-eluting stents failed to demonstrate superiority over bare stents in the superficial femoral artery.
Materials/Methods: In a prospective, blinded, multicenter trial, 154 patients were randomized to receive Taxan either locally administered with a balloon-catheter during balloon-angioplasty, or together with contrast media. One group served as control group (balloon-angioplasty only).
Results: No major side effects which could be attributed to the local Taxan administration were noted so far. For an interim analysis, we compared 25 patients with an uncoated-balloon with 20 patients treated with the drug-coated balloon. At six months, the minimum lumen diameter (MLD) of the patients who were treated with the drug-coated balloon was significantly greater than the MLD of those who were treated with an uncoated balloon (p=0.029).
Conclusion: Local Taxan administration did not result in any undesired side-effect during the intervention and at six-month follow-up. This is the first trial which showed that drug-coated balloons have the potential to reduce restenosis in peripheral arteries. At CIRSE 2006, complete six-month data will be available.

49.4.1

Radiofrequency thermal ablation versus percutaneous ethanol injection for "early" hepatocellular carcinoma: final results of a randomized controlled study

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Purpose: To compare radiofrequency thermal ablation (RFA) versus percutaneous ethanol injection (PEI) for "early" hepatocellular carcinoma (HCC) („Barcelona Clinic Liver Cancer" staging classification).
Materials/Methods: Cirrhotic patients with early HCC (177 nodules ≤3 cm overall) were randomised for RFA (70) or PEI (69). Results were evaluated for effectiveness at the end of treatment, one year post-treatment (primary end point), complications, distance recurrences, survival, costs.
Results: One-year local disease-free rates were 67% (RFA) and 35% (PEI) (p=.0005). At the end of treatment, local success also was significantly higher in the RFA group (96% versus 61%; p<.0001) and was achieved with less sessions than PEI (1.13 versus 1.33; p=.0005). Complications and distance recurrences were similar. Three-year survival curves showed a trend in favour of RFA (58% versus 46%; p=.214), but Child's A versus B score was the only significant predictive factor at a multivariate analysis (p=.0007). RFA and PEI costs were 6,691 and 4,224 € respectively; the incremental cost per one additional one-year disease-free patient obtained by RFA was 7,790 €.
Conclusion: One-year effectiveness of RFA is superior to PEI for early HCC. RFA obtains more local successes with less treatment sessions and acceptable costs. Survival curves do not show statistically significant differences.

49.4.2

Computed tomography-guided brachytherapy versus laser ablation of colorectal liver metastases: a matched-pair, same patient analysis

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Purpose: To compare local control after percutaneous tumor ablation by laser-induced interstitial thermotherapy (LITT) or computed tomography (CT)-guided brachytherapy
Materials/Methods: A matched-pair analysis included patients displaying i) liver metastases of colorectal primary and ii) liver tumor ablation by LITT and CT-guided brachytherapy. We identified 18 patients with 36 colorectal liver metastases. In these patients, the following matching factors were considered: i) tumor size <5 cm, and ii) absence/presence of chemotherapy after tumor ablation. Primary endpoint was local control.
Results: Fourteen patients fulfilled all matching criteria, while four exceeded the 5-cm tumor size for either method. Tumor size distribution was equal (p=0.8; brachytherapy: 3.8 cm, 1.0-6.0 cm; LITT: 3.4 cm, 1.8-5.8). With respect to the presence/absence of adjuvant chemotherapy, all the patients demonstrated a full match. Median follow-up was 14 months (3-24) for both groups. Five of 18 patients (28%) after CT-guided brachytherapy and 10/18 patients (56%) after LITT demonstrated local tumor progression. Differences encountered were significant for all patients (p=0.04). In the 14 patients displaying a full match, a significance level was not reached.
Conclusion: At long-term follow-up, CT-guided brachytherapy demonstrated a superior local tumor control as compared with LITT.

49.4.3

Percutaneous ethanol injection of medium and large hepatomas using a multi-pronged needle: early experience

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Purpose: Percutaneous ethanol injection (PEI) is effective and safe in treating small hepatomas (<3 cm) but is seldom used for larger hepatomas. We report our early results of treating unresectable medium/large hepatomas with large-volume PEI under conscious sedation.
Materials/Methods: Thirty-four cirrhotic patients with unresectable hepatomas (3-9 cm) received alcohol injections with with an extendible, multi-pronged needle (Quadrafuse, RexMedical, PA). Each patient received three injections or less. Those with a nearly complete necrosis (90-99%) received further treatments with radiofrequency ablation or conformal radiation. Patients were followed up with imaging every three months.
Results: Average tumor size was 5 cm; average total alcohol volume was 55 ml; average number of sessions was 2.3. Complete tumor necrosis was achieved in 56%, nearly complete in 35%, and partial (50-89%) in 9%. Eight of the ten patients with a nearly complete necrosis underwent further treatment and achieved complete necrosis. One patient died of respiratory failure; another developed hepatic encephalopathy but recovered, a third patient had tumor seeding. After 27 months, four patients had died from the disease, seven had a local recurrence, and six had new intrahepatic lesions.
Conclusion: Large-volume PEI under conscious sedation is a safe and effective treatment option for unresectable medium/large hepatomas.

49.4.4

Modified radiofrequency ablation technique creates larger ablation zones than standard radiofrequency ablation in *ex-vivo* liver using a proprietary expansile needle

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Purpose: To compare the effect of modified radiofrequency ablation (mRFA) with standard radiofrequency ablation (RFA) when delivered through a multi-tine needle.
Materials/Methods: Using an RFA machine constructed with a modified LeVeen circuit, ten ablation zones were created in *ex-vivo* liver using a proprietary 3.5-cm expansile needle (LeVeen 3.5 cm MRI needle, Boston Scientific, Natick, Massachusetts, USA). Ten control ablation zones were created with the same needle using standard RFA technique.
Results: The mean size of the mRFA zones was 6.2 cm, compared with 3.4 cm for the standard RFA technique.
Conclusion: In *ex-vivo* liver, a proprietary multi-tine needle can produce an ablation zone with a diameter which is approximately 85% wider than that achievable with standard RFA technique.

49.4.5

Computed tomography-guided radiofrequency ablation of hepatic and non-hepatic malignancies. A six-year experience

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Purpose: To discuss the effectiveness of radiofrequency ablation (RFA) as a therapeutic tool for malignant tumors.
Materials/Methods: During a 74-month period, 248 patients with malignant tumors were treated with RFA (516 sessions). The procedure was carried out under local anaesthesia in 163 hepatic,13 renal, 26 osseous, 42 pulmonary, and 11 lymph node tumors. An analgesic treatment was administered and the whole procedure lasted from 30 to 45 minutes. Follow-up evaluation was performed with dual-phase computed tomography.
Results: A total tumors necrosis was evident in 50.3% of hepatic, in 71.4% of pulmonary, in 100% of renal (all were resected), in 62% of osseous (with pain relief) and in 63% of lymph node tumors. Mean survival rates for the first, second, third, fourth, and fifth year were 96, 86, 78, 67, and 54% for hepatocellular carcinomas, and 80, 70, 30, 20, and 9% for hepatic metastases. Mean survival for primary lung malignancies was 2.5 years and for metastatic lung malignancies 1.5 years. There were no major complications.
Conclusion: Percutaneous RFA is a safe and effective alternative treatment for hepatic and non-hepatic malignancies.

49.4.6

Thermal ablation of hepatocellular carcinoma before liver transplantation: patient outcome and tumor necrosis in explanted livers

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Purpose: To assess efficacy and outcome of thermal ablation for hepatocellular carcinoma (HCC) prior to liver transplantation.
Materials/Methods: Twenty-four patients with 28 HCCs underwent 37 thermal ablations before liver transplantation. Twenty-five patients with HCC underwent liver transplantation and no thermal ablation. Pre-transplant computed tomography or magnetic resonance and histopathologic examination of the explanted livers evaluated effectiveness of ablation. Histology served as reference standard. The groups were compared with respect to recurrent HCC and survival.
Results: Mean waiting time for liver transplantation in the ablation group was 7.1±1.4 months. Imaging showed 87.5% complete necrosis. Histology showed that 81.4% of tumors had complete or greater than 50% necrosis. Imaging accuracy was 47.8%, sensitivity 20% and specificity 100% in detecting residual disease. One (4.2%) ablation patient developed recurrent disease after transplantation. Eighteen (75.0%) patients were alive without recurrence after follow-up of 16.3±3.4 months. The 25 patients without pre-transplant treatment had similar survival rate (p=0.78) but shorter waiting time of 4.2±0.8 months (p=0.046). Three non-ablation patients (12%) developed recurrent disease after transplant.
Conclusion: Thermal ablation of HCC is effective as a bridge to liver transplantation.

49.4.7

Is it possible to identify markers of inadequate response to percutaneous ethanol injection and radiofrequency thermal-ablation of suprarenal adenomas in secondary hypertension due to hyperaldosteronism?

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Purpose: To identify markers of inadequate response to percutaneous ethanol injection (PEI) and/or radiofrequency thermal ablation (RFTA) in patients with primary aldosteronism (PA).
Materials/Methods: Since 1999, 104 patients with suprarenal adenoma (SR-adenomas) screened by aldosterone concentration (AC)/renin activation (RA) ratio underwent PEI and RFTA. SR-adenomas were identified by computed tomography. In >1-cm SR-adenomas (39 patients), RFTA alone was used; in patients (65) with <1-cm SR-adenomas, PEI was also employed. Clinical and laboratory parameters were analysed by t-test logistic regression for odds ratio and confidence intervals. The software SPSS for Windows, version 9, was used for statistics.
Results: With PEI and RFTA, 66 (63.5%) patients where clinically cured; 29 (27.9%) improved, and nine (8.6%) were not controlled. Odds ratios for blood pressure after treatment showed that: a) time of diagnosis of hypertension >15 years, b) body mass index (BMI) >35, and c) the presence of urinary proteins are strongly associated with improved and uncontrolled patients (p<0.01). The analysis of these markers showed a correlation (+) with no response to RFTA and PEI (the nine uncontrolled patients presented this association).
Conclusion: Long-time interval of untreated hypertension, increased BMI, and urinary proteins are markers of inadequate response to percutaneous treatment in PA patients.

49.4.8

Radiofrequency ablation of liver metastases from colorectal cancer: medium-term results in 122 patients

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Purpose: Medium-term results analysis of radiofrequency ablation (RFA) for colorectal metastases to evaluate predictors of complications, local efficacy, and survival.
Materials/Methods: One-hundred twenty-two patients with 199 non-resectable metastases (0.5-8 cm; median 2.5) underwent 145 RFA sessions percutaneously or during surgery. The technique was simple or "combined" (with vascular occlusion). Mean follow-up was 24.2 months. Complications, local efficacy, and survival rates were statistically analysed.
Results: Adverse events occurred in 8.1% of lesions (major complications 1.1%), 7.1% in the simple and 16.7% in the „combined" technique (p=0.15).
An early complete response (CR) was obtained in 151 lesions (81.2%), but 49 lesions (26.3%) recurred locally after a mean of 10.4 months. A durable CR was achieved in 66.7% of ≤3-cm versus 33.3% of >3-cm lesions (p<0.0001). Survival rates at one, three, and five years were 91, 54, and 33% from diagnosis of metastases (comparable with surgery) and 79, 38, and 22% from RFA. Mean survival from RFA was 31.5 months [36.2 in patients with main metastases measuring ≤3 cm and 23.2 in those with at least one lesion of >3 cm (p=0.006)].
Conclusion: "Simple" RFA is safe and successful for ≤3-cm metastases; it contributes to prolong survival when patients can be completely treated.

49.4.9

In-vivo **radiofrequency liver thermoablation under real-time magnetic resonance temperature monitoring**

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Purpose: To assess *in-vivo* online magnetic resonance imaging (MRI) temperature monitoring of radiofrequency (RF) ablation of the liver.
Materials/Methods: Twenty RF lesions were induced in nine pig livers, using an bipolar cooled-electrode. Output power of 20-50 W was applied during 5-20 minutes. In-/out-of-field RF filters were designed to avoid interferences. MRI was performed on a 1.5-T system with a bidimensional fast field echo respiratory-gated sequence. Temperature maps were calculated by proton resonance frequency from phase images with a separate software. Four pigs were sacrificed after the procedure and five after seven days. Shapes and volumes of the lesions were compared with histological findings.
Results: Images with non noticeable artifacts were obtained, thus allowing temperature monitoring with a good accuracy (SD 2.5°C). Isotherms and energy deposition maps were superimposed on anatomical images. Morphologically, there was an excellent correlation between the images and the histologic slices, even in the vicinity of main hepatic vessels. There was also a very good correlation (R=0.745, p=0.02) between estimated and measured volumes.
Conclusion: *In-vivo* RF ablation with simultaneous thermo-MRI is feasible and may predict the shape and volume of the RF ablation zone induced by RF.

49.5.1

Sexuality after uterine artery embolisation and hysterectomy in the treatment of uterine fibroids: a randomized comparison (EMMY trial)

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Purpose: A randomised controlled trial comparing sexuality in patients assigned to either hysterectomy or uterine artery embolisation (UAE) for menorrhagia caused by uterine fibroids was performed.
Materials/Methods: Patients were randomised to either hysterectomy (n=89) or UAE (n=88). Questionnaires, including the Sexual Activity Questionnaire (SAQ) were completed by all patients at baseline, at six weeks, and six, 12, and 18 months after treatment. Satisfaction with current sexual life was also assessed.
Results: Six weeks after treatment, the sexual activity had decreased in both groups; it restored to baseline--again with no difference between the two groups--at 18 months (p=0.48). As for the SAQ score, there was a significant improvement in UAE patients, but not for hysterectomy patients. Between the groups however no differences were present. Overall sexual satisfaction deteriorated in a minority of cases at all time points, with the only significant difference between the groups at 18 months (UAE: 31.7% versus hysterectomy: 11.5%; p=0.03).
Conclusion: Both UAE and hysterectomy do not adversely influence sexuality. No differences were observed between the groups. After UAE sexuality improves significantly. UAE patients are more likely to report a worse sexual satisfaction in the long term than hysterectomy patients.

49.5.2

Ovarian artery embolization for symptomatic uterine leiomyomata

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Purpose: To evaluate clinical outcomes after ovarian artery embolization (OAE) as adjuvant treatments to uterine artery embolization (UAE) for symptomatic uterine leiomyomata.
Materials/Methods: Consecutive premenopausal women who underwent OAE and UAE for patent ovarian-uterine anastomosis were studied. Symptom severity scores (SSS), basal follicle-stimulating hormone (FSH) levels, and magnetic resonance imaging examinations were performed prior to procedures and repeated at six months post-procedures. Transformed SSS, basal FSH levels, and volumes of leiomyoma were compared and analyzed. Six-month post-procedure basal FSH levels were obtained and compared with FSH levels pre-procedures.
Results: Fifty-three OAEs in 48 patients (mean 45.4±6.3 years) were studied. Five patients underwent bilateral and 43 underwent unilateral OAE. There was significant symptom improvement, as the transformed SSS improved from the baseline of 50.3±23.2 to 17.7±19.6 post-procedure (p=0.0001). There was 49.9% volume decrease in the most dominant leiomyoma, as the mean baseline volume was 459.7 cm^3 versus 151.2 cm^3 post-procedure. Mean baseline basal FSH level was 13.6±15.1, and that of post-procedure was 20.2±25.8 (p=0.208).
Conclusion: OAE in combination with UAE procedure does not elevate basal FSH level significantly. OAE with UAE appears safe and effective.

49.5.3

Microcoil embolization of patent uterine-ovarian anastomosis

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Purpose: To evaluate clinical outcomes after microcoil embolization of patent uterine-ovarian anastomosis prior to uterine artery embolization (UAE) for symptomatic uterine leiomyomata.
Materials/Methods: Consecutive premenopausal women who underwent microcoil embolization of the patent uterine-ovarian anastomosis prior to UAE were studied. Symptom severity scores (SSS), basal follicle-stimulating hormone (FSH) levels, and magnetic resonance imaging examinations were performed pre- and post-procedures, and results were compared and analyzed.
Results: Thirty-three microcoil embolizations in 30 patients (mean 42.9±5.3 years) were studied. All patients underwent microcoil embolization due to torrential flow from uterine artery to ovary. There was significant symptom improvement, as the transformed SSS improved from the baseline levels of 57.4±16.7 to post-procedure levels of 28.6±20.9 (p=0.0001). There was 47.7% volume decrease in the most dominant leiomyoma, as the mean baseline leiomyoma volume was 386.2 cm^3 versus 261.1 cm^3 post-procedure. Mean baseline basal FSH level was 10.6±8.2, and that post-procedure was 18.4±21.4 (p=0.138).
Conclusion: Microcoil embolization of patent uterine-ovarian anastomosis does not result in significant change in basal FSH levels. Uterine-ovarian anastomosis embolization with microcoils appears safe and effective.

49.5.4

Pregnancy after uterine fibroid embolization: one-centre data

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Purpose: The effects of uterine fibroid embolization (UFE) on fertility in women remain unclear. The aim of our paper is to evaluate one-centre data on pregnancy after UFE
Materials/Methods: Between November 2001 and December 2005, 710 women with symptomatic leiomyoma at the mean age of 43 years (27-53) underwent UFE. Mean uterus volume was 487 cc, mean dominant fibroid volume 198 cc (14-915), and non-dominant fibroid 93 cc. Magnetic resonance follow-up (3-48 months) was performed in 520 patients. Three months post-UFE, 520 women were queried by questionnaire.
Results: Our paper presents 20 cases of post-UFE pregnant women. Seven cases delivered a normal fetus [Activity, Pulse, Grimace, Appearance, and Respiration score (Apgar) >8 at the 1^{st} minute], while nine women are still pregnant. Four women underwent artificial abortion. At delivery, mean fetus weight was 3300 g, with only one hypotrophic fetus. In this group, mean dominant fibroid volume before embolization was 144 cc (42-640). There was no correlation between volume, position, number of dominant fibroids and pregnancy.
Conclusion: Our one-centre data are an example of possible procreation following UFE, although there is no clear indication for the procedure in young women.

49.5.5

Ovarian damage after uterine artery embolisation: a randomised comparison with hysterectomy

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Purpose: To compare uterine artery embolization (UAE) and hysterectomy with regard to ovarian damage.
Materials/Methods: One-hundred and seventy-seven pre-menopausal women with menorrhagia due to uterine fibroids were randomised (1:1) between UAE and hysterectomy. At baseline and follow-up visits, follicle-stimulating hormone (FSH) was measured and menopausal symptom questionnaires were administered. In a subset of patients (n=63) anti-Müllerian hormone (AMH) was measured.
Results: FSH increased significantly in both groups after a mean follow-up of 16 months (within-group analysis: p<0.01 (both groups); between-group analysis: p=0.32). Eighteen months after treatment 17.5% of patients in the UAE group and 22.7% in the hysterectomy group had FSH levels >40 IU/L (p=0.42). No significant change was observed for menopausal symptoms. Only in UAE patients AMH significantly decreased in the first year after treatment as compared with the expected AMH decrease due to ageing, with no differences between the two groups.
Conclusion: Both UAE and hysterectomy cause relative damage to the ovaries. This results *a)* in an earlier menopause in older women, and *b)* in reducing ovarian reserve in younger women. UAE should therefore be offered with reserve and after appropriate counselling to women who wish to conceive.

49.5.6

Uterine artery embolization versus hysterectomy: comparison of clinical outcome and quality of life after 12 months

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Purpose: Compare uterine artery embolization (UAE) and hysterectomy regarding menorraghia, pain, bulk-related complaints and quality of life after 12 months.
Materials/Methods: Between February 2002 and February 2003, 177 patients were randomized to UAE (n=88) or hysterectomy (n=89). UAE was done with polyvinyl alcohol particles. Hysterectomies were performed as total or subtotal (vaginal or abdominal). Improvements of menorrhagia, pain, and bulk-related complaints were scored on a five-point Likert scale. Quality of life was scored using the Medical Outcome Short-Form (36) Health Survey.
Results: At 12 months, 72/81 (88.9%; CI 79.9-94.8) UAE and 75/75 (100%) hysterectomy patients showed menorrhagia improvement. Pain improvement was reported in 55/73 (75.3%; CI: 63.0-84.7) UAE patients and 49/59 (83.1%; CI: 71.0-91.6) hysterectomy patients (p=0.28). Improvement in bulk-related complaints occurred in 48/67 (71.6%; CI: 59.3-82.0) UAE patients and 43/65 (66.2%; CI: 53.4-77.4) hysterectomy patients (p=0.50). In both groups, the quality of life improved significantly compared to baseline, but between the groups there was no significant difference.
Conclusion: At 12 months, there was a good menorrhagia improvement in UAE and hysterectomy patients, no significant difference in pain and bulk-related complaints improvement between UAE and hysterectomy and a significant improvement of quality of life compared to baseline in both groups.

49.5.7

Devascularization of fibroids on early contrast-enhanced magnetic resonance after uterine artery embolization: infarction rate determines clinical outcome and probability of re-intervention. Results of a prospective study

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Purpose: Evaluate the impact of residual uterine fibroid perfusion on clinical outcome.
Materials/Methods: Consecutive patients (115) underwent uterine artery embolization (UAE) with polyvinyl alcohol particles or trisacryl microspheres. Baseline volume measurements and contrast-enhanced magnetic resonance were performed 72 hours post-UAE. Based on infarction rate, patients were divided into three groups (I: 100%, n=60; II: 90-99%, n=32; III: 0-89%, n=23) and followed for 36 months. Clinical outcome was compared by Kaplan-Meier analysis, Log-rank test (LRT), and Cox proportional hazard regression.
Results: Median reductions of UV and DFV were significantly higher in patients with >90% devascularization (p<0.02). Two years post-UAE, only 50.2% of group-III patients and 80.3% in group II had no re-intervention. Group-I patients did not need re-treatment (LRT: p<0.001). Hazard ratio for re-intervention between groups I and II was 15.9 (95% CI 1.2-2225.5; p=0.034) and between I and III 73.1 (8.3-9636.4; p<0.001). Menorrhagia (I: 90%, II: 83.5% III: 71.8%; LRT: p=0.019) and bulk-related symptoms (I: 86.8%, II: 90.3%, III: 64.3%; LRT: p=0.004) improvements differed significantly as did hazard ratios of groups I and III for worsening or recurrence of menorrhagia [7.5 (2.1-28.3); p=0.002] and bulk-related symptoms [5.9 (1.7-21.9); p=0.007].
Conclusion: Infarction rate post-UAE is a major determinant of clinical outcome.

49.5.8

Transarterial embolization for massive vaginal bleeding: importance of the round ligament artery as a potential bleeder

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Purpose: To report our experiences with transarterial embolization (TAE) in the management of massive vaginal bleeding and its angiographic findings.
Materials/Methods: During the last three years, 38 women (mean age: 31 years; range: 18-49) with massive vaginal bleeding were managed by TAE. Symptoms occurred after Cesarian section (18 patients), normal vaginal delivery (11), curettage (4), transabdominal hysterectomy (1), or uterotomy (1). Angiographies showed hypervascular staining from both uterine arteries (32 patients), arteriovenous malformation(4), arteriovenous fistula (1), pseudoaneurysm and extravasation from uterine, inferior epigastric or vaginal artery (6). Collateral circulations through the round ligament artery from the inferior epigastric or lateral circumflex iliac artery were seen in eight patients. Embolization was done with gelfoam pledgets, polyvinyl alcohol, embolization coils or cyanoacrylate glue in each patient. Technical and clinical results and angiographic findings were assessed.
Results: A successful embolization of targeted bleeders and hemostasis were achieved in all patients. Collateral through round ligament arteries was noted in patients after Cesarian section. Two patients died for underlying disease and multi-organ failure in spite of successful hemostasis.
Conclusion: Transcatheter arterial embolization is safe and effective in controlling massive vaginal bleeding. Potential collateral through round ligament arteries should be excluded to complete vaginal bleeding control.

49.5.9

Endovascular therapy of ectopic tubal pregnancies

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Purpose: Current therapeutic solutions for tubal pregnancy include methotrexate in the first month or radical/conservative surgery in the other cases. We suggest a conservative endovascular therapy for tubal pregnancies.
Materials/Methods: Embolization of the ipsilateral uterine artery was performed in 16 cases of tubal pregnancies (between the fourth and the ninth week). Methotrexate was associated in six cases. Our method consists in the devascularization of the embryonic pouch through selective catheterization and embolization of the uterine artery, using a biodegradable hemostyptic material (Tachocomb, Nycomed, Denmark). Ultrasound and beta-hCG levels were carried out for monitoring.
Results: In 14 cases (87.5%), the postembolization evolution was good, with a gradual resorption of the ectopic pregnancy and a significant decrease of the beta-hCG level. One patient became pregnant again eight months after embolization and had a healthy child by cesarean delivery (with a normal aspect of her tube). In two cases, a salpingectomy was necessary. No ovarian dysfunctions were recorded.
Conclusion: This technique allows the conservative therapy of tubal pregnancies after the fourth week by maintaining tubal integrity and patient's fertility. According to us, no other cases were reported in the literature. This method opens new perspectives for ectopic pregnancies therapy.

49.6.1

Water-soluble polyvinyl alcohol in the renal artery of pigs: radiological-pathological evaluation for temporary arterial occlusion

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Purpose: To evaluate the embolic effect, the tissue reaction, and the absorption of water-soluble polyvinyl alcohol (PVA) particles in renal arteries of pigs.
Materials/Methods: Water-soluble PVA were specially made for this study. The chemical and physical properties of these round-shaped particles are: polymerization degree: 300, saponification degree: 97 and 99%, diameter range: 150-212 µm. The solubility of PVA into water was adjusted by the saponification degree. PVA (1 g in 5 ml of water-soluble contrast medium) was injected via a microcathter into the renal artery of pigs. Occlusion time was evaluated on angiography, and tissue reaction and absorption were evaluated by pathological examination.
Results: Occlusion time on angiography was 30 minutes and three weeks with PVA saponification degrees at 97 and 99%, respectively. On histopathology, there was no residual embolization or severe foreign body reaction in the renal artery occluded with either PVA.
Conclusion: Water-soluble PVA particles are an efficient temporary embolic material, since they block blood vessels without major tissue reactions, and their absorption can be controlled by adjusting their chemical properties.

49.6.2

Necrosis induced by acetic acid release from sodium acrylate polyvinyl-microspheres in sheep liver embolization

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Purpose: To evaluate hepatic necrosis caused by acetic acid (AA)-release from sodium acrylate polyvinyl alcohol microspheres (SAP) in embolized sheep liver.
Materials/Methods: SAP loaded with AA (AA-SAP) versus saline (control). Hepatic artery embolization with 3 ml of SAP sediment was done in six sheep, sacrificed after 48 hours. HES staining and morphometry were performed for: (i) presence/absence of necrosis of occluded hepatic arteriole (HA), portal veinule (PV), biliary duct (BD), hepatocytes (HEP), (ii) necrosis area (NECarea), necrosis diameter (NECdiam).
Results: No complications occurred during embolization in the controls versus 75% blood pressure reduction for several minutes in AA-SAP group; 141 SAP centred areas were analysed. SAP diameter (227±69 µm) was no different between the two groups (p=0.3549, NS KW). Damages were limited to HA fibrinoid necrosis (25%) in controls. AA-SAP induced a necrosis of: AH (coagulation necrosis, 56% p<0.0001 versus control SAP), HEP 40%, BD 31%, and PV 15%. NECarea was 1382196 ±1830441 µm^2, median 529468 µm^2, min-max=117409-6846748. NECdiam was 1112±740 µm, median 817 µm, min-max=386-2952), ie five times SAP diameter.
Conclusion: AA-release from SAP has a strong necrotizing effect. It could be proposed for SAP loading only if its immediate release could be reduced to avoid systemic effects.

49.6.3

A new composite gel for embolization: evaluation in an animal model

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Purpose: Gelling solutions based on poly[N-(2-hydroxypropyl)metha crylamide] (pHPMA) in ethanol have been developed and optimized by adjusting copolymer composition, molecular weight, and concentration (Seron, CIRSE 2005). Specially-tailored particles have been added to pHPMA solutions to (i) increase the injected mass and decrease the amount of solvent; (ii) enhance gel cohesion; (iii) allow drug-release. Our purpose was to prove, in animal models, that addition of particles to the composite solution was effective.
Materials/Methods: Seventeen intercostal arteries were catheterized in sheep and embolized with 1 ml pHPMA solutions without (n=8) or with 5% (vol/vol) particles (n=9), manually injected with 1-ml syringes in 2.7-F microcatheters. Two parameters were noted on angiograms at 10 mn: (i) fragmented versus non-fragmented embolus, (ii) distal versus proximal to the catheter tip blockade. The software Statview SAS 2000 was employed.
Results: Solutions were easy to inject. There were no blockades during injection or catheter gluing during withdrawal. After 10 minutes, the composite gel was more cohesive than non-loaded solution: 8/9 fragmented versus 0/8 non-fragmented (p=0.0013), and blocked more proximally: 7/9 proximal versus 0/8 distal (p=0.0053).
Conclusion: Addition of tailored particles in pHPMA solutions increased gel cohesion and stability *in vivo*. Such product seems promising for embolization and drug release.

49.6.4

Magnetic resonance-detectable microspheres for embolization: biocompatibility and detectability in sheep uterus at three weeks and seven months

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Purpose: Magnetic resonance (MR)-marking of trisacryl embolization microspheres is efficient (CIRSE 2005, Chapot). Purpose was to assess that these microspheres are *1)* still detected after long-term implantation in sheep uterus, *2)* well tolerated at short- and long-terms.
Materials/Methods: Trisacryl microspheres were marked with two MR contrast solutions (MR1, MR2) and compared with unloaded control microspheres (MS). Eighteen ewes underwent uterine artery embolization with 500-700µm MR1, MR2 or MS. Euthanasia was done at three weeks (3W) or seven months (7M). Uterus samples were analysed with 1.5-Tesla MR and by histology with HES, MGG stainings and immunohistochemistry for foreign body reaction (FBR) cells (T-cells, B-cells, macrophages, and giant cells). Parameters were detection rate with MR and FBR intensity.
Results: MR1 and MR2 were both detected at 3W and 7M, while MS were not. T-cells, macrophages, and giant cells were present at 3W and, at lower degrees, at 7M. B-cells were absent at both time points. FBR intensity was not significantly different between MR and MS microspheres. MR2 were slighty more inflammative than MS at 3W.
Conclusion: MR microspheres were still detected at long-term after embolization. Marking with MR contrast agent did not modify short- or long-term tolerance of trisacryl microspheres.

49.6.5

Ibuprofen-loaded embolisation microspheres: quantification of their anti-inflammatory effect in a sheep uterus model

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Purpose: Ibuprofen (IBU)-loaded polyvinyl alcohol (PVA) microspheres are indicated to alleviate pain (Biocompatibles, UK). We assessed the release and effect of IBU-microspheres on foreign body inflammatory reaction in sheep uterus.
Materials/Methods: Twelve randomised hormonally-cycled ewes were embolised in uterine arteries with 0.5 ml IBU-loaded BeadBlock (IBU-BB) (n=6) or non-loaded BeadBlock (BB) (n=6), and sacrificed at one (1W) or three weeks (3W) (n=3 each group). HES staining and CD-immuno-histomarking of inflammatory cells types: CD3, CD4, CD8, D21, CD45RA, D11B, CD172a, MHC-II, anti-IBU-IgG were done. The software Statview SAS 2000 was used.
Results: IBU was still present in small amounts in IBU-BB at 1W, but quite not detectable at 3W. At 1W, there was quite no inflammatory response on IBU-BB, and a moderate one on BB. Compared to BB, IBU-BB had significantly less lymphocytes (<0.0001, Chi2 test) in HES, less CD172a (p=.0411, MW), CD3 (p=.0111, MW), CD4 (p=.0300, MW) and MHCII (p=.0043, MW) than BB in immunohistochemistry. At 3W the inflammatory response on IBU-BB developed significantly while it decreased on BB. There was no or very low amounts of CD8, CD45RA, and CD21 in all groups.
Conclusion: IBU-BB proved to release IBU and have an anti-inflammatory action on foreign body reaction post-embolisation.

49.6.6

Lung radiofrequency ablation: *in-vivo* **experimental study with perfused multi-tined electrodes**

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Purpose: To investigate feasibility and safety of lung radiofrequency (RF) ablation by using perfused expandable multi-tined electrodes in an *in-vivo* animal model
Materials/Methods: Ten New Zealand White rabbits underwent RF ablation by using perfused expandable multi-tined electrodes (Starburst Talon, RITA Medical Systems, Mountain View, CA) and 200-W RF generator. Saline perfusate was doped with nonionic iodinated contrast agent to render it visible on computed tomography (CT). An immediate posttreatment CT scanning documented the distribution of the doped saline and the presence of immediate complications. The animals were monitored for delayed complications and sacrificed within 72 hours (n=4), two weeks (n=3), or four weeks (n=3). Assessment of ablation zone and adjacent structures was done at autopsy.
Results: Major complications consisted of pneumothorax requiring drainage (n=2) and skin burn (n=1). Immediately after the procedure the area of ablation was depicted at CT as a round, well-demarcated area, homogenously opacified by iodinated contrast media. The presence of a sharply demarcated area of coagulation necrosis without severe damage to adjacent structures was confirmed at autopsy.
Conclusion: Lung RF ablation performed in an *in-vivo* animal model by using perfused expandable multi-tined electrodes is feasible and safe. No severe damage to adjacent structures was demonstrated.

49.6.7

Endovascular therapy of visceral artery aneurysms

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Purpose: Visceral artery aneurysms (VAAs) are a rare entity with a high rate of morbidity (20% are symptomatic) and mortality. We present our results with the embolization therapy of VAAs.
Materials/Methods: Between September 1984 and February 2006, 36 patients (ten women, 26 men, mean age 59 years) with 42 VAAs were treated endovascularly. VAAs locations were: splenic artery: n=10, hepatic artery: n=8, pancreaticoduodenal artery: n=6, renal artery: n=5, celiac trunk: n=4, gastroduodenal artery: n=4, jejunal artery: n=3, ileocolic artery: n=1, superior rectal artery: n=1. Mechanically detachable coils were used in all cases as embolization material. In two cases, stent-assisted coiling was performed. Parent vessel was occluded in mycotic VAAs only.
Results: A primary complete or sufficient VAA occlusion was achieved in 37 cases (88%). In four patients with coil compaction, re-coiling was performed. Two patients underwent a staged procedure. Minor complications occured in five cases: one segmental renal infarction and four splenic infarctions (one with a secondary infection). No major complications or mortalities occurred.
Conclusion: Embolization of VAAs is a minimally invasive and safe therapeutic option, even in emergency cases. Mechanically detachable coils should be the embolic agent of choice, especially for preserving the parent artery.

49.6.8

Emergent transcatheter embolization of traumatic mesenteric hemorrhage

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Purpose: To assess technical feasibility and clinical efficacy of embolization to manage traumatic mesenteric arterial injuries.
Materials/Methods: In five unstable polytraumatized patients, an active bleeding in the mesenteric area was diagnosed on admission computed tomography (CT). Associated low-grade hepatic (n=1), or splenic (n=1) injury were observed in two cases. No sign of digestive tract perforation nor gastrointestinal tract bleeding was present. Angiographic findings included active peritoneal bleeding arising from distal ileal (n=3), jejunal (n=1) or sigmoid (n=1) arterial branches. Superselective embolization with coils was performed through either two or one feeders in three and two patients, respectively. Additional glue injection was performed to complete the hemostasis in one patient. A synchronous embolization of the transected internal iliac artery was done in two patients.
Results: An immediate mesenteric hemostasis with dramatic hemodynamic stabilization was achieved in all five patients. No delayed mesenteric rebleeding nor mesenteric ischemia or gastrointestinal stricture occurred during follow-up (8-54 months) in four patients. In the remaining patient, CT at day 8 confirmed clinical suspicion of colonic ischemia requiring a limited surgical resection.
Conclusion: Embolization may be considered the primary treatment modality in traumatic mesenteric hemorrhage. Serial control CT are needed to detect early complications requiring surgery.

49.6.9

Diagnostic angiography and interventional approach for gastrointestinal bleeding

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Purpose: Patients with acute gastrointestinal bleeding referred for angiography were reviewed; indications and roles of angiography and trans-catheter treatment were discussed.
Materials/Methods: Twenty-eight angiographies in 20 patients with acute gastrointestinal bleeding were included. Based on medical records, the presence of shock, blood transfusion requirements, angiographic results, treatment choices, outcomes, and final diagnoses were reviewed. Incidence of positive angiographic results (angiography+R) and consequent treatment choices were investigated, depending on patients' conditions and final diagnoses.
Results: Angiography+R were found in 9/28 examinations. They were statistically more often associated with the presence of shock (5/9 versus 2/19) and trans-catheter therapy (8/9 versus 2/19). Patients with colonic diverticula and gastric ulcer always showed angiography+R and simultaneous embolotherapy was quite effective (4/4). In patients with Crohn's disease, endoscopy-guided trans-catheter treatment was effectively performed even in patients with negative angiographic results (4/8). Angiographic results were negative or unuseful in treatment choice in most patients with ulcerative colitis, small bowel ulcers, or gastrointestinal bleeding of unknown cause (14/15).
Conclusion: Angiography for gastrointestinal bleeding should be performed in patients with colonic diverticula and Crohn's disease, when simultaneous trans-catheter treatments are effective. The role of post-endoscopy angiography for gastrointestinal bleeding of unknown cause is confirmed in massively bleeding patients.

49.7.1

Acute results of 4-F sheath-compatible self-expanding nitinol stents for the treatment of infragenicular arteries following unsuccessful balloon-angioplasty

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Purpose: To assess feasibility of self-expanding nitinol stents in the treatment of infragenicular arteries following unsuccessful balloon-angioplasty. Options for lower limb percutaneous revascularization are limited, especially for complex vessel obstruction. Depending on the lesion and the experience of the operator, the failure rate of balloon-angioplasty (PTA) ranges between 10 and 40%. Until recently, no self-expanding stents for the use in infragenicular arteries are available.
Materials/Methods: This is the first report on acute results of 19 consecutive patients who received 4-F sheath-compatible self-expanding nitinol stents following unsuccessful PTA.
Results: Twenty-six stents were implanted in 22 arteries for various indications: residual stenosis >50% due to heavy calcification, flow-limiting dissection, and occluding thrombus resistant to thrombolyis, thrombaspiration, and PTA. Stent implantation was feasible in all cases. No complications occurred. After stent implantation, all primarily unsuccessful interventions could be transformed into successful procedures with no residual stenosis >30% in any case.
Conclusion: The use of self-expanding nitinol stents in tibioperoneal arteries is a safe and feasible option for the treatment of unsuccessful PTA.

49.7.2

Endovascular therapy in Takayasu's arteritis

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Purpose: To assess the efficacy and safety of percutaneous transluminal angioplasty (PTA) and stent implantation in Takayasu's arteritis.
Materials/Methods: PTA was performed for 35 lesions in 28 patients with symptomatic stenoses (>70%) secondary to Takayasu's arteritis. Stent implantation was carried out in those patients in whom an adequate luminal patency could not be achieved by PTA alone. All interventions were performed during the inactive phase of the disease.
Results: Symptoms regressed in all the patients immediately after the procedure. Primary technical success was 96%. Complications occurred in two patients (renal artery dissection, back pain). Restenoses developed in three cases in four arteries and were treated with repeat angioplasty. Mean follow up was 38 months.
Conclusion: Takayasu's arteritis involves larger vessels such as the aorta, the main branches, the coronary and pulmonary arteries and leads to stenoses or occlusions. The endovascular treatment (PTA, stent implantation) is an effective and safe option in stenotic complications of Takayasu's arteritis.

49.7.3

Superficial femoral artery subintimal angioplasty: our experience in 148 patients

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Purpose: To evaluate indications, feasibility, and results of subintimal angioplasty of long femoropopliteal occlusions in patients with severe claudicatio and/or critical limbs ischaemia.
Materials/Methods: We treated 148 patients (91 men, 57 women; mean age: 71.3 years) with long femoropopliteal occlusions (>10 cm). Seventy-five patients were symptomatic for claudicatio, 22 had rest pain, and 51 presented with gangrene. All the patients were evaluated by angio-magnetic resonance and Doppler-ultrasound before the treatment. Recanalization of the superficial femoral artery was always performed. A concurrent recanalization of limb arteries was carried out in 64 patients. In 139 cases, recanalization was obtained by antegrade femoral approach, in three cases by retrograde trans-popliteal approach, and in six by a combined femoral-popliteal approach. Follow-ups with physical examinations and Doppler-ultrasounds were at one, three, and six months after the procedure and every six months thereafter.
Results: Technical success was 93.5%, with a resolution of rest pain or claudicatio in 83/97 patients and a complete resolution of gangrene in 40/51 patients. Six patients underwent a minor amputation only. A mean follow-up of 13.3 months demonstrated the patency in 122/148 patients.
Conclusion: Subintimal angioplasty of long femoropopliteal occlusions is a safe and effective technique and a valid alternative to surgery.

49.7.4

Leg reconstruction by reversed saphenous flap: role of interventional radiology

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Purpose: Reconstruction of skin degloving lesions remains a significant challenge for reconstructive surgery. A reliable and vital saphenous reversed flap represents an excellent therapeutic option. This study is related to the angiographic evaluations of microvascular pattern improvement after surgery.
Materials/Methods: In the period December 2001-December 2005, 37 patients (21 men) were treated by sural or saphenous reversed flap. Surgical indications for lower leg, heel, and proximal foot were chronic ulcer (14), open fractures (8), diabetic ulcer (8), ischemic (5), and neoplastic ulcer (2), One- or two-step techniques of flap preparation were considered according to the patient conditions. Nineteen patients underwent peripheral percutaneous transluminal angioplasty (PTA) to improve distal circulation.
Results: All the patients were evaluated by digital subtraction angiography preoperatively and three months after surgery. The flap survived completely in 31 (83.8%) patients, and, in all cases, a microcirculation improvement was achieved. Eleven patients with severe systemic diseases (seven diabetes and four peripheral vasculopathy) suffered from delayed healing due to venous congestion. PTA of tibio-peroneal arteries was successful in all cases.
Conclusion: The evaluation of these patients confirmed the role of microvascular pattern improvement after plastic surgery, enhanced by the positive results of the endovascular treatment.

49.7.5

Cutting-balloon angioplasty versus conventional balloon angioplasty in short femoro-popliteal arterial stenoses

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Purpose: To compare medium-term results of cutting-balloon angioplasty (CBA) with percutaneous transluminal angioplasty (PTA) for the treatment of short femoro-popliteal arterial stenoses (TransAtlantic InterSociety Consensus, Type A).
Materials/Methods: Between February 2004 and June 2005, 55 consecutive patients with 61 focal (<3 cm) calcified femoro-popliteal severe stenoses underwent endovascular treatment: 27 patients (29 lesions) were treated with PTA (Group A) whereas 28 patients (32 lesions) underwent CBA (Cutting-Balloon Ultra; IVT/Boston Scientific; 3.5-5 mm diameter/10-15 mm length) (Group B). Follow-up consisted of clinical and color duplex ultrasonography examinations at one and three months, and every three months thereafter.
Results: All treatments were successfully performed via anterograde approach with a technical success rate of 100%, without major complications. In two Group-A treated lesions (2/29, 6.9%) stents were implanted due to dissection, whereas no patient of Group B required stent placement because of recoil, dissection, or arterial tears. At 12 months, primary and secondary patency rates were 73.8% and 77.9% in Group A, and 80.5% and 87.7% in Group B, respectively.
Conclusion: CBA seems to be a valuable tool in the endovascular treatment of short femoro-popliteal stenotic lesions achieving an increased patency and better medium-term results as compared with conventional PTA.

49.7.6

Percutaneous transluminal angioplasty for atheromatous peripheral lesions: a prospective evaluation of mortality and morbidity rates

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Purpose: To evaluate mortality and morbidity in a prospective multicenter study in patients treated by percutaneous transluminal angioplasty (PTA) for atheromatous peripheral artery diseases.
Materials/Methods: Between May 1998 and December 2003, 2773 post-PTA patients (75% men, 25% women) coming from 12 centers were enrolled in a prospective registry. Treated sites were the lower limbs artery (67%), the renal artery (28%) and other sites (5%). Follow-up at one, six months and every year was recommended by ultrasound and clinical evaluation.
Results: After five years, morbidity and mortality were respectively 25% and 5.5% in the total population, 22.7% and 4.1% in the lower limbs group, and 29% and 8% in the renal group. Restenoses occurred in 25.1% of total population; in 29% of the lower limbs group, and in 22.7% of the renal group. No difference was noticed between centers. Mortality and morbidity rates decreased with time, possibly due to prevention programs.
Conclusion: Post-PTA evaluation and follow-up of the treated patients should be mandatory in good clinical practice. Our study demonstrates that restenosis, cardiovascular events, and mortality rates are significant, thus confirming the need of follow-ups.

49.7.7

Comparison of rotational thrombectomy and ultrasound-enhanced thrombolysis in acute limb ischemia

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Purpose: The aim of this study was to compare ultrasound-enhanced thrombolysis (EKOS Lysus®) with less invasive mechanical thrombectomy (Straub Rotarex™) for treatment of acute limb ischemias.
Materials/Methods: Forty-five patients, mean age 67±7.6 years (range 42-82), with acute occlusions (<14 days) of lower limb arteries were treated with either a mechanical thrombectomy system (n=25), or with local thrombolysis [recombinant tissue plasminogen activator (rt-PA), n=22]. Mean occlusion length was 21.5 cm (range 5-37) in the thrombectomy group, and 23.6 cm (range 2-50) in the thrombolysis group.
Results: Technical success rate was 96% for thrombectomy and 91% for thrombolysis. Total clot removal was achieved after a mean time of 0.75 hours (0.5-1.5) with mechanical thrombectomy and 12.4 hours (range 5.8-25.0 hours) with thrombolysis. After a mean follow-up of three months, primary patency rate was 92% for thrombectomy and 87% for thrombolysis. Distal embolizations occurred in six patients in the thrombolysis group, but were not recorded in the thrombectomy group. There were no cases of amputation or death during follow-up.
Conclusion: Patency rates did not show significant difference between mechanical thrombectomy and local thrombolysis. The advantages of mechanical thrombectomy were its lower complication rate and shorter time to restore blood flow.

49.7.8

Rapid-exchange monorail technique enhances technical success of percutaneous transluminal angioplasty in patients with femoropopliteal occlusive disease

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Purpose: To evaluate procedural outcome of rapid-exchange (RX) monorail versus conventional over-the-wire (OTW) technique for femoropopliteal angioplasty.
Materials/Methods: Procedure details, success, and complications of 328 consecutive percutaneous transluminal angioplasties (PTA) were collected from a prospective database. RX technique was used in 102/328 patients (31%), OTW technique in 226/328 (68%). Demografic data, procedural details, technical success, and complication rates were analyzed.
Results: Technical success was 100% in RX versus 95.4% in OTW technique (p=0.02). A significantly greater number of stents was implanted with the OTW technique (OTW: 13.7%, RX: 5.9%, p=0.04). There were no significant differences in fluorocopy time, dose-area product, or amount of contrast media. The RX system facilitated the use of smaller sheath sizes (5 F=38%, 6 F=59% in RX versus 5 F=16.8%, 6 F or larger=82.5% in OTW), but there was a trend towards lower complication rates (major complications: 5.8% in RX versus 9.1% in OTW, p=0.18); there was no effect on length of hospitalizations. Overall, RX monorail systems were not associated with higher costs when compared with conventional OTW technique.
Conclusion: Monorail systems enhance technical success of femoropopliteal interventions with a trend towards lower complication rates. Overall cost is not higher when compared with conventional OTW technique.

49.7.9

Long-term results of hybrid (combined open vascular and endovascular) interventions for the treatment of chronic lower limb ischemia

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Purpose: To assess acute and long-term results of the combination of conventional open surgical techniques with endovascular measures within the same sitting in the treatment of symptomatic lower limb ischemia.
Materials/Methods: One-hundred and twelve lower limbs of 96 patients (78 men, mean age 65±9.4 years) with symptomatic peripheral arterial disease (stage I: n=1, stage II: n=65; stage III: n=16, stage IV: n=30) were treated with a hybrid therapy of open surgical treatment (thrombendarterectomy n=84; bypass n=25; patch insertion n=78; Fogarty thrombectomy n=36) and endovascular interventions (percutaneous transluminal angioplasty n=131; stent implantation; n=107) within the same session; 373 occlusions/stenoses were treated (iliac: n=155, femoral: n=172, popliteal n=28; infrapopliteal n=18). Patients were followed up to six years (mean: 833± 623 days).
Results: Acute technical success of hybrid interventions was 94%. Ankle-brachial index increased significantly from 0.55 to 0.87. Four early thrombotic reocclusions and seven major complications occurred. Six-month and one-, two-, three-, and four-year cumulative limb salvage rates were 92%, 88%, 88%, 88% and 88%.
Conclusion: Hybrid procedures enabled treatment of chronic lower limb ischemia with reduced invasiveness, since inflow (iliac) or outflow (infraingunal) lesions can be treated from a femoral surgical cut down. Long-term results are comparable with extensive surgical reconstructions.

P1

What is the most important factor for the successful interventional embolization of gastrointestinal hemorrhages? A logistic regression analysis

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Purpose: We compared the relationship between angiographic extravasation and pre-angiography examination results using a multivariate analysis of preoperative study.
Materials/Methods: We retrospectively analyzed 35 patients with acute gastrointestinal hemorrhage who had undergone angiographic examinations. Their age ranged from 25 to 91 years. Pre-operative examination results, including shock index (SI), pulse rate (PR), systolic and diastolic blood pressure (SBP, DBP), hemoglobin (Hb), red blood cell counts (RBC), and hematocrit (Hct) were quantitatively analyzed. Statistical analysis was performed using a logistic regression model.
Results: Of the 35 patients, 17 manifested angiographic evidence of extravasation; in nine of them, extravasation was demonstrated on selective angiograms. Bleeding was completely stopped by initial embolization in 13 of the 17 patients, while the other four required additional embolizations. Factors significantly associated with angiographic visualization of extravasation in patients with gastrointestinal hemorrhage were SI, Hb, Hct, SBP, PR, RBC, and DBP. Among these, the SI was the most important one (range 0.403 - 2.050, mean 0.812).
Conclusion: In patients with gastrointestinal hemorrhage, angiographic visualization of extravasation is associated with pre-embolization SI. Patients with high SI values should undergo angiographic studies to facilitate planning of their optimal treatment.

P2

A newly developed biodegradable stent for the gastrointestinal tract: a preliminary clinical trial

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Purpose: We newly developed an Ultraflex type biodegradable stent constructed of knitted polylactic acid monofilaments for the treatment of benign alimentary tract stenoses. In this study, its clinical application was attempted and its usefulness and safety assessed.
Materials/Methods: Six patients with benign gastrointestinal stenoses in whom previous balloon-dilatations were unsuccessful were enrolled. The stents were placed under a combined fluoroscopic and endoscopic guidance.
Results: Stent placements were successful in all six cases (100%). Improvements were achieved immediately after stent placement in all six cases (100%). In three cases (50%), the stents had migrated at 15-day follow-up; in two cases (33%), stents had migrated after 12 days; and in one case (17%), the stent had migrated after ten days. In all cases, the stent was excreted with feces without any complications. At two-month follow-up, mild stenoses had recurred in four cases (66%) and a severe stenosis in one case (17%).
Conclusion: The results of six clinical cases confirmed the usefulness of this newly developed biodegradable stent for the alimentary tract.

P3

Percutaneous gastrostomy: long-term experience

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Purpose: Interventional radiologists play a main role in the technical evolution of gastrostomy from the first surgical/endoscopical approaches to percutaneous interventional procedures. The aim of this study is to evaluate the results of a 12-year series.
Materials/Methods: During the period December 1992-December 2005, 244 new consecutive gastrostomies and 265 replacement procedures were performed in selected patients. All the cases were treated by T-fastener gastropexy and tube placement. The procedures were monitored by analyzing indications, patients' selection, duration, type of sedation, morbidity, and mortality.
Results: All 244 gastrostomies were successfully carried out. One patient with severe neurologic disorders (0.4%) died after the procedure without signs of procedure-related complications; seven (2.86%) major complications occurred (four duodenal lesions with peritoneal leakage, three gastric bleedings, and one gastric lesion). Minor complications were easily managed; three tube ruptures were resolved. Replacement procedures also were successfully performed.
Conclusion: This long-term series and follow-up showed that a group of interventional radiologist can manage a competitive service for gastrostomy placement and long-term tube management. Percutaneous gastrostomy is less invasive if compared with other approaches and it matches the need even in high-risk patients.

P4

Microcatheter-port system with the use of a coaxial method for hepatic intraarterial chemotherapy

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Purpose: To assess the feasibility of transfemoral placement of a microcatheter-port system with the use of a coaxial method for hepatic intraarterial chemotherapy.
Materials/Methods: One-hundred and four adult patients (mean age: 62 years) underwent transfemoral placement of a microcatheter-port system with a coaxial method under local anesthesia for hepatic intraarterial chemotherapy during a two-year period. There were 72 hepatocellular carcinomas, 17 liver metastases, five cholangiocarcinomas, and ten other diseases. There were 12/104 difficult cases for the current 5-F catheter-port system due to tortuous or stenotic common hepatic arteries. The 2.9-F microcatheter was placed coaxially in the appropriate position after placement of the 5-F catheter at the orifice of the celiac artery.
Results: Technical success rate was 99% (103/104). The microcatheter tip-fixation method was applied in 17 cases, the non-fixation method was used in 86 cases. The mean port patency was 292 days. During follow-up, dislocations (n=12), catheter infection (n=1), port infections (n=2), skin defect (n=1), and acute occlusion of the hepatic artery (n=1) were recorded as complications.
Conclusion: Placement of a microcatheter-port system with the use of a coaxial method for hepatic intraarterial chemotherapy is feasible, particularly in difficult cases with tortuous or stenotic common hepatic arteries.

P5

Endovascular treatment of chronic splanchnic syndrome

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Purpose: This retrospective study evaluates the endovascular treatment of chronic splanchnic syndrome (CSS). Indications for endovascular and surgical treatment will be discussed.
Material/Methods: In the period 2000-2005, 530 patients were evaluated for CSS. One-hundred sixty-seven patients had proven CSS on clinical criteria: 83 of them underwent surgery, 25 were treated conservatively, 59 patients underwent stent placement: 30 in the celiac artery (CA), 14 in the superior mesenteric artery (SMA), 13 in both these arteries, and two in the inferior mesenteric artery (IMA). The femoral as well as the brachial approach were used.
Results: In 61 patients there was an intention-to-treat. We recorded two failures due to technical reasons. In the 59 patients with stent placement, this was technically successful. In 89% of patients there was a complete or a significant relief of complaints. In 11% there were no changes. Two stent fractures were recorded in patients with celiac artery compression syndrome (CACS). Complications included: one procedure-related death and two false aneurysms in the brachial artery.
Conclusion: Stent placement is a safe therapeutic option in patients with CSS and significant atherosclerotic stenosis in the CA and/or SMA. Stenting stenosis in CACS is contraindicated due to the risk of stent fracture.

P6

Co-morbidities prolong pancreatic drainage duration of catheterization

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Purpose: To evaluate the effect of co-morbidities in duration of catheterization after percutaneous drainage of pancreatic fluid collections (PFCs).
Materials/Methods: This prospective study includes 83 consecutive patients who underwent percutaneous drainage of PFCs. Pancreatitis causes were: alcohol abuse (n=34); posttraumatic (n=28); postoperative (n= 24); blunt abdominal trauma, (n=5); hyperlipidemia (n=7); biliary (n=6); drugs (n=3); vasculitis (n=2); transplantation (n=1); idiopathic (n=1). Drainage indications were: sepsis, pain, biliary or gastrointestinal obstruction. Mean duration of catheterization (MDC) was compared for patients that had no co-morbidities and those with diabetes, malnutrition and steroid use. Patients were followed up for at least one year after catheters were removed.
Results: PFCs resolution occurred in 68/ 83 patients; nine patients died; two patients had surgery and four were lost to follow-up. MDC for the 68 patients was 47 days; MDC for patients without co-morbidities (n=34), 27 days; patients with comorbidities (n=34), 68 days; steroids and diabetes, 90 days; diabetes and malnutrition, 95 days; steroids alone, 77 days; diabetes alone, 64 days; malnutrition, 26 days.
Conclusion: MDC is expected to be more than doubled for patients with diabetes and steroid use. Malnutrition alone does not affect MDC.

P7

Percutaneous radiologic gastrostomy and gastrojejunostomy in children

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Purpose: To evaluate the results of percutaneous radiologic gastrostomy and gastrojejunostomy in children.
Materials/Methods: Twenty-six percutaneous gastrostomies and seven percutaneous gastrojejunostomies in 33 children (21 boys, 12 girls) were performed under fluoroscopy guidance and intravenous sedation. Ages were ranging from eight months to 15 years (mean, six years). Routine gastropexy was performed and 12- to 20-F catheters were used. Periodic catheter exchanges were performed in the follow-up. Indications were neurologic disorders in 12, oncologic disorders in six, metabolic disorders in five, and miscellaneous disorders in ten patients.
Results: Technical success rate was 100%. No procedure-related mortality was seen. One patient died within 30 days for underlying disease. Major complications were not detected. Catheter-related complications--such as infection, dislodgement ,and leakage--were detected in nine patients and managed with catheter exchanges. Mean follow-up period was 218 days (range, 14- 540 days) for 33 patients. In the follow-up period, other four patients died for their primary disease. In 11/28 patients, catheters were removed when they tolerated oral feeding. In the remaining 17/28 patients catheters are still in use.
Conclusion: Percutaneous radiologic gastrostomy and gastrojejunostomy in childen are safe and effective procedures with high success and low complication rates.

P8

A review of 125 computed tomography-guided percutaneous treatments of residual cavities after hydatidectomy

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Purpose: To evaluate efficacy and safety of computed tomography (CT)-guided percutaneous treatment of residual cavities after hydatidectomy.
Materials/Methods: A retrospective analysis on 125 CT-guided percutaneous treatments of residual cavities after hydatidectomy was performed between 1999 and 2005 at the National Scientific Center of Surgery. Patients' age ranged between 13 and 69 years (mean 41); cavities' sizes ranged between 3 and 15 cm (mean 9). The procedures were performed by Seldinger technique and pigtail catheters in 25 (20%) cases, in two steps in 68 (54.4%), and by trocar method in 32 (25.6%). In 85 (68%) cases cavities were suppurated.
Results: Technical success rate was 85.5%. No procedure-related mortality was seen. In five patients bleeding occurred, in nine cases--in whom the cavity was localized at the VII and VIII liver segments--the partial collapse of the right lung was recorded, which did not require any treatment. Major complications were not detected. The duration of catheterization ranged between two and 47 days. In 15 (12%) cases, the treatment was unsuccessful and the patients underwent repeat surgical treatment.
Conclusion: CT-guided percutaneous treatment of residual cavities after hydatidectomy is a safe and effective alternative procedure to surgery, without mortality, low morbidities, and high success rates.

P9

Percutaneous radiological gastrostomy in advanced amyotrophic lateral sclerosis

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Purpose: Enteral nutrition may be required in amyotrophic lateral sclerosis (ALS), and is usually achieved by percutenous endoscopic gastrostomy (PEG). PEG, however, is not indicated in patients with severe respiratory impairment; an alternative, therefore, is represented by percutaneous radiological gastrostomy (PRG). The aim of the present work is to evaluate PRG safety and its effect on survival and respiratory function in ALS patients with respiratory failure.
Materials/Methods: from October 2000, 40 consecutive ALS patients with severe dysphagia and forced vital capacity (FVC) <50% underwent PRG and compared with 40 consecutive ALS patients with FVC <50% who underwent PEG before October 2000. The respiratory function was evaluated before and after the procedure
Results: The two groups were similar for all relevant characteristics. PRG was successful in all cases, PEG in 36/40. One patient in each group died after the procedure. The mean survival time after the procedure was 204 days in the PRG group and 85 days in the PEG group ($p<0.004$). Respiratory function decreased more in the PEG group than in the PRG group ($p<0.02$).
Conclusion: PRG appears to be safer than PEG in ALS patients with moderate or severe respiratory impairment, and is followed by a longer survival.

P11

Endovascular repair of hypogastric artery aneurysms: nine-year experience

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Purpose: To report a single-center experience in the endovascular repair of hypogastric artery aneurysms (HAAs).
Materials/Methods: Over a nine-year period, 67 HAAs in 59 patients (55 men, four women) underwent embolization procedures with Gianturco coils. Of the 59 aneurysms, 45 were associated with aorto-iliac aneurysms, nine were associated with common iliac artery aneurysms, and three were isolated HAAs. Patients with associated aneurysms were scheduled for stent-graft placement over the origin of the hypogastric artery. Patients were followed by office visits and computed tomography-angiography at one month, six months, and annually following treatment to monitor for the presence of endoleak and size of the aneurysm sac.
Results: The mean HAA size treated was 59 mm (range 20-113). All embolizations were successful with no major complications. Follow up was available for 48 patients over a period ranging from 1 to 70 months (mean 28). Endoleaks were seen in the HAA in four patients (8%). Five patients required re-intervention for endoleak (n=4) and rupture (n = 1). Thirty-three patients with no endoleak had shrinkage of the sac at 12 months (range 3-27 mm).
Conclusion: Endovascular repair for HAAs is an effective procedure with excellent long-term results. Successful treatment leads to sac shrinkage.

P13

Preclose technique for percutaneous repair of large-bore femoral access in percutaneous aortic stent-graft intervention

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Purpose: To evaluate technical feasibility and clinical effectiveness of the "preclose technique" using 6-F Closer S^{TM} devices in percutaneous aortic stent-grafting.
Materials/Methods: Sixty-one patients who had undergone percutaneous aortic stent-graft placement (20 patients with an abdominal aortic aneurysm; 13 patients with a thoracic aortic aneurysm; 28 patients with an aortic dissection) with the „preclose technique" were reviewed retrospectively. Eighty-one femoral accesses were performed with this technique. Sizes of the introducer sheaths were: 18 F (n=35), 16 F (n=10), 14 F (n=27), and 12 F (n=9). Six-F Closer S^{TM}devices were used as closing devices. Three (n=25) or two (n=56) preclose devices were used.
Results: A technical success was achieved in 78 of the 81 preclose femoral accesses (96.3%). Two technical failures were due to low femoral puncture sites, and one case to suture loop entanglement. Pseudoaneurysms developed in three cases (3.7%), and hematomas were observed in two cases (2.5%). The patients with these complications did not require further invasive treatments.
Conclusion: The „preclose technique" using 6-F Closer S^{TM} devices was a technically feasible and a clinically effective method for closing large-bore femoral accesses in percutaneous aortic stent-graft interventions with introducer sheaths measuring less than 18 F.

P14

Endovascular repair of inflammatory aortic aneurysms: long-term results

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Purpose: To report long-term follow-up results of endovascular aneurysm repair (EVAR) of inflammatory aortic aneurysms (IAA).
Materials/Methods: In a retrospective cohort study, based on the findings of pre-interventional computed tomography angiographies (CTA), we identified eight patients with IAA who underwent EVAR. Primary and follow-up images were reviewed by two observers for changes in the aneurysm sac diameter, periaortic fibrosis (PAF), potential renal impairment, and procedure-related and long-term complications.
Results: EVAR was successfully completed in all the subjects. Five patients had a minimum follow-up period of 36 months (median 65 months). The maximum diameter of their aneurysm sac decreased from a median of 57 mm (47-95) to a median of 45 mm (36-60), thus resulting in a median relative regression of 21.1% (4.8-63.1). PAF regressed in all patients; hydronephrosis--which was previously present in two patients--remained unchanged in one and disappeared in the other case. In two patients, a type III endoleak was detected and overstented during the follow-up period.
Conclusion: EVAR of IAA excludes the aneurysm and seems to reduce the size of the aneurysmal sac and the extent of PAF with acceptable peri-procedure and long-term morbidity rates.

P15

Endovascular abdominal aortic aneurysm repair and renal dysfunction: comparison between suprarenal and infrarenal endograft fixation

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Purpose: To compare the impact of suprarenal and infrarenal endograft fixation on renal artery complications and late postoperative renal function.
Materials/Methods: A retrospective analysis of 102 patients with infrarenal abdominal aortic aneurysm who underwent endovascular aneurysm repair (EVAR) was performed: 60 patients were treated with suprarenal endograft fixation (Cook Zenith, Medtronic Talent) (group A), whereas in 42 patients, infrarenal fixation devices (Gore Excluder, Medtronic AneuRX) (Group B) were implanted. Baseline patient demographic data, pre- and post-procedural renal function (CrCl=creatinine clearance), and incidence of renal artery (steno-obstructive disease) and procedure-related (proximal type I endoleak and migration rates) complications, detected on follow-up computed tomography (one, three, six, 12 months), were collected and compared.
Results: No significant differences were found between the two groups in terms of demographic data and pre-operative risk factors. Proximal neck length was significantly shorter in group A ($p<0.05$). CrCl decreased during follow-up in both groups (Group A: 64.24 to 60.66 mL/min; Group B: 72.41 to 68.73 mL/min) without statistically significant differences as well as renal artery and procedure-related complications.
Conclusion: Suprarenal fixation allowed to expand the inclusion criteria for EVAR without increasing renal artery and procedure-related complication rates as well as the likelihood of postoperative renal impairment.

P16

Endovascular stenting of thoracic aortic pathologies

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Purpose: To evaluate short to medium-term results of endovascular stenting of thoracic aortic aneurysms (TAA).
Materials/Methods: A retrospective study of 96 cases with median follow-up of 13 months (range 1-56) was included. Main etiologies were: atherosclerosis (n=64), dissection (n=14), Marfan's (n=4), ulcer (n=5), trauma (n=4), and mycotic (n=5) with eight urgent, 14 emergency, and 74 elective cases. The aneurysms were Crawford Type I (27), II (37), or III (18). Forty-four of the 96 patients underwent adjunctive surgery (four carotid-carotid cross over, 40 retrograde visceral revascularisation). Stents used were Talent (59), Gore (22), Cook (8), AneuRx (2) and combination (5).
Results: The technical success rate was 100%. The 30-day mortality was 16.6% and over all mortality was 22.9%. There were 34/96 (35%) endoleaks: Type I (18), Type II (12), and Type III (4). Of 34 endoleaks, 26 were treated or resolved. Major complications included respiratory support (>5 days) (10), renal impairment requiring temporary support (10), bowel resection (5), neurological (9, 8 resolved).
Cconclusion: Stent-grafts have significantly changed practice with excellent early and medium-term results in this high-risk group of patients. However, long-term data are still awaiting.

P17

Endovascular treatment of abdominal aortic aneurysms. Technical success does not mean overall success in treating abdominal aneurysms

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Purpose: Our purpose was to present our 4.5-year experience with the endovascular treatment of abdomianl aortic aneurysms (AAA) and evaluate follow-up results.
Materials/Methods: From June 2001 to November 2005, 107 patients (103 men, four women; mean age 71±6.9 years) with AAA were treated with endovascular prosthesis placement. One-hundred patients were treated electively and seven were treated on an emergency basis (six patients with rupture and one with aortoenteric fistula). Sixteen patients underwent local, 72 spinal, and 19 general anesthesia.One-hundred and two bifurcated grafts and five abdominal iliac prostheses were inserted.
Results: Technical success was 98%, with no conversions. Peri-procedural complications included one renal artery thrombosis, three iliac dissections, and 45 extension placements (11 cuffs, 34 iliac). Sixty percent of patients had a controllable follow up and 40% were lost to follow up or had unreliable examinations. Three iliac thromboses, three Type I endoleaks (one Ia, two Ib), and five Type II endoleaks were reported.
Conclusion: Endovascular treatment of AAA is considered successful after at least three years of follow-up. Post-procedural follow-ups are mandatory for the prevention and management of late complications.

P18

A single-centre experience in the treatment of ruptured abdominal aneurysms using endovascular stent grafts

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Purpose: Review of procedural success, and durability of endovascular repair of ruptured abdominal aortic aneurysms.
Materials/Methods: Between 2001 and 2006, all anatomically suitable patients with confirmed rupture of an abdominal aortic aneurysm were treated with an endovascular stent graft. Fifty two such patients have been treated, an aorto-uni-iliac system being used for the majority of cases.
Results: Inital operative mortality was very low with only one death in the first 12 patients, this has risen and the possible reasons are explored. The overall mortality for patients presenting to our institution has dropped by 20% since the introduction of our policy to stent if possible.
Conclusion: Endovascular treatment of ruptured abdominal aortic aneurysms is certainly feasible and can provide a definitive treatment or a bridge to subsequent elective open repair.

P19

Hypogastric artery embolization during endovascular treatment of abdominal aortic aneurysms

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Purpose: Hypogastric artery embolization is sometimes required to facilitate endovascular repair of aortoiliac aneurysms. The literature describes several adverse effects (claudication, colon ischemia, buttock tissue necrosis, sexual and neurological dysfunction) in association with internal iliac artery embolization. The aim of this study was to assess safety, efficacy, and adverse effects of hypogastric artery embolization during abdominal aortic anerysms (AAA) repair.
Materials/Methods: From January 1998 to September 2005, 202 patients underwent elective or emergent endovascular AAA repair. Thirty nine patients required unilateral or bilateral periprocedural coil embolization of the hypogastric artery (33 and six, respectively).
Results: No ischemic colitis or buttock necrosis occurred in this series; there was no death related to internal iliac artery occlusion. Mild to severe claudication was found in one (3%) of the 33 patients with unilateral, and in one (16%) of the six patients with bilateral hypogastric embolization. No impotence occurred in any patients and there were no neurological deficits.
Conclusion: Unilateral or bilateral internal iliac artery embolization can be performed with limited morbidity; it increases the applicability for endovascular repair of aortoiliac aneurysms in patients unfit to surgery. However, bilateral occlusion of the internal iliac artery is recommended only when surgical revascularization is not feasible.

P20

The role of the left subclavian artery in patients with short proximal neck during stent-graft treatment of thoracic aortic pathologies

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Purpose: To assess clinical consequences and complications after intentional occlusion of the left subclavian artery (LSA) during stent-graft deployment for thoracic aortic pathologies.
Materials/Methods: From December 2000, 43 type B dissections and 20 thoracic aneurysms (TAA) underwent endovascular treatment. A short proximal neck (<2 cm) was present in 23/43 dissections and in 6/20 TAAs. Pre-treatment evaluation of carotid and vertebral arteries was done in all cases. Dissection: all LSAs were covered by the stent-graft. TAA: LSA origin was covered in five cases.
Results: After LSA exclusion, blood pressure in the left arm significantly decreased. TAA: 5/5 patients were asymptomatic; two endoleaks (40%) originating from the LSA were evident. Dissection: 1/23 patient (4.3%) required a surgical transposition of the LSA for visual impairment eight months after. In eight patients (34.8%), revascularization of the false lumen occurred from the LSA. Endoleak sealed spontaneously in one case (12.5%). LSA origin and false lumen were occluded with coils (N=1), glue (N=4) and coils+glue (N=2).
Conclusion: Prophylactic LSA transposition is not necessary prior to stent-graft placement. For the high incidence of endoleaks, occlusion of the LSA during stent-graft deployment is highly recommended.

P21

Flat-panel computed tomography as a new perinterventional imaging modality in aortic stentgraft procedures. A work in progress

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Purpose: To assess the value of flat-panel computed tomography (CT) during aortic stent-graft procedures.
Materials/Methods: Flat-panel CT was performed in 12 patients immediately after endovascular treatment of aortic aneurysms (five thoracic, seven abdominal aortic aneurysms) on the angiographic table. Images were acquired with a rotating C-arm (Axiom Artis; Siemens), acquisition time was 20 seconds. During a 200°-rotation, 538 projections were acquired. Images were displayed in maximum intensity projection and volume-rendering technique modes. Eight patients received intraarterial contrast medium (CM).
Results: The entire stent-graft was exactly depicted and prosthesis alignment along the landing zones was well displayed in all cases. The aneurysmal sac was well shown in 11 patients (one had a traumatic rupture). One type II endoleak was detected, two angiographically-verified type I endoleaks were not detected (one suboptimal CM timing, one no CM administered). Aortic side branches were well shown in all but one (suboptimal CM timing) contrast-enhanced studies. In one patient, a distal extension was thought to be due to suspected short stent-graft at the distal neck. Flat-panel CT showed a sufficient neck coverage and no extension was inserted.
Conclusion: Flat-panel CT is a promising imaging tool during stent-graft procedures and may be helpful, especially in problematic procedures.

P22

Thoracic aorta dissection with concomitant aneurysmal disease. Possibilities for the endovascular therapy

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Purpose: Among 465 patients who underwent stentgraft implantation for aortic dissection or aneurysm, six presented complex vascular pathologies which mandated non-standard therapeutic approach. The aim of our study was to present strategies and treatment results of patients with complex vascular pathologies.
Materials/Methods: Six patients (aged 19-65 years; three men) were included. In three cases, dissection coexisted with an abdominal aorta fusiform aneurysm; in two, the aneurysm began under an aortic coarctation and progressed into a descending dissection (one of them ruptured upon admission); in one case, a saccular aneurysm below a lusoria artery coexisted with the dissection.
Results: Patients with aneurysms above the dissection were successfully treated with stentgraft implantation. Patients with aortic dissection progressing into the aneurysm sac were treated either by abdominal and thoracic stentgraft implantation (2) or by hybrid endovascular and surgical techniques (1). During the three-month follow-up period, one patient died as a result of late aortic rupture.
Conclusion: Early observations showed a high success rate of stentgraft treatment of thoracic aneurysms progressing into dissection of thoracoabdominal aorta. Patients with aortic dissection progressing into the aneurysm, on the other hand, require the use of more complex techniques and represent a more difficult therapeutic problem.

P23

Percutaneous lumbar interbody fusion: application of translaminar facet screws under computed tomography-guidance

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Purpose: Translaminar facet screws are a minimally invasive technique for posterior lumbar fixation with good success rates. This study evaluates the percutaneous placement of translaminar facets screws under computed tomography (CT)-guidance after anterior lumbar arthrodesis.
Materials/Methods: From September 2004 to January 2006, 15 spinal arthrodeses by posterior approach under CT-guidance with translaminar facets screws were performed. For each patient, the intervention followed a previous anterior lumbar fixation in which an intersomatic stability was not obtained.
Results: All screws-entry points were judged optimal by the radio-surgical team, with the screws passing through the articular facets of two vertebrae, and their distal end positioned inside the vertebral body.
Conclusion: CT-guidance provided a significant assistance in percutaneous placement of translaminar facet screws, thus proving its technical feasibility and efficacy.

P24

Percutaneous discectomy. Clinical experience and results

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Purpose: To evaluate efficacy of percutaneous discectomy (PD) in 15 patients.
Materials/Methods: From April 2004 until January 2006, 16 PDs were performed (15 patients). Indications were lumbago, sciatica, and small herniation (at magnetic resonance), with no neurological deficit. Levels were L3-L4 (1), L4-L5 (5), and L5-S1 (10). A diminished disk height was noted in 6/15. Pain was assessed with preoperative pressure discography. Under local anesthesia (2%-Lidocaine, 10 cc) and fluoroscopy, PD was performed with a 17-G nucleotome (Stryker Corp., Kalamazoo, USA) on positive discographies. Prophylactic antibiotics (Cefuroxime 750 mg) were administered. Follow-up included pain evaluation, mobility improvement, and non-steroid antinflammatory drugs use.
Results: Follow-up (ten days-21 months, mean 6.42 months, SD=6.26), varied according to pain relief. Mean pain relief and mobility improvement was 68.7% (SD=32.051, 0-100%). Eight patients presented 100% pain relief (53.3%), one 80% (6.7%), three 50% (20%-one case operated 21 days later), and three patients no relief (20%-operated one year later). These last six patients had reduced disc height. No complications were noted.
Conclusion: PD seems efficient (68.7% mean relief) when associated with small herniation. Discs with decreased height had partial pain relief. Pressure discography is a useful tool. Although most common complication is discitis, none was noticed.

P25

Pain treatment in vertebral fractures by percutaneous vertebroplasty. Our experience and future perspectives

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Purpose: Vertebroplasty is an image-guided technique to treat vertebral compression fractures by injection of cement into vertebral bodies. We present our 18-month experience at our Department.
Materials/Methods: From March 2004 to December 2005, 33 vertebroplasties were performed in 30 patients (18 women, nine men, aged 44-92 years) with primary or secondary osteoporosis; one case of Paget's disease and one trauma were also included. Twenty-eight transpedicular approaches were done under fluoroscopy-guidance, five procedures were done under combined computed tomography+fluoroscopy-guidance. Seventy-one vertebrae were treated (28 thoracic, 42 lumbar, one sacral metameres). Thirteen procedures involved a single vertebral body and 20 procedures two (10), three (4), four (4), or five (2) vertebrae.
Results: Periprocedural complications (such as myelic diffusion of the cement) did not occur. One case only of discitis occurred in 20 days, resolved medically. The patients reported a drastic pain reduction. Three patients completed the procedures by further interventional treatments in other unstable metameres.
Conclusion: Vertebroplasty is highly effective and safe, with high patient satisfaction rates; our low complication rate (no myelic damages) shows the feasability of this technique. In the near future, radiologic treatment could become the main option to manage resistant back pain due to vertebral compression fractures.

P26

Percutaneous computed tomography-guided radiofrequency ablation of osteoid osteoma with multi-tined expandable electrode

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Purpose: To determine feasibility, safety, and effectiveness of percutaneous computed tomography (CT)-guided radiofrequency (RF) ablation of osteoid osteoma (OO) with a multi-tined expandable electrode.
Materials/Methods: Eleven patients (all men aged 14-58 years, median: 22 years) with a single OO were enrolled in a prospective, single-center, single-arm clinical trial. CT-guided RF ablation was performed under conscious sedation by using a 150/200-W generator and expandable multi-tined electrode (RITA Medical Systems, Mountain View, CA). Follow-up period ranged from three to 22 months (mean 12±7 months) and included magnetic resonance (MR) examinations and clinical consultations performed six months after the procedure and at 12-month intervals thereafter.
Results: RF ablation was technically feasible in all 11 patients (technical success: 100%) without need of surgical access. No major complications occurred; in particular, no skin burns were observed. A prompt pain relief and the complete ablation of the nidus, as shown by six-month MR, was achieved in ten of the 11 osteomas (primary effectiveness rate: 91%). In one patient, recurrence of pain and persistent contrast uptake of the nidus at MR were present.
Conclusion: Percutaneous CT-guided RF ablation of OO performed with a multi-tined expandable electrode yields high effectiveness rates and has a favourable safety profile.

P27

Newly developed isocenter puncture method for percutaneous unipedicular vertebroplasty. A work in progress

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Purpose: Percutaneous unipedicular vertebroplasty (PUV) has potential advantages of reduction in procedure time, radiation exposure, and cost over the bipedicular approach. The best puncture (target) point for PUV is an anterior one third from the median vertebral body. To improve puncture accuracy, we developed an isocenter puncture method (ICPM). The purpose of this paper is to describe the ICPM and our initial results.
Materials/Methods: The isocenter is the point in which C-arm rotational axes all intersect. In collaboration with Toshiba Medical Inc., we also developed an isocenter marker (ICM) which can be displayed as a square dot on the center of the screen monitor. After adjustment of the ICM to the best puncture point on frontal and lateral views by fluoroscopic monitor, an accurate puncture can be achieved by targeting the ICM to the center of the vertebral arch pedicle by rotating the C-arm. Thirty-one vertebral bodies in 18 patients were treated using this ICPM.
Results: The puncture needle tip could be accurately inserted into the target point in all 31 procedures without any complication. A clinical success was achieved in 100% of patients.
Conclusion: With the use of our ICPM, PUV could potentially replace bipedicular vertebroplasty.

P28

Heat distribution in the spinal canal during radiofrequency ablation of vertebral bodies. An experimental study

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Purpose: To assess the safety of percutaneous radiofrequency ablation(RFA) for spinal lesions, heat distribution in the spinal canal was monitored during ablation.
Materials/Methods: *In-vivo* study: the lumbar vertebrae of pigs were heated with internal cooled electrodes. The temperature was monitored in the spinal canal. *Ex-vivo* study: cavities were created in the vertebral bodies and pieces of muscle were stuffed into the cavities as tumor models. Tumor models, with and without cortical bone defect, were ablated and temperatures at the canal were monitored.
Results: *In-vivo* study: the temperature of the tip and that in the canal rose to 66.5±6.8°C and 37.8±4.1°C, respectively. *Ex-vivo* study: the temperature of the tip and that in the canal rose to 73.4±8.1°C and 30.5±5.5°C, respectively. However, in the tumor model with cortical defect, the temperature of the tip and that in the canal rose to 78.8±5.1°C and 46.2±14.0°C, respectively.
Conclusion: The temperature in the spinal canal with cortical defect rose to 46.2°C which can potentially injure the spinal cord and peripheral nerves. When RFA is carried out for spinal tumors with cortical defect, spinal cord and nerve root injury must be cared.

P29

Computed tomography-guided injections of oxygen-ozone for the treatment of lumbar disc herniations: indications and technical approach

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Learning Objectives: 1) To illustrate the indications and technique of computed tomography (CT)-guided intradiscal and intraforaminal injections of oxygen-ozone (O_2-O_3) mixture for the treatment of lumbar disc herniations. **2)** To review physiopathology and results of this treatment.
Background: Intradiscal and intraforaminal injection of O_2-O_3 mixture is a minimally invasive intervention for the treatment of lumbar disc herniations. This technique can be a good alternative to surgery and to other interventional treatments. Ozone is an allotropic form of oxygen, without toxic effects at therapeutic concentration. O_2-O_3 mixture determines disc shrinkage and inflammation reduction. O_2-O_3 is usually injected with long acting steroids and anesthetics. According to our experience and to the literature, this technique is safe and provides good results in 70-80% of patients.
Clinical Findings or Procedure Details: Indications, physiopathology, technical aspects and results of CT-guided intradiscal and intraforaminal injection of O_2-O_3, steroids, and anesthetics are reviewed. Procedure details are exposed step by step with images and videos. Advantages of CT over fluoroscopy guidance are discussed. Possible complications are considered.
Conclusion: CT-guided intradiscal and intraforaminal injection of O_2-O_3 mixture is an effective treatment for lumbar disc herniations. The procedure is simple, safe, and cost-effective. CT-guidance offers advantages on fluoroscopic guidance.

P30

Foraminal corticosteroid injections in cervical neuralgias under computed tomography guidance (220 patients)

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Purpose: To demonstrate feasibility and efficacy of foraminal injections under computed tomography (CT) guidance in cases of cervico-brachial neuralgias (CBN) due to a disk fragment.
Materials/Methods: From 2000 to 2005, 220 patients with CBN due to a disk fragment resistant to analgesics were systematically included in a prospective protocol of pain treatment. Percutaneous lateral foraminal infiltration was performed with Cortivazol (7.5 mg) under CT guidance and local anesthesia, with a 22-G needle positioned behind the ganglion, against the articular process. A control CT with contrast (0.3 ml) verified the diffusion volume into both the foramen and the intracanalar epidural space. Each patient was given a pain scoring (0→10) compared with baseline over the following 14 days. All were reviewed at one, six, and 12 months.
Results: No complications were recorded. At two-week follow-up, a significant and durable pain relief was observed in 75% of cases (long-term identical results, with a mean delay of 20 months). Among failures, 25 patients (12.5%) were operated during the first month.
Conclusion: Cervical foraminal injection is a routine out-patient procedure in case of CBN due to a disk fragment. These encouraging results allow to consider this technique as a reliable and competitive management of CBN.

P31

Interest of the cortico-steroids epidural injection in the case of massive intracanalar lumbar disk herniations (12 patients)

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Purpose:A pain prospective study to demonstrate the interest of intra-canalar epidural infiltration with cortico-steroids in cases of large and compressive lumbar disk herniations.
Material/Methods: From 2003 to 2004,12 patients (males 4,females 8,mean age 40 years) were examinated for severe no complicated sciatica with low back pain.All underwent CT and MRI which showed a massive intra-canalar disk herniation compressing the thecal sac at L5-S1.The volume of the disk fragment represented 75 % in size of the neural arch.Percutaneous infiltration of Cortivazol was performed under CT guidance,after local anesthesia,within the posterior epidural space,controlled by injection of contrast medium. All patients received analgesics and anti-inflammatory drugs.The rest in bed was the rule during 15-20 days with a total professional activity arrest.
Results: In this group,the sciaticas and the low back pain slowly decreased during the first 3 weeks.After 8-10 weeks,the normal activity recovery was the rule.CT and MR controls,after a delay of 6 -8 months,demonstrated significative regression of all herniations.
Conclusion: Benefits of epidural foraminal infiltration under CT guidance is well known.This study in cases of massive disk herniations allows to comment that large recent disk fragments are probably of soft consistance.There is certainly a softening effect of the cortico-steroids on the disk material structure.

P32

Radiofrequency ablation of osteoid-osteoma: initial results with a bipolar ablation device

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Purpose: To report initial results of percutaneous radiofrequency (RF) ablation in osteoid-osteomas using a bipolar ablation device.
Materials/Methods: Twelve patients (seven men, mean age: 17.3±10.5 years) with clinical and radiological suspicion of osteoid-osteoma underwent computed tomography-guided percutaneous bipolar RF ablation. The procedure was performed under regional or general anaesthesia. After localisation of the nidus, a 11-G hollow drill was introduced into the nidus through a 9-F introducer sheath. Then, a bipolar 18-G RF-probe with a 9-mm active tip was inserted. After connection to the RF generator, energy application was started at 2 W and increased to a maximum of 5 W. The procedure was stopped when a resistance of 900 Ohm was reached.
Results: The duration of energy deposition was 8.3±4.0 minutes, with a mean energy application of 1.8±2.9 kJ (0.3-7 kJ). No major complications were seen during the procedure. Patients resumed their normal activity within 24 hours. Primary and secondary success was obtained in 11/12 patients during a 13.1±10.2 (3-28)-month follow-up.
Conclusion: Percutaneous bipolar RF ablation of osteoid-osteomas is safe and effective. Short-term efficacy of bipolar RF ablation equals the results of monopolar RF procedures.

P33

Use of ultrasound guidance for temperomandibular joint injections in pediatric patients with arthritis

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Learning Objectives: To learn about ultrasound as a technique in children for access to the temporomandibular joints (TMJs).
Background: TMJs may be affected by inflammatory arthropathies in children. Local joint injections are beneficial. Ultrasound guidance is used to access the joint in our institution. Research Ethics Board approval was obtained to review our experience with ultrasound in joints.
Clinical Findings or Procedure Details: Between 2001 and 2005, 92 TMJs were injected in 35 children (ages 6-20 years), using ultrasound. A linear 10- or 15-MHz probe or vector 8-MHz probe was used under sterile conditions. In the coronal plane, the sonographic landmarks identified where the zygomatic arch intersected the condyle of the posterior ramus of the mandible. Confirmation was achieved with computed tomography in a subgroup of 37 patients, in ten of whom minor adjustment was needed as the needle was either too anterior or superficial. A 25-G needle was used to inject steroid and local anesthetic, with good effect and clinical improvement in the majority.
Conclusion: Ultrasound guidance is a useful method for TMJ injection in children; care is needed to avoid being too anterior or superficial.

P34

Treatment of malignant bone metastases by magnetic resonance-guided focused-ultrasound surgery

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Purpose: Evaluation of safety, feasibility, and efficacy of the treatment of symptomatic bone metastases by non-invasive magnetic resonance-guided focused-ultrasound surgery (MRgFUS).
Materials/Methods: Two patients with symptomatic bone metastases were treated by MRgFUS using an Exablate 2000 System (Insightec, Israel) under real-time MR-thermomapping (GE, Twin Speed). Pre-treatment and 14 days, one month, three months and six months post-treatment, patients were evaluated for clinical status, quality of life, and pain intensity; MR and computed tomography images were also acquired.
Results: Periprocedural complications were not recorded and procedure-related side-effects were not encountered during the follow-up period. Pre-treatment pain index on visual analogue score (range 0-10) was 6, immediate post-treatment score was 4, and pain score had reduced to 0 and remained stable after three months. Immediate post-treatment imaging assessment showed a significant edema in the treated area. Tumor size remained stable post-treatment for the whole follow-up period (six months).
Conclusion: MRgFUS is a safe method to treat symptomatic bone metastases. There was a fast and lasting pain relief after the treatment. A stable condition could be achieved concerning tumor-load. MRgFUS of bone metastases can be considered an additional option in palliative bone tumor treatment.

P35

Bilateral carotid angioplasty and stenting

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Purpose: Bilateral carotid stenosis is generally rarely treated simultaneously but rather by staged procedures, due to concerns about hemodynamic impairment and risks of cerebral hyperperfusion syndrome. This study evaluates feasibility and safety of simultaneous bilateral carotid angioplasty stenting (BCAS).
Materials/Methods: Among 784 procedures, we retrospectively analyzed procedural outcomes and complications of BCAS in 57 (39 symptomatic, 70%) high-risk patients with a mean age of 64±9 years. Seventeen patients underwent simultaneous BCAS, 40 in a staged manner: time interval between the two procedures was 24 hours in 10/40 cases, and >2 days in 30/40 cases. Neuroprotection devices were used in the last 42 patients.
Results: Technical success was 100%. Transient bradycardia and/or hypotension occurred in 25 (44%) patients. Four (7%) neurological complications occurred: one major stroke due to hyperperfusion syndrome leading to death and one myocardial infarction (death at day 8) with simultaneous BCAS; two transient ischemic attacks (one treated with a time interval of 24 hours) with staged procedures.
Conclusion: Among carefully selected patients, BCAS is feasible simultaneously or the day after with safety and complication rates comparable to those of larger published series of CAS or endarterectomies in high-risk patients. Careful patient monitoring is mandatory. Larger series are awaited.

P36

Carotid angioplasty and stenting: selection of the appropriate stent

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Purpose: Protection devices are indispensable tools in the prevention of neurological complications after carotid angioplasty and stenting (CAS), but the selection of the appropriate stent is also a major factor. Carotid stents are not similar and have their own characteristics and geometric effects that we will describe. These differences lead to specific indications, depending on arterial anatomy, lesion, and plaque characterization.
Materials/Methods: Seven hundred and eighty-seven CAS procedures were performed with different stents: 292 balloon-expandable stents (BES) (implanted at the beginning of our experience), and 495 self-expandable stents (284 Wallstents and 211 nitinol stents).
Results: With a careful stent selection, differences in terms of complications were not observed. Embolic events rates were: 3.8% with BES, 1.8% with Wallstent:s, and 2.4% with nitinol stents. Death and stroke rates were: 2% with BES, 1.4% with Wallstents, and 1.4% with nitinol stents.
Conclusion: Stenting is a major step with CAS. An appropriate stent selection is therefore mandatory to avoid complications and achieve good immediate and long-term results. Improvements in stent designs are awaited.

P37

Carotid stenting without cerebral protection: results in 400 patients

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Purpose: Interventional radiologists, neuroradiologists, and vascular surgeons have been witnessing the technical evolution of the percutaneous treatment of carotid stenoses. The role of protection devices, however, is not presently clearly assessed as yet. The aim of this study is to evaluate the results of a multidisciplinary group of 350 cases treated without protection devices.
Materials/Methods: During the period March 1995-December 2006, 400 patients underwent carotid revascularization by angioplasty and stenting. All the procedures were monitored by analyzing indications, patients' selection, duration, complications, morbidity, and mortality. In all the cases, the treatment was accomplished without cerebral protection device.
Results: Three procedures (0.75%) were unsuccessful: two cases of extreme tortuosities of the carotid arteries, and one severe and calcified stenosis. Seven major complications occurred (1.75%): three major and four minor strokes. Two short-term stent occlusions were observed (after 24 hours and after seven days). Minor complications included six transient ischemic attacks. Those patients still enrolled for follow-up show a stent patency without clinical symptoms of cerebral ischemia.
Conclusion: Our series shows that carotid angioplasty and stenting without cerebral protection is a reasonable procedure, since we believe that the safety and efficacy of such devices is still unproven.

P38

New distal embolic protection device using the FiberNet™, a three-dimensional filter. First carotid and renal human study

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Purpose: Atheroemboli are frequent in any intervention in atherosclerotic disease and the leading cause of complications during percutaneous carotid intervention, carotid, and probably renal angioplasty. All embolic protection devices have limitations which could be addressed by the new FiberNet™ (Lumen Biomedical Inc, USA).
Materials/Methods: FiberNet is a three-dimensional, expandable, unique-fiber filter, expanding radially to fill the lumen, mounted on a 0.014 wire with aspiration. It can fill vessels to 7 mm without requiring a disease-free landing zone. FiberNet can capture particles as small as 40 microns.
Results: Twenty-six lesions (three renal, 23 carotid) were treated in 25 patients (20 men, age: 70±10) with an average stenosis of 85.5%±8.4. Technical success was 25/26. FiberNet crossed 24/25 lesions without predilation. One lesion was treated with the FilterWire. Average deployment time was 14.7±2.8 min. No stroke or death within 30 days occurred. One myocardial infarction (not device-related) occurred. All samples contained significant amounts of emboli, and preliminary analysis indicated an average surface area of 122±94 mm^2. Particles size ranged from 28 to 7874 microns with 74% of the particles <100 microns.
Conclusion: The first human use of FiberNet is encouraging. It was easy to use and confirmed ability to capture particles <100 microns.

P39

Carotid arterial stenting without neuroprotection: experience in 92 patients with 105 consecutive lesions

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Purpose: To present our results and complications in 105 stenotic lesions of the carotid artery (CA) treated with the stent ACCULINK without neuroprotection.
Materials/Methods: From May 1999 to December 2005, 92 patients (105 lesions) were treated by stent placement. Inclusion criteria were: a) symptomatic and asymtomatic >70% stenoses; b) <70% stenoses with vulnerable plaques.
Results: Both technical and clinical success were 100% (105 lesions). In ten (9.5%) patients complications occurred: six major and four minor strokes, plus other non-neurological complications. Periprocedural complications were 3/10 (3.2%): one (0.9%) minor and two (1.9%) major strokes. Early (<30 days) post-procedural complications were 3/10 (2.8%): one (0.9%) minor stroke and two (1.9%) non-neurological complications. Late (>30 days) post-procedural complications were 4/10 (3.8%): three (2.8%) hemorrhagic strokes and one (0.9%) major stroke. Restenoses occurred in four (4.3%) patients. The follow-up ranged from 86 to 1696 days.
Conclusion: In our experience, carotid stenting without neuroprotection was a safe and easy procedure. Complication rates were similar to those published in the medical literature with neuroprotection.

P40

"Real world" TAXUS® Liberté™ outcomes: six-month results from Phase I of the TAXUS OLYMPIA post-approval registry

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Purpose: TAXUS OLYMPIA is a multicenter, prospective, global registry with five phases analyzing safety and clinical outcomes in patients receiving TAXUS® Liberté™ coronary stent in routine clinical practice. This presentation will report the six-month results from Phase I.
Materials/Methods: The study device is the TAXUS® Liberté™ coronary paclitaxel-eluting stent system. Phase I is a post-approval, web-based registry involving 16 centers in seven countries in which TAXUS® Liberté™ is commercially available. Clinical follow-up was planned at one, six, and 12 months post-implantation. Overall, 100% of 30-day follow-up records and cardiac events (CE) were verified against patients' charts. The primary safety outcome is 30-day rate of TAXUS® Liberté™ -related CE (cardiac death, myocardial infarction, re-intervention).
Results: Of the 529 patients enrolled in Phase I, 49.9% were diabetic, 49.1% had multi-vessel disease, and 57% had expanded use compared with patients studied in randomized, controlled trials. The 30-day TAXUS® Liberté™ -related CE rate was 1.3%; 1.0% of patients required re-intervention, and stent thrombosis rate was 1.1%.
Conclusion: Initial 30-day clinical data demonstrated low occurrence of CE, with excellent outcomes in high-risk patients. Six-month clinical outcomes are currently being conducted and will be presented.

P41

Automated computed tomography-angiography quantification of internal carotid artery stenosis: a pilot trial

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Purpose: Automated computed tomography-angiography (CTA) analysis software allows visual evaluation and quantification of potential vessel stenoses in the assessment of internal carotid artery stenosis (ICAS).
Materials/Methods: Feasibility and accuracy of the technique was evaluated in 46 consecutive patients with known cerebrovascular disease. ICAS was graded according to the North American Symptomatic Carotid Endarterectomy Trial (NASCET) by two experienced vascular radiologists in consensus using axial source images. Results were then compared with those obtained by automated-CTA analysis software and those of manually-adapted automated-CTA analysis.
Results: Results of automated-CTA analysis as well as manually-adapted automated-CTA analysis correlated significantly to those of axial-CTA (r=0.53 and r=0.82, both P<0.05). As compared with axial-CTA, automated-CTA analysis revealed a median difference of -16% and manually-adapted automated-CTA of -10%; circumscribed calcification or kinking of the internal carotid artery origin did not significantly influence these differences (both P>0.05). Manually-adapted automated-CTA analysis revealed a sensitivity of 44.2% and a specificity of 97.7% for the detection of >70%-ICAS; automated measurement revealed inferior results (sensitivity: 34.9% and specificity: 93.1%).
Conclusion: Commercially available automated-CTA analysis is a feasible tool, but its sensitivities and specifities are still insufficient for its clinical application.

P42

Computed tomography-angiography quantification of internal carotid artery stenosis: assessment of inter-observer variability using luminal area versus luminal diameter measurements

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Purpose: To correlate computed tomography-angiography luminal (CTAdia) and cross-sectional area (CTAarea) stenosis assessment with digital subtraction angiography (DSAdia) and to assess inter-observer variabilities of both CTA techniques in 54 patients with known internal carotid artery stenosis (ICAS).
Materials/Methods: CTA images were reviewed by two blinded observers and ICAS was assessed according to the North American Symptomatic Carotid Endarterectomy Trial criteria; by applying CTAdia and CTAarea, DSAdia was assessed by a third blinded observer.
Results: ICAS percentages of CTAdia and CTAarea, as assessed by both observers, revealed comparable significant correlations with DSAdia (r=0.79-0.87, all P<0.01); median differences were in the range of +8% to -6%. Inter-method agreement between CTAdia and CTAarea was excellent (κ=0.86) for observer 1 and moderate for observer 2 (κ=0.51), thus resulting in a moderate inter-observer agreement for CTAdia (κ=0.60) and an excellent inter-observer agreement for CTAarea (κ=0.86). Sensitivity of CTAarea for the detection of >70%-ICAS was 100% for both observers; the corresponding results for CTAdia were 97.1% and 71.4%, respectively (using DSAdia as the gold standard).
Conclusion: CTAarea assessment of ICAS correlates well with the results of DSAdia and provides an excellent sensitivity for the detection of >70-ICAS with a superior inter-observer agreement as compared with CTAdia.

P43

Evaluation by magnetic resonance imaging of the effectiveness of cerebral protection during carotid artery stenting

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Purpose: There has been concern regarding the safety of carotid artery stenting (CAS) because of the risk of cerebral embolization during the procedure. The hypothesis of this study is that diffusion-weighted magnetic resonance (MR) imaging of the brain can reveal new diffusion abnormalities after CAS with cerebral protection (filter).
Materials/Methods: Fourteen symptomatic atherosclerotic stenoses of the internal carotid artery were treated in 12 patients [four women, eight men (two with two stenoses)] with an average age of 65.7 years (47-76 years) during 12 interventional procedures. A MR examination was carried out before the procedure and 24 hours later.
Results: An average of 1.64 new ischemic lesions--with an average size of 4.3 mm--were detected in the vascular territory supplied by the treated vessel. None of the patients in whom new diffusion abnormalities were found had new neurologic symptoms. No new lesions were seen outside the treated territory.
Conclusion: New ischemic lesions were depicted in diffusion-weighted MR images after CAS with cerebral protection. Cerebral protetion during CAS does not eliminate the risk of distal embolization in a definite manner.

P44

Use of angio-volumetric computed tomography in the pre-planning of internal carotid artery stenting

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Purpose: To assess the advantages of angio-volumetric computed tomography (VCT) in planning internal carotid artery (ICA) stenting.
Materials/Methods: Seventy consecutive patients with ICA stenosis at Doppler-ultrasound underwent VCT examination. Scans started from the pulmonary bifurcation to the head top; scan duration was six seconds, with a slice thickness of 6 mm. All the patients received 70 ml of contrast material, followed by 40 ml of saline i.v. at 4 ml/sec. Smart Prep was applied. Stenoses were evaluated by multiplanar and AVA reconstructions. Information about arch, vessels anatomy, and plaque morphology/composition were obtained.
Results: Angio-VCT evaluation confirmed the stenoses in all cases, thus permitting to obtain the information necessary for planning the intervention. In six cases, a plaque ulceration was found. Stents with a tight mesh were used in 36 cases because of the presence of soft plaque. Nitinol stents were used in 35 cases for vessels tortuosity. In five cases at high risk for plaque, stop-flow protection systems were used; in the remaining cases a protection device (filter) was used.
Conclusion: Angio-VCT is safe and effective in the pre-planning of ICA stenting. With this tool we were able to obtain the necessary information to select suitable stents and protection devices.

P45

Sixty four-row multidetector computed tomography of carotid arteries: low-dose iodinated contrast material protocol

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Purpose: To assess feasibility of multidetector computed tomography (MDCT)-angiography of carotid arteries by employing a lower amount of iodinated contrast medium.
Materials/Methods: Fifteen patients with diffuse atherosclerotic disease, previously studied by color-Doppler sonography, underwent carotid 64-row MDCT-angiography (Philips Brilliance, Koninklijke Philips Electronics NV, Amesterdam, NL). Twenty milliliters of contrast medium (400 mg I/mL) at 3.0 mL/sec were administered intravenously, followed by a 40-mL saline flush at 3.0 mL/sec.
Results: In all the cases, a sufficient opacification of the carotid arteries was reached (>200 HU) without venous contrast enhancement. Acquired data sets were effectively handled by employing multiplanar reformation, maximum intensity projection, and volume rendering recontructions, always obtaining the clinical information necessary for the therapeutic treatement.
Conclusion: 64-row MDCT permits a significant iodinated contrast agent saving in carotid CT-angiography.

P46

Carotid artery stenting in elderly people

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Purpose: Recent studies report a high complication rate for carotid angioplasty and stenting(CAS) in elderly people. The aim of our study was to evaluate whether CAS performed in octogenarians really increases the procedure-related risk.
Secondary aim was to assess the incidence of complex anatomy in patients >80 years old which can increase the technical difficulty.
Material/Methods: 1219 successful CAS (out of 1222 attempted) were performed in 2 centers. Patients were separated into 2 age categories: under 80 (n=1078 procedures,88.4%) and 80 or older (n=141 procedures,11.6%). Data analysis included death and stroke rate at discharge and at 30 days, and anatomic characteristics of aortic arch, supra-aortic vessels and carotid lesion.
Results: The overall death and any stroke rate at 30 days was 2.12% in the older group and 1.11 % in the younger group(p=*.40*). A significantly high frequency of aortic arch type III, tortuosity and calcification of arch and supra-aortic vessels was observed in the older group(p <.001).
Conclusion: In our experience CAS has proved to be safe and effective in elderly patients. Different age-related anatomical features can represent an adjunctive technical challenge. These difficulties can be successfully managed without increase peri-operative risk if CAS is performed in high volume centers by highly skilled operators.

P47

Patients with chronic renal failure undergoing carotid artery stenting: use of gadolinium-diethylenetriaminepentacetic acid, electroencephalographic monitoring, and post-intervention cerebral nuclear magnetic resonance

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Purpose: To demonstrate the efficacy of carotid artery stenting (CAS) with gadolinium-diethylenetriaminepentacetic acid (Gd-DTPA) as the first choice treatment in patients with chronic renal failure.
Materials/Methods: Thirteen patients with high-degree internal carotid artery stenoses and chronic renal failure were treated with CAS. Nine patients had previously reported carotid artery stenosis-related symptoms (transient ischemic attack or stroke). Seven cases had undergone aorto-coronary by-pass and had arterial hypertension, insulin-dependent diabetes mellitus (IDDM) and systemic arteriopathy; three had arterial hypertension, IDDM and dyslipidemia; and three had dilatative cardiomiopathy, arterial hypertension, IDDM, and systemic arteriopathy. Under epidural anesthesia, all the patients underwent CAS. The procedure was performed with the use of Gd-DTPA in eight patients and by injection of iodine contrast medium in five patients. Intra-operative patients monitoring included an electroencephalogram. Post-CAS magnetic resonances were performed in all cases.
Results: All the patients were successfully treated without complications. One patient reported a low-level allergy to iodine contrast medium. All the patients treated with iodine underwent haemodialysis.
Conclusions: The use of Gd-DTPA made CAS possible in patients with chronic renal failure without requiring any haemodialysis session, thus representing an important alternative for patients with systemic failure.

P48

Non-embolic neurologic complications in carotid revascularization: surgical and endovascular comparison

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Purpose: To evaluate non-embolic cerebral ischemic complications after carotid endarterectomy and carotid artery stenting.
Materials/Methods: Forty-six patients treated with 58 endarterectomies (13 bilateral) and 49 patients treated with stenting (seven bilateral) were evaluated with cranial magnetic resonance imaging (MRI) 24 hours following the procedure. Sixty-five percent of surgical patients and 59% of endovascular patients were symptomatic. During stenting, filters which permitted the blood flow were used. Endarterectomies were performed without by-pass grafts for cerebral protection.
Results: Fourteen acute ischemic lesions were detected by MRI in the surgical group. Cerebral complications were seen in eight embolic and in six non-embolic patients. Non-embolic complications consisted of watershed ischemia (3), hyperperfusion syndrome (1), and reperfusion injury (2). Seven embolic ischemic lesions were seen in the endovascular group. A non-embolic cerebral complication (hyperperfusion syndrome) was detected in one patient only.
Conclusion: Non-embolic neurologic complication rate is five times lower with the endovascular treatment. Embolic ischemia rates were the same in both groups.

P49

Carotid artery stenting: a single center six-year experience

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Purpose: To evaluate safety and efficacy of carotid artery stenting (CAS) performed with cerebral protection devices.
Materials/Methods: From February 2000, CAS with cerebral protection was performed in 230 patients with carotid artery stenosis. Stenoses were primary (181) or secondary (49) to a previous thrombus endarterectomy. A total of 257 stents was implanted: 185 Wallstent, ten Acculink, 49 Precise, four Exact, nine Protégé. All the patients underwent pre- and post-procedure neurologic examinations. A cerebral magnetic resonance examination with diffusion and perfusion sequences was also performed before and after the procedure to evaluate neurologic complications occurring during CAS.
Results: A technical success (residual stenosis <30%) was achieved in all cases. No death occurred during the whole follow-up ranging from one to 72 months. Fifteen early complications (6.5%) were recorded: eight major (3.4%) and seven minor strokes (3%); five late complications were: four transient ischemic attacks (1.7%) and one pseudo-aneurysm (0.4%). In 20 cases (8.6%), embolic material was found inside the cerebral protection. In three cases (1.3%), a moderate in-stent restenosis was detected and treated with angioplasty (1) and angioplasty+restenting (2).
Conclusion: CAS represents a feasible procedure that can be performed in high-risk patients and is associated with a low restenosis rate.

P50

Management of atheromatous disease of the extracranial carotid artery with Wallstent alone: a preliminary experience

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Purpose: To present our short-term results with Wallstents implantation without pre- or post-dilatation in moderate carotid stenoses.
Materials/Methods: Eighteen symptomatic patients (12 women), with a mean age of 57 years (range: 49-78) and 70-95% carotid stenosis were included. Pre-treatment with Clopidogrel and acetylsalicylic acid and intraprocedural full heparinization was used in all cases. Carotid Wallstent (Boston Scientific) was the selected prosthesis. Balloon-angioplasty and embolic protection device were not used. Stent luminal diameters were measured immediately after deployment and 15 minutes later. In addition, measurements using plain films and carotid duplex ultrasound were obtained at day one, seven, 14 and 28.
Results: Average narrowest segment stent luminal diameter was 2 mm immediately post-deployment and 3.1 mm at day seven. Minimum percentage increase in stent diameter at the stenotic segment after 28 days was 24% and maximum percentage increase was 95%. No neurological complications or transient ischemic attacks were observed.
Conclusion: Although comprehensive results of a dedicated wide-scale study is required, Wallstent insertion alone without angioplasty may be a good alternative in the management of carotid bulb stenoses. Safety implications of this technique may be enormous, such as the elimination of hyperperfusion-associated intracranial hemorrhages and minimization of intra-operative cerebral embolic complications.

P51

Diagnostic accuracy of magnetic resonance imaging in arrhythmogenic right ventricular cardiomyopathy

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Purpose: Evaluation of a magnetic resonance imaging (MRI)-based scoring model formation and its diagnostic significance in patients with suspected arrhythmogenic right ventricular cardiomyopathy (ARVC).
Materials/Methods: Fifty-three patients with myocardial abnormalities in the right ventricle (RV) confirmed by MRI were divided into Group 1 (17 patients with ARVC) and Group 2 (36 patients with other RV arrhythmias). Decision tree learning (DTL) and linear classification were used to identify and assess MRI criterion.
Results: All major ARVC criteria were more frequent in Group 1. Among minor criteria, regional RV hypokinesia, mild segmental RV dilatation, and prominent trabeculae were more frequent in Group 1; mild global RV dilatation was more frequent in Group 2. Diagnostic rules defined by DTL yielded a mean predictive accuracy (76.8%) and RV aneurysm emerged as a key criterion in the diagnosis of ARVC. A sensitivity of 93.3% and a specificity of 89.5% were achieved when the value of the modified scoring model was equal to four, corresponding to the following criteria combinations: two major, or one major and two minor, or four minor criteria.
Conclusion: Combinations between major and minor criteria contributed to a statistically valid model for ARVC diagnosis, with RV aneurysm as the most important criterion.

P52

Aortic calcification on computed tomography as a predictor of coronary artery obstructive disease

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Purpose: Aortic and coronary calcification is a typical manifestation of atherosclerosis and easily quantified with computed tomography (CT). The purpose of this study was to evaluate the usefulness of aortic calcification measurement with CT as a predictor of coronary artery obstructive disease (CAOD).
Materials/Methods: A total of 252 patients underwent 64-slice multidetector row CT scanning with or without contrast enhancement. We measured the amount of calcification of coronary artery (CAC), thoracic aorta (TAC), and abdominal aorta (AAC). The extent of CAOD was graded according to the number of vessels diseased in coronary CT-angiography. The Spearman's correlation coefficient (r) was obtained among CAC, TAC, and AAC. The diagnostic performance was evaluated with the area analysis of receiver operating characteristic (ROC) curves.
Results: Patients with multi-vessel disease had a higher proportion of CAC, TAC, and AAC. The amount of CAC was highly correlated with that of TAC (r = 0.90) or AAC (r = 0.67). The areas (z) of ROC curves of CAC, TAC, and AAC were 0.917, 0.845, and 0.740, respectively.
Conclusion: In this study, aortic calcification detected with CT was a good predictor of CAOD as other independent risk factors.

P54

Retrospective analysis of coronary artery bypass graft imaging with 16- and 64-slice spiral computed tomography

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Purpose: To retrospectively analyze the scan technique and clinical value of 16- and 64-slice spiral-computed tomography (CT) in coronary artery bypass graft (CABG) imaging.
Materials/Methods: Twenty-seven cases of CABG multislice spiral-CT imaging were retrospectively analyzed. Eight cases were done by 16-slice spiral-CT scanner (Siemens, SOMATOM Sensation 16), and 19 cases by 64-slice spiral-CT scanner (Siemens, SOMATOM Sensation 64). All patients underwent breathhold-enhanced scan. Two experienced radiologists, first separately and then jointly, evaluated four aspects: proximal anastomosis, bypass graft, distal anastomosis, and distal blood vessel, including image quality, artifacts, patency rate, and observer consistency of the two doctors.
Results: Rates of 64-slice spiral-CT to evaluate proximal anastomosis, bypass graft, distal anastomosis, and distal blood vessel were 100%, 100%, 90.2%, and 93.9%, respectively, while those of 16-slice spiral-CT were 92.3%, 95.2%, 90.0%, and 90.0%, respectively. Patency rates of the above four aspects evaluated by 64-slice spiral-CT were 66.7%, 70.0%, 71.70%, and 70.0%, respectively, while those by 16-slice spiral-CT were 83.3%, 85.0%, 83.3%, and 88.9%. Interobserver consistency was good.
Conclusion: 64-slice spiral-CT is better than 16-slice spiral-CT for CABG imaging; it can therefore be used as a noninvasive clinical follow-up to evaluate CABG.

P55

Electrocardiography-gated 64-detector row cardiac computed tomography: Imaging the heart valves

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Learning Objectives: To provide a pictorial review of cardiac valve pathology using multi-detector row cardiac computed tomography (MDCT).
Background: MDCT, with its high spatial and temporal resolution, now has an established clinical role in imaging. It has a valuable problem-solving role such as delineating complex coronary artery anomalies and excluding significant coronary artery disease, and can be used where other imaging modalities have failed to provide a diagnosis. The same data set can be also used to examine cardiac morphology and ventricular function. It can provide artefact-free images in valvular heart disease and of prosthetic valves, where traditionally this has not been a particular use of CT.
Clinical Findings or Procedure Details: Making use of near-isotropic imaging, 3D volume-rendering, multi-phasic movie loop and virtual imaging software capabilities of 64-MDCT, we aimed to provide a pictorial review of normal and diseased valves. Illustrations will include: aortic stenosis, bicuspid aortic valves, aortic regurgitation, valvular complications of aortic dissection, the 'mitralised heart', pulmonary stenosis, tricuspid valve disease, cardiac complications of carcinoid syndrome, infective endocarditis and a variety of valve prostheses.
Conclusion: The use of electrocardiography-gated MDCT in the assessment of the heart valves should not be overlooked.

P56

Is coronary imaging with multislice computed tomography still impossible in patients with atrial fibrillation? Comparison of a new frequency adapted multislice computed tomography reconstruction algorithm and standard invasive angiography

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Purpose: To compare multislice spiral-computed tomography-angiography (MSCTA) using a new frequency adapted algorithm and standard selective coronary angiography (CA) and to determine the optimal reconstruction window during the cardiac cycle in patients with atrial fibrillation (AF).
Materials/Methods: Thirty patients with permanent AF (mean heart rate 78+/-23 bpm; range 42-156) were imaged on a 16-slice scanner. Each coronary segment was reconstructed in increments of 10% of the cardiac cycle. All coronary segments were evaluated for image quality (1=very poor, 5=excellent) and the stenosis degree (1=0%, 2=1-49%, 3=50-74%, 4=75-99%, 5=100%) by two independent radiologists and compared with CA findings.
Results: Visualisation of all coronary artery segments was superior ($p<0.01$) at 40% (image quality 3.35) as compared with the standard diastolic reconstruction window at 80% (2.54). The second best image quality (3.17) was acquired at 0% of the cardiac cycle. Sensitivity and specificity in the detection of >50%-stenoses for all segments with MSCTA were 93.9%(42/45) and 70.8% (286/405). Negative predictive value was 99.4% (all segments).
Conclusion: A frequency adapted reconstruction algorithm and the choice of an endsystolic reconstruction window provides diagnostically valuable images in patients with AF with good sensitivity and specificity. MSCTA seems to be an attractive method also in these patients.

P57

Usefulness of electrocardiography-gated multidetector computed tomography in the management of patent ductus arteriosus in adult cases

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Purpose: To describe the usefulness of electrocardiography (ECG)-gated multidetector computed tomography (MDCT) in the management of patent ductus arteriosus (PDA) in adult cases.
Material/Methods: In five adult cases with PDA, ECG-gated MDCT, cardiac catheterization, and descending aortography in left posterior oblique position were performed. Three cases were successfully treated by interventional radiology (IVR): two by coil embolization using 0.052 detachable and 0.035 PDA coils, and one with Porstmann's method. Two cases were treated by open surgery [one with simultaneous patch-closure of a co-existing atrial septal defect (ASD)].
Results: Shapes, lengths, and diameters of PDA could be precisely evaluated by MDCT. In two cases, MDCT visualized a narrow PDA neck and an infundibular shape, suitable for coil embolization. In one case, MDCT accurately depicted the PDA shape with a diameter of 6.2 mm (difficult to be evaluated by aortography). An adequate embolization plug could be made based on CT findings. In one case, the short and straight PDA shape was thought to be inadequate for IVR and treated by surgery. In one case, an ASD overlooked by ultrasound was detected by CT.
Conclusion: ECG-gated MDCT is useful in the diagnosis, treatment planning, and pre-interventional imaging of adult cases with PDA.

P58

Noninvasive evaluation of cardiac veins with 64-multislice computed tomography-angiography in the planning of pacing and electrophysiology

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Purpose: To assess the role of topographic study of cardiac veins in the planning of pacing and electrophysiology.
Material/Methods: Between October and December 2005, we evaluated retrospectively cardiac veins in 22 patients (18 men and four women, mean age 62.5 years, range 31-79). Cardiac-computed tomography was performed with 64-multislice computed tomography (MSCT) (Aquilion-64, Toshiba) (contrast medium: 100 ml 400 mgI/ml 4/5 ml/sec; saline solution: 50 ml 4/5 ml/sec). Cardiac veins were emphasized with 3D post-processing (volume rendering reconstruction).
Results: The great cardiac, the anterior interventricular, and the middle cardiac vein were visualized in all cases, the marginal vein was depicted in 20/22 cases (90.9%) and the posterior vein in 19/22 cases (86.4%). In the posterior wall of the left ventricle we observed: one vein in five cases, two veins in 11 cases; three or more veins in six cases; the marginal vein was considered dominant on the posterior vein in 6/11 cases. In 3/22 cases (13.6%) a small cardiac vein was observed.
Conclusion: The study of cardiac veins with 64-MSCT angiography allows a good visualization of localizations and anatomic variants. Cardiac vein computed tomography could be therefore considered as an important tool in the planning of pacing and electrophysiology.

P59

Real-time computed tomography-guided fluoroscopy-guided intraventricular navigation: a readily available technique

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Purpose: Recent advances in multi-detector computed tomography (MDCT) imaging provide real-time „fluoroscopic-like" capabilities with excellent spatial resolution. This new tool expands our ability to perform image-guided interventions in anatomically complex locations. Although MDCT fluoroscopy is currently used at our institution for a variety of procedures ranging from spinal nerve blocks to radiofrequency ablation, we believe these same techniques can be used to navigate within the ventricles of the central nervous system to treat conditions requiring placement of intra-ventricular catheters, depth electrodes, or potentially stents for the relief of cerebrospinal fluid outlet obstruction.
Materials/Methods: Using three fresh, unfrozen human cadavers, we studied the feasibility of using MDCT fluoroscopy for intra-ventricular catheter placement and to stent the aqueduct of Sylvius.
Results: The ventricles were entered via a single needle pass and catheters were placed over the wire. Contrast was then injected demonstrating leakage along the catheter tract. The aqueduct of Sylvius was successfully stented by passing a wire into the 4^{th} ventricle and deploying a coronary stent over the wire.
Conclusion: Based on our success with these procedures, we believe this technique can be used to limit complications and improve efficacy of a number of neurosurgical procedures.

P60

Endovascular treatment of ruptured intracranial aneurysms in 65 patients using Guglielmi detachable coils

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Purpose: To present anatomical/clinical outcomes of coiling using Guglielmi detachable coils (GDC) in 65 patients with subarachnoid hemorrhage.
Materials/Methods: From August 2004 to December 2005, 66 ruptured and six unruptured intracranial aneurysms were treated (16 men; mean age: 54 years). Fifty-three (82%) patients were in a Hunt-Hess grade I-III at the time of treatment and 52 (80%) patients were treated in the acute phase.
Results: Procedure-related mortality and morbidity were 3.1% and 0%, respectively. Two months after the (intended) procedure, mortality was 12% (6% Hunt-Hess grade IV/V) and morbidity was 18%. Immediate angiographic results showed a complete obliteration in 45 (63%) or a residual neck in 13 aneurysms (18%), leaving eight residual aneurysms (11%) and six failures (8%). Two treated aneurysms rebled. Short-term follow-up angiography in 34 treated intracranial aneurysms showed a total occlusion in 18 (53%), a neck remnant in nine (26%) and a subtotal packing in seven (21%) aneurysms. Intermediate follow-up angiography in ten aneurysms showed a complete occlusion in eight (80%) and a neck remnant in two (20%) aneurysms. Recoiling was performed in six patients.
Conclusion: Endovascular treatment of ruptured intracranial aneurysms with GDC is safe and effective in preventing rebleeding in the short-term.

P61

Mechanical thrombectomy and thrombolysis in patients with severe cerebral sinus thrombosis

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Purpose: Cerebral sinus thrombosis is a dangerous condition, often effectively treated with heparin. A subgroup of patients has however a poor prognosis, and may benefit from a more aggressive treatment with mechanical thrombectomy and thrombolysis.
Materials/Methods: Carotid angiographies are performed to evaluate venous drainage; then, puncture of the jugular vein and selective catheterization of the thrombosed sinus is done, followed by the mechanical thrombectomy via a 6-F Possis Angiojet thrombectomy catheter. A True-line multiple-sidehole catheter is finally positioned for local Urokinase administration (100.000 I.E./hour, max.12 hours). Control angiographies and computed tomographies evaluated treatment results.
Results: Nineteen patients (15 women) were treated; mean age 32 years; mean Glasgow Coma Score 7.5 (range 3-14). Twelve patients had haemorrhagic infarcts before thrombolysis, 11 had seizures, and 12 were comatose. Ten patients recovered to independent living (seven with Rankin score 0 or 1; three with Rankin 2), three had residual neurological handicaps (Rankin 3 or 4) and six died (most of them had large infarcts and oedema before thrombolysis, which caused transtentorial hernation). Mechanical thrombectomy-related complications were not recorded.
Conclusion: Mechanical thrombectomy and thrombolysis may be effective in severe sinus thrombosis; patients with large infarcts and impending herniation, however, did not benefit.

P62

Clinical interests of in-space three-dimensional angiography

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Purpose: In-space three-dimensional (3D) reconstruction of intracranial vessels is of great interest for the evaluation of aneurysms.
Materials/Methods: Two-hundred and thirteen patients underwent 3D-digital subtraction angiography (DSA) and bidimensional-DSA in last year at the Department of Interventional Radiology Clinical Center Nis. 3D-angiography images are obtained by reconstruction of rotational angiography acquisition done on a Siemens Axiom Artis dFT spinning at 40^{o} per second. Carotid or vertebral selective injection of 15 ml of contrast media at 3 ml/sec over 5 seconds was carried out. All 3D-angiographic studies were analysed in maximum intensity projection and volume rendering views on a Leonardo workstation.
Results: When the endovascular treatment is the appropriate indication, 3D-angiography allows to define the optimal view angle and accurately select microcoils dimensions. Our current research activities focus on the matching without stereotactic frame between 3D X-ray angiography and volumetric magnetic resonance acquisition, which should improve the treatment of intracerebral aneurysms.
Conclusion: 3D-angiography has proven to be a highly valuable adjunct to conventional angiography in both diagnostic and interventional procedures. Due to the high speed of the postprocessing software, 3D-angiography has evolved as a valid on-line tool for planning and performing endovascular interventions.

P63

Upgrading predictivity before interventional procedures: modern tools

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Purpose: To present a software providing patient's personalized outcome, statistically determined, before uterine artery embolization (UAE).
Materials/Methods: We retrospectively analyzed a monocentric consecutive series of 250 UAEs. Epidemiologic, clinical, sonographic and magnetic resonance imaging data were noted. Methods of data mining work out Bayesian networks highlighting direct correlations between variables. We performed automatic discretization for numerical values. The Bayesian network calculates the *a-posteriori* probability distribution for variables with missing data. Then, a model of simulation worked out starting from a supervised analysis in increased naive architecture.
Results: Thanks to this tool and by integrating patient's parameters, we were able to obtain, before UAE, a real-time predictive evaluation of the clinical outcome.
Conclusion: The use of some of the most powerful Bayesian algorithms applied to one of the most significant monocentric consecutive series, in UAE, enabled us to develop a software providing decision support systems and patient's information; other endovascular procedures will be considered.

P64

Computer-assisted simulation of ultrasound-guided procedures

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Learning Objectives: Training in targeted needle placement under ultrasound guidance.
Background: Targeted needle placement is a core skill and the starting point of virtually all interventional radiology procedures. We describe the development of a low-cost, augmented-reality simulator capable of developing and assessing the requisite skills for accurate needle placement under ultrasound guidance.
Clinical Findings or Procedure Details: The simulator comprises a mannequin representing the patient, an ultrasound transducer with 3D-position sensors, needle and a PC. Ultrasound datasets have been reconstructed and mapped onto the mannequin. As the mannequin is "scanned," an anatomically correct image is generated corresponding to the position and orientation of the probe. The operator has to identify an anatomical target and pass a needle to the target under "virtual imaging guidance." Position sensors attached to the "needle" allow it to be visualised in real time as it passes through viscera towards the target and subsequently provides the user with accurate feedback upon completion. Validation studies are currently being carried out to determine whether simulator training transfers to the clinical setting.
Conclusion: Ultimately, the use of such simulators could improve and shorten the training of interventional radiologists at a time when they are in short supply.

P65

Basic investigation on cisplatin-eluting gelatin microspheres

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Purpose: To construct cisplatin-eluting gelatin microspheres (CE-GMSs), confirm cisplatin elution, evaluate antitumor effects against VX2 liver tumors (VX2) in rabbits.
Materials/Methods: *1. Preparation:* (a) Cisplatin was immersed in GMSs and freeze-dried; (b) the (a) product was rinsed with distilled water and freeze-dried; (a) and (b) were repeated five times. *2. Evaluation:* 2 mg/kg of CE-GMSs (cisplatin: 0.04 mg/kg) were used for transarterial embolization (TAE) of the right renal artery (rRA) (n=3). Cisplatin concentration (CC) in the blood and in the renal parenchyma were measured after TAE. As a control, cisplatin (0.04 mg/kg) was infused (n=3). *3. Antitumor effects:* To evaluate antitumor effects, tumor volumes were analyzed by 7T-MRI (n=3). As a control, cisplatin (1.75 mg/kg) was infused into the rRA (n=3).
Results: Repetition of the immersion procedure increased the binding of cisplatin with GMSs. Renal parenchyma CCs were higher with TAE than with infusion. CCs in the blood were detected five minutes later, but not at other times. Histology revealed renal infarction and renal tubular dilatation in TAE. Tumor reduction was remarkable in TAE.
Conclusion: The immersion of cisplatin in GMSs improved cisplatin-eluting function in addition to the embolizing effect. These properties may reduce cisplatin doses and prolong exposure time.

P66

Protective embolization of utero-ovarian anastomoses during uterine fibroids embolization

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Learning Objectives: To report our experience with utero-ovarian anastomoses evaluation during uterine fibroids embolization (UFE).
Background: The prevention of nontarget embolization of the ovary during UFE is of vital importance; protective embolization of anastomoses is therefore suggested.
Clinical Findings or Procedure Details: From May 2000 to November 2005, 87 women with uterine fibroids were treated by uterine artery embolization. The presence of utero-ovarian anastomoses was ruled out in all procedures. Serum follicle-stimulating hormone (FSH) level was assessed pre- and post-procedurally and menstrual cycle was checked. The presence of significant anastomoses was proved in 34 patients; one-side embolization only was done in six, three women received protective coil embolization of collaterals, and 25 patients underwent bilateral limited embolization with large-sized particles. All women with protective embolization had normal FSH levels before and after the procedure and normal menstrual cycle. Of the 25/34 patients who had undergone a limited embolization with large-sized particles, three had post-procedure elevated FSH levels, two experienced a transient amenorrhea for two months, and one had an ovarian failure at the age of 34.
Conclusion: Ovarian failure is a possible complication of UFE. Although its cause seems multifactorial, protective embolization in selective cases can lower the risk.

P67

Percutaneous vascular embolization using nitinol vascular plugs

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Purpose: To present our initial experience with the Amplatzer vascular plug in arterial and venous systems with short-term results.
Materials/Methods: Seven patients (five men and two women, aged between 24 and 71 years) who had undergone percutaneous embolotherapy with the Amplatzer vascular plug since May 2005 were retrospectively evaluated. Bilateral multiple pulmonary arteriovenous malformations (eight in total), three internal iliac arteries, one main renal artery (prior to branched-endograft for endovascular aneurysm repair), one competing branch of a left internal mammarian artery bypass graft, and one testicular vein were embolized using total of 14 Amplatzer vascular plugs sized between 4 and 16 mm in diameter. The largest size (8 F) of introducers or guiding-sheaths was used for all procedures.
Results: Technical success rate was 100% with total occlusion of all target vessels. No major complication occurred. A minor asymptomatic pulmonary artery dissection recovered spontaneously. The target vessel occlusion time of the nitinol plug after placement was 6-10 minutes in pulmonary arteries and 20-30 minutes in systemic arteries.
Conclusion: We believe that the Amplatzer vascular plug placement is safe, feasable, and technically easy as well as cost-effective with appropriate patient selection in either the arterial or the venous territory.

P68

Comparison of computed tomography-angiography and digital subtraction-angiography for displaying vascular anatomy relevant to regional therapy for liver cancers

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Purpose: Compare computed tomography-angiography (CTA) and digital subtraction-angiography (DSA) sensitivity for displaying arterial and portal vein anatomy relevant to performing transarterial chemoembolization (TACE) or selective internal radiation therapy (SIRT).
Materials/Methods: Thirty-five patients for either TACE or SIRT procedures underwent preprocedural spiral-CTA. CTA and intraprocedural DSA images were retrospectively assessed by two blinded interpreters. The hepatic arterial anatomy was tabulated by Michel's classification. The presence of hepatosplanchnic arteries, extrahepatic arterial tumor supply, and portal vein patency and blood flow direction were recorded.
Results: DSA/CTA discordance for hepatosplanchnic arteries was 20/35 (57%) patients: 20 arteries were seen only on DSA, one only on CTA. Extrahepatic arterial tumor supply discordance was 17/35 (48%): DSA identified four arteries and CTA 14 (missed by DSA). Portal vein patency discordance was 5/35 (14%): DSA missed four, and CTA missed one patent portal vein. CTA was unable to determine the direction of portal vein flow. DSA identified hepatopetal flow direction in 19/35 (82%) and was indeterminate in 6/35 (18%).
Conclusion: DSA and CTA provided complementary information. DSA was more sensitive for visualization of hepatosplanchnic arteries and determining portal vein flow direction. CTA was more sensitive for detection of extrahepatic arterial tumor supply and proving portal vein patency.

P69

Product optimization and characterization of Ibuprofen drug-eluting beads for uterine artery embolization

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Purpose: Uterine artery embolisation (UAE) is associated with significant pain lasting hours to days post-procedure. Ibuprofen drug-eluting beads (DEB) are designed to control local inflammation and pain; we present here the drug impact on the performance properties of these beads.
Materials/Methods: Ibuprofen DEB were prepared at various drug doses and formulated with different excipients to minimize drug crystallization. Prototypes were evaluated according to size, dose, visual appearance, aggregation, compressibility, and microcatheter deliverability. The distribution and localization of the Ibuprofen DEB *in vivo* was determined in a sheep uterine artery model of embolization.
Results: *In-vitro* performance of Ibuprofen DEB was significantly improved by the inclusion of a drug crystallization inhibitor. The excipient reduced the tendency for drug to crystallize on the bead surface, thus limiting bead aggregation and adhesion and promoting easy handling and delivery. The dose of drug achievable was bead size-dependent and *in-vitro* elution studies indicated sustained release. This optimised product (85-mg/mL beads) was used successfully *in vivo*. Bead distribution with respect to proximal, perimyometrial, myometrial, and endometrial location and the relationship to *in-vitro* characteristics will be presented.
Conclusion: Ibuprofen DEB have been formulated to maintain the physical properties desirable for their use in UAE.

P70

Initial clinical experience using the Amplatzer vascular plug

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Purpose: To describe our experience with the Amplatzer vascular plug (AVP), a self-expanding nitinol mesh embolization device.
Materials/Methods: We present our experience in 17 patients in a variety of clinical situations including renal artery embolization prior to resection of carcinoma, internal iliac artery embolization before stent-grafting, ruptured internal iliac artery aneurysm, closure of transjugular intrahepatic portosystemic shunt for intractable encephalopathy, portal embolization prior to hemi-hepatectomy, splenic artery embolization for bleeding gastric varices with occluded splenic vein, and embolization of an aneurysmal bovine ureteric haemodialysis loop-graft. Devices were oversized by approximately 50% relative to the target vessel. Use of additional embolization materials was recorded.
Results: Target vessel occlusion occurred within 15 minutes in all cases. No procedure- or device-related complications were encountered. A total of 1-4 AVPs was deployed per case, with an average of two devices per target vessel (median=2).
Conclusion: The AVP device allows accurate and rapid vascular occlusion. Embolization with an AVP is quicker than using multiple coils, but each device costs the equivalent of several conventional coils. Hence it is particularly indicated for embolization of large high-flow vessels and when the target vessel is too short to safely occlude with conventional coils.

P71

Embolization in the treatment of epistaxis

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Purpose: Epistaxis represents a challenge for otolaryngologists, particularly in clinically unstable patients after significant blood loss. This study is aimed at retrospectively reviewing those patients treated with percutaneous embolization for severe epistaxis.
Materials/Methods: Thirty-one cases were studied for cause and previous treatment of epistaxis, vessels embolized, materials used, and results of embolization.
Results: In ten patients, epistaxis could not be controlled by nasal cavity packing and six received transfusions. In five cases, bleeding followed a trauma, in three patients an operation was the cause of bleeding, one had a giant internal carotid artery aneurysm perforation. In one case, epistaxis was idiopathic. Except for the ruptured aneurysm, the bleeding source was always the maxillary artery (MA), and in two cases the anterior ethmoid artery was also involved. In all cases, embolization with polyvinyl alcohol (PVA) (6), Gelfoam (3), or coils (1) resolved the symptoms. In 21 patients epistaxis was due to nasopharyngeal angiofibromas; in these cases, the MA was the main tumour feeder. Embolization was performed 1-2 days pre-operatively with PVA, thus providing a significant reduction of intraoperative bleeding.
Conclusion: Angiography with embolization is an effective modality to treat severe epistaxis; it allows precise source bleeding localization and hemostasis.

P72

Management of renal angiomyolipomas by selective arterial embolization

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Purpose: To evaluate the long-term efficacy of selective arterial embolization in the treatment of renal angiomyolipoma (AML).
Materials/Methods: Fifteen patients with renal AMLs underwent selective arterial embolization. Four patients had tuberous sclerosis (TS) with multiple AMLs and 11 patients had a solitary sporadic AML. Thirteen patients were symptomatic and two patients with large AMLs underwent prophylactic embolization. Mean tumor size was 86±31 mm (range, 45-140 mm). Embolization was performed with polyvinyl alcohol (PVA) particles in all cases; microcoils were used in addition to PVA particles in six cases.
Results: All the patients showed tumor devascularization on post-embolization angiograms. Clinical symptoms disappeared in all 13 symptomatic patients. One patient with TS and end-stage renal insufficiency underwent bilateral nephrectomy one month after embolization. After a mean follow-up of 34.7 months (range: 1-130), one patient rebled at 38 months and was successfully managed by partial nephrectomy. Another patient presented with pain and progressive regrowth 41 months after the procedure and was successfully treated by repeat embolization. The other 12 patients remained asymptomatic without radiographic changes througthout the follow-up.
Conclusion: Selective arterial embolization is an effective treatment option for patients with renal AMLs.

P73

Partial embolisation of the thyroid gland in hyperthyroidism

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Purpose: In this study we evaluated the use of a partial embolisation of the thyroid gland as an alternative treatment for those patients who do not tolerate current therapies for the presence of a goitre with hyperthyroidism.
Materials/Methods: Between January 2004 and December 2005, partial embolisation of the thyroid gland in 17 patients with hyperthyroidism was performed. A selective arteriography for evaluation of the blood supply to the thyroid gland preceded the embolisation, by means of mixture of Histoacryl and Lipiodol, of two or three thyroid arteries. A post-embolisation angiography was also carried out to evaluate embolisation effectiveness.
Results: At the end of the follow-up period, all 17 patients had a normal thyroid function with a decreased size of their thyroid gland. Complications were not recorded.
Conclusion: Our clinical post-embolisation follow-up suggests that the procedure is an effective, minimally invasive, and safe method in the treatment of patients with hyperthyroidism.

P74

Endovascular management of parapancreatic aneurysms

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Learning Objectives: 1. To describe various techniques in transarterial embolization (TAE) for parapancreatic aneurysms. **2.** To understand optimal embolic materials and complications in these procedures.
Background: In visceral aneurysms, parapancreatic aneurysms are important, because life-threatening pseudoaneurysms are often caused by pancreatitis or surgical complications. Emergent TAE is required for these aneurysms, and the optimal planning for endovascular management should be decided promptly. Parapancreatic aneurysms are often found in complex arterial communications originating from the celiac axis and superior mesenteric arteries, and therefore, even in TAE for true aneurysms, various techniques are needed to obtain technical success and to avoid complications.
Clinical Findings or Procedure Details: TAE for true parapancreatic aneurysms (n=16) and pseudoaneurysms (n=39) was performed by using several embolic materials [various metallic coils, coil anchor, and n-butyl cyanoacrylate (NBCA)]. Aneurysms were seen in several arteries such as celiac, splenic, gastroduodenal, pancreaticoduodenal, dorsal, and transverse pancreatic arteries. Primary technical success rate was 97% in pseudoaneurysms, and 94% in true aneurysms. In some cases, NBCA must be used to rescue the patient. Complications included hepatic failure, migration of embolic materials, and pancreatitis.
Conclusion: We described the various techniques and optimal embolic materials in TAE for parapancreatic aneurysms.

P75

Embolization of symptomatic non-functioning renal allograft in pediatric patients

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Purpose: Non-functioning graft nephrectomy in pediatric patients is associated with a high morbidity. Post-transplantation adhesions and scars can be a threat. We report our experience with embolization of non-functioning kidney transplant in children as an alternative to surgery.
Materials/Methods: Between August 1994 and August 2005, we performed 16 embolizations in 13 renal transplants for graft intolerance or irreversible rejection in 12 children (mean age:12.7 years). All procedures were performed under general anesthesia. A contralateral femoral access was used in 7/13 cases with end-to-end anastomosis of the internal iliac artery. An ipsilateral access was preferred in 6/13 cases with end-to-side anastomosis to the external or the common iliac artery. Occlusion-balloons were used prior to embolic agents injection (absolute alcohol and coils). Clinical and Doppler-ultrasound follow-up was between two and 120 months (mean 51).
Results: Initial technical success rate was 81.2% (13/16). In 3/16 (18.8%) patients with partial initial embolization an additional completion procedure was required. One child underwent two successful embolizations in two rejected kidney transplants during 2.5 years. There was no evidence of revascularization on follow-up Doppler-ultrasound.
Conclusion: Arterial embolization of non-functioning renal allograft is effective and safe. We advocate this method as an initial treatment in pediatric patients.

P76

The use of hemoglobin concentration in establishing ongoing hemorrhage after transcatheter splenic artery embolization for traumatic splenic injury

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Purpose: Evidence of persistent blood loss after transcatheter splenic artery embolization (TSAE) for traumatic splenic injury, commonly a decrease in hemoglobin concentration (Hb) (g/dL), results in rescue splenectomy with TSAE deemed a failure. The purpose of this study is to determine if Hb decrease alone is sufficient to justify rescue splenectomy.
Materials/Methods: The interventional radiology database and clinical records were used to identify 11 patients who underwent rescue splenectomy over a four-year period. Charts were reviewed.
Results: Hb decrease was a reason for rescue splenectomy in 9/11 patients (sole reason in six). In 8/11 patients, Hb decreased at least transiently after splenectomy to less than the immediate pre-splenectomy Hb. In 5/11 patients, Hb at discharge was less than that of immediate pre-splenectomy Hb. In only 2/11 patients did Hb on discharge exceed immediate pre-splenectomy Hb. In only 6/11 patients did the highest post-splenectomy Hb exceed immediate pre-splenectomy Hb. Of 3/11 hypotensive patients, the largest Hb decrease between presentation and TSAE was 1.8 compared to an average decrease of 5 in normotensive patients.
Conclusion: Hb decrease alone is unreliable in establishing ongoing hemorrhage in post-TSAE patients given persistent Hb decreases post-rescue splenectomy and failure of Hb decreases to correlate with hypotension.

P77

Can failure of transcatheter splenic artery embolization for traumatic splenic injury be predicted?

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Purpose: Failure of transcatheter splenic artery embolization (TSAE) for traumatic splenic injury (TSI) requires rescue splenectomy. The purpose of this study is to determine any association of failure with technical parameters of TSAE or initial imaging findings.
Materials/Methods: The interventional radiology database of a level-1 trauma center was used to identify 66 patients who underwent TSAE for TSI from June 1998 to July 2004, 11 requiring rescue splenectomy. An interventional radiologist experienced in TSAE retrospectively reviewed initial computed tomography (CT) and pre- and post-TSAE angiographic images.
Results: 0 patients with AAST (American Association for the Surgery of Trauma)-grade I or II splenic injuries required splenectomy. 0 patients who had no free fluid on initial CT required splenectomy. The failure rate of distal and combined distal+proximal embolizations was 25% each versus 9.4% for proximal embolization alone. Both the splenectomy and the non-splenectomy groups included some patients with persistent splenic artery flow, persistent extravasation, or filling of collateral vessels on post-embolization angiography.
Conclusion: AAST-grade I or II splenic injury (versus grades III-V) and lack of free fluid on CT are predictors of TSAE success. Proximal (versus distal or combined) embolization may be less likely to fail.

P78

Utility of segmental Lipiodol-transarterial embolization for hepatocellular carcinoma with various tumor stages and hepatic functional reserves, especially assessed by the Japan Integrated Staging Score system

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Purpose: Evaluate with various factors the utility of segmental Lipiodol-transarterial embolization (Seg-TAE) of hepatocellular carcinoma (HCC).
Materials/Methods: In 281 consecutive patients with HCC treated with Seg-TAE since 1986, their survivals were analyzed in relation to tumor stage, Child's classification and a combination of both using the Japan Integrated Staging Score (JISS).
Results: Overall cumulative survival rates (CSR) were 92% at one, 66% at three, 43% at five, 10% at ten years. At one, three, and five years, CSR of tumor stage-1 patients were 98%, 75%, 63%, respectively. CSR of stage-2 patients were 92%, 68%, 43%; CSR of stage-3 cases were 89%, 56%, 29%; CSR of stage-4 patients were 80%, 60%, 30%. CSR of Child's A patients were 97%, 70%, 48%; CSR of Child's B cases were 94%, 66%, 40%; CSR of Child's C patients were 77%, 53%, 29%. CSR of JISS-0 patients were 100%, 74%, 67%; CSR of JISS-1 patients were 94%, 76%, 51%; CSR of JISS-2 cases were 94%, 60%, 37%; CSR of JISS-3 patients were 85%, 57%, 33%; CSR of JISS-4 patients were 62%, 45%, 11%.
Conclusion: These results contribute to the selection of therapeutic methods; Seg-TAE is applicable and offers favorable therapeutic results for most of HCCs.

P79

Percutaneous management of iatrogenic arterial pseudoaneurysms associated with orthopaedic and abdominal surgery

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Purpose: To review our experience in the percutaneous management of iatrogenic arterial pseudoaneurysms associated with orthopaedic and abdominal surgery.
Materials/Methods: We have reviewed our five-year (2001-2005) records to identify 15 cases of arterial pseudoaneurysms. Eight of them were secondary to orthopaedic surgery and seven to abdominal surgery. Clinical and imaging records were reviewed for type of injury, arterial segment involved, percutaneous management, complications, and outcome.
Results: Among orthopedic surgeries, six cases were treated for a femur fracture, one for total hip arthroplasty, and one had a meniscectomy. Among abdominal surgery cases, the inferior epigastric artery was the most affected vessel (three cases). In all cases, the resolution of bleeding was reached only by arterial embolization. No alternative treatments were needed. Gelfoam and coils (two cases) were used as embolic material. We did not record any distal embolic complication.
Conclusion: Transcatheter arterial embolization of pseudoaneurysms following orthopaedic and abdominal surgery is an easy and effective option for the management of bleeding as a complication of iatrogenic arterial injury.

P80

Endovascular coil embolization under flow regulation using an occlusion balloon-catheter

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Learning Objectives: To learn a technique of coil embolization under flow regulation using an occlusion balloon-catheter.
Background: Transcatheter coil embolization for the treatment of torrential blood flow lesion sometimes gives rise to migration of coils during deployment. The prevention of coil migration to avoid most serious complications is of vital importance.
Clinical Findings or Procedure Details: We performed coil embolization for the treatment of torrential blood flow lesions under temporary balloon occlusion for regulation of blood flow using a 5-French occlusion balloon catheter placed at an afferent or efferent vessel for preventing coil migration. Four splenic arterial aneurysms with dilated splenic arteries in patients with liver cirrhosis, one huge pulmonary arterio-venous fistula and one dilated lead-pipe like spleno-renal shunt were treated. Coaxial microcather system was used for embolization of an efferent vessel of splenic aneurysm. A pre-shaped sheath was used for easy manipulation of the balloon catheter. All cases were successfully treated without coil migrations.
Conclusion: Blood flow regulation with an occlusion balloon catheter provided safe and effective coil embolization for the treatment of torrential blood flow lesion.

P81

Outcomes of uterine artery embolization using gelatin sponge particles for symptomatic fibroids

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Purpose: To evaluate outcomes of uterine artery embolization (UAE) using gelatin sponge particles for symptomatic fibroids.
Materials/Methods: Between January 2002 and January 2006, 80 patients (age range, 27 to 53 years; mean age, 39.7 years) underwent UAE with gelatin sponge particles (mean 5.8 cc) for symptomatic fibroids. The follow-up period ranged from one to 36 months. Changes in clinical symptoms, additional intervention, and complications were assessed by questionnaires at three months, six months, one year, and two years after UAE.
Results: Mean fibroid size pre-UAE was 273.8 cc (range 3.7-1146.6 cc) and mean uterine size post-UAE was 44.3 cc (range 0-178 cc). Mean uterine size pre-UAE was 660.8 cc (range 83.2-2433.8 cc), and mean uterine size post-UAE was 303 cc (range 84.2-481.6 cc). There were significant overall symptomatic improvements in all the patients including bleeding symptoms, pressure/tightness and urinary siymptoms. Minor and major complications and failures will be described.
Cconclusion: UAE was effective in treating uterine fibroids and alleviating symptoms associated with uterine fibroids.

P82

Efficacy of transarterial embolization using N-butyl-2-cyanoacrylate and Lipiodol for acute arterial bleeding in patients with coagulopathy

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Purpose: Transarterial embolization (TAE) is widely accepted in the treatment of acute arterial bleeding. However, failed hemostasis using gelatin sponge or metallic coils, especially in patients with coagulopathy, is not a rare event. In these cases we therefore performed TAE using a mixture of N-butyl-2-cyanoacrylate (NBCA) and Lipiodol.
Materials/Methods: Between May 2004 and October 2005, 21 procedures were undertaken in 18 patients with acute arterial bleeding and uncorrectable coagulopathy. Postoperative bleeding was present in eight, trauma in three, perinatal hemorrhage in two, and other causes in five. A mixture of NBCA diluted by Lipiodol three to 12 times was used. Outcomes and related complications were evaluated.
Results: We embolized 21 arteries (six internal iliac arteries, four uterine arteries, four gastroduodenal arteries, two hypogastric arteries, two right gastric arteries and three others). The procedures were all successful and an initial hemostasis was achieved in all cases. Rebleeding occurred in three patients whose embolizations were combined with metallic coils. End-organ damages or iatrogenic ischemias attributable to NBCA-TAE were not recorded.
Conclusion: NBCA-TAE is a useful treatment in acute arterial bleeding in patients with coagulopathy.

P83

Techniques of coronary fistulae embolization

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Purpose: Coronary arteriovenous-fistulae are a rare entity. Because of a variety of severe symptoms and complications there is a demand for therapy. We report our experience with the endovascular therapy.
Materials/Methods: During the last two years, three women with coronary fistulae, aged from 34 to 63 years, were referred for embolization therapy. Two patients were soccer players. The first patient presented with a complex ventricular arrythmia, due to a coronary-pulmonary fistula arising from both main coronaries. The second case had a posterolateral myocardial infarction. The third woman showed a high-flow fistula with multiple feeders arising from the left anterior descending (LAD) artery and was suffering from dyspnoea. The first and the third patients were embolized with a mixture of glue, while the remaining patient underwent endovascular embolization with detachable microcoils.
Results: Two fistulae could be completely occluded; one fistula, because of one feeder arising from the ostium of the LAD, was occluded only partially. There were no procedure-related side-effects or complications. All the patients had a complete recovery.
Conclusion: In addition to the established surgical therapy, embolotherapy seems to be an effective alternative in the treatment of coronary fistulae. An interdisciplinary approach and a therapeutic strategy is strongly recommended.

P84

Catheter-directed gastric artery fundal ablation modulates systemic ghrelin levels in a swine model

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Purpose: Ghrelin, produced in the gastric fundus, induces weight gain by stimulating food intake. We investigated the effects of gastric artery fundal ablation (GAFA) on systemic ghrelin levels in a swine model.
Materials/Methods: The left gastric artery supplying the fundus was catheterized. GAFA was performed by infusing Morrhuate sodium selectively into this artery. A dose-escalating regimen (37.5, 50, 56.25, 62.5, 125, 2000 mg) was used in six swine while two controls underwent a sham procedure. Weight and fasting plasma ghrelin levels were compared in animals at baseline, days 7, 14, 21, and 28. Stomachs were excised and analyzed by histochemical and immunofluorescence staining.
Results: With lower dosages, serum ghrelin concentrations increased linearly up to 300% at one month (p=.002). At a higher dose (125 mg) serum ghrelin values were sharply reduced to -77% of baseline at one-month follow-up (p=.002). Weight change of +8.5% and +1.5% were seen in control animals and ablated animals, respectively. Immunofluorescence staining showed a dramatic decrease of ghrelin in animals that underwent GAFA.
Conclusion: There is a direct link between GAFA and systemic ghrelin levels. Complete suppressive effect of ghrelin is feasible. GAFA may offer a innovative minimally invasive approach to control systemic ghrelin levels.

P85

Transarterial chemoembolization in the treatment of hepatocellular carcinoma: a single-center experience over a five-year period

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Purpose: To retrospectively evaluate results, safetey, and efficacy of transarterial chemoembolization (TACE) in hepatocellular carcinoma (HCC) patients not candidate for transplantation.
Materials/Methods: TACE [10 mg MitomycinC, 10-20 ml Lipiodol, sessions every six weeks, 688 sessions (4.6+/-3.5) in total] was performed in 149 HCC patients (126 men; 63.7+/-10.1 years). Follow-up included multislice-computed tomography and laboratory tests. Group A (1-3 TACE) and B (>3 TACE) were statistically identified.
Results: Okuda stage I versus II: 49.7% versus 50.3%. Tumor size: 6.3+/-3.8 cm. Unifocal versus multifocal tumor disease: 20 (13.4%) versus 129 (86.6%) patients. Both liver lobes were involved in 62.4%. Portal vein thrombosis was present in 51/149 (34.2%) cases. One-, two-, and three-year survivals: 51.3, 24.4, and 13.1%. Mean survival: 18.3 months (CI 95%, 15.0-21.6). Group-A survivals: 16.9, 5.6, and 5.6% at one-, two-, and three years versus 80.4, 39.5, and 22.9% for group B. Both groups differed significantly (p<0.05) in relation to: tumor size, alfa-fetoprotein values, and portal vein thrombosis. Independent prognostic factors (multivariate analysis): number of TACE, alfa-fetoprotein value, Okuda stage.
Conclusion: Repeated TACE showed significant better survivals than less numerous embolizations. Results should however be discussed with respect of deteriorated liver functions and patients' selection according to tumor size.

P86

Blunt splenic injury: efficacy of superselective transcatheter arterial embolization

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Purpose: To determine the efficacy of superselective transcatheter arterial embolization in patients with splenic blunt injury.
Materials/Methods: We retrospectively reviewed 24 consecutive patients with blunt splenic injury at a large Level 1 trauma center. After angiographic confirmation of splenic injuries, embolizations were performed with gelfoam particles (n=15) with or without coil and liquid embolic materials (D-Stat Flowable Hemostat; Vascular Solutions Inc., Minneapolis, USA; n=9). Outcome measures included technical success and recurrence of symptoms requiring additional intervention or surgery after embolization.
Results: All patients showed technical success with immediate occlusion of selective vessels after embolization. One patient underwent pancreatico-splenectomy three days after splenic embolization due to symptoms related to distal pancreatic injury. A second embolization was performed 1-3 days after initial embolization in four patients with clinical suspicion of re-bleeding. Of these four patients, one patient underwent splenectomy three days after a second embolization due to concern of associated bowel injury. Another one patient underwent splenectomy one day after a second embolization due to need for continuous transfusion.
Conclusion: Superselective transcatheter arterial embolization of the spleen can be performed as a safe alternative to splenectomy in patients with blunt splenic trauma, especially when there is no associated major organ injury.

P87

Use of the Amplatzer Vascular Plug for arterial and venous embolization: preliminary experience

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Purpose: The Amplatzer Vascular Plug (AVP) (AGA Medical Corp, Golden Valley, MN, USA) is a new self-expandable nitinol-based embolization device which is attached to a delivery cable via a microscrew allowing controlled release. We report our early experience with this device.
Materials/Methods: Embolization of 16 arteries and three veins was attempted with AVP in 18 patients (age 39-83, mean 65 years). The indications were prevention of endoleak in thoracic (n=5), abdominal aortic (n=9), and iliac artery (n=1) stent-graft procedures, treatment of splenic artery aneurysm (n=1), and treatment of varices during transjugular intrahepatic portosystemic shunt (n=2). Technical and clinical success, ease and speed of use, complications, and findings upon imaging follow-up were recorded.
Results: Embolization of the intended target vessel was technically and clinically successful in 19/19 vessels (100%). In 6/19 vessels (32%), additional coil embolization was performed. Imaging follow-up (computed tomography- or magnetic resonance-angiography) was available in 100%, ranged from 5-175 days (mean 62), and demonstrated sustained clinical success in all patients. There were no complications attributed to the AVP and operators preferred it over coils.
Conclusion: Use of the AVP is effective and safe and was preferred over coils in anatomically suitable vessels by all operators.

P88

Value of hepatic angiography and Brehmsstrahlung imaging in hepatic radioembolisation

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Purpose: To review the role of hepatic angiography and Brehmsstrahlung imaging for safe hepatic radioembolisation.
Materials/Methods: Patients with unresectable hepatic metastases were treated with hepatic radioembolisation with SIR spheres (Sirtex, Sydney, Australia). Potential patients were screened with technetium-99 macroaggregated albumin shunt studies and hepatic angiography to exclude significant lung shunting and uncorrectable gastrointestinal uptake. Brehmsstrahlung imaging is performed after catheter directed injection of SIR spheres. Follow-up was using positron emission tomography and computed tomography at six-week intervals.
Results: Eighteen patients received SIR spheres during the 18-month study period. One treatment was terminated due to leakage of SIR spheres. Brehmsstrahlung imaging confirmed delivery of radioisotope to the desired hepatic arterial territory in all but one patient. In one patient, the Brehmsstrahlung imaging showed selective right hepatic arterial isotope delivery rather than the expected injection to both arterial territories. There was one patient's death within 30 days of the procedure, not directly related to the treatment. Inadvertent embolisation of an aberrant gastric artery resulted in gastric ulceration.
Conclusion: While hepatic radioembolisation is a safe treatment for unresectable hepatic malignancy, the complications can be minimised by careful planning.

P89

Creation of an animal model of post-hepatic portal hypertension by inducing hepatic vein stenosis in swine

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Purpose: To present preliminary data on the creation of a model of post-hepatic portal venous hypertension in swine.
Materials/Methods: The study was conducted in four Yorkshire microswine. All procedures were performed using a jugular vein access. Baseline biochemical, hemodynamic, and histologic evaluation was conducted. After the baseline evaluation, self-expandable metallic stents were placed into the hepatic vein trunks. Evaluation was repeated one and two months after stent placement. The swine were sacrificed after the two-month study. Data were analyzed using t-student and chi-square tests.
Results: Baseline studies were normal in all animals. A mean of seven stents was placed. Venograms showed varying degrees of stenosis within the hepatic veins at one month and worsening stenoses at two months. The mean hepatic vein gradient was 5.25 ± 7.8 mm Hg before stent placement, 4.5 ± 5.2 mm Hg at one month (p=0.85), and 12.3 ± 9.8 mm Hg at two months (p= 0.02). Liver biopsies showed grade 2 portal fibrosis and centrilobular congestion in all animals at two months (p=0.01).
Conclusion: Preliminary results indicate that stenting of the hepatic veins causes hemodynamic and histopathologic changes consistent with post-hepatic portal hypertension at two months. Improvements in model creation may be necessary.

P90

Experimental investigation on photodynamic effect of polyethylene glycol-modified fullerene

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Purpose: Fullerene (C60) efficiently generates singlet oxygen when irradiated with light. C60 is part of a unique group of substances called „photosensitizers." Tabata et al. succeeded in solubilizing C60 by adding a polyethylene glycol (PEG), thus enabling intravascular administration. We evaluated C60-PEG cytotoxicity in a normal rabbit liver and in an atherosclerotic model.
Materials/Methods: C60-PEG (C60: 2.4 mg/ml) was injected just into the subcapsular region of the rabbit liver which was laparotomized. The site was photoirradiated (1.1 W/cm^2 x 6 min), observed one day later, and resected after seven days. Following a slow infusion of C60-PEG (C60: 2.4 mg/ml) into the left femoral artery (FA) of the atherosclerotic model, the affected region was photoirradiated (1.1 W/cm^2 x 6 min). Bilateral FAs were removed two weeks post-infusion, and compared for the development of atherosclerosis.
Results: The liver on which subcapsular infusion of C60-PEG and photoirradiation were performed showed a tissue injury from day one on the treatment site. The combined administration of C60-PEG infusion and photoirradiation in the left FA induced the suppression of atherosclerosis development, as compared with the right FA.
Conclusion: This trial showed C60-PEG cytotoxicity. By administering appropriate concentrations, C60-PEG could potentially inhibit atherosclerosis and tumor growth.

P91

Effect of inflammation on angiogenesis in restenosis

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Purpose: Endovascular interventions are often performed at sites of advanced macrophages rich atheromatous lesions. The objective of the present study is to test the hypothesis that activated macrophages stimulate endothelial cell into angiogenesis.
Materials/Methods: Human aortic endothelial cells (HAEC) were seeded and grown to confluence on a cross-linked thick, firm collagen gel for 24 hours. Then, either non-treated human monocytic leukemia cells (naTHP-1) or THP-1 activated (aTHP-1) with 50 nM of 12-O-tetradecanoylphorbol-13-acetate (TPA) added on top of the collagen. After 15 and 21 days, samples were analyzed for evidence of angiogenesis and compared with control.
Results: HAEC cultured in the presence of aTHP-1 changed in morphology from cobble stone appearance in the control group to a fusiform shape and formed capillary like networks in the 3D angiogenesis model.
Conclusion: These results indicate that endovascular interventions in the presence of activated macrophages, such as found in vulnerable atherosclerotic plaques, may result in negative angiogenesis.

P92

A new foreign body retrieval device with an adjustable snare: experimental evaluation in a swine model

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Purpose: To establish the efficacy and overall handling characteristics of the miniTEX™ (mTX) foreign body retrieval device (IDev Technologies, Inc.) in a swine model.
Materials/Methods: The 4-F mTX device features a ≤10-mm adjustable radiopaque loop opening perpendicular to the catheter shaft. Homemade repositionable foreign bodies (0.035-inch, 10-cm long, 8-mm diameter stainless steel coils) were placed in the infrarenal aorta (8 mm in diameter). Six devices were tested; three attempts with each were made from a carotid approach to capture and remove the foreign bodies. Times needed to capture the foreign bodies (capture time, CT) were recorded.
Results: All the six devices worked efficiently. All the 18 attempts to capture the foreign bodies were successful. The CT was 25.9 ± SD 17.4 seconds (median 21 s, range 4-64 s). The mTX showed excellent pushability, trackability, and torque control.
Conclusion: The adjustability and preserved perpendicular orientation of the mTX loops during closure resulted in high-rate efficiency in capturing. Also, the ability to adjust continuously the loop during intervention enabled a versatile capturing technique that facilitated capture of foreign bodies with the devices. In addition, the low-profile mTX showed 1:1 torque control.

P93

Ethiodized oil-based capillary embolization techniques used for transcatheter renal ablation in rabbit kidneys inoculated with VX2 carcinoma: a pilot study

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Purpose: To compare ablation by a 1:1 Ethiodol-ethanol mixture (EEM) and by pure Ethiodol in rabbit kidneys inoculated with VX2 carcinoma.
Materials/Methods: The right kidneys of ten rabbits were inoculated transarterially with VX2 tumor fragments. After one week, the kidneys were injected with 1:1 EEM (Group 1, n=6) or pure Ethiodol (Group 2, n=4) for capillary embolization. A 9:1 ethanol-Ethiodol mixture (eEM) was injected to achieve arterial occlusion in both groups. The kidneys were followed up to one week.
Results: Capillary embolization followed by eEM resulted in arterial stasis and arterial occlusion in all kidneys. There was no statistically significant difference between the amounts of capillary agents and eEM, but the total procedure time was significantly longer for Group 1 than for Group 2 (17.5±5.47 min vs. 10.0±1.41 min, P=.018). Histologically, both protocols caused thrombosis of capillaries and arteries and resulted in ischemic coagulative necrosis. Small tumor clusters, predominantly as arterial thrombi, survived in some kidneys in both groups.
Conclusion: There was no difference between the two protocols in the potential for complete tumor ablation. The use of Ethiodol, however, seemed to be promising because it resulted in less arterial spasm, more homogeneous capillary filling, and significantly shorter procedure time.

P94

Active connection matrix system: a new paradigm for intelligent image processing in digital subtraction angiography

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Purpose: In the last years, many clinical studies showed the potential role of different kinds of artificial adaptive systems in automated image processing for detection and/or diagnostic purposes. The goal of this preliminary experience is to assess the usefulness of a new system called active connection matrix (ACM) in interventional radiology.
Materials/Methods: ACM is able to automatically extract features of interest (e.g. edges, tissue differentiation, etc.) from digital images to a special kind of artificial adaptive system. During the period September 2003-December 2005, 27 patients with abdominal aortic aneurysms (3), peripheral (15) and carotid (9) diseases were investigated by digital subtraction angiography (DSA). The need of further information from diagnostic and post-procedure images suggested the use of ACM.
Results: Every image was processed according to different protocols relying on original recursive non-linear equations and results were assessed by independent comparative analyses. ACM allowed the expression of hidden morphological features and, on this basis, an improvement of diagnostic images was achieved in all cases.
Conclusion: ACM represents a new and challenging paradigm for intelligent image processing able to improve DSA information by overcoming the problem of invariant feature extraction from digital images.

P96

Closed renal circuit for ethanol embolization: preliminary experiment in a pig model

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Purpose: To assess the efficacy of a closed renal circuit for ethanol embolization.
Materials/Methods: Ten pigs were included in the study and divided into two groups. In group A (n=5), the renal artery and vein were occluded with balloon catheters, and the renal artery was embolized with absolute ethanol under aspiration of the renal venous flow (closed renal circuit). In group B (n=5), a standard ethanol embolization was employed. The dosage of absolute ethanol was 0.2 ml/kg. Serum ethanol concentrations in the systemic circulation were monitored during the procedure and 5 minutes after infusion. Four days after the procedure, nephrectomy was performed and histological studies were carried out.
Results: The maximum ethanol concentration in group A (0.032 mg/ml, SD: 0.05) was significantly lower than in group B (0.22 mg/ml, SD: 0.04) ($p<0.05$). There was no histological difference between group A and group B.
Conclusion: Ethanol embolization with a closed renal circuit decreases ethanol leakage to the systemic circulation. This novel infusion therapy may be effective by increasing the maximum dosage of absolute ethanol.

P97

Determination of effective doses and skin doses during computed tomography interventional procedures

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Purpose: To develop a method to determine the effective dose (*E*) and the maximum entrance skin dose (ESD_M) in computed tomography (CT) interventional procedures and investigate for possible deterministic effects to the patient's skin.
Materials/Methods: The study included 14 collection drainages and six nephrostomy procedures performed using a spiral single-slice CT scanner. The *E* was estimated using Monte Carlo conversion coefficients and the Impactscan data base. The ESD_M was estimated using the Computed Tomography Dose Index in soft tissue ($CTDI_{soft\ tisue}$).
Results: The median value of *E* was 15 mSv for collection drainages and 11 mSv for nephrostomies. The corresponding values of ESD_M were 139 and 165 mGy. The catheter positioning was responsible for 41% of the ESD_M for collection drainages and 48% for nephrostomies.
Conclusion: The threshold for deterministic effects (2Gy) was never reached. The estimated median *E* in collection drainages was approximately 50% higher as compared with routine abdomen CT (8-10 mSv) whereas nephrostomies appeared to have similar *E* values. The median ESD_M was about 40 times the ESD for a routine X-ray abdomen examination (3 to 4 mGy) as a result of the scans overlapping at the same anatomical position.

P98

A new design for a self-expanding, nitinol, microporous, covered stent. An experimental study

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Purpose: A new nitinol covered stent was developed by us to reduce in-stent restenosis rates. We report here its usefulness and safety in an animal (dog) model.
Materials/Methods: The Sendai Stent--a newly designed nitinol stent--was created with flexible and self-expanding properties. This novel drug-eluting covered stent has a microporous elastometric covering film and a flat luminal surface immobilized with heparin for anticoagulation. Its outer surface is immobilized with Tacrolimus to prevent neointimal hyperplasia.(pore diameter, 100 micron; interpore distance, 150 micron). One month after implantation into the bilateral common iliac arteries of adult dogs, all stented arteries were patent and luminal surfaces were fully covered with a confluent of endothelial cells in spite of drug immobilization.
Results: There was no significant neointimal thickening as compared with existing bare stents. Endothelialization of the stent inner wall was confirmed by animal study.
Conclusion: These results suggest possible future new applications, such as improvements in carotid and splanchnic aneurysmal stenting.

P99

Type II endoleak model and aneurysm sac embolization: an experimental study

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Purpose: To create an animal model that would develop type II endoleaks endoluminally and evaluate the efficacy of embolization of the aneurysmal sac.
Materials/Methods: Tsuzumi drum-shaped stent-grafts, with their diameter narrowed in the center, were deployed in the mid-thoracic aorta of 13 swines. A residual space (RS) between the aortic wall and the graft with intercostal arteries simulating an aneurysm sac was created. A 5-F catheter was placed into the RS and then aortography, RS-angiography, and intra-RS pressure measurement were performed. Embolic material was injected into the RS via the 5-F catheter (fibrin glue n=4, gelatin sponge n=4) (control group n=5). After ten-day follow-up studies, animals were sacrificed.
Results: RS with two or three pairs of intercostal arteries were successfully created in all cases. In the control group, aortography showed a type II endoleak in 2/5 swines immediately after stent-graft placement; RS-angiography showed circulation between the RS and the intercostal arteries in all cases up to ten days after. In the embolization group, aortography showed no type II endoleaks; intra-RS pressure could not be measured in most of the cases.
Conclusion: We successfully created a type II endoleak model. Embolization of the aneurysmal sac was useful to prevent type II endoleaks.

P100

Complex stent assemblies: feasibility of stent-through-stent deployment

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Purpose: Stent extension into side branches at bifurcations is a challenge when a previously placed stent covers the newly involved limb. Placement of a stent through side struts of an *in-situ* stent may be necessary. This *in-vitro* study compares performance of various stents in such complex assemblies.
Materials/Methods: Ten-mm wide Wallstents, nitinol Protege and Sentinol stents were deployed *in vitro*. Secondary stents were deployed through the side struts of the primary stents followed by 10-mm balloonplasty. Stent expansion and deformation were assessed using 3D multidetector computed tomography reconstructions.
Results: Deployment of any secondary stent through the middle of a primary 68-mm Wallstent resulted in 42% narrowing of secondary stents with primary stents intact. Structural integrity of primary and secondary stents was preserved. Deployment of secondary stents at 1 cm from a primary Wallstent edge lead to less narrowing of secondary stents (25.2%) but resulted in severe deformation of primary Wallstents. When any secondary stents were deployed through a primary nitinol stent, secondary stents expanded completely regardless of the deployment location. Primary nitinol stents demonstrated fractures of strut interlinks to accommodate secondary stents following balloonplasty.
Conclusion: If complex stent reconstruction is clinically foreseeable, primary placement of a nitinol stent is preferable.

P101

Integrative imaging-genomic analysis of hepatic cell carcinoma with biphasic computed tomnography to predict treatment response profiles

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Purpose: To determine if noninvasive imaging phenotypes could be associated with specific drug response gene expression programs based on genome-wide gene expression analyses of hepatocellular carcinoma (HCC).
Materials/Methods: Thirty HCCs were analyzed across biphasic computed tomography (CT) scans and scored across six pre-defined imaging phenotypes. Bioinformatic analyses were performed for correlation of each imaging trait against the corresponding microarray data and a doxorobucin response gene expression program for the same 30 HCCs (representing gene expression measurements across ~18,000 genes).
Results: A characteristic tumor margin imaging phenotype significantly correlated with the doxorubicin-response transcriptional program ($p<0.05$, FDR<0.1) but was not significant for a broader multi-drug resistance transcriptional program. This imaging trait also strongly correlated with separate HCC venous invasion, and liver differentiation gene expression programs ($p<0.05$, FDR<.05). Further, this imaging trait was also associated with HCC tumor stage and microscopic venous invasion by histology ($p<0.05$, FDR<0.1). Tumors with worse tumor margin scores were more strongly associated with the doxorubicin resistant transcriptional program, had greater prevalence of venous invasion and worse stage.
Conclusion: It is possible to identify HCC imaging phenotypes that correlate with specific drug response gene expression programs. Such an approach could help guide HCC tumor therapies on a tumor-by-tumor basis.

P102

Rhenium-188-mercaptoacetyltriglycine-filled balloon dilation following bare-stent placement results in reduced tissue hyperplasia in a rabbit esophageal model

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Purpose: Evaluation of β-irradiation using ^{188}Re-MAG$_3$-filled balloons for preventing tissue hyperplasia following bare-stent placement in rabbit esophageal models.
Materials/Methods: Immediately following bare-stent placement, ten rabbits underwent conventional contrast-filled balloon dilation (group I), and 20 rabbits underwent ^{188}Re-MAG$_3$-filled balloon dilation, half receiving 20 (group II) and half receiving 40 Gy (group III) at 1-mm tissue depth. Diameter percentage stenoses on esophagography and gross/microscopic pathologic findings were evaluated. Apoptosis and apoptotic index in the mid-stent area were evaluated in two rabbits of each group using TUNEL assay.
Results: Thirteen rabbits survived six weeks. Diameter percentage stenosis in groups II and III was significantly lower than in group I. Esophageal mucosa showed nodularity in group-I tissue, and smoothness in group-II and -III tissues. Esophageal mucosal redness (n=9) and perforations (n=10) were observed in group-II and -III tissues only. Mid-stent epithelial layer thickness and muscularis propria destruction differed between the three groups ($p<0.05$). There was an apoptosis increase in epithelial and in muscle layers in group-II and -III tissues; apoptotic index was also higher in group-II and -III tissues.
Conclusion: β-irradiation using ^{188}Re-MAG$_3$-filled balloon dilation prevented tissue hyperplasia following bare-stent placement in rabbits. Maybe, apoptosis is a mechanism underlying irradiation-induced suppression of tissue hyperplasia.

P103

The analysis of hydrophilic wires for debris and rapidity of drying using high-power optical microscopy

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Purpose: Hydrophylic wires are widely used in interventional radiology, and work superbly well when suitably lubricated. They are however prone to drying out, and current methods of maintaining their lubrication may involve wiping with a saturated gauze. We examine these wires to evaluate for debris due to this wiping. We also study the rapidity with which these wires dry, and the increased friction and stickiness that develops as this occurs.
Materials/Methods: We examine .035-inch hydrophilic wires in a laboratory environment. Wires in different states of lubrication are wiped with gauze, and examined under 115x optical microscopy. Further to this, wires in different states of lubrication are specifically tested for their degree of slipperiness by using a highly sensitive friction meter.
Results: We confirm that hydrophilic wires dry exceptionally quickly, and demonstrate changes on the wire surface as this occurs. We demonstrated that anything but saturated gauze can leave tiny fibres on the wire surface.
Specific measurements also show the increase in friction which occurs as these wires dry.
Conclusion: Wire lubrication is of the utmost importance in maintaining appropriately slippery wires, and such lubrication must be achieved carefully to avoid debris being left on the wire surface.

P104

Selective induction of mild brain hypothermia using retrograde venous perfusion with a catheter-based technique: a feasibility pilot study in two animal models

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Purpose: Hypothermia is frequently used in intensive care to protect patients from severe brain damage, but whole-body technique risks systemic side-effects. Our study (in collaboration with A. Lunderquist's group in Malmo) aimed at evaluating: feasibility of selective induction of mild brain hypothermia while maintaining central temperature and its effect on intracranial pressure (ICP).
Materials/Methods: Temperature and ICP probes were inserted into the brain of four pigs (50-60 kg) and two Rhesus monkeys (8-12 kg). Body temperature (BT) was monitored using central venous catheters and rectal probes. To induce brain hypothermia, 4-F inflow catheters in internal jugular veins (monkeys) or at the rete mirabile level (pigs), and 8.5-F outflow catheters in inferior vena cava (both models) were connected to a roller pump with heat exchanger. Pump settings were: 10-20°C at 20-100 mls/min (pigs); and 10°C at 20-30 mls/min (monkeys).
Results: A mild brain hypothermia of ±2 degrees was achieved within 1-1.5 hours. BT decreased less than the brain, with achievement of a balance between the two temperature values. Both models showed a relationship between infusion flow rate, infusion temperature, and BT. ICP was uneffected.
Conclusion: Retrograde venous perfusion technique inducing a selective mild brain hypothermia without affecting ICP appears feasible.

P105

Renal, mesenteric, and iliac arteries ablation in a rabbit model using radiofrequency guidewires: comparison between conventional angiography and pathologic findings

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Purpose: To evaluate the effect of renal, mesenteric and iliac arteries ablation using radiofrequency (RF) guidewires in a rabbit model.
Materials/Methods: Twenty-one New Zealand rabbits were used. Renal, mesenteric, and iliac arteries via the carotid artery were selected using a guidewire with a denuded tip. RF ablation was done using several protocols: 1 watt for 1 minute (n=3), 1 watt for 2 minutes (n=4), 2 watt for 1 minute (n=4), 2 watt for 2 minutes (n=4), 3 watt for 1 minute (n=3), 3 watt for 2 minutes (n=3). To evaluate thrombus formation, endothelial injury, and complications, angiography was carried out after 30 and 60 minutes. After angiography, arteries were explanted to evaluate pathologic findings.
Results: Various changes were depicted by angiography, including vascular stenoses, thromboses, embolisms, arterial ruptures, and occlusions. Effects on the endothelial wall and the surrounding tissues were increased by watt increments, prolonged ablation time, and decrement of vascular diameter.
Conclusion: Despite some limitations, ablation of arteries using RF guidewires can be used as an embolization tool in selected cases.

P106

Transauricular endovascular access through the ear artery or vein in rabbits: a novel platform for experimental endovenous or intra-arterial cardiovascular interventions

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Learning Objectives: To present a pictorial essay of a novel method of transauricular endovascular access in New Zealand White rabbits, which may serve as a multi-purpose non-surgical platform in cardiovascular research.
Background: Traditionally, experimental interventions involve vascular access via surgical cut-down of either the femoral or the cervical arteries and veins. This surgical approach is time-consuming and is associated with pain and local or systemic infections. A percutaneous technique of endovascular access that could enable rapid, safe, and repeatable cannulation of the central arterial and venous system may serve as an excellent experimental platform of catheter-based diagnostic and therapeutic cardiovascular interventions.
Clinical Findings or Procedure Details: Under anesthesia, the central auricular artery or marginal ear vein of New Zealand White rabbits is cannulated with a 22-G venous catheter. A 0.018-inch guidewire is advanced down to the brachiocephalic vessels under road-mapping technique and a 4-F hydrophilic sheath is inserted over-the-wire. Subsequently, selective catheterization of the whole venous and arterial vasculature may be performed. Angioplasty, stenting, and embolization procedures are easily carried out using standard instruments.
Conclusion: The rabbit transauricular endovascular approach may improve and expedite experimental cardiovascular interventions obviating the need for surgical cut-down and consequent sacrifice of the peripheral vessels.

P107

***In-vivo* imaging and quantitative analysis of angiogenesis in animal models with the application of sophisticated image processing and analysis algorithms**

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Purpose: *In-vivo* vascular imaging of angiogenesis is necessary for the reproducible evaluation of the vascularization process in studies of proangiogenic and antiangiogenic agents.The goal of this project, which received the CIRSE 2005 research grant, was to develop computerized image processing algorithms that enhance microvessels depiction and quantification.
Materials/Methods: Therapeutic angiogenesis was studied in a rabbit hindlimb ischemia model after bilateral surgical excision of the femoral artery and unilateral intramuscular thrombin infusion. Tumoral neovascularization was investigated after bilateral implantation of Walker sarcoma in rats' thighs. Unilateral external beam irradiation was applied (7.5 Gy total dose) to inhibit angiogenesis. Selective angiography and computerized quantification with novel algorithms were employed for comparative study of regional vascularity.
Results: Serial application of sophisticated image segmentation algorithms (probabilistic neural networks, support vector machines, and wavelets processing) and image post-processing filters deducted background noise and amplified the signal-to-noise ratio of digital subtraction angiograms.We achieved to accurately quantify the area and the length (after a skeletonization process) of the microvessels down to the 100 μm scale. Thrombin augmented therapeutic arteriogenesis, while beam irradiation effectuated tumoral antiangiogenesis.
Conclusion: Quantitative vascular imaging with the application of advanced computational algorithms enabled the accurate evaluation of both therapeutic and tumoral angiogenic processes.

P108

A passive guidewire for magnetic resonance-guided vascular interventions in humans

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Purpose: To develop a magnetic resonance (MR)-compatible guidewire for vascular interventions.
Materials/Methods: The guidewire is based on a polyaryletherketone (PEEK) polymer core and coated with another soft polymer, in which small iron particles are embedded. The guidewire has a flexible tip and can be used with any 0.035"-compatible catheter. It was manufactured in collaboration with Biotronik (Vascular Intervention, Buelach, Switzerland). A passive device tracking technique was designed utilizing a susceptibility artifact induced by the wire in images acquired with a balanced steady-state free precession (b-SSFP) sequence using small flip angles $\alpha \leq 5°$. Guidewire tracking and balloon angioplasty of an artificial stenosis were attempted in two configurations of a flow phantom.
Results: Successful passive guidewire tracking was performed for all phantom configurations. Except for the desired susceptibility artifact, no other artifacts were observed.
Conclusion: The tracking scheme includes simplicity and ease of use. No additional hardware is required, and data analysis is readily integrated into the scanner software. The guidewire appears well-suited for clinical application due to an absence of the risk of core fracture and its atraumatic flexible tip. It opens novel prospects for the realization of MR-guided vascular interventions in humans that need to be explored in future studies.

P109

The reduction of in-stent restenosis of ultra-low and low profile poly[bis(trifluoroethoxy)phosphazene]-CeloNova nanocoating of bare cobalt chromium versus Taxus Express and Cypher stents in a porcine model

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Purpose: To compare reduction of late in-stent stenosis of low and ultra-low poly[bis(trifluoroethoxy)phosphazene]-CeloNova brand (PTFEP-CN)-nanocoated cobalt chromium (CC) stents versus Taxus Express and Cypher stents.
Materials/Methods: Low (250 nanom) and ultra-low nanocoated (15 nanom) CC stents, Taxus Express, and Cypher stents were implanted in the right coronary artery of minipigs via a transfemoral approach (four- and 12-week follow-up, eight groups, five animals/group) and evaluated by angiography and light microscopy (analysis of neointima height, inflammation, and injury score).
Results: Stent placement was successful in all animals. Angiography revealed similar average luminal diameters (ALD) and mininum luminal diameters (MLD) of both the low and ultra-low PTFEP-coated CC stents when compared to Taxus Express and Cypher. The average late loss of the low nanocoated CC stents measured only 6.6% at four and 12 weeks. It was 7% in ultra-low nanocoated stents, 8.3% in the Taxus group, and 13.7% in the Cypher group. Light microscopy revealed no significant difference between the four stents.
Conclusion: Low and ultra-low PTFEP-nanocoated CC stents seem to provide a highly promising alternative to expensive drug-eluting stents in reducing late in-stent stenosis.

P110

Effects of stent-based radiation therapy after carotid artery stenting

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Purpose: Endovascular radiation remains an approach in restenosed peripheral vessels, even though it is no longer used in the coronaries. Although restenosis does not seem to represent a major problem after angioplasty and stenting in the carotid artery, therapeutic options in this particular vessel are yet to be defined.
Materials/Methods: Seventeen minipigs received balloon-expandable stents after denudation of the common carotid artery. The radiation doses delivered via the stents were 260 and 470 Gray in a distance of 0.5 mm. Angiography was conducted eight weeks post-interventionem. Animals were sacrificed after 12 weeks and specimens examined with morphometric and histopathologic methods.
Results: Irradiated vessels showed an increased intimal area compared with controls. Histopathologic evaluation revealed a thinned media, incomplete vessel healing, and a distinct adventitial fibrosis. The angiographic follow-up showed a higher stenosis at the stent margins as well as a bending of the stents due to the fibrosis.
Conclusion: According to our data, the limiting factor of intravascular radiation in the carotid artery is a more pronounced intimal hyperplasia, especially at the stent margins. Furthermore, the bending of the stents is of particular interest since the cervical region is exposed to radiation therapy for treatment of malignant diseases.

P111

Elution kinetics in a *in-vitro* model of paclitaxel drug-eluting stents. Evaluation of three different polymers: drug ratio concentration

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Purpose: To determine elution kinetics of three different poly[bis(trifluoroethoxy)phosphazene]/paclitaxel (PTFEP/PCTX) drug-eluting stents in *in-vitro* models.
Materials/Methods: Three different levels of polymer thickness, as well as three different PCTX concentrations (25 micrograms/stent, 50 micrograms/stent, and 150 micrograms/stent) were evaluated. Elution curves and residual PCTX concentrations were assayed with a high-pressure liquid chromatography method in phosphate buffer solution and albumin.
Results: Kinetic curves in *in-vitro* models were more homogeneous, showing a slow release pattern especially in the low-dose group (25 micrograms/stent).
Conclusion: Kinetic curves in our *in-vitro* model showed a release pattern which was more dependent on the polymer thickness rather than on total drug concentration. Although the initial burst showed a fast release pattern in medium- and high-dose groups, the homogeneous and slow release pattern in the low-dose stent could play an important role in the endothelial response to cytostatic drugs preventing intimal hyperplasia after drug-eluting stents implantation.

P112

Non-fibroid indications for uterine artery embolization: 12 cases

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Purpose: To evaluate feasibility of uterine artery embolization (UAE) in patients with different conditions other than leiomyomata.
Materials/Methods: Since 2003, we performed UAE in 604 patients. In 592/604, the main indication was symptomatic leiomyomata while in 12 cases other conditions were present. These included: haemostasis during a caesarean section in three patients with placenta percreta; haemostasis immediately after delivery for hemorrhage caused by uterine atony in one case; haemostasis in two patients with cervical pregnancy (as part of a complex treatment); uterine arterio-venous (AV) malformations in two women; haemostasis in two patients with vaginal bleeding caused by necrosis of cervical/endometrial cancer; preoperative embolization of a retroperitoneal tumor with uterine artery supply in one case; haemostasis in one patient with amyloidosis of uterine vessels. In these cases, polyvinyl alcohol particles and microcoils were both used for embolization.
Results: In all cases, an immediate haemostasis was achieved. There were three clinically successful reinterventions for recurrency: in 1/2 patient with cervical pregnancy, in 1/1 patient with AV-fistulas, and in 1/1 patient with amyloidosis. The patient with AV-fistulas concieved 14 months post-UAE and delivered without major complications.
Conclusion: UAE is safe and effective method for haemostasis in patients with vaginal bleeding of different origins.

P113

Prophylactic embolization of placental disorders

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Purpose: To evaluate the efficiency in preventing severe haemorrhage of prophylactic uterine arteries embolization in case of placental disorder.
Materials/Methods: From 1997 to 2005, six patients were hospitalized for placental disorders: two cases of placenta accreta, one case of placenta percreta, one cervical pregnancy, one patient with trophoblastic disease, and one case of post-molar uterine arterio-venous fistula. All the patients underwent prophylactic embolization. In five cases, both uterine arteries were selectively catheterized and embolized: by gelfoam + microparticles (3), by gelfoam + coils (1), by gelfoam only (1). One patient needed right uterine artery embolization only, with particles.
Results: One patient bled after embolization and required a second successful embolization. No other bleeding occurred. Embolizations were followed by pregnancy and medical treatment in four patients. The other two patients did not need any other treatment.
Conclusion: Placental disorder--such as placenta accreta or percreta, cervical pregnancy, trophoblastic disease and post-molar uterine arterio-venous fistula--are associated with a high risk of hemorrhage and hysterectomy. Prophylactic embolization of placental disorders is an efficient and safe tool to prevent the risk of major bleedings and avoid hysterectomy.

P114

Acute ischemic changes of uterine fibroids immediately after uterine artery embolization: evaluation by diffusion-weighted magnetic resonance imaging

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Purpose: To evaluate ischemic fibroid changes by diffusion weighted imaging (DWI) immediately after uterine artery embolization (UAE).
Materials/Methods: Eleven patients with 47 symptomatic fibroids greater than 20 mm were evaluated. DWI (b-factor 1000) was performed within 5-6 hours post-UAE and compared with contrast-enhanced magnetic resonance imaging (MRI) performed before (within three months) and after (1-3 months) UAE. Apparent diffusion coefficient (ADC) map was generated before and immediately post-UAE.
Results: A homogeneous hyperintensity in the entire fibroid was noted in 30 lesions on DWI immediately post-UAE. Post-UAE contrast-enhanced MRI showed a complete necrosis in 29/30. The remaining case was a pedunculated subserosal uterine fibroid which showed enhancement. A partial fibroid hyperintensity was found in five lesions. In these lesions, necrosis was found in hyperintensity areas. In 12 lesions, DWI did not show an increased intensity, thus suggesting an incomplete embolization. A significant ADC decrease was noted when an obvious signal change was detected on DWI. (mean ADC decrease rate: 31.9%). Mean ADC decrease rate in non- increased intensity areas on DWI was 2.9%.
Conclusion: Post-UAE acute ischemic changes in fibroids and the effect of embolization can be efficiently evaluated by DWI..

P115

Uterine artery embolization for fibroids. Is a hormone-free period of two months enough to achieve good results?

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Purpose: To evaluate if a period of two months without hormone therapy is enough to obtain good results with uterine artery embolization (UAE) for fibroids in patients who are under hormone therapy.
Materials/Methods: Six patients who required UAE for fibroids were under hormone therapy. Before embolization, hormones were stopped for a two-month period. Ultrasound and enhanced-magnetic resonance (MR) were performed before, and two weeks and six months post-UAE. All the patients had haemorrhages longer than ten days. Embolization was performed with polyvinyl alcohol particles. Six months later, a second embolization was carried out.
Results: In every patient, a certain post-UAE haemorrhage decrease was recorded. In all of them, however, a recurrence occurred two months later. Enhanced-MR showed ischemia (<10%) and only a slight decrease of fibroid and uterus sizes. Uterine artery branches of the second angiography had a larger calibre than those of the first angiography in which the vessels had some spasm. Following the second embolization, there was a significant decrease of the haemorrhage, of fibroid and uterus sizes, and fibroid ischemia increased over 90%.
Conclusion: A two-month hormone-free period before UAE is not enough to achieve good results with this procedure.

P116

Endovascular treatment of varicocele. Our six-year experience in 918 patients

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Purpose: To report our six-year experience in the treatment of varicocele (affecting 10-15% of male population aged 15-25 years) by retrograde transcatheter sclerotherapy of the internal spermatic vein.
Materials/Methods: From 1999 to 2005, 937 treatments were performed in 918 men aged between 9.6 and 65.5 years (mean: 29.2±7.6). The catheterization of spermatic veins, under local anaesthesia, assessed incontinence and/or collateral vessels, and embolizations were achieved by Polidocanol (hydroxy-polyethoxy-docanol) injection. All the patients were discharged six hours later.
Results: Catheterization and sclerosis were obtained in 915/937 cases (97.7%). Nineteen patients (2.06%) were treated twice because of a recurrence or to complete a previous procedure. Patients were followed by ultrasound and Doppler for possible recurrences; sperm analysis was performed to evaluate clinical results of the percutaneous therapy. As compared with preprocedural assessments, spermiograms showed constant improvements in sperm count, motility, and morphology. Radiation doses were negligible.
Conclusion: Percutaneous treatment of varicocele, also in recurrences, is rapid, minimally traumatic, and does not require hospitalization. As compared with surgery, reflux mechanisms are better understood during phlebography, thus allowing the procedure to be adapted to the venous anatomy. Liquid embolus diffuses and scleroses collateral veins, with low recurrence rates.

P117

Superselective angio-computed tomography of female pelvis

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Learning Objectives: To understand **1.** the combination of multidetector-computed tomography (MDCT) and angiography system; **2.** the clinical usefulness of angiography-assisted MDCT for the diagnosis of female pelvic diseases; **3.** the clinical usefulness of angiography-assisted MDCT and interventional procedures for the treatment of female pelvic diseases.
Background: CT-angiography, in which CT images are acquired during angiography, has been found to be effective in the abdominal region. A new interventional CT-angiography system, which combines a MDCT scanner and a digital subtraction angiography system has been developed as a next-generation system. Highly integrated imaging diagnosis and interventional treatment of female pelvic diseases were carried out with this system.
Clinical Findings or Procedure Details: Angiography-assisted MDCT was performed for the diagnosis of ovarian and uterine tumors. Angiography-assisted MDCT with interventional treatments were performed for transarterial embolization of uterine fibroids, adenomyosis, postpartum hemorrhage, and intraarterial infusion chemotherapy of ovarian and uterine carcinomas.
Conclusion: Technical aspects and pitfalls of superselective angio-MDCT in female pelvic diseases, as well as knowledge of its applications in the various clinical settings, will be discussed.

P118

The role of radiological intervention in the management of complications of horseshoe kidneys

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Learning Objectives: To describe the role of the interventional radiologist in the management of complications of horseshoe kidneys.
Background: Horseshoe kidney is the most common renal fusion abnormality. These patients are prone to a variety of complications, such as stone disease, pelviureteric junction obstruction, trauma, infections and a variety of tumours. Treatment pathways vary substantially from the normal kidney because of variations in the anatomy and vascular supply of these kidneys.
Clinical Findings or Procedure Details: We retrospectively reviewed the urological database of two University-affiliated hospitals. In total, 29 patients with horseshoe kidneys underwent radiological interventional treatment of complications of their disease. Eighteen patients required treatment for stone disease--such as percutaneous nephrolithotomy, nephrostomy and ureteric stent insertion. Others were treated with renal tumour embolisation, radiofrequency ablation, renal artery stenting, and drainage of perirenal abscesses. One patient underwent embolisation following trauma and three had biopsies of renal masses. From this group, we have compiled a variety of these procedures to demonstrate the varied role of radiological intervention in this subgroup of patients
Conclusion: In this pictorial review we comprehensively depict the wide range of complications associated with horseshoe and the role of the modern interventional radiologist in their management.

P119

Medium- and long-term quality of life assessment in patients undergoing uterus fibroid embolization

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Purpose: To assess the medium- and long-term outcome concerning fibroid-specific and associated quality of life (QoL) in patients treated by uterine fibroid embolization (UFE).
Materials/Methods: Retrospective analysis was performed in a cohort study by a questionnaire consisting of six topics represented by 49 questions.
Results: The analysis was performed on the questionnaires of 53 of 62 patients (85.5%), the mean follow-up period was 3.0+/-1.0 years (range 1.0 to 5.0 years). UFE led to a reduction of bleeding symptoms by 81.3%, of pain by 81.5%, of bulk-related symptoms by 78.6%, of urinary dysfunction by 60%, of sexual dysfunction by 71.4%, of fatigue by 62.5%, of limitations in the social life by 88.2% and of a depressed mood by 89.5%. The median impairment score concerning bleeding and pain decreased significantly from 6 to 0 and from 4 to 0, respectively (both $P<0.001$), the general QoL index increased significantly from 6 to 9 ($P<0.001$). Forty-two patients (79.2%) finally judged the result as very satisfactory and would highly recommend UFE to other patients.
Conclusion: UFE leads to an impressive medium- and long-term improvement of all investigated physical and psychological fibroid-related and associated symptoms, and significantly improves women´s health-related QoL.

P120

Superselective transcatheter embolization of high-flow priapism

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Purpose: To reassess treatment efficacy of superselective transcatheter embolization for high-flow priapism.
Materials/Methods: Between 2002 and 2005, 11 patients underwent superselective transcatheter embolization for high-flow priapism. A blunt trauma to the penis or perinea was reported in nine of 11 cases. Etiologies were not evident in the remaining two cases. All the patients underwent diagnostic examination by colour-flow Doppler ultrasound and superselective pudendal arteriography, which revealed bilateral arteriocorporal fistulas and pseudoaneurysms in two cases, bilateral arteriocorporal fistulas in one case, a unilateral arteriocorporal fistula in seven cases, and a unilateral arteriocorporal fistula and a pseudoaneurysm in one case. N-butyl-cyanoacrylate was used as embolization agent in one case and autologous blood clot in the others, with a microcatheter-guidewire combination
Results: A technical success was achieved in all cases. In two cases, a second embolization was required due to recurrence. The interval from priapism onset to resolution was four to 30 days. Return of full erectile function was delayed from two to four weeks, most likely from clot lysis.
Conclusion: Our experience demonstrates that superselective transcatheter embolization is an effective therapy for high-flow priapism. Embolization with autologous blood clot restores the erectile function due to clot lysis and consequent vessel recanalization.
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P121

Rhenium-188-mercaptoacetyltriglycine-filled balloon dilation in the treatment of recurrent urethral strictures: initial experience with five patients

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Purpose: To evaluate the efficacy of β-irradiation therapy using a rhenium-188-mercaptoacetyltriglycine (^{188}Re-MAG$_3$)-filled balloon for preventing restenosis in urethral strictures refractory to repetitive surgical or interventional procedures.
Materials/Methods: Institutional review board approved our prospective study. Five men with traumatic (n=4) or postoperative anastomotic (n=1) recurrent urethral strictures were treated with ^{188}Re-MAG$_3$-filled balloon dilation. In case of recurrence of the urethral stricture after balloon dilation with concurrent β-irradiation the treatment was repeated.
Results: One to four sessions of 20-30 Gy β-irradiation at a 1-mm tissue depth using ^{188}Re-MAG$_3$-filled balloon dilation were undertaken in the five patients. No procedural complications or toxicities were noted. During the mean follow-up period of 16.2 months (range, 9-20 months), strictures were not recorded in two patients, whereas three patients required additional balloon dilations. In two of these patients, the treatment intervals between the required sessions were significantly prolonged. For the entire group, the mean treatment interval was prolonged from 2.2 months before ^{188}Re-MAG$_3$-filled balloon dilation to 10.7 months after the therapy.
Conclusion: ^{188}Re-MAG$_3$-filled balloon dilation seems to be effective in preventing or delaying stricture recurrence in patients with recurrent urethral strictures.

P122

Preoperative embolization of large uterine fibroids in 25 young women

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Purpose: To assess efficacy of preoperative embolization of large uterine fibroids in young women. Medium- and long-term magnetic resonance (MR) study of the endometrium and myometrium are presented.
Materials/Methods: Between 2000 and 2005, 25 women (mean age 34), willing to become pregnant, were treated--before planned surgery--by uterine arteries embolization with gelatin sponge particles. Both ultrasound and MR had confirmed at least one large fibroid (mean size: 14/8/6 cm). T1-weighted dynamic gadolinium-enhanced sequences demonstrated the hypervascularized character of fibroids. MR and ultrasound controls at six and 12 months were performed.
Results: No complications were reported. Surgical myomectomy was easily done with rapid leiomyomas ablation and without bleedings. In one patient, MR depicted an uterine collection due to wall surgical effraction. At medium-term follow-up, MR demonstrated a normal aspect of both the endometrium (thickness and signal) and the myometrium, without ischaemic areas.
Conclusion: Large fibroids embolization represents an excellent preoperative procedure which allows surgical ablation improvement because of:: possible access by coelioscopy, no blood loss, and optimized uterine reconstruction. With time, uterine muscles are totally preserved. In this series, no post-procedure amenorrheas were reported and all women have a normal sexual life. During follow-up, uterine volumes had decreased, with disappearance of symptomatology.

P123

Treatment of hepatic and renal cysts by aspiration and Minocyclin hydrochloride injection

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Purpose: To demonstrate the efficacy of percutaneous sclerotherapy by injections of Minocyclin hydrochloride in the treatment of hepatic and renal symptomatic cysts.
Materials/Methods: From November 2003 to December 2005, 34 adult patients with simple hepatic and renal cysts (31 renal, diameter range: 65-140 mm; three hepatic, diameter range: 50-110 mm) were treated by a single injection of Minocyclin hydrochloride. Under local anesthesia and ultrasound guidance, the cysts were punctured and a 6-F pig-tail drainage catheter was introduced. After cystic material aspiration, a solution of saline and Minocyclin hydrochloride (100 mg/100 ml), (in a quantity equal to half of the cystic volume) was reinjected. The pig-tail drainage catheter was then removed and the injected solution left into the cyst. At the end of the procedure the largest cystic diameter was measured.
Results: At a mean follow up of eight months, no patient reported any related symptoms or cystic expansion. Furthermore, nobody presented complications or pain associated to the procedure.
Conclusion: The injection of Minocyclin hydrochloride is simple, safe, and effective and can be considered as the first choice therapy for hepatic and renal cysts.

P124

Nephrostomy: when it is complicated

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Learning Objectives: 1. Understand the technique of percutaneous nephrostomy using ultrasound and fluoroscopy. **2.** Be aware of strategies for dealing with difficult nephrostomies in a variety of scenarios. **3.** Learn how the interventional radiologist deals with complications which may arise.
Background: Percutaneous nephrostomy is a common interventional radiology procedure which many general radiologists perform. There are however patients in whom specialist skills are required. These include patients with undilated obstructed systems, non-obstructed systems, transplant kidneys, children and pregnant women.
Clinical Findings or Procedure Details: Our presentation illustrates the alterations in technique that are required in the aforementioned situations. We will demonstrate each of the above with images from our experience. The complications which may arise are outlined, together with practical advice on how to deal with them.
Conclusion: Percutaneous nephrostomy insertion is the most common procedure performed on the kidney by a radiologist. Out-of-hours nephrostomy insertion is commonly performed by general and interventional radiologists. The aim of our article is to arm radiologists with key information in dealing with the difficult nephrostomy insertion.

P125

Preventive embolisation of renal angiomyolipomas

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Purpose: Preventive embolisation of renal angiomyolipomas (ERAM) could be an alternative to surgery in selected cases. We present a series of patients that underwent elective ERAM in terms of technical success, complications, and follow-up.
Materials/Methods: From 1994 to 2005, 15 patients (13 women, mean age 52 years, range 29-74) with renal angiomyolipomas (mean size 65 mm) treated electively by embolisation were retrospectively evaluated. Indications for preventive ERAM included previous haemorrhage (5), flank pain (4), or a size >40 mm (6). The procedures were performed selectively, with the use of a microcatheter if needed. The embolic material included particles (Embospheres®, Ivalon®), coils, and microcoils. Post-procedure imaging follow-up included computed tomography or magnetic resonance.
Results: ERAM was 100% successful. Follow-up ranged between one and 39 months. A single session was definitive in 13 patients; one case required a repeat embolisation, in one patient a partial nephrectomy was performed. Size reduction ranged from 10 to 50% after a mean follow-up of 17.8 months. No immediate complications or haemorrhagic episodes were recorded. One patient presented late liquefactive tumor necrosis requiring percutaneous drainage.
Conclusion: In our series, ERAM was a safe procedure with a good clinical success at medium-term follow-up. Longer follow-up is needed.

P126

Therapeutic transcatheter arterial embolization in the management of intractable bladder haemorrahage from malignant pelvic tumors and bladder irradiation therapy

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Purpose: To illustrate our experience with arterial embolization as a measure in the control of intractable bladder haemorrhage from malignant pelvic tumors and bladder irradiaton therapy. To describe the results of the procedure based on a series of 16 patients.
Materials/Methods: We have treated 16 patients from June 2000 to July 2005 with bladder haemorrhage for advanced pelvic malignancies. The internal iliac artery bilaterally, or cystic arteries when possible, are selectively catheterized through a femoral artery access using microcatheters and embolized using Espongostan® and coils. Patients were followed up clinically at regular intervals; immediate and late complications and efficacy were evaluated.
Results: Transcatheter arterial embolization was effective in 14 of 16 patients. Immediate complications were observed in 6%; few major complications and low recurrence rates concerning bleeding were recorded.
Conclusion: We believe that this technique could be considered the treatment of choice in intractable bladder hemorrhage, mainly in cancer patients who present a deteriorated general condition.

P127

Long-term results of percutaneous therapy of ureteric complications after renal transplantation

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Purpose: To evaluate long-term outcome of percutaneous therapy of ureteric complications after renal transplantation.
Materials/Methods: From November 1997 to October 2005, we percutaneously managed 29 renal transplanted patients with ureteral stenosis (n=22) or leak (n=7). Patients with leak were treated with nephroureterostomy and subsequent double J stenting. Balloon-dilatation (high-pressure or cutting-balloons) and stent (double J or metallic) placement were used to treat ureteral strictures. Criteria of success were defined by resolution of ultrasound signs of hydronephrosis associated with normalization of serum creatinine (for strictures) and disappearance of contrast extravasation on control antegrade pyelograms (for leaks). Surgical or percutaneous revisions (repeated dilatation and stenting) were considered to be treatment failures.
Results: A technical success was achieved in 28 patients (96%). We could not cross a distal ureteric occlusion in one patient. Percutaneous therapy was successful in 13 patients with stenosis (59%) (average follow-up 28.7 months) and in six patients with leak (85%) (average follow-up 43.4 months).
Conclusion: In renal transplanted patients with ureteric complications, long-term outcome of percutaneous therapy is good in leaks, but less encouraging in strictures.

P128

Evaluation of drug perfusion during balloon-occluded arterial infusion for gynecologic tumors using angio-magnetic resonance imaging

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Purpose: Despite the efficacy of balloon-occluded arterial infusion (BOAI) for gynecologic tumors, there are reports of complications related to improper drug perfusion. We therefore evaluated perfusion images on the state-of-the-art angio-magnetic resonance imaging (MRI) system MRXO™ (Philips) during arteriography with and without balloon occlusion (BO).
Materials/Methods: Eight patients with uterine cervical carcinoma (stage II-IIIb) were included in this study before hysterectomy. Two cases were performed twice. We advanced the balloon-catheter tip into both internal iliac arteries distal to the superior gluteal artery ostia, and injected simultaneously 36 mL of 10-time dilated Gadolinium contrast medium into the vessels during each scan using a 1.5-Tesla magnetic resonance machine. The perfusion in the uterus and the other parietal organs, such as gluteal muscles etc., was compared before and after BO.
Results: In all patients, the uterus was more strongly perfused with BO than without BO, while the perfusion into parietal organs decreased to 30-50% with BO. No serious complications occurred.
Conclusion: Angio-MRI system demonstrated that a stronger and more selective perfusion into the uterus was obtained using the BO technique.

P129

New dialysis access graft with self-sealing ports

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Purpose: To present the use of a new dialysis access graft with self-sealing ports in an animal model.

Materials/Methods: The expanded-polytetrafluoroethylene (ePTFE) dialysis access graft with self-sealing ports was implanted between the carotid artery and the jugular vein of five, six-month old, Yucatan pigs. The grafts were tested with fistulograms, multiple punctures, and followed for up to three weeks. Histologic analysis was performed after autopsy.

Results: There was development of a thick fibrous capsule around the port device, with good integration with the tissues. Integrity of the septum and skin, after 52 sticks, was observed. There was good stability of the device for puncture immediately following implant. Excellent hemostasis was obtained after needle removal. There was intimal hyperplasia and thrombosis in the pig animal model.

Conclusion: The port was a sure target for puncture, allowing repeated punctures without significant damage to the skin and septum material simulating one year use. Direct trauma to the graft was avoided, and it allowed immediate use of the graft after implantation. The animal model used produced excessive intimal hyperplasia and thrombosis in the short-term follow-up time. Any graft material can be used with the self-sealing ports.

P130

Results of a peripheral cutting-balloon^{TM} prospective multicenter European registry in hemodialysis vascular access

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Purpose: To report our initial experience with peripheral cutting-balloons^{TM} (PCB) in the treatment of failing hemodialysis shunts and grafts.

Materials/Methods: A total of 204 patients [103 men, 101 women; average age 64.1±12.1 (23-87)] with arteriovenous (AV) shunt pressure-resistant stenoses/restenoses/failed percutaneous transluminal angioplasties (PTA) treated by PCB were followed in seven European centers using a simple registry. The lesions treated by PCB were located at the AV shunt anastomosis or the venous limb in 173 patients, at the outflow vein in 22 cases, the prosthesis was approached in six cases and the radial or brachial artery in three patients.

Results: A technical success was achieved in 88.7% of cases. Primary patencies were: 90% at one month (136 patients); 83% at three months (138 patients); 72% at six months (129 patients); 82% at 12 months (39 patients). No complications occurred. The patients experienced an equal or lower level of pain during the procedure as compared with convential PTA.

Conclusion: The PCB proved to be highly successful in dilating pressure-resistant stenoses. We cannot conclude whether PCB angioplasty can lower restenosis rate in hemodialysis access lesions, but our results are promising. Further randomised studies are advisable.

P131

Pharmacomechanical thrombectomy of thrombosed hemodialysis grafts and native fistulas using the Castañeda-brush catheter: preliminary results

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Purpose: To evaluate safety and efficacy of the Castañeda-brush catheter in the treatment of thrombosed hemodialysis fistulas.

Materials/Methods: Twenty-four revascularization procedures using the Castañeda-brush catheter and Urokinase were retrospectively analyzed in 20 patients (mean age 68 years, range: 35-87). Hemodialysis shunts were native arteriovenous fistulas (AVFs) (n=15; 16 procedures) or polytetrafluoroethylene (PTFE) grafts (n=5; eight procedures). Major outcomes included procedure time, anatomical and clinical success rate, complication rate, primary, primary assisted and secondary patency.

Results: The brush-catheter was used in combination with a mean dose of 239.792 IU Urokinase (range: 60.000-300.000). Additional angioplasty was performed in all procedures; five procedures (21%) required additional stenting. Mean procedure time was 93.5 min (range: 49-261). Anatomical and clinical success rates were 100% and 95.8%, respectively. In 8% of cases, minor complications occurred: one case of extravasation--successfully treated by balloon tamponade--and one hematoma at the distal puncture site without need for surgery or transfusion. Primary, primary assisted, and secondary patency rates for native fistulas were 75%/63%, 75%/69%, 87%/80% at three and six months, respectively and 38%/38%, 38%/38%, 80%/80% for PTFE grafts.

Conclusion: The Castañeda-brush catheter is a safe and effective pharmacomechanical thrombectomy device for the treatment of thrombosed hemodialysis grafts and native AVFs.

P132

Percutaneous transluminal angioplasty of hemodialysis-related inflow arterial stenosis: results of patency rates in 32 patients

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Purpose: To evaluate the effectiveness of percutaneous transluminal angioplasty (PTA) for hemodialysis-related inflow arterial stenoses by comparing PTA for outflow venous stenoses.

Materials/Methods: From August 2000 to January 2006, PTAs were performed in 32 patients with 38 inflow arterial stenoses and in 246 patients with 336 outflow venous stenoses. Hemodialysis access was placed in the upper limb in all the patients. Clinical success of PTA was defined as an improvement in hemodialysis access failure and resumption of normal dialysis for one dialysis session after PTA. The patency rates of the two groups were calculated by Kaplan-Meier method and compared by log-rank statistics.

Results: Clinical success rate of PTA was 90.6% for inflow arterial stenoses and 97.6% for outflow venous stenoses. For inflow arterial stenoses, six-month patency rate was 82.1% and one-year patency rate was 77.8%. For outflow venous stenoses, six-month patency rate was 70.3% and one-year patency rate was 47.7%. Primary patency rate of PTA for inflow arterial stenoses was significantly higher than that for outflow venous stenoses (p=0.001).

Conclusion: PTA for hemodialysis-related inflow arterial stenoses obtained longer primary patency as compared with outflow venous stenoses.

P133

Percutaneous transluminal angioplasty for hemodialysis-related central venous stenosis: results of patency rates

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Purpose: To evaluate the effectiveness of percutaneous transluminal angioplasty (PTA) for hemodialysis-related central venous stenosis.
Materials/Methods: All PTAs were performed on patients exhibiting >50% stenosis and clinical abnormalities. From August 2000 to February 2006, PTAs were performed in 278 patients with 373 hemodialysis-related access stenoses and on ten patients with ten central venous stenoses as primary subjects. Ten patients had not had temporary or tunneled dialysis access catheter placed until PTA. Balloon angioplasties were performed in all patients, and stent placement was done in two. Clinical success of PTA was defined as an improvement in hemodialysis access and resumption of one normal dialysis session after PTA. The patency rates of central venous stenoses and of other hemodialysis-related stenoses were calculated by Kaplan-Meier method and were compared by log-rank statistics.
Results: Fifteen PTA sessions were performed in ten patients. Clinical success rate was 100%. Six-, 12 -, and 24-month patency rates were 100%, 83.3%, and 41.7%. No significant differences in primary patency rates were identified between central venous stenoses and other stenoses (p=0.369).
Conclusion: PTA for hemodialysis-related central venous stenosis can obtain similar patency rates as for other stenoses.

P134

Outcomes of tunnelled internal jugular catheters in 425 patients. A single-center experience

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Purpose: To evaluate long-term results of tunnelled internal jugular catheter placements in oncologic and hemodialysis patients performed in an interventional radiology suite.
Materials/Methods: Between December 2002 and January 2006, demographic information with detailed procedure notes as well as follow-up interventions were prospectively recorded in a computerized database which was then reviewed together with electronic charts. A total of 538 tunnelled catheters was placed in 425 patients with mean age of 52.6 years (206 women, 219 men aged between 17 and 88 years).
Results: Technical success rate was 100%. One-hundred ninety-six catheters were intended to be mainly used for infusion therapies in oncology patients, and 342 catheters for hemodialysis. One-hundred and sixty (29.7%) catheters were lost to follow-up. Mean catheter indwelling time was 71.8 days, range: 1 to 495 days. Catheter explantation following late infections was needed in 19% of infusion catheters and in 8.8% of dialysis catheters. Immediate complications rate (including malpositioning, bleeding, acute superior vena cava syndrome) for tunnelled catheter placements was 2%.
Conclusion: Long-term central venous accesses using tunnelled internal jugular catheters appeared to be safe and effective for both hemodialysis and long-term infusion therapies with a relatively higher infection rates in oncologic patients.

P135

Treatment and follow up of arterial-venous fistula (FAV) in hemodialysis patient: Role of interventional radiology

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Purpose: to analyse our experience in percutaneous treatment and follow-up in haemodialysis patient with arterial-venous-fistula.
Material/Methods: from 1997 to 2005, 120 patients (88 native FAV, 32 GRAFT) were investigated with angiography of afferent artery, efferent vein and central vein by direct puncture of FAV (16 pz), by retrograde puncture of femoral artery (47pz) and by anterograde puncture of humeral artery (57pz). We revised the angiography and the treatment's report and we revised the clinical follow up.
Results: we reported 130 lesions (115 stenosis/15 occlusions). We treated 120 lesions (100 pz) by PTA (97), by cutting-PTA (9), by thrombolisys and PTA(2), by stenting (10), by stent-grafting (2). We registered 18 arterials vasospasm (solved by intra arterial injection of 0.5 mg nitro-glycerine), 7 injury of venous wall (solved by extended dilatation), 2 perforation (solved by embolization). There weren't major complications. We noted a clinical success (restoration flow/restarting hemodialisis) in 87/100 patients. After 6 months primary patency were observed in 51% of patients. Forty patients were treated again another two/three times.
Conclusion: interventional treatment of FAV is complementary/alternative to surgery. It's repeatable, low costing and can minimize the provisional access resort. Tight interaction between interested professional figures is mandatory to warrant results.

P136

Guidewire *„pull-through technique"* in native forearm blood access malfunctions

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Purpose: In native forearm blood access malfunctions, there are cases in which guidewires only can cross the lesion but balloon-catheters will not. Our purpose was to evaluate the effectiveness of a guidewire *„pull-through technique"* to traverse percutaneous transluminal angioplasty balloon-catheters through stenotic or tortuous portions (especially anastomotic portions) of forearm native blood accesses.
Material/Methods: Twelve patients with obstruction or stenosis of the forearm native blood access underwent balloon-angioplasty by transvenous approach. Because of severe stenosis or tortuosity of the blood access, crossing of the balloon-catheter along the guidewire failed. Either by inserting another sheath into the brachial artery or the upstream of the venous portion, guidewires were then captured by a self-made retriever and pulled out from the sheath. Bended guidewires attached to the sheath-kit were used as retrievers. By pulling the guidewires from both sides of the sheath, balloon-catheters were again tried to be traversed. Balloon-catheters measured 4-5 mm in diameter and 2 cm in lentgh.
Results: In all 12 cases, balloon-catheters successfully traversed the stenotic or tortuous portion.
Conclusion: The guidewire *„pull-through technique"* is a useful and convenient way to traverse the balloon-catheter through stenotic or tortuous portions of the forearm native blood access.

P137

Angiojet mechanical thrombectomy for percutaneous recanalization of thrombosed hemodialysis grafts: long-term results

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Purpose: The authors report their long-term results after percutaneous application of Angiojet mechanical thrombectomy for recanalization of thrombosed hemodialysis grafts.
Materials/Methods: Between January 2000 and January 2006, 32 patients (25 men and seven women, mean age 71 years) underwent successful Angiojet mechanical thrombectomy of thrombosed hemodialysis grafts. Underlying lesions at outflow veins and anastomosis sites were treated with balloon-angioplasty and stenting, as necessary, during the same session. Patency rates were calculated by life-table analysis.
Results: Thirty-two thrombosed straight (n=8) or loop (n=24) forearm hemodialysis grafts were treated. In total, 49 declotting procedures were successfully completed. In 25 cases, recanalization was expedited by intra-thrombus administration of low-dose local thrombolysis (100,000-300,000 IU Urokinase). Mean duration of the procedures was 80 minutes (range, 50 to 160 minutes). Median follow-up period was 11 months (range, one to 36 months). Median primary and secondary patencies were six and 14 months, respectively. Cumulative secondary patency rates were 83, 77, 31, and 0% at six months, one year, two years, and three years, respectively.
Conclusion: Angiojet mechanical thrombectomy is highly efficacious in recanalizing and restoring function of thrombosed hemodialysis grafts with favorable long-term patency rates.

P138

Plasmin: phase I clinical trial in hemodialysis graft occlusions

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Purpose: Plasmin is a direct-acting fibrinolytic that can be purified from human plasma. Our aim was to evaluate the *in-vivo* safety of plasmin in patients with acute hemodialysis graft occlusions in a dose ranging fashion.
Materials/Methods: Five hemodialysis patients with acute graft thrombosis were each dosed with plasmin (1, 2, 4, 8, 12, and 24 mg, respectively). Plasmin was instilled and left to dwell within the arteriovenous grafts for 30 minutes. Heparin (3000 IU) was administered intravenously. Angiography was performed at time zero, at 30 minutes, and at the completion of the procedure.
Results: Thirty patients completed the evaluation. No definite study drug-related bleeding or allergic reactions occurred. No antibodies to plasmin were detected. No viral serological conversions occurred. Adverse events occurred in 22 (71%) patients; however, none of the events were clearly related to plasmin. No significant change in fibrinogen or hemoglobin levels were noted. All five patients receiving 24 mg of plasmin had >50% lysis at 30 minutes, four had antegrade flow at angiography, and three had a palpable thrill at 30 minutes.
Conclusion: Plasmin appears to be safe in humans at the doses studied. Plasmin showed thrombolytic activity and has potential for catheter-based applications.

P139

Cutting-balloon angioplasty in hemodialysis patients for vascular stenoses resistant to high-pressure conventional balloon-angioplasty

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Purpose: To report initial and short-term results of percutaneous cutting-balloon angioplasty for vascular stenosis in native arteriovenous fistulas (AVF) in patients after failed high-pressure balloon dilatation.
Materials/Methods: Thirty-one patients with native AVFs as permanent vascular access and symptomatic severe (>50%) vascular stenosis were treated with cutting-balloon angioplasty after failed high-pressure (>18 atm) balloon dilatation. Patients were 16 women (52%) and 15 men (median age, 56; range, 16-76 years). AVF locations were radiocephalic in 19 patients (61%), and brachiocephalic in 12.
Results: Technical and clinical success rates were 100%. Primary patency rates at three, six, and 12 months were 92%, 76%, and 53%, respectively. Dilatation of anastomotic stenoses required significantly higher pressure than that of efferent vein stenoses (10.5±3.3 versus 6.5±3.0 atm; $p<0.005$). Complications ranging from slight extravasation to frank rupture occurred in eight patients (26%). All ruptures were controlled with prolonged low-pressure balloon inflation.
Conclusion: Cutting-balloon angioplasty was successful in the dilatation of native AVF vascular stenoses resistant to high-pressure balloon dilatation.

P140

Haemodialysis lines: should we strip?

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Purpose: The most common reason for haemodialysis line failure is the formation of a fibrin sheath. We present our data on technical success and patency duration following percutaneous fibrin sheath stripping of these split tip lines.
Materials/Methods: Data were collected retrospectively on haemodialysis patients who had undergone percutaneous fibrin sheath stripping over the previous four years. Technical success, procedural complications, and duration of line patency following stripping was analyzed.
Results: Twenty-six non-functional split tip haemodialysis catheters in 26 patients underwent percutaneous fibrin sheath stripping on 29 occasions. Technical success and re-achievement of dialysis via the stripped line was 100%. There were no procedural complications. Line stripping produced mean patency duration of 98 days (range 13-330 days). Five lines remain patent to date. A total of 11 lines did not fail but remained patent until the patient had a functional arterio-venous fistula formed or changed to peritoneal dialysis
Conclusion: In patients in whom intravenous access sites is a problem, percutaneous fibrin sheath stripping has been shown to markedly extend the duration of line patency. The procedure will therefore allow the long-term preservation of central veins. The procedure has a high success rate and a very low complication rate.

P141

Use of Viabahn endoprosthesis in dialysis access graft or fistula outflow stenoses or occlusions

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Purpose: To study the efficacy of the Viabahn endoprosthesis in angioplasty-resistant stenoses or occlusions in the outflow of hemodialysis arteriovenous (AV) grafts or fistulae.
Materials/Methods: Twenty-four Viabahn stent-grafts (W.L.Gore & Associates) were used in 18 patients to stent across 18 occlusions or stenoses which were not responsive to angioplasty alone. There were 13 women and five men with a mean age of 55 years (range 21-82). Thirteen pateints had AV grafts and five had AV fistulae. Technical and clinical success were evaluated. Clinical follow-ups were performed in all patients.
Results: All 18 lesions were successfully stented and all patients were able to undergo dialysis after stenting for technical and clinical success rates of 100%. There were three cephalic arch lesions and two lesions across the elbow that were successfully stented. Stented segments ranged from 2.5 to 15 cm. There were three occluded venous outflows that were stented. There were no associated procedural complications. The primary patency rates were 82%, 63%, and 44% at 30-day, 90-day, and 180-day, respectively.
Conclusion: The Viabahn stent-grafts were safe to deploy and yielded acceptable patency rates for stenoses or occlusions that were not responsive to angioplasty alone.

P142

Clinical significance of fistulography by brachial artery approach in hemodialysis patients

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Purpose: Fistulography is usually performed through transvenous approach in hemodialysis patients. Our study evaluates the clinical significance of a brachial arterial approach for fistulography in hemodialysis patients.
Materials/Methods: The study included 13 cases from 12 hemodialysis centers who underwent fistulogram or percutaneous transluminal angioplasty through a brachial artery approach between November 2003 and June 2005. Indications, radiologic findings, complications, and outcomes of fistulographies and percutaneous transluminal angioplasties were investigated.
Results: Indications of transbrachial artery approach were an immature arteriovenous fistula or a poor visualization of the venous route. The brachial artery puncture was successfully performed in all patients. In ten cases, stenoses or occlusions were detected at the arteriovenous anastomosis site, the distal radial artery, or the proximal cephalic vein. Four patients had a severe arterial stenosis. Additionally, a percutaneous transluminal angioplasty was performed in 8/13 cases. A procedure-related complication (a focal pseudoaneurysm formation at the brachial artery puncture site resulting in a transient radial nerve palsy) occurred in one case only.
Conclusion: The transbrachial artery access may be considered effective in immature hemodialysis arteriovenous fistulas or arterial vascular problems. We should however pay attention to the brachial artery approach because of its significant complications.

P143

Salvaging and maintaining non-maturing Brescia-Cimino fistulas by percutaneous intervention

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Purpose: To report out experience in treating non-maturing Brescia-Cimino fistulas by percutaneous transluminal angioplasty (PTA).
Materials/Methods: We treated 22 patients with non-maturing Brescia-Cimino fistulas by PTA. Forty PTAs, including the 22 initial procedures, were performed during follow-up. A retrospective analysis was done evaluating fistulogram findings, PTA techniques and success rates, and patency rates.
Results: Seventeen segmental stenoses and five segmental occlusions of cephalic veins were the causes of non-maturation. Sixteen stenoses and two occlusions were located at the cephalic vein adjacent to the anastomosis site, three occlusions and one stenosis were seen at the downstream cephalic vein distant from anastomosis. A focal arterial stenosis at the anastomosis site (one case) and two accompanying accessory veins (one case) that might hamper cephalic vein maturation were recorded. PTA initial success rate was 95.5% (21/22). Overall success rate, including 18 additional PTAs performed during follow-up, was 97.5% (39/40). No major complications occurred. Primary and secondary patency rates were 72% (16/22) and 95%(21/22) at three months, and 50% (11/22) and 77% (17/22) at six months.
Conclusion: All Brescia-Cimino fistulas that fail to mature have underlying stenoses or occlusions. PTA is an effective and safe method to overcome this problem and salvaging non-maturing Brescia-Cimino fistulas.

P144

Sharp-needle recanalization for salvaging arteriovenous accesses with chronically occluded outflow

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Purpose: To describe a novel endovascular technique creating an artificial tract through soft tissues connecting arteriovenous accesses with chronically occluded outflow to a patent outflow vein.
Materials/Methods: From November 2005 to January 2006, six patients, aged 55 to 82 years (average age 66.83 years), were referred for poorly functioning fistulae (1/6), arm swelling (3/6), high pressure with excessive bleeding after dialysis (1/6), and thrombosis (2/6). All six patients had chronic occlusion of the upper body or outflow vein of their access. Conventional recanalization techniques failed. A detailed duplex ultrasound exam was then performed to search for an adjacent vein which drained into a patent outflow vein. A needle was used to bridge the fistula body to the patent vein followed by sequential balloon dilatation. Uncovered stents were placed if necessary.
Results: All patients underwent successful sharp-needle recanalization with restoration of normal function and complete reversal of symptoms. Five of the six patients required 8- or 10-mm diameter stents (uncovered). Mean follow up was four weeks. No complications were seen.
Conclusions: Sharp-needle recanalization for chronically occluded arteriovenous accesses is a feasible, safe and excellent option to salvage the dying access.

P145

Percutaneous transhepatic treatments for biliary complications following living donor liver transplantation

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Learning Objectives: To demonstrate techniques, efficacy, and safety of percutaneous transhepatic treatments for the management of various biliary complications after living donor liver transplantation (LDLT).
Background: Biliary complications--including anastomotic strictures, intrahepatic bilomas, and bile leaks--remain the most common complications after LDLT. Endoscopic treatments are a valuable tool for such complications, but they are not feasible in many patients. We reviewed our percutaneous transhepatic experience with biliary complications after LDLT in 248 of 883 patients over an eight-year period.
Clinical Findings or Procedure Details: Indications for percutaneous procedures were jaundice, abnormal liver enzymes, biliary stones, intrahepatic biloma, or bile leak. Fifty-seven patients received two or more biliary drainage catheter placements to treat biliary complications. Most patients underwent several sessions of balloon dilations and drain catheter interpositions for several months to treat strictures. Stone (n=46) or foreign body (n=18) removals and intrahepatic biloma drains through a percutaneous transhepatic biliary drainage tract (n=9) were also performed. Symptoms improved in 211 patients following percutaneous transhepatic treatments alone, but 28 patients died of various causes. Nine cases were converted into the surgical treatment.
Conclusion: Percutaneous transhepatic treatments are effective for the management of various biliary complications after LDLT.

P146

Retrievable, polytetrafluoroethylene-covered, self-expandable nitinol stent insertion in benign biliary strictures

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Purpose: To investigate the efficacy of retrievable, polytetrafluoroethylene (PTFE)-covered, self-expandable nitinol stents in patients with benign biliary strictures.
Materials/Methods: From January 2005 to September 2005, six stents were implanted in five patients (four post-operative strictures, one cholangitis). All had symptoms and signs related to cholangitis. Percutaneous transhepatic biliary drainages were performed before stenting. PTFE-covered, self-expandable, nitinol stents measured 10 to 14 mm in diameter and 4 to 8 cm in length. Afer six weeks, stents were removed.
Results: All six stents were inserted without complications. After six weeks, stent migration had occurred in one case. The stricture was however already sufficiently dilated. The mean diameter of the initial stricture was 1.1 mm. The retrievable stent was inserted without balloon dilatation, and six weeks later, the stricture diameter had increased significantly to 8 mm. Two to four days after stent removal, the stricture diameter had remained 7.9 mm. During the five- to the 12-month follow-up, all the patients were asymptomatic. Imaging studies and laboratory data did not show any evidence of biliary obstruction.
Conclusion: Retrievable, PTFE-covered, self-expandable nitinol stents are safe and effective in the treatment of patients with benign biliary strictures.

P147

Interventional management of choledocholithiasis

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Learning Objectives: To learn the interventional management of various types of choledocholithiasis.
Background: Preoperative lithotripsy for choledocholithiasis is usually performed endoscopically. However, in patients with acute cholecystitis or acute cholangitis, interventional lithotripsy is easier to perform via the percutaneous transhepatic biliary drainage (PTBD) or percutaneous transhepatic gallbladder drainage (PTGBD) route. In rare cases in whom the common bile duct enters a diverticulum at the duodenum, endoscopic management is difficult, but interventional lithotripsy is possible. In this presentation, we explain various interventional techniques and instruments for choledochal lithotripsy.
Clinical Findings or Procedure Details: PTBD was always performed after visualizing the biliary tree with a fine multi-hole needle, even if there was no dilatation. A sheath catheter was inserted via the PTBD or PTGBD route. The ampulla of Vater was always dilated with a balloon catheter. Small stones (<1 cm in diameter) were directly pushed into the duodenum, while larger stones (>1 cm in diameter) were broken up by using a lithotripsy basket catheter or electrohydraulic lithotripsy catheter.
Conclusion: Interventional management of choledocholithiasis might be the method of first choice after performing PTBD or PTGBD, or when an endoscopic procedure would be difficult.

P148

Percutaneous interventional therapy of persistant biliary fistulas

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Purpose: To present our experience with percutaneous transhepatic radiologic interventions to treat persistent biliary fistulas of different etiologies.
Materials/Methods: During five years, percutaneous transhepatic endoluminal repair and/or embolization of bile duct fistulas were performed in ten patients with persistent fistulas despite prolonged conservative treatment and biliary drainage. Digital subtraction cholangiography was routinely used in all patients to detect the injured bile duct.
Results: One bronchobiliary fistula in a patient with previous hepatic resection for hydatid disease, one biliovenous fistula in a patient with posttraumatic bilhemia, three biliocutaneous fistulas occurring after a hepatojejunostomy in two and biliary drainage in one, two cysto-biliary fistulas following surgery for hydatid cysts, one bilio-retroperitoneal fistula in a patient with previous Whipple-operation, one biliocavitary fistula in a patient with hepatic abscess following surgery for cholangiocarcinoma, and one common bile duct rupture due to T-tube removal after laparascopic cholecystectomy were successfully treated with covered-stents, coils, and/or Histoacryl. Embolization was well tolerated by all the patients, and no major complication was observed.
Conclusion: Percutaneous endoluminal bile duct repair and embolization of persistent biliary fistulas, despite adequate conservative treatment methods, should be considered as a simple alternative to major surgical interventions in the treatment of complex biliary fistulas.

P149

Preoperative portal vein embolization with a mixture of gelatin-sponge particles and iodized oil: efficacy and safety

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Purpose: To evaluate the efficacy and safety of preoperative portal vein embolization (PVE) with a mixture of gelatin-sponge (GS) particles and iodized oil for inducing hypertrophy in future liver remnants (FLR).
Materials/Methods: PVE was performed in 14 patients with a diagnosis of malignant liver tumor. Liver volume changes, biochemical data changes, PVE-related complications, perioperative complications, and histopathology changes of embolized lobes were retrospectively evaluated.
Results: Increases of absolute FLR volume and FLR/total liver volume ratio were a mean of 102 cm^3 (range 10 to 269 cm^3) and 7.9% (range 0 to 19%; before PVE: mean 39.3%, after PVE: 47.2%), respectively. Biochemical data returned to baseline in 1-2 weeks. Transient elevation of body temperature and mild or moderate abdominal pain were seen. No major PVE-related complications occurred. There were no patients in whom hepatectomies were cancelled due to insufficient FLR volume. No perioperative complications caused by hepatic failure were seen. In specimens, proximal or larger vessels were completely obstructed and the hepatic parenchyma showed necrosis or regeneration.
Conclusion: A mixture of GS particles and iodized oil may be effective and safe for inducing hypertrophy in FLR after PVE.

P150

Role of interventional radiology in the management of severe iatrogenic biliary tract complications

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Purpose: To evaluate efficacy and outcome of the percutaneous treatment of iatrogenic complex biliary tract injuries.
Materials/Methods: From October 2002 to January 2006, 23 patients were treated in our interventional radiology unit for iatrogenic biliary tract injuries: 15 following laparoscopic cholecystectomy, four secondary to laparotomic cholecystectomy, four after major liver surgery. In all the patients a percutaneous approach was performed; seven cases required a radiologic-endoscopic rendez-vous technique. The first dilatation was programmed after three weeks; nine patients required a second dilatation after one week; six patients underwent cryobilioplasty (PolarCath™ with liquid nitrogen insufflation). Plastic biliary stents were positioned in six patients and metallic stents in other two cases.
Results: The treatment was completely successful in 13 patients; a second treatment was required in nine patients; one patient needed three attempts for a successful treatment. In two patients with a biliary stricture the surgical treatment was mandatory. The mean follow-up was 16.2 +/- 6.7 months.
Conclusion: In high-risk patients, interventional radiology approach in the treatment of iatrogenic biliary tract injuries can be a valid alternative to surgery.

P151

Lithotripsy for choledocholithiasis via the percutaneous transhepatic gallbladder drainage route

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Learning Objectives: To learn interventional lithotripsy for choledocholithiasis via the percutaneous transhepatic gallbladder drainage (PTGBD) route.
Background: In patients with cholecystitis, PTGBD is performed when cholecystectomy is too difficult. If choledocholithiasis is detected, interventional lithotripsy can be done via the PTGBD route. Such interventional lithotripsy is simpler than endoscopic procedure. Preoperative lithotripsy relieves the patient's symptoms, saves time, and reduces costs.
Clinical Findings or Procedure Details: A sheath catheter was advanced into the common bile duct (CBD) through the PTGBD route. The ampulla of Vater was then dilated with a balloon-catheter in all cases. The most important point is to maintain (or move) the stone in the distal CBD below the ostium of the cystic duct. Stones that migrated into the proximal CBD past the cystic duct were retrieved through creation of a negative pressure by moving the distally placed balloon rapidly along the guidewire. Small stones were directly pushed into the duodenum, while larger stones were broken up by using a lithotripsy basket-catheter or an electrohydraulic lithotripsy catheter.
Conclusion: In patients who have undergone PTGBD, interventional lithotripsy for choledocholithiasis via the PTGBD route is generally easy and can alleviate symptoms.

P152

A new nitinol stent for palliation of malignant biliary obstructions: preliminary results of a multicenter study

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Purpose: This is a prospective multicenter trial to analyse clinical efficacy and safety of a new self-expanding nitinol stent for palliation of malignant biliary obstructions.
Materials/Methods: From February to December 2005, 138 nitinol stents were inserted in 116 patients with malignat biliary obstruction in 12 Spanish hospitals. Eighteen patients with hiliar obstruction were treated by placing bilobar stents; 54 patients were women and 62 men, with a median age of 70.3 years (range, 41-100). One- or two-stage procedures and post-stent dilation or not were performed according to the patient- and tumor-related characteristics.
Results: Transhepatic biliary stenting was 100% successful. An adequate palliation from jaundice was achieved without further intervention in more than 90% of cases in these preliminary results. Thirty-day mortality rate was of 10.3%, without any procedure-related death. Nine patients (7.7%) had major complications. There were no inmediate stent-related complicatións. At patients' discharge, stent expansion was of at least 75%, and it was 100% at one month in all cases.
Conclusion: This stent provides effective palliation for patients with inoperable malignant biliary tumors. Remarkable properties of this new stent are its no-shortening, flexibility, radial force, delivery system, and profile. We are waiting for stent patency and survival results.

P153

True one-step percutaneous transhepatic cholangiogram and stent: assessing Spongostan™ embolization of the percutaneous transhepatic tract

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Purpose: To assess a true one-step procedure for percutaneous, transhepatic cholangiogram (PTC) and stent with immediate gelatin foam embolization of the transhepatic tract in patients with biliary tract obstruction.
Materials/Methods: A rolled, fine core of Spongostan™ gelatin foam was inserted along the percutaneous, transhepatic tract on sheath withdrawal, following PTC and stent. A prospective study of intention-to-treat by true one-step PTC was done. Inclusion criteria were: cardiovascular stability, absence of systemic sepsis, no significant coagulopathy. Exclusion criteria for true one-step: drainage of infected bile or haemobilia, inability to deploy a stent, lack of free drainage to duodenum following stent deployment. Clinical notes were reviewed for indications, procedure detail, complications, time to discharge and survival data.
Results: In 50 consecutive patients, 50% underwent a true one-step procedure (group 1). The remainder were unsuitable (group 2). Average length of hospital stay following intervention was six days and 17 days, respectively. An external drain-related complication rate of 13% in group 2 was noted. There were no serious complications.
Conclusion: In suitable patients, embolization of the percutaneous transhepatic tract with Spongostan is a safe and acceptable procedure that removes the need for external drainage, reduces complications, and may speed hospital discharge.

P154

Hepatobiliary intervention revisited

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Learning Objectives: 1. To outline the complex hepatobiliary anatomy including normal variations. **2.** To review the clinical pathologies (benign and malignant) requiring percutanous radiological intervention. **3.** To evaluate the interventional and non-interventional radiological methods of diagnosis and work-up. **4.** To describe the technique and materials (with their advantages and disadvantages) used in the biopsing, stenting, draining, bypassing, embolising, and ablating the hepatobiliary system pathologies.
Background: Radiological hepatobiliary intervention is a growing field due to earlier and more accurate diagnosis and percutaneous interventions resultant improved patient survival outcome and symptom relief, in particular of carcinomatous and alcoholic liver disease.
Clinical Findings or Procedure Details: Through our institutional experience and a review of literature, we will provide a case-by-case pictoral review outlining the vast array of radiological interventions for both benign and malignant disease.
Conclusion: We provided a thorough, concise, and informative review.

P155

Transcatheter arterial chemoembolization with HepaSphere™ Microspheres mixed with a chemoterapy agent: preliminary experience of a multicentric study

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Purpose: To present the preliminary experience of an Italian multicentric (Cuneo, Pavia, Pisa) study in transcatheter arterial chemoembolization (TACE) of hepatocellular carcinomas (HCC) using HepaSphere™ Microspheres, a new embolic agent launched by BioSphere Medical Inc., premixed with a chemotherapy agent (Doxorubicin).
Materials/Methods: From December 2005 to January 2006, 15 patients (11 men and four women, mean age 68 years) with HCC were treated by selective TACE using HepaSphere™ (50-100 µm or 100-150 µm) premixed with Doxorubicin (50 mg). HCCs ranged from 20 to 70 mm, with a maximum of three lesions per patient. Fifty milligrams of dried microspheres were re-hydrated with 50 mg of Doxorubicin in 5 ml of saline solution and 10 ml of ionic contrast medium. Selective TACE was performed using 4-F catheters or microcatheters. Follow-up was performed with computed tomography (CT) after one, three, and six months.
Results: No major complications occurred; a mild pancreatitis resolved with the medical therapy. CT follow-ups showed good results without complications in most of the cases.
Conclusion: Our preliminary experience suggests that the results of this new agent are encouraging; a longer follow-up is required to confirm the efficacy.

P156

Chemoembolization and radiofrequency ablation as a complementary treatment in hepatic hypervascular malignant tumors

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Purpose: To present an interventional therapeutic protocol for inoperable primary hepatocellular carcinomas (HCC) or liver metastases including radiofrequency ablation (RFA) and chemoembolization according to lesions' characteristics.
Materials/Methods: In a four-year period, 25 patients were treated (15 with hypervascular HCC and ten with hypervascular metastases). HCC were unifocal lesions larger than 6 cm in diameter, while liver metastases measured more than 5 cm. All lesions were treated with chemoembolization (60 mg of Doxorubicin, 8 mg of Mitomycin, 6 mg of Lipiodol, and polyvinyl alcohol particles--whose size was selected according to the feeding artery and the tumor vascularity). Subsequently, all the lesions were treated by RFA.
Results: A good response (100%) was achieved in all lesions with both procedures, with a total and segmental necrosis demonstrated at dual-phase spiral-computed tomography at six-month follow-up. Eighty-five percent of treated lesions were stable or smaller in size. No major complications occurred (except for a right upper quadrant pain following liver chemoembolization or a mild pain at the puncture site when RFA was performed, all treated by analgesics).
Conclusion: Percutaneous treatment of inoperable primary and metastatic liver disease using chemoembolization and RFA is a safe and effective method which provides a better patients' life quality.

P157

Percutaneous treatment of biliary fistulas after ortothopic liver transplantation

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Purpose: To evaluate efficacy of percutaneous transhepatic biliary drainage (PTBD) in the treatment of biliary fistulas in choledocho-jejuno anastomosis (CJA) post-orthotopic liver transplantation (OLT) or at resection sites (split liver).
Materials/Methods: Between 10/90 and 11/05, 18 patients with post-OLT CJA biliary fistulas and two with fistulas at resection sites were treated (two cases presented a percutaneous biliary fistula feeding a subphrenic or a subhepatic collection). In all the patients, a PTBD was inserted to stent the bile duct and decrease leak. Biliary collection was percutaneously drained. PTBD was left for 4-74 days (median 22.6) and removed after complete leak recovery. Percutaneous biliary fistulas were embolized with Spongostan.
Results: In all cases, PTBD insertion was successful and a complete biliary leak recovery was obtained; in 18 patients, resolution was obtained after 4-10 days, in two after 29 and 74 days. Despite recovery of biliary fistulas, one patient underwent surgery for a multiloculated subhepatic biliary abscess.
Conclusion: In our experience, percutaneous treatment is the first choice to treat post-OLT CJA biliary fistulas with a high success rate. The absence of biliary ducts dilatation is not a contraindication, but can represent another reason to suggest surgery in case of percutaneous treatment failure.

P158

Role of interventional radiology in the treatment of biliary strictures following orthotopic liver transplantation

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Purpose: To evaluate efficacy and safety of the percutaneous treatment of biliary strictures complicating orthotopic liver transplantation (OLT).
Materials/Methods: Between October 1990 and June 2005, 1253 patients underwent 1368 liver transplants. Among these 1252 patients, 133 had a biliary stricture and underwent bilioplasty. A cohort of 102/133 patients were clinically followed for more than 12 months after the last percutaneous treatment.
Results: After one to three treatments, 82/102 patients (80.4%) were stricture-free at ultrasound and magnetic resonance-cholangiography follow-ups. In two cases (1.9%), a delayed stricture recurrence required a fourth percutaneous bilioplasty. In 11/102 (10.8%) a surgical bilioenteric anastomosis was performed. Retransplantation was performed due to ischemic damage in 7/102 (6.9%) patients.
Conclusion: Interventional radiology is an effective therapeutic alternative for the treatment of most biliary strictures complicating OLT. It has a high success rate and should be considered before surgical interventions. Elective surgery may be necessary in a few failed cases or in those with more severe and extensive biliary strictures.

P159

Expanded-polytetrafluoroethylene and fluorinated ethylene propylene-covered metallic stents versus uncovered mesh stents for palliation of malignant biliary disease. Clinical results in 160 patients

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Purpose: To compare clinical effectiveness of expanded-polytetrafluoroethylene and fluorinated ethylene propylene (ePTFE/FEP)-covered metallic stents with uncovered mesh-stents in the palliative treatment of malignant biliary disease.
Materials/Methods: We used 10-mm wide Viabil stents, 6-8 cm in length, with/without side-holes, in 80 patients, (Viabil group) and 10-mm wide uncovered mesh-stents (58 Wallstent, 19 Ultraflex, and three Protégé), 6-9 cm in length, in another 80 (mesh group). All tumors were Bismuth type I-II. In 41 cases, obstructions were caused by cholangiocarcinomas, in 80 by pancreatic head tumor, in six by gallbladder carcinoma, in nine by papillary tumor, in 19 by gastric carcinoma, and in five by liver hilar lymph node enlargement. All the patients were followed-up until death.
Results: Technical success was 98.7% (Viabil group) and 97.5% (mesh group). Early stent occlusion was noted in three patients (Viabil) due to sludge formation, and was treated by dilatation. Complication rates were 3.7% (Viabil) and 6.2% (mesh). Mean survivals were 177 days (Viabil) and 139 days (mesh). One-year primary patencies were 72.7% (Viabil) and 50% (mesh).
Conclusion: Viabil stents are safe and effective in the palliative treatment of malignant biliary disease and seem to offer a better patency rate than mesh stents.

P160

Radiologic-endoscopic combined treatment of biliary ducts transection: medium- and long-term follow-up results

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Purpose: To describe the technique and evaluate the results of a radiologic-endoscopic combined approach in patients with iatrogenic damage of the biliary ducts.
Materials/Methods: Eighteen patients with complete biliary ducts transection underwent a radiologic-endoscopic rendez-vous treatment. Biliary ducts damage was due to a trauma in one case and to a videolaparoscopic cholecystectomy in 17 cases. The procedure consisted in re-establishing biliary ducts continuity by a combined radiologic-endoscopic approach, with dilation and placement of two percutaneous biliary drainages. After 4-6 weeks, the drainages are replaced by 3-6 endoscopic plastic endoprostheses which are left *in situ* for 12-14 months.
Results: The combined approach with rendez-vous technique was successfully performed in all cases with a fast resolution of symptoms. Two patients underwent surgery, while in 16 patients biliary drainages were replaced by plastic endoprostheses. After removal of the endoprosthesis, nine patients are asymptomatic after 3-18 months. Seven patients are still under treatment with the biliary endoprosthesis and are asymptomatic after 3-18 months.
Conclusion: To delay or avoid surgery, the radiologic-endoscopic combined approach represents the only possible treatment in patients with complete biliary duct transaction.

P161

Endovascular treatment of portal vein thrombosis following liver transplantation in pediatric patients

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Purpose: To evaluate endovascular treatment results of portal vein thrombosis following liver transplantation in pediatric patients.

Materials/Methods: Eleven children underwent percutaneous transluminal angioplasty (PTA) or stent placement (SP) as treatment of portal vein stenosis after liver transplantation. The diagnosis of the obstruction was made by clinical and laboratory findings, Doppler ultrasound, and liver biopsy. Translesion pressure gradient was measured and portal angiography confirmed the exact site and length of the stenosis.

Results: A total of 14 endovascular procedures was performed. A single PTA session was effective in 63.6% of portal vein stenoses. A re-intervention was instead necessary in three patients (27.2%) with successful SP in all of them. In one case, there was no indication for the endovascular treatment. In another case, failure to access the portal system occurred (7.1%).

Conclusion: PTA can be an attractive alternative to the surgical treatment in selected patients. Implantation of vascular stents should be limited to cases of PTA failures. Its characteristics include the possibility of extra-dilatation in case of future need of increasing the portal vein diameter.

P162

Histopathologic changes of renal cell carcinoma after magnetic resonance-guided cryoablation

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Purpose: To evaluate long-term effects of *in-vivo* human renal tumors treated by magnetic resonance (MR)-guided cryoablation, and describe histopathologic changes of cryoablated lesions.

Materials/Methods: Thirteen patients with suspected small renal cell carcinoma measuring less than 4 cm underwent MR-guided percutaneous cryoablation under local anesthesia. Two freeze-thaw cycles were performed for cryoablation. Three patients subsequently underwent radical or partial nephrectomy due to suspected recurrent tumor on follow-up computed tomography images. The resected tumor tissues were histopathologically evaluated.

Results: The follow-up period ranged from ten to 45 months (mean 37.5 months). In the three patients with a suspected recurrent tumor, mean time from cryoablation to surgery was 21.0 months. Tumor specimens showed a coagulative and colliquative necrosis with cholesterol clefts in all materials. Arcuate and lobar arteries showed entire walls destruction and hyalinization with occlusion. Renal and perirenal tissues showed infarction, scar formation, fibrosis, and fat necrosis. Recurrent tumors showed viable cells and something similar to apoptosis.

Conclusion: MR-guided cryoablation in human renal tumors demonstrated longer term effects. Pathologic findings suggest that these effects may be due to ischemic changes by vascular injury as well as cryoinjury.

P163

Establishing a renal radiofrequency ablation service: early experience in 15 cases

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Purpose: To understand the process of establishment of a radiofrequency ablation (RFA) service: experience in the first 15 cases in our institution.

Materials/Methods: Indication for RFA in our institute is an increase in tumour size of 3 mm or more over six months in patients unsuitable for nephrectomy. Patient cohort: ten men, five women; average age 71 years (range: 56-84). Fourteen cases were performed under general anaesthesia; one under local anaesthesia and sedation. Tumour sizes ranged from 2.5 to 4.5 cm. Thirteen cases were primary renal cancers. Two were isolated lesions in patients with previous contralateral nephrectomy for cancer. Follow-up imaging was performed three months post-procedure and yearly thereafter.

Results: Technical success was achieved in all cases. Procedure was poorly tolerated under sedation. Average follow-up period was 9.2 months (range 0.5-20). Fourteen patients were discharged after overnight stay. One patient (4.5-cm diameter tumour) was an in-patient for four days on morphine infusion. Two patients suffered complications: perinephric haematoma and psoas collection, both resolved with conservative management.

Conclusion: Early experience suggests RFA is a safe and efficacious treatment for small renal cancers unsuitable for nephrectomy. Careful patient selection in multidisciplinary team meeting is important. Procedure is better tolerated under general anaesthesia.

P164

Percutaneous radiofrequency ablation of lung tumour

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Purpose: To evaluate preliminary outcome of computed tomography (CT)-guided radiofrequency (RF) thermoablation of primary and secondary lung malignancies.

Materials/Methods: From February to October 2005, nine patients (ten lesions: four primary and six metastases), not candidates to surgical resection, underwent RF thermoablation with percutaneous approach. The preliminary detection of the lesion was based on CT, positron emission tomography scan, and CT-guided fine needle aspiration biopsy. CT-guided procedures were performed under anaesthetic sedation, using a 200-W generator and co-axial Le Veen electrode (Radiotherapeutics).

Results: Post-RF thermoablation CT-scans demonstrated the complete tumour necrosis, with consideration of the lesions' oncological margins. Three patients developed small pneumothoraces at the puncture site: two resolved with aspiration through the coaxial cannula, one required a drainage catheter (5-F pig-tail catether), accessing through the coaxial cannula. In one patient, a minimal hemorrhagic effusion along the needle-electrode was seen. During the 1±10-month follow-up, one treated lesion recurred and two new lesions were identified in other two patients.

Conclusion: Percutaneous RF ablation can be considered a safe and effective procedure, with low rates of complications, to treat primary and secondary lung malignancies in non-surgical patients.

P165

Breast radiofrequency: study on non-surgical patients

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Purpose: To determine efficacy and tolerance of radiofrequency ablation (RFA) in subjects with breast cancer who are not surgical candidates or refuse surgery.
Materials/Methods: Eleven patients aged >70 years with breast tumor were treated by hormonotherapy for six months. The remaining tumor is documented with ultrasound, mammography, and magnetic resonance (MR), then treated by RFA under local anesthesia, sedation, and ultrasound-guidance. Multi-tine electrodes were used. Follow-up was clinical and documented by ultrasound, mammography, and MR every two months for six months.
Results: Treatment was always well tolerated without any complications. Two cases of skin burn which healed spontaneously after two months were noted. Immediately after treatment, an increase of tumoral volume (>50%) due to an inflammatory reaction was always described. At six months, a palpable mass was still persisting in all the patients. On mammography, tumors persisted or had disappeared and was, in all cases, surrounded by a fine border corresponding to the heating limit. On MR controls, the treated nodules did not enhance, as compared with pre-treatment MR.
Conclusion: RFA of breast tumors is well tolerated and effective at immediate follow-ups. A palpable mass corresponding to the heated zone was always present six months after the procedure.

P166

Cross-sectional imaging predictors of pulmonary shunting in patients with hepatocellular carcinoma considered for treatment with Yttrium-90 Theraspheres

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Purpose: To evaluate cross-sectional imaging predictors of pulmonary shunting in patients with hepatocellular carcinoma (HCC) considered for treatment with Yttrium-90 Theraspheres.
Materials/Methods: Retrospective review of periprocedural liver computed tomography or magnetic resonance of 15 consecutive patients with HCC evaluated for pulmonary shunting using intra-arterial ^{99m}Tc-MAA. Shunt fraction assessed by ^{99m}Tc-MAA scan was correlated with the following imaging findings: quantitative parameters: number of tumors (NT), total tumor volume (TTV), total tumor volume as percent of total liver volume (TTV%), relative tumor enhancement, relative hepatic and portal vein enhancement, and alpha fetoprotein level. Qualitative parameters: presence of ascites, adenopathy, biliary enlargement, perilesional edema, necrosis, and portal involvement. Differences were assessed for statistical significance using paired student t-test.
Results: Of 15 patients studied, four had significant shunting defined as greater than 20% pulmonary uptake on ^{99m}Tc-MAA study (average 30%). No statistically significant difference ($p<0.05$ for all parameters) was found in the quantitative assessment of the two groups. Furthermore, no pattern regarding qualitative analysis of cross-sectional imaging was found to correlate with degree of pulmonary shunting.
Conclusion: No significant cross-sectional imaging predictors of pulmonary shunting exist which could obviate the use of ^{99m}Tc-MAA as pre-treatment evaluation prior to Y-90 Therasphere treatment of HCC.

P167

Radiofrequency ablation and percutaneous vertebroplasty: a combined therapy for metastatic spinal tumors

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Purpose: Our purpose is to evaluate the efficacy of the combined therapy radiofrequency ablation (RFA) and percutaneous vertebroplasty (PVP) for painful bone metastases.
Materials/Methods: Fourteen patients with 21 painful spinal metastases were treated by RFA and PVP. In these 14 cases, standard treatments such as radiation or opioid analgesics had failed or patients were poor candidates. The first RFA session was performed with a cool-tip electrode through a bone biopsy needle; bone cement was then injected into the tumor cavity.
Results: All the procedures were successfully completed in 13/14 patients. The mean cement volume injected was 2.7 ml/lesion. Before the procedure, the mean visual analogue scale for worst pain was 7.8 (range, 5/10-10/10). After the combined therapy, the scale for worst pain decreased to 3.4. Eighty-six percent (12/14) of patients experienced a pain decrease that was considered as clinically significant. Opioid usage significantly decreased immediately after the procedure. In three patients, a paravertebral cement leakage occurred, but no other adverse events were recorded.
Conclusion: The combined therapy RFA + PVP for painful vertebral metastases provides significant pain relief for those patients in whom standard treatments have failed.

P168

Complications after computed tomography-guided percutaneous radiofrequency ablation of primary and secondary hepatic tumors. A five-year experience

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Purpose: To assess complication rates after radiofrequency ablation (RFA) of focal hepatic tumors.
Materials/Methods: In a 60-month period, 422 patients (252 men, aged 26-83 years) were treated. Hepatocellular carcinoma was present in 115 patients, 307 had metastases (134 colorectal cancers, 125 breast cancers, 48 other tumors). RFA was performed under conscious sedation using computed tomography (CT)-fluoroscopy. All the patients were followed for 24 hours and had a control CT-scan before hospital discharge. By keeping in touch with the patients and their referring physicians, we were able to find out whether delayed complications occurred. Adverse events were divided into major and minor complications (further therapy/no further therapy mandatory).
Results: Nine-hundred and five procedures were performed in 442 patients. Sizes of treated tumors ranged from 5 to 60 mm (mean 28). Major complications were diagnosed in 10/905 treatments (three pneumothoraces, two bleedings, four abscesses, one common bile duct stenosis). Minor complications occurred in 37/905 treatments (24 small capsule hematomas, prolonged pain in ten cases, three small pneumothoraces). No treatment-related death occurred.
Conclusions: RFA with an overall complication rate of about 5% and a major complication rate of about 1% is a safe therapeutical option for patients with primary or metastatic liver tumors.

P169

Changes in the respiratory function induced by radiofrequency ablation for pulmonary malignancies

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Purpose: To prospectively assess whether radiofrequency ablation (RFA) for pulmonary malignancies has a negative impact on respiratory function.
Materials/Methods: Thirty-eight patients (29 men, age range, 40-87 years; mean, 69) with primary or metastatic lung tumors measuring (maximal diameter) a mean of 2.2 cm (range, 0.5-4.8) were included after informed consent was obtained. All were considered by a surgeon as high-risk surgical patients because of recurrent tumors, advanced age, or refused the operation. Percutaneous RFA with local anesthesia was therefore performed under computed tomography (CT)-guidance. The whole tumor was ablated using an overlapping technique with an expandable electrode. Examined values were: total lung capacity, vital capacity (VC), %VC, forced expiratory volume in 1 sec. (FEV1.0), %FEV1.0, diffusing capacity of the lung for carbon monoxide (DLCO), %DLCO. Evaluations were done two/three days pre-and three/five days post-procedure. A chest CT was done within one week post-procedurally.
Results: A minor pneumothorax without need of chest intubation occurred in six patients. All the examined values did not show statistically significant deteriorations. According to CT images calculations, ablated areas represented less than 1% of the total lung volume. Dyspnea did not occur.
Conclusion: RFA for pulmonary malignancies has a minor negative impact on respiratory functions.

P170

Stereotactic placement of multiple probes for ablation of liver lesions

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Purpose: Our purpose was to develop and evaluate a novel method for stereotactic placement of radiofrequency ablation (RFA) probes.
Materials/Methods: A 2.5-mm contrast-enhanced helical-computed tomography (CT) scan was obtained in maximal expiration. Depending on the tumor size (0.5-11 cm, mean size: 2.8 cm), pathways for the placement of 1-11 radiofrequency needles were planned on the Treon navigation system (Medtronic Inc., USA). After sterile draping, the Atlas aiming device (Medical Intelligence, Schwabmünchen, Germany) was adjusted using the navigation system. In maximal expiration, the probes were advanced through the targeting device to the predefined depth. After determination of the accuracy of needle placement, with fusion of intraoperative CT with planning CT, RFA was performed. This novel method was applied to 81 tumors in 35 patients (33 metastases, 53 hepatocellular carcinomas; three clear cell carcinomas, tumor size: 0.5-11 cm). Twenty-one sessions were performed with the multipolar Celon radiofrequency device (Olympus), 21 sessions with the unipolar Cooltip device (Tyco).
Results: Image-fusion revealed a mean needle displacement of 4.3 mm. Follow-up contrast-enhanced control CT scans (mean follow-up time: 5.9 months) revealed recurrences in 4/81 lesions (4.9%).
Conclusion: Navigation allows for a precise planning and execution of the ablation procedure.

P171

Computed tomography-guided percutaneous cryoablation of lung malignancy using 17-G ultra-thin cryoneedle: early experience

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Purpose: To report our early experience with computed tomography (CT)-guided percutaneous cryoablation (PCA) of lung malignancies using 17-G ultra-thin cryoneedles.
Materials/Methods: Ten patients who were not surgical candidates underwent CT-guided PCA for the treatment of lung malignancies; the size of each tumor was 1.5 to 4.5 cm (mean: 2.7). There were six primary lung cancers and four lung metastases. Two freezing and thawing cycles were done for each tumor using Argon and Helium gas and a 17-G cryoneedle (IceRad, Oncura, PA, USA). Thirteen ablation sessions were performed. CT scans were obtained during PCA and one and six months after.
Results: Three (30%) periprocedural pneumothoraces occurred, all spontaneously resolved. There were no other complications or procedure-related mortalities. Ice-ball formation was identified on CT as a low attenuation. At follow-up CT scans, four (40%) cases showed a complete tumor resolution and other six (60%) cases showed a decreased tumor size, from 2.9 to 1.4 cm, in its mean diameter.
Conclusion: CT-guided PCA using ultra-thin cryoneedles was safe and effective.

P172

Percutaneous ultrasound-guided cryoablation of small renal tumours. First European results

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Purpose: To describe our preliminary experience with percutaneous cryoablation of renal masses using real-time sonography for guidance and monitoring of the cryo-procedure.
Materials/Methods: In four patients, a small (<4 cm) renal tumour was incidentally found by computed tomography (CT) or magnetic resonance imaging (MRI) and verified by biopsy. Cryoablation was performed using general anesthesia and 17-Gauge cryoneedles percutaneously placed into the tumour under ultrasound guidance. Follow-up CT or MRI was performed one week and one month after the procedure in all the patients.
Results: One patient treated with platelet aggregation inhibitor (Plavix®) had a short-duration bleeding into the renal pelvis during the procedure. Consequent hydronephrosis was treated with percutaneous nefrostomy. No other perioperative complications were noted. Three patients were discharged after 24 hours and one patient after 72 hours. Postoperative pain was controlled with non-narcotic medications. CT or MRI performed after one week showed no contrast-enhancement at the tumour site.
Conclusion: Our initial experience shows that percutaneous, sonography-guided renal neoplasm cryoablation can be an useful method for treating renal masses.

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Percutaneous radiofrequency ablation in 216 patients with hepatocellular carcinoma: a six-year experience

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Purpose: To evaluate the efficacy of computed tomography (CT)-guided radiofrequency ablation (RFA) in the treatment of patients with hepatocellular carcinoma (HCC).
Materials/Methods: Between February 1999 and January 2006, 216 patients (173 men, 43 women) with 302 HCCs underwent 462 RFA sessions. Tumours' diameters ranged from 1.5 to 5 cm (mean 2.8±0.7 cm). Before RFA sessions, alfa-fetoprotein was normal (<20 ng/ml) in 100 patients, slightly elevated (20-200 ng/ml) in 69, and markedly elevated (>200 ng/ml) in 47. Evaluation of the therapeutic result with dual-phase spiral-CT was performed post-RFA and at one-, three-, six-, and 12-month intervals and every year afterwards. Alfa-fetoprotein measurement also was part of the follow-up. Patients were surveyed for recurrences of the treated lesions and for the onset of new HCCs.
Results: No major complications occurred. Minor complications were noticed in 13% of patients. Post-RFA recurrences were recorded in 25 patients and were managed with a second session. One-, two-, three-, four- and five-year survival rates were 95.8, 86.1, 77.7, 67.4, and 54.3%, respectively. A post-RFA reduction of alfa-fetoprotein was recorded in all cases.
Conclusion: RFA seems to be an effective procedure with low-complication rates; it can be proposed to patients with non-operable HCC with quite promising results.

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Five-year survival after radiofrequency ablation of colorectal liver metastases. Results comparable to the best surgical series

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Purpose: Patients with colorectal liver metastases were evaluated by a multidisciplinary team for the best individual treatment. Those referred for radiofrequency ablation (RFA) treatment were prospectively registered in a clinical database.
Materials/Methods: One-hundred and two patients with colorectal liver metastases were treated with RFA; 75 of them (74%) were treated percutaneously and 27 patients (26%) were treated perioperatively as an adjunct to surgical resection. All underwent general anaesthesia. Follow-up examinations were performed after one, four, eight, and 12 months and then every six months for five years. In case of residual tumour or new metastases, the patient was treated with a new RFA session.
Results: Three-hundred thirty-two tumours were treated in 178 sessions (1-6/patient), median 3.3 tumours/patient (1-17). Tumour diameter measured an average of 2.7 cm (0.5-6.5). The observation period was a median of 23.6 months (1-92). Median survival was 51 months and five-year survival rate was 41%.
Conclusion: RFA treatment of colorectal liver metastases is now comparable with the best surgical results, achieving a five-year survival rate of over 40%. The results of the present study and those from studies of other centres call for a randomised controlled trial to be compared with surgical resection.

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Hepatic vascular applications of DynaCT

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Learning Objectives: The exhibit will illustrate the value of DynaCT in the planning process during angiographic procedures by: **1.** clarifying the distribution of tumor anatomy in relation to arterial anatomy, **2.** depicting variant anatomy that may have resulted in nontarget embolizaton, **3.** determining endpoints in chemoembolization, **4.** aiding in sub-selection of hepatic arterial branches for optimal chemotherapy delivery.
Background: Conventional digital subtraction angiography (DSA) can depict vascular anatomy with high spatial resolution however eliminates soft tissue details. DynaCT (Siemens Medical Solutions Inc., Malvern, PA, USA) is a software post-processing technique that provides soft tissue information obtained from an upgraded conventional angiography unit. This simultaneous acquisition of angiographic and soft tissue data can be reconstructed in multiplanar format, which can be manipulated by the operator to aid in decision making during diagnostic and therapeutic interventional procedures.
Clinical Findings or Procedure Details: The presentation will discuss the imaging protocol for DynaCT along with examples from hepatic vascular directed interventions. Examples of DynaCT application will include planning and/or confirmation of treatment success during hepatic arterial embolization/chemoembolization, intra-arterial microsphere brachytherapy and portal vein embolization.
Conclusion: In our experience, the ability to perform DynaCT adds incremental value above traditional DSA that assists in intra-procedural decisions.

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Radiological insertion and management of peritoneovenous shunt

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Purpose: To report our experience on the management of complications following insertion of peritoneovenous shunt for intractable malignant ascites.
Materials/Methods: From June 1999 to January 2006, 26 patients underwent insertion of peritoneovenous shunt for ascites by interventional radiologists. We have used ultrasound and portography to assist in the diagnosis of the cause of shunt blockage. Successful techniques for restoration of the shunt function include stripping of any fibrin sheath, revision of either the venous or peritoneal catheter, and port pumping.
Results: The procedure was initially successful in all patients with continued patency until death in 13. A further five patients are still alive with a functioning shunt, with the longest survival time now at five years. There was one immediate post-procedure death due to pulmonary oedema. Two patients developed pneumothorax managed successfully with either a chest drain or aspiration. Shunt dysfunction occurred eight times in seven patients. There were five successful revisions in four patients. Overall shunt patency has been maintained in 88% of patients.
Conclusion: Shunt dysfunction is seen in a significant number of patients, but successful revision of the shunt can be achieved in the majority.

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Hepatic artery occlusion as a complication of continuous hepatic arterial infusion: comparison between gastroduodenal artery coil method and direct hepatic artery method

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Purpose: Hepatic artery infusion chemotherapy via a reservoir system is widely used to treat hepatic neoplasms. However, hepatic artery occlusion is a common complication of this treatment. Our purpose is to compare hepatic artery occlusion rates between the standard gastroduodenal artery fixation with coils (GDA-coil) method and direct hepatic artery (DHA) fixation method, including a newly developed microcatheter tip system.
Materials/Methods: Between December 2003 and November 2005, in 52 patients with hepatic neoplasms (50 metastases, two hepatocellular carcinomas) a reservoir system was implanted. Thirty-two patients were performed by GDA-coil method and 25 by DHA method. During follow-up (seven days-24 months; mean 20.5 weeks), the occlusion rates of the hepatic artery were compared.
Results: Hepatic artery occlusion occurred in seven (21.8%) GDA-coil method patients and in eight (32%) DHA method patients. Occlusion of the hepatic artery occurred only in two of the nine (22%) patients with DHA method in whom a microcatheter tip was used.
Conclusion: DHA method using a microcatheter tip seems comparable with the standard GDA-coil method.

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Characterization of irinotecan drug-eluting beads and *in-vitro: in-vivo* correlation

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Purpose: To evaluate the *in-vitro* performance characteristics of irinotecan drug-eluting beads (DEB) and correlate this to drug plasma levels in a porcine model of hepatic arterial embolization. These studies support the clinical assessment of DEB for the treatment of colorectal cancer liver metastases.
Materials/Methods: Irinotecan DEB were characterized *in vitro* with respect to size, compressibility, suspension, microcatheter deliverability, and drug elution by T-apparatus. Porcine hepatic arterial embolization was performed in four groups of animals (n=5/group): 100-300-µm control beads, 100-300-µm irinotecan DEB, 700-900-µm irinotecan DEB and intraarterial (IA) injection of drug alone. Plasma samples were taken over 90 days and histopathology performed at 30 and 90 days.
Results: The beads contained up to 50 mg irinotecan/mL beads. *In-vitro* characterization showed that drug loading had no adverse impact on bead handling and deliverability. T-apparatus studies indicated that small beads released drug faster than larger beads due to a surface-area effect. This observation was confirmed *in vivo* with C_{max} in the order IA >> small DEB > large DEB. The *in-vitro: in-vivo* data correlated very well for both small and large beads (R^2 0.980/0.997).
Conclusion: Irinotecan DEB is a potential new agent for chemoembolization that warrants consideration for clinical studies.

P179

Use of yttrium-90 microspheres for the treatment of liver neoplasia: long-term follow-up

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Purpose: Determine safety and efficacy of transarterial yttrium-90 microspheres (TheraSphere) treatment in patients with liver metastases.
Materials/Methods: One-hundred thirteen patients (median age 62) underwent 171 yttrium-90 administrations. Primary sites included colon (n=43), breast (n=18), neuroendocrine (n=11), pancreas (n=7), lung (n=5), cholangiocarcinoma (n=5), melanoma (n=4), renal (n=4), esophageal (n=3), ovary (n=2), adenocarcinoma unknown primary (n=2), and one of each from lymphoma, gastric, duodenal, bladder, angiosarcoma, squamous cell carcinoma, thyroid, adrenal, parotid. All patients had failed standard polychemotherapy. Patients had baseline and follow-up liver function tests, tumor markers, computed tomography/magnetic resonance, and positron emission tomography (PET). Patients were followed for survival from time of treatment.
Results: Mean activity and dose infused were 2.4 GBq and 117 Gy. All were discharged six hours post-procedure. Clinical toxicities included fatigue (54%), abdominal pain (11%), and nausea/vomiting (11%). Follow-up carcinoembryonic antigen levels in patients with colorectal cancer demonstrated a mean post-therapy 61% decrease. On imaging follow-up, responses were: 29%, 67%, and 79%, according to the Response Criteria In Solid Tumors, the European Association for the Study of the Liver, and PET, respectively. Median survival was 300 days.
Conclusion: Yttrium-90 is a safe and effective outpatient treatment for patients with unresectable liver neoplasia. Further investigation is warranted.

P180

Computed tomography-guided percutaneous core biopsy of small pulmonary nodules: diagnostic accuracy and complication rate

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Purpose: To assesss safety and efficacy of percutaneous core biopsy of pulmonary nodules measuring 1 cm or less.
Materials/Methods: Computed tomography (CT)-guided percutaneous core biopsy was performed in 50 patients aged 25-76 years with 56 small lung nodules measuring 0.4-1.0 cm (mean 7.8±1.3). CT-guided core biopsy was done under local (23) or general (27) anaesthesia. An automated biopsy gun with a detachable 17-G coaxial cutting needle was used, with a mean number of 7±3 biopsy attempts.
Results: Core biopsy samples were adequate for diagnosis in 49 (87.5%) of 56 lesions. Diagnosis was malignant in 24/56 (49%) and benign in 25/56 (51%) lesions. Findings were non diagnostic in 7/56 (12.5%) lesions. Seven biopsy procedures, initially performed under local anaesthesia, had to be repeated under general anaesthesia. A perilesional hemorrhage was observed in almost all the patients, but no severe hemoptysis was noted. Six (12%) of the 50 patients had a pneumothorax and two of them (4%) required CT-guided percutaneous chest tube placement. One patient died due to myocardial infarction one day after CT-guided biopsy.
Conclusion: CT-guided percutaneous core biopsy of small (≤1 cm) pulmonary nodules is a safe and effective technique to obtain adequate samples for histologic examination.

P181

Tumor assessment in patients undergoing local chemotherapy: first experience with angiographic computed tomography images acquired with an angiographic C-arm system

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Purpose: To assess the value of angiographic computed tomography (ACT) images for local chemoperfusion and chemoembolization of abdominal tumors.
Materials/Methods: Chemoperfusion or chemoembolization was performed in eight patients for local therapy of tumors of the pancreas, the liver, and the kidney. All procedures were performed in an angiographic C-arm system (Axiom Artis; Siemens Medical Solutions, Forchheim, Germany). To generate CT-like images of the abdomen, an ACT run (DynaCT®; scan time 10s, 70kV, 80mA, 0.8°/image, 1 k-akquisition matrix) was performed. After image reconstruction on a workstation, CT-like images were available in the angio-lab. The interventionalist recorded if the image quality was sufficient for a therapeutic decision and if the findings had an immediate impact on therapy. After the procedure, image quality was assessed with corresponding multidetector-CT images as a reference.
Results: ACT images could be obtained and were available during the intervention in all patients. The overall image quality was rated inferior to multidetector-CT in all cases. The interventional radiologist rated the image quality sufficient for decision-making in all patients with an actual therapeutic impact in seven patients.
Conclusion: ACT is able to provide CT-like images in an angiographic C-arm system. It allows immediate, therapeutically relevant decisions during local abdominal chemotherapy.

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Percutaneous transluminal angioplasty of the subclavian arteries

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Purpose: To review feasibility, safety, and long-term results of subclavian artery angioplasty.
Materials/Methods: Over 14 years, 237 patients (mean age: 64±12 years) underwent percutaneous treatment for severe subclavian artery occlusive disease (stenoses: 192, occlusions: 45). Isolated balloon angioplasty was done in 59 cases, angioplasty + stenting in 164.
Results: Technical success was 94%. Thirty-one occlusions only were recanalized (69%). Four (1.2%) periprocedural events occurred: one major (fatal) stroke, one transient ischemic attack, two arterial thromboses. At follow-up (mean 65.8±33.5 months), 27 restenoses (12 %) were treated with angioplasty alone in 13 cases (18.8 %) and with angioplasty + stenting in 14 (8.4%) patients. Primary and secondary patencies at ten-year follow-up were 78.1% and 84.5%, respectively. In patients without stent, they were 67.5% and 75.5%, while in those with stents, 89.7% and 96.9% ($p<0.01$). Primary patencies for all recanalized lesions were 84.6% and 79.1% without stent, 89.7% with stent ($p<0.04$) and secondary patencies were 91.6%, 88.5%, and 96.9%, respectively ($p<0.02$).
Conclusion: Percutaneous transluminal angioplasty is currently the treatment of choice for subclavian artery lesions. It is a safe and effective procedure associated with low risks and good long-term results. Stents seem to limit restenosis rate and improve long-term results.

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Percutaneous transluminal angioplasty and stenting of extracranial vertebral artery stenoses

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Purpose: To evaluate safety and efficiency of angioplasty/stenting in patients with symptomatic vertebral artery stenosis (VAS).
Materials/Methods: Sixty-six (64 atheromatous, two inflammatory lesions) angioplasties in 60 patients (mean age 68.4±6.9 years) were performed. Lesions' locations were: 59 at V0, five at V1, and two at V2 segments. Protection devices were used in three patients. Eleven subclavian and three carotid angioplasties were performed simultaneously.
Results: A technical success was achieved in 64/66, while clinical success was obtained in 58/60 (two failures). Six lesions were treated by angioplasty alone [three V0- (first three patients), two V1-, one V2-lesions). One lesion was treated by cutting-balloon alone, 58 were stented with balloon-expandable stents. Three V1- and one V2-lesions were managed with self-expandable stents. No post-procedure neurological complications occurred. Angiographic success was achieved in 64/66 lesions (97%). Four patients (8%) developed symptomatic restenoses during follow-up (mean: 26.5±26.3 months): three post-percutaneous transluminal angioplasty (PTA) alone, one post-PTA/stenting (one occlusion was treated medically, three stenoses were successfully managed with balloon-angioplasty).
Conclusion: Endovascular treatment of symptomatic VAS can be performed safely and effectively with high technical success, low complication, and low restenosis rates, and a durable clinical success. Stents seem to improve immediate and long-term results.

P185

Percutaneous transluminal angioplasty for the treatment of infrapopliteal critical limb ischemia: early outcomes following the use of Sirolimus-eluting stents

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Purpose: This investigation is aimed at assessing safety and efficacy of Sirolimus-eluting stents (SES) in the treatment of patients with severe infrapopliteal critical limb ischemia (CLI).
Materials/Methods: Between October 2004 and January 2005, 18 patients (seven women, 11 men, mean age 72.8 years) presenting with CLI received 24 SES in 20 procedures. Predilation was performed in half of the patients. The majority of lesions (95.7%, n=22) was treated with a single SES. Two patients underwent two procedures, each one receiving two SES. Clinical examination and quantitative vascular analysis (QVA) were performed in all patients at discharge and at six-month follow-up.
Results: SES was successfully implanted in all 18 patients. Mean stent length and diameter were 30.29 mm and 3.23 mm, respectively. Mean follow-up was 256 days (170 - 368 days). Minimum lumen diameter as measured by QVA was 0.25 mm (pre-procedure), 2.79 mm (post-procedure) and 2.39 mm (at six-month follow-up), with a late lumen loss of 0.38 mm. The overall six-month survival, limb salvage, and binary restenosis rate were 94.4%, 94% and 0%, respectively.
Conclusion: Our results suggest that treatment with SES in infrapopliteal lesions can be considered as an effective and safe treatment for patients with CLI.

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Endovascular repair of complex internal iliac aneurysms using customised tapered stent-grafts

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Purpose: To evaluate the safety, efficacy and clinical sequelae of combined outflow embolisation and customised tapered stent-grafting in the treatment of isolated internal iliac artery (IIA) aneurysms.
Materials/Methods: Five patients, all men, age range 61-75 years (mean 70.1), with aneurysm morphology unsuitable for conventional stent-grafting, each underwent endovascular treatment of isolated IIA aneurysm by coil embolisation of the efferent IIA vessels and placement of a customised tapered stent-graft across the IIA origin. Aneurysm occlusion was assessed angiographically at the time of stenting and using contrast-enhanced computed tomography (CECT) thereafter.
Results: In all five patients, the aneurysms were successfully occluded. There were no instances of post-procedural pelvic pain, impotence, ischaemia, urinary dysfunction, or type 1 endoleak prior to patient discharge. Of two small type 2 endoleaks noted at the time of stenting, only one remained on CT follow-up three months post-procedure, with no increase in sac size.
Conclusion: Endovascular management of IIA aneurysm appears to be effective and safe with a reduced morbidity and mortality relative to elective surgical repair and shorter inpatient stay. Furthermore, the use of customised tapered stent-grafts allows treatment of IIA aneurysms with morphology that would previously have rendered them unsuitable for endovascular repair.

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Cutting-balloon percutaneous transluminal angioplasty: treatment of choice in femoro-popliteal artery lesions

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Purpose: To evaluate the efficiency of cutting-balloon in the obstructive chronic arteriopathy of the lower limbs.
Material/Methods: From May 2003 to May 2005, 46 patients with obstructive chronic arteriopathy were treated with cutting-balloon technique: 34/46 patients were classified as stage II of La Fontaine classification and were previously studied by multidetector computed tomography (MDCT)-angiography to identify vascular calcifications and plan the endovascular therapy; 8/46 patients were classified as stage III; 4/46 patients presented necrosis of some foot fingers (stage IV). In six patients, the cutting-balloon technique was performed on both limbs in two sessions, and in one patient in one session. The vascular lesions treated, which showed a great calcific component in all cases, were located in the superficial femoral artery only in 30 patients, in the popliteal artery only in five patients, and in both arteries in 11 patients.
Results: All the procedures achieved an immediate technical success and one complication only occurred (a popliteal acute thrombosis treated with local thrombolysis). In 18 patients, MDCT-angiography was performed after six, 12, and 18 months; one recurrence only was recorded.
Conclusion: Cutting-balloon technique is the treatment of choice for femoro-popliteal calcific vascular lesions.

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Superior vena cava obstruction with lung carcinoma: endovascular stenting versus radiation therapy

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Purpose: To evaluate effectiveness and long-term results in the treatment of superior vena cava (SVC) syndrome by endovascular stenting versus radiation therapy (RT).
Materials/Methods: A retrospective analysis of 53 patients (49 men; median age: 65 years) with endovascular stenting and 21 patients (20 men; median age: 57 years) with SVC syndrome due to lung carcinoma was done. Patients were followed with posteroanterior chest film and computed tomography, and clinical success was evaluated by symptom relief and survival duration.
Results: Thirty-day mortality was 20% (11 patients) in the stenting group and 43% (nine patients) in the RT group. Symptoms improved in 47 patients (89%) with endovascular stenting and in 13 patients (62%) with RT; 89% (42/47) in the endovascular stenting group and 69% (9/13) in the RT group remained symptom-free throughout their course. At follow-up, 47 patients had died (19 weeks, range 1-64) and six were alive (55 weeks, range: 12-10 weeks) in the endovascular stenting group. In the RT group, all the patients died in 1-227 weeks (mean: 29 weeks).
Conclusion: Endovascular stenting in lung carcinoma with SVC syndrome provides good long-term results as compared with RT, and should be the primary treatment for immediate relief of symptoms.

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Feasibility of a contralateral approach to femoro-popliteal occlusive lesions

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Purpose: To retrospectively assess vascular-access in femoro-popliteal angioplasty.
Materials/Methods: From 1999 to 2006, 71 patients (50 men, mean age 71.4 years) underwent femoro-popliteal angioplasty by contralateral-approach (CLA). Patients treated by CLA only were included in the „C-group" (52), those treated by CLA followed by antegrade-approach in the „CA-group" (19). Additional antegrade-punctures were performed with guide-wires in the superficial femoral artery. Both groups were compared for occlusion characteristics, location, and length, and the therapeutic range for coexistent iliac lesions managed by a single treatment evaluated.
Results: In the C-group, 50 stenoses and 18 occlusions (mean occlusion length: 11.5 cm) were present (initial success rate: 94.2%). The CA-group included seven stenoses and 15 occlusions (mean occlusion length: 20.1 cm - initial success rate: 94.7%); 87.7% of stenoses were treated by CLA only; 45.5% of occlusions were significantly longer and harder and required additional antegrade puncture, safely and easily performed with a marking guide-wire. Hard lesions requiring penetration technique with balloons and guidewire-tails were 3.8% (C-group) and 21% (CA-group). Coexistent iliac lesions needed angioplasty (27/71 limbs, 42 lesions), and 37/42 lesions were successfully treated in the contralateral tract.
Conclusion: Contralateral approach for ilio-femoro-popliteal angioplasty can prevent additional antegrade puncture.

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"Full metal jacket" for recanalization of complete occlusions of superficial femoral artery

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Purpose: To assess feasibility and effectiveness of percutaneous recanalization of complete occlusions of superficial femoral arteries (SFA).
Materials/Methods: In the last three years, 38 patients (26 men; mean age 71.8 years) with 43 complete SFA occlusion and unfit to open conventional repair for critical limb ischemia (24 stage III and 14 stage IV Leriche-Fontaine) were selected. Twenty-two were treated with percutaneous transluminal angioplasty and stenting and 21 with direct stenting. Follow-up was performed with clinical evaluation and color-Doppler ultrasound one, three, six months after the procedure and yearly thereafter.
Results: An immediate technical success was obtained in 43/47 (91.4%) cases; four occlusions were not crossed. In 7/43 (16.2%), a distal embolism occurred (five treated with thrombolysis and two by thromboaspiration). Five patients (with six occlusions) died during the first year. During follow-up, performed in 37 occlusions, primary patency was 91.8% at six months, 78.3% at 12 months, and 42.8% at 24 months. Two occlusion-related stent fractures were recorded.
Conclusion: Percutaneous recanalization is a feasible treatment for complete SFA occlusions (Transatlantic Intersociety Consensus, category D); the procedure allows fast revascularization with resolution of critical ischemia; moreover, it does not preclude conventional surgical repair but it can delay it.

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Infra-popliteal revascularization in critical limb ischemia: three-year experience in endovascular and surgical treatment

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Purpose: To evaluate the role and the efficacy of subintimal angioplasty (SA) and surgical by-pass (SBP) in critical limb ischemia
Materials/Methods: Between January 2002 and February 2005, 114 patients underwent revascularization of infra-popliteal arteries. All the patients were previously assessed with clinical evaluation, color-duplex ultrasound and angiographic study (magnetic resonance or digital subtraction angiography). SA was performed in 77 patients (obstruction length <10 cm in 33 cases and >10 cm in 44 cases); SBP was performed in 37 patients (autogenous conduit in 32 cases and composite conduit in five cases). Median follow-up was 11.5 months, including clinical assessement, color-duplex ultrasound at six months and every six months thereafter, using magnetic resonance-angiographic study if indicated.
Results: Post-intervention evaluation included: SBP primary patency at 30 days, SA immediate technical success, limb salvage and complications rates in both treatments. SA technical success was 83%, with limb salvage and complications rates of 86% and 4.8%,respectively. SBP primary patency, limb salvage, and complications were: 81%, 74%, and 20%, respectively.
Conclusion: SA is an effective and safe technique with a low incidence of complications and should be considered as the primary preferred therapeutic option in lower limb salvage.

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Early experience with the Amplatzer® vascular plug in peripheral arteries

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Purpose: To report our experience in larger vessels occlusion with the Amplatzer®.
Materials/Methods: Between November 2004 and January 2006, ten consecutive patients (65±12 years, range 41-89) underwent occlusion of a large vessel by implantation of 11 Amplatzer through 6- or 8-F long sheaths. The Amplatzer is a nitinol cage of 4-20 mm in diameter designed to occlude larger vessels. Indications for occlusion were as follows: internal iliac artery occlusion prior to stent-graft placement (n=5) or limb extension into the external iliac artery (n=3); aorto-pulmonary fistula following a surgical treatment by ventral aorta of an aortic coarctation (n=1); pulmonary arterio-venous fistula and subclavian back flow into a type B dissection following thoracic stent-graft exclusion (n= 1). Results were assessed on immediate angiographic control and follow-up computed tomography (CT).
Results: Immediate success rate was 100%. CT prior to discharge confirmed exclusion in all the patients. Immediate complications or device displacements were not observed. Follow-up was obtained in nine patients after 5-12 months (mean 5) and confirmed the maintained occlusion of the vessel in all nine patients.
Conclusion: The Amplatzer is a very effective and easy to manipulate embolization tool for larger vessel occlusion.

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Cutting-balloon angioplasty in the treatment of iliac artery in-stent restenosis

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Purpose: To report our preliminary experience using cutting-ballon angioplasty (CBA) in symptomatic iliac artery in-stent restenoses.
Materials/Methods: Eight men (mean age 64 years, range: 55-75) with angiographic >50% restenosis inside five common and three external iliac artery stents, a resting translesional mean pressure gradient >10 mmHg, and a clinical deterioration of at least 1 Rutherford category, were treated with 8x10-mm (7) and 7x10-mm (1) cutting-balloons (CB). Mean restenosis development duration was 58 months (range 12 months-10 years). In four focal (<10 mm) lesions, CBs were inflated once, while in four diffuse (>10 mm) lesions at least three inflations were performed, moving from distally to proximally.
Results: A <20% residual angiographic stenosis and a resting translesional mean pressure gradient <5 mmHg was achieved in all cases who improved of at least 1 Rutherford category. In two cases, postdilation with a 9x4-mm conventional balloon was performed. One uncomplicated balloon slippage occurred, with diffuse intimal hyperplasia. A small pseudoaneurysm following dilation of a severe stenosis at the distal edge of a Wallstent was treated with stent-grafting.
Conclusion: CBA seems to be effective in the treatment of symptomatic iliac in-stent restenoses. Vessel rupture could however occur when dilating restenosis at the stent edges.

P194

A trans-femoral and trans-tibial combined approach in the treatment of obstructions extending on popliteal and distal vessels origin

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Purpose: To describe our technique of subintimal recanalization of long femoropopliteal and leg vessels origin obstructions, by a trans-femoral and trans-tibial combined approach.
Materials/Methods: In six patients with trophic lesions, subintimal recanalizations by a trans-femoral and pedal artery combined approach (two cases) and a trans-femoral and posterior tibial artery approach (four cases) were performed. Tibial arteries punctures were performed under ultrasound guidance, as distally as possible. By pre-treatment magnetic resonance angiography or Doppler ultrasound examinations, the best distal run-off vessel was selected.
Results: A technical success was achieved in 100% of cases. Sub-intimal antegrade and retrograde rendez-vous was obtained by wire snaring into the sub-intimal space. At seven-month Doppler-ultrasound follow-up, all recanalized vessels were patent. All the patients had a resolution of rest pain and an initial healing of trophic lesions.
Conclusion: These patients are often poor candidates to surgical by-pass and amputation may follow an endovascular failure. A combined antegrade and retrograde sub-intimal recanalization--in case of long obstructions involving the origin of the leg vessels--is performed to exactly recanalize the best distal run-off vessel.

P195

Percutaneous transluminal angioplasty of infrapopliteal arteries. Limb salvage rate according to indications and arterial patency after treatment

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Purpose: To evaluate technical success and one-year limb salvage rate in patients with chronic critical limb ischemia treated by infrapopliteal percutaneous transluminal angioplasty (PTA).
Materials/Methods: Since 1985 to the end of 2005, 1416 left limbs were treated by PTA (3045 infrapopliteal arteries). Patients were 985 men and 431 women (average age, 66.7 years). The interventions performed until the end of 2003 were retrospectively evaluated, since these patients had at least a 12-month clinical follow-up. This group consisted of 799 followed patients.
Results: Secondary left limb salvage in the whole group was 83.5%. Secondary left limb salvage rates according to the indications were: gangrene 80.5%, non-healing ulcer 88.5%, rest pain 81.2%, phlegmone 88.2%, non-healing amputation wound 82.4%, claudication/other indications 100%. Limb salvage rate according to arterial patency after PTA: no patent artery 63%, one patent artery 82.1%, two patent arteries 87.5%, three patent arteries 93.1%.
Conclusion: Secondary limb salvage is statistically significantly affected by the post-PTA number of continuous patent arteries and by the anatomical conditions of peripheral arteries (plantar and dorsal pedal arteries). Infrapopliteal interventions are nearly equally effective in patients with different comorbidities; even dialysis and diabetic patients should not be discriminated when indications for PTA are established.

P196

Infrapopliteal paclitaxel-eluting stents for critical limb ischemia: six-month clinical and angiographic results

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Purpose: Paclitaxel-eluting stents displayed exciting results in inhibiting neointimal hyperplasia after coronary stenting. Six-month clinical and angiographic results after selective infrapopliteal placement of paclitaxel-eluting stents for critical limb ischemia are reported.
Materials/Methods: Twenty-three patients (15 men, mean age 65±11 years) with critical limb ischemia (Rutherford category 4 and above) underwent infrapopliteal angioplasty and selective placement of coronary paclitaxel-eluting stents (TAXUS, Boston Scientific Co., USA) for suboptimal angioplasty outcome. In total, 49 lesions (14 occlusions and 35 stenoses) in 34 arteries of 24 limbs were recanalized.Clinical assessment and intra-arterial angiography were performed at six months.
Results: Immediate technical success was 100%. The pre-procedure mean ankle-brachial index was 0.69 and rose to 0.97 at hospital discharge. Six-month mortality rate was 4.3% (1/23), while major amputation rate was 8.3% (2/24). Up to date, angiographic follow-up was available in 30 lesions of 15 limbs. Primary patency of the treated lesions was 46.7% (14/30) with 46.7% (14/30) of occlusion rate. Six-month angiographic binary (>50%) in-stent and in-segment (stent area ±0.5 cm margin) restenosis rates were 63.3% (19/30) and 76.7% (23/30), respectively.
Conclusion: Selective infrapopliteal placement of paclitaxel-eluting stents for critical limb ischemia achieves an acceptable short-term clinical outcome despite the decreased vascular patency rate.

P197

The role of Protégé self-expanding nitinol stent in the treatment of superficial femoral artery lesions: a work-in-progress

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Purpose: To evaluate medium-term results of Protégé (Sulzer IntraTherapeutics, Inc.) nitinol stents in patients with superficial femoral artery (SFA) disease.
Materials/Methods: Twenty-four symptomatic patients with stenosis (15) or occlusion (9) of the SFA underwent primary stenting using a Protégé self-expanding nitinol stent. Sixteen patients required more then one stent to completely recanalize the SFA. Mean lesion length was 12.2 cm (range 4-28 cm) with a stenosis degree ranging from occlusion to 65% evaluated with Doppler and angiography. A good distal run-off was evident in all cases. Clinical and Doppler evaluations were performed during the follow-up.
Results: An immediate technical success was achieved in all cases. The stent-device easily crossed all the lesion with a correct deployment of the stent. After a mean follow-up of 3.5 months (1-6 months), 18 stents were patent (74.8%). In two cases (8.3%), a stent occlusion was observed after three months and resolved by local fibrinolysis. In-stent restenoses occurred in four cases (16.6%) after one, three, six, and six months and were treated with angioplasty and re-stenting. Moreover, in two cases a stent fracture was observed.
Conclusion: The Protégé can be considered as a valid tool in the treatment of SFA; obviously, longer follow-up is mandatory.

P198

Infrapopliteal sirolimus-eluting stents for critical limb ischemia: one-year clinical and angiographic results

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Purpose: Following publication of encouraging six-month clinical and angiographic results in patients with critical limb ischemia treated with selective infrapopliteal placement of sirolimus-eluting stents, we report on medium-term outcomes of this patient cohort.
Material/Methods: Twenty-nine patients (21 men, mean age 68.8 years) with critical limb ischemia (Rutherford category 4 and above) and infrapopliteal arterial occlusive disease underwent infrapopliteal angioplasty and selective placement of coronary sirolimus-eluting stents (CYPHER®, Cordis Co., USA) for suboptimal angioplasty outcome. Sixty-six lesions (20 occlusions, 46 stenoses) in 41 arteries of 29 limbs were recanalized. Clinical assessment and intra-arterial angiography were scheduled at 12 months.
Results: Revascularization technical success was 100% (29/29). One-year mortality rate was 13.8% (4/29; two malignancies), while limb salvage was 89.7% (26/29). One-year angiographic follow-up is presently available in 38 lesions (15 limbs). Primary patency of the treated lesions was 89.5% (34/38) with 10.5% (4/38) of occlusion rate. One-year secondary patency was 89.5% (34/38). Angiographic binary (>50%) in-stent and in-segment (stent area ±0.5 cm margin) restenosis rates were 28.9% (11/38) and 57.9% (22/38), respectively.
Conclusion: Selective infrapopliteal placement of sirolimus-eluting stents for critical limb ischemia achieves a favorable clinical outcome and inhibits vascular restenosis with excellent medium-term angiographic patency rates.

P199

Frequency of stent fractures in the femoropopliteal artery

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Purpose: Stent implantation in the femoropopliteal artery is a very much promoted procedure. Nevertheless, the issue of stent fractures is an unresolved problem.
Materials/Methods: After unsuccessful percutaneous transluminal angioplasty, 46 self-expandable stents were implanted in the femoropopliteal artery of 34 patients over a seven-month period. The number of implanted stents per segment was 1 (64.7%)-4 (2.9%), covering from 28 to 180 mm. At follow-ups, an X-ray of the specific area was performed.
Results: In 46 implanted stents, 15 fractures (32.6%) occurred. Seven stents (15.2%) showed a slight irregularity of the stent wall (grade I fracture), whereas five stents (10.9%) showed two severe irregularities (grade II fracture), and in two stents (4.3%) more than two irregularities (grade III fracture) were found. One stent (2.2%) showed a total fracture with dislocation. Most of the fractures (8; 17.4%) occurred in segment III of the femoral superficial artery. Stent fractures occurred significantly more often in calcified vascular segments (20.1%) than in non-calcified vascular segments (6.5%).
Conclusion: The occurrence of stent fractures seems to be rather high in the femoropopliteal artery, especially in segment III, and there is a positive relationship between calcification and stent fracture.

P200

Renal angioplasty and stenting under protection. The way for the future?

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Purpose: Despite good immediate and long-term results, deterioration of the renal function (RF) may occur in 20-40% of cases after renal artery angioplasty and stenting (RAAS), thus limiting the benefits of this technique. Atheroembolism seems to represent a major risk. We evaluated feasibility and safety of RAAS under protection to reduce the risk of atheroembolism and avoid RF deterioration.
Materials/Methods: One-hundred eleven RAAS performed under protection in 95 hypertensive patients with atherosclerotic renal artery stenoses (36 with renal insufficiency) were done. Occlusion balloons (n=46) or filters (n=65) were used.
Results: Technical success was 100%. Visible debris were aspirated with occlusion balloons in all patients and removed with filters in 80%. Mean particle number was 98.1±60.00, mean diameter 201.2±76 µ, and mean follow-up15.2±5 months. Mean creatinine levels remained constant during all follow-up. After six months, 60 patients were stable, 19/36 with baseline renal insufficiency had improved, and one (1.2%) RF deteriorated. After two years, 44 patients were stable, 14 had improved, and in two (4%) RF deterioration occurred.
Conclusion: These preliminary results suggest the feasibility and safety of distal protection during renal interventions to prevent atheroembolism and avoid RF deterioration in the long-term. Larger and randomized studies are awaited.

P201

Polarized light: evidence of cholesterol embolism at renal stenting

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Purpose: *Ex-vivo* studies have demostrated that athero-emboli produce local arteritis in the kidney and could cause substantial damage to the renal parenchyma. With the aid of polarized light we were able to prove the presence of cholesterol particles released during renal artery stenting.
Materials/Methods: From May 2004 to August 2005, 12 significant atherosclerotic stenoses in the main renal artery of nine patients were treated with primary stenting and adjuvant filter protection. Median patient age, seven men and two women, was 67 years (range, 49-78). Filter device was made of polyurethane with a pore size of 115 µm. The device was over a 0.014" guidewire and was compatible with an 8-F guiding catheter. For the pathologic analysis, the recaptured filter basket was compressed between two slides and examined in a microscope under polarized light.
Results: All stenoses were successfully treated without complications. The filters were deployed and recaptured without complications. Cholesterol crystals were clearly detected in 11 filters. In one case, a problem with filter manipulation precluded the pathologic analysis.
Conclusion: Microscopic analysis with polarized light easily detects cholesterol crystal microparticles trapped in the filter devices.

P202

Long-term follow-up of patients with angioplasty of transplanted kidney artery

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Purpose: To assess if percutaneous transluminal renal angioplasty (PTRA) in patients with transplanted kidney can favorably influence hypertension or graft function.
Materials/Methods: Within 24 years, 58 PTRAs in 55 adults (three times repeat-PTRA) with transplanted kidney were performed. The group included 34 men and 21 women with an average age of 41±10.6 (18-72) years. All accesses were from the ipsilateral femoral artery, except one contralateral approach. After the exclusion of seven technical failures, 51 procedures were followed up at one week, one and six months, and one, two, and three years. Blood pressure (BP) was evaluated as systolic, diastolic, and mean (MAP). Hypertension improvement was defined as BP decrease of at least 15%. Graft function was evaluated by serum creatinine and creatinine clearance (CCr) levels, the improvement was considered as 20% change.
Results: PTRA technical success was 88.4%. BP improved in 51 kidney recipients (53%) (MAP decreased from 123±13.1 to 107±12.1 mmHg). Graft function improved in 50-60% of patients and stabilized in 30% (CCr before PTRA: 0.48±0.29, after PTRA: 0.78±47 ml/sec). PTRA complications occurred in 13.7% of procedures, most often dissections treated by stent implantation.
Conclusion: PTRA results in kidney recipients confirm its value mainly in preserving graft function.

P203

Renal artery stenting in children

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Purpose: To evaluate renal artery stenting in children with renovascular hypertension (RVH).
Materials/Methods: Cases were obtained from a prospectively-maintained database.
Results: There were nine children, aged two to 15 years. Four children have mid-aortic syndrome. Thirteen stents were inserted in 12 renal arteries (six right, three left, one right upper pole, one transposed artery, one transplant artery). Indications were immediate recoil at angioplasty (7), early restenosis (2), kinked transplant artery (1) and complications of angioplasty (2). Technical success was 92% (12/13). One premounted stent detached from its delivery catheter and was retrieved by arteriotomy. There were no other procedural complications. One stent occluded two months after insertion, and this required surgical revascularization. Restenosis in four stents (31%) caused worsening RVH at two to 13 months, and was treated by repeat angioplasty (2), surgical revascularization (1), or both (1). One other patient (two stents) required renal revascularisation surgery despite patent stents, because of stenosis of the abdominal aorta. Nine stented arteries (75%) were patent at last follow-up (four to 32 months).
Conclusion: Stenting is effective for treatment of RVH in children, but in-stent restenosis is common. Stenting can potentially delay definitive surgery until the child is fully grown.

P204

Percutaneous interventions in the treatment of transplanted renal artery stenosis affecting graft perfusion

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Purpose: Renal or iliac artery stenoses proximal to the transplant anastomosis may result in an impairment of kidney graft perfusion, arterial hypertension, and consequent graft loss. The aim of our study was to evaluate the role and effectiveness of endovascular methods in the treatment of transplant renal artery stenosis (TRAS).
Materials/Methods: A retrospective review of percutaneous transluminal angioplasty (PTA) and stent placement procedures performed for TRAS from September 1993 to December 2005 was conducted. Forty three patients with evident TRAS and three with stenosis of the proximal iliac artery (pTRAS) were selected. Patients' age ranged from 19 to 51 years. There were 11 women and 35 men. Mean preintervention creatinine levels were 2.6±1.2 mg/dL.
Results: Thirty six interventions involved PTA alone, while eight had combined PTA and stent insertions (PTAS). Follow-up was from one to 147 months. Restenosis occurred in nine (19.6%) cases, six following PTA and three after PTAS. A one-month post-intervention creatinine mean level of 2.2±0.7 mg/dL was observed.
Conclusion: Primary treatment of TRAS with PTA with or without stent placement has good intermediate-term patency and is associated with an improvement in blood pressure and creatinine levels.

P205

Endovascular management of Budd-Chiari syndrome

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Learning Objectives: To understand the effect of hepatic vein (HV) outflow obstruction on liver function, hemodynamics, and pathologic changes. To learn the role of transjugular liver biopsies and the anatomopathologic findings of Budd-Chiari syndrome (BCS) in the management decision process. To learn the endovascular therapies in the management of BCS.
Background: BCS is caused by HV outflow obstruction. The obstruction can be partial or total. The etiology of the venous obstruction in the western hemisphere is commonly associated to hypercoagulative states. The main goal of the treatment is relief the liver from congestion, thus improving liver function and portal hypertension. Among the treatment options, there are medical, endovascular, and surgical choices. This exhibit will describe the clinicopathologic and angiographic findings of BCS and discuss available endovascular treatments.
Clinical Findings or Procedure Details: Therapeutic strategies in the management of BCS will be reviewed and their indications discussed and correlated with patients' clinical presentation, liver biopsies, and venographic and hemodynamic findings. Percutaneous interventions, (angioplasty, stenting, and thrombolysis of HV, and transjugular intrahepatic portosystemic shunt) will be illustrated.
Conclusion: Percutanous techniques in BCS, when performed in properly selected patients, may help to preserve liver function and arrest the disease progression and liver destruction.

P206

Parallel technique for transjugular intrahepatic portosystemic shunt reduction: initial results

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Purpose: Feasibility, safety, and outcome evaluation of a parallel technique for transjugular intrahepatic portosystemic shunt (TIPS) reduction.

Materials/Methods: The records of 15 patients (11 men; mean age 60 years, range 50-79) who had undergone TIPS reduction for hepatic encephalopathy (HE) with a parallel technique were retrospectively analyzed. Age, indication for TIPS, Child-Pugh's score, HE grade, portosystemic pressure gradient (PSPG), surface reduction percentage, time interval between TIPS and HE onset, and angiographic findings were compared regarding outcome.
Results: TIPS reduction was technically successful in all patients without complications; 4/5 patients with a fatal outcome showed no/minimal HE improvement after reduction. Portal vein branches opacification after TIPS and TIPS reduction was significantly higher in patients with a favourable outcome. Pre-TIPS, PSPG differed significantly between patients with fatal and good outcomes (17 versus 13 mmHg). Although not significant, three patients with fatal outcome showed HE immediately post-TIPS versus none in the other group. No significant differences were seen in age, indications for TIPS, Child-Pugh's score, HE grade, and PSPG after reduction or surface reduction percentage.
Conclusion: TIPS reduction with a parallel technique is feasible and safe. PSPG before TIPS and angiographic findings after TIPS reduction have more influence on outcome than post-reduction PSPG.

P207

Short-term complications on liver and renal functions of balloon-occluded retrograde transvenous obliteration: changes in laboratory data

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Purpose: Balloon-occluded retrograde transvenous obliteration (B-RTO) is an effective treatment of gastric varices. Ethanolamine oleate (EO) is used as sclerosing agent. Since EO affects liver and renal functions, its dosage is very important. However, there are few reports about the relationship between liver function changes and the dosage of EO.
Materials/Methods: Fifty-five patients with cirrhosis and gastric varices, successfully treated by B-RTO, were enrolled in this study. Serum tests were done before and one, three, seven, and 14 days after B-RTO.
Results: The amount of EO at 5% was 28.2±13.5 ml. Total bilirubin levels had significantly increased from 1.3±0.7 to 2.4±1.0 mg/dl one day later, but had improved seven days later. A weak correlation between the amount of EO and the increase of total bilirubin levels was detected. Serum albumin levels had significantly lowered from 3.3±0.5 to 3.1±0.4g/dl one day later, but had improved seven days later. Creatinine levels had increased from 0.77±0.34 to 0.86±0.38 mg/dl one day later, but had improved seven days later.
Conclusion: Liver and renal functions tend to temporarily worsen with the use of EO. However, if the amount of EO at 5% is less than 40 ml, B-RTO is a safe management of gastric varices.

P208

Bleeding of ectopic varices in cirrhotic patients: usefulness of transjugular intrahepatic portosystemic shunt

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Purpose: To evaluate safety and efficacy of transjugular intrahepatic portosystemic shunt (TIPS) in the control of bleeding from ectopic varices.
Materials/Methods: From 1995 to 2004, 24 cirrhotic patients [mean age 54.5 years (15-76 years)] with bleeding from ectopic varices were treated with TIPS. Varices were duodenal (n=5), stomal (n=8), ileocolic (n=6), anorectal (n=3), umbilical (n=1), and peritoneal (n=1).
Results: Bleeding was controlled by TIPS in all patients and portocaval gradient decreased from 19.7±5.4 to 6.4±3.1 mm Hg. Complications included intra-abdominal bleeding (n=2), hemobilia (n=1), acute shunt thrombosis (n=1), and bile leak requiring the use of a covered stent (n=1). Median follow-up was 592 days (28-2482). Rebleeding occurred in six patients. In two patients, rebleeding occurred despite a post-TIPS portocaval gradient lower than 12 mm Hg and was controlled by embolization; one patient underwent surgical portocaval shunt; in three patients rebleeding was related to TIPS stenosis and treated with dilatation and stenting. The cumulative rate of rebleeding was 23% and 31% at one and two years, respectively. One- and two-year survival rates were 80% and 76%, respectively.
Conclusion: Bleeding from ectopic varices can be safely managed by TIPS with low rebleeding and good survival rates.

P209

Value of carbon dioxide-wedged hepatic venography to identify the portal vein: comparison with iodinated, direct portography and analysis of predictive factors influencing its level of opacification

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Purpose: To assess the value of carbon dioxide (CO_2)-wedged hepatic venography (WHV) for identification of the portal venous system in cirrhotic patients. Additionally, the predictive value of several parameters, potentially influencing the level of portal vein opacification by CO_2-WHV, was analyzed.
Materials/Methods: In 163 patients, CO_2-WHV was performed prior to transjugular intrahepatic portosystemic shunt creation. Concordance between CO_2-WHV and direct iodinated portography was assessed by analyzing sensitivity parameters. Additionally, analysis of those factors potentially influencing the opacification of the portal vein using CO_2-WHV was assessed.
Results: CO_2-WHV was successfully performed in all 163 patients. Sensitivity of CO_2-WHV for opacification of both right and left portal veins and portal main trunk opacification were respectively 93.83% and 68.52%. Positive predicting factors ($p<0.05$, Wilcoxon two-sample test) are high portosystemic gradient, spontaneous splenorenal shunt, esophageal varices, and reversed portal flow. Negative predictive factor is a patent umbilical vein.
Conclusion: CO_2-WHV is safe, highly efficient and reliable to identify the right and left portal vein. CO_2-WHV is clearly less performant in opacifying the entire portal main trunk. Positive predictive factors are high portosystemic gradient, spontaneous splenorenal shunt, esophageal varices and reversed portal flow. Negative predictive factor is the presence of a patent umbilical vein.

P210

Comparison of transjugular intrahepatic portosystemic shunt and balloon-occluded retrograde transvenous obliteration for control of gastric variceal bleeding

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Purpose: To compare therapeutic efficacy of transjugular intrahepatic portosystemic shunt (TIPS) and balloon-occluded retrograde transvenous obliteration (B-RTO) for controlling gastric variceal bleeding.
Materials/Methods: Between August 2000 and March 2005, TIPS (n=27) and B-RTO (n=17) were performed to control gastric variceal bleeding. There were no statistical difference in age, sex, and Child-Pugh's class between each group. All patients had patent portal vein and gastrorenal shunt on computed tomography. Data regarding technical success, initial bleeding control, rebleeding, hepatic encephalopathy and survival were statistically analyzed.
Results: A technical success was achieved in 100% of patients with TIPS and in 94.1% of patients with B-RTO. Early rebleedings within five days were 7.4% (TIPS) and 17.6% (B-RTO). Late rebleedings after five days were 28% (TIPS, all caused by gastric varices), and 21.4% (B-RTO, all caused by esophageal varices). Hepatic encephalopathy deteriorated in 37% (TIPS) and in 0% (B-RTO) (p=0.014). Child-Pugh's class worsened in 33.3% (TIPS) and in 6% (B-RTO) (p=0.02). Rates of initial bleeding control, rebleeding, and survival did not have statistical differences in each group.
Conclusion: TIPS and B-RTO have similar effectiveness in controlling gastric variceal bleeding. B-RTO is however more effective in preventing Child-Pugh's class and hepatic encephalopathy worsening.

P211

Foam sclerotherapy for gastroduodenal varices and splenorenal shunt s. Evaluation by interventional radiology-computed tomography system

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Purpose: For gastroduodenal varices, percutaneous transhepatic obliteration (PTO), balloon-occluded retrograde transvenous obliteration (B-RTO) or dual balloon occlusion embolotherapy (dBOE) can be used. Among embolic materials, ethanolamine oleate (EO) is mainly used for B-RTO. Overdosages of EO may however cause severe complications, such as hemolysis, allergy, acute respiratory distress syndrome, etc. Foam sclerotherapy was then introduced to reduce the amount of EO and obliterate larger varices under the interventional radiology-computed tomography (IVR-CT) system.
Materials/Methods: In eight patients, five B-RTO, two PTO, and one dBOE were performed. Under balloon-occlusion, a mixture of 5%-EO (20 mL) with contrast media and air (20 mL) using a pumping method was injected into the target varices until full occupation was obtained. During balloon-occlusion, IVR-CT was performed to confirm filling of the sclerosant into the target vessels. After obtaining the thrombosis, the catheter was retrieved and followed by CT and endoscopy.
Results: In all the patients, air mixed with the sclerosant was contained in the target vessels and full thrombosis was confirmed on post-contrast CT one week after the procedure. No procedure-related complications occurred.
Conclusion: Theoretically, foam sclerotherapy allows 50% reduction of the sclerosant.

P212

Portal vein embolization prior to liver resection

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Purpose: To assess the role of portal embolization prior to major hepatic resection in inducing residual liver parenchyma hypertrophy.
Materials/Methods: From July 1997 to January 2006, 42 patients (27 men, 15 women, mean age: 54 years) underwent portal vein embolization. In 34 patients with a normal liver function, preliminary computed tomography (CT) scans showed a left lobe volume lower than 25% (range 18.4-25.6%) of the total volume; in eight patients with a compromised liver function, scans depicted a left lobe volume inferior to 35% (range 28-35.3%) of the total liver volume. Following portography, a superselective catheterization of the segmental veins of the right lobe and embolization with Histoacryl-Lipiodol ultra-fluid was done in 16 patients and with Glubran-Lipiodol ultra-fluid in the remaining 26 patients. The procedure was performed under sedation and with minor analgesics for pain control.
Results: Post-embolization portography showed patency of the portal vein and segmental vessels of the left lobe. CT scans made at four weeks demonstrated left lobe hypertrophy, evaluated in mean percentage of 31% (range 9-57%). Thirty-two patients underwent liver surgical resection.
Conclusion: Portal vein embolization is a safe, effective, and well tolerated procedure; hypertrophy of the residual liver allows a relatively safe right lobe resection.

P213

Percutaneous transhepatic angioplasty and stenting on portal vein stenosis complicating liver transplantation: ten-year experience at Queen Mary Hospital, Hong Kong Special Administrative Region, China

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Purpose: To evaluate the efficacy of percutaneous transhepatic angioplasty and stenting on portal vein stenosis in patients after liver transplantation.
Materials/Methods: Over a ten-year period (1997-2006), 16 consecutive patients (14 men, two women, mean age: 44 years, range: 1-62) with portal vein anastomotic stenosis after liver transplantation had percutaneous transhepatic angioplasty performed in our centre. Portal vein stenosis was documented on direct portal venogram and pressure gradient measurement. After the dilatation procedure, these patients were closely monitored for clinical status and portal vein patency. Mean follow-up period was 30 months (range: three months - nine years).
Results: Twenty-two percutaneous transhepatic angioplasties were performed in these 16 patients with 100% technical success rate. No procedure-related complication was encountered. Twelve patients underwent angioplasty once, three patients twice, and one patient four times. On follow-up, 13 patients had clinical improvement. One patient had re-transplantation due to co-existing liver graft complications. Another patient was refractory to repeated angioplasties and had portal vein stenting performed.
Conclusion: Percutaneous transhepatic angioplasty is safe and effective for patients with portal vein stenosis complicating liver transplantation. This procedure should be the first treatment option before considering surgical intervention. Portal vein stenting can be reserved to patient refractory to angioplasty.

P214

Portal vein stenting for the treatment of steno-occlusive disease following pediatric liver transplantation

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Purpose: To evaluate the efficacy of stent placement for treating or preventing portal vein steno-occlusive disease in pediatric recipients.
Materials/Methods: Percutaneous (n=10) or intraopertive (n=6) stent placement was attempted in 16 of 115 pediatric recipients (age range, six months to eight years). Indications for stent placement were portal hypertension (melena or hematochezia, n=6; splenomegaly, n=6; ascites, n=3), abnormal liver function (n=4), and size discrepancy (n=4) between the donor and the recipient portal vein during transplantation. Stent measuring 6-10 mm in diameter were used and balloon-angioplasty before or after stent placement was performed in seven patients.
Results: Stent placement failed in two (12.5%) patients due to failure to traverse an occluded segment. Twelve of the remaining 14 patients were healthy with patent portal flow during a mean follow-up period of 710± 487 days. One patient died of acute rejection; another patient also died of acute rejection following a second stent placement due to stent collapse 14 days after initial stent placement. No procedural complication occurred.
Conclusion: Although follow-up period is limited, stent placement is safe and effective for treating or preventing portal vein steno-occlusive disease following pediatric liver transplantation.

P215

Relationship between hemodynamics of gastric varices and aggravation of esophageal varices after balloon-occluded retrograde transvenous obliteration

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Purpose: To investigate the relationship between hemodynamics of gastric varices (GV) and aggravation of esophageal varices (EV) as a complication after balloon-occluded retrograde transvenous obliteration (B-RTO).
Materials/Methods: Forty-seven patients with GV underwent arterial splenic venography (ASV), 3D-computed tomography (3D-CT), and balloon-occluded retrograde transvenous venography (B-RTV) before B-RTO to define **outflow** and **inflow** vessels connected with GV. Patients were divided into four groups: two groups according to the number of **outflow** vessels on B-RTV (Group A: one vessel, B: more vessels). Two groups were classified according to the number of **inflow** vessels on ASV or 3D-CT (Group C: one vessel, D: more vessels). Ethanolamine oleate was retrogradely injected via the occlusion balloon-catheter and advanced into the gastrorenal shunt. EV were endoscopically evaluated pre-and post-B-RTO.
Results: Cumulative rates of EV aggravation were 20% at one month, 50% at one year and 69% at three years. Cumulative rates of EV aggravation in Group A were significantly lower than in Group B. Significant differences were not described between Groups C and D.
Conclusion: Aggravation of EV after B-RTO is not related to the number of **inflow**, but rather to that of **outflow** vessels. Attention should be paid when GV are completely non-visualized on B-RTV.

P216

Preoperative percutaneous transhepatic portal vein embolization with ipsilateral approach

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Purpose: To evaluate efficacy and safety of percutaneous transhepatic portal vein embolization (PTPE) performed with an ipsilateral approach in the preoperative management of patients who are to undergo extensive liver resection.
Materials/Methods: Forty-one patients underwent preoperative PTPE with an ipsilateral approach. The study group comprised 29 men and 12 women. Their age ranged from 48 to 78 years (mean, 64 years). PTPE was usually performed two weeks before surgery; the portal branch selected for embolization was punctured under ultrasound guidance. Absolute ethanol as embolic agent was used in all the procedures.
Results: PTPE with an ipsilateral approach was successful in 42 of 43 procedures (97.7%). Complications occurred in 4/43 procedures (9.3%), including subcapsular hematoma in three, pseudoaneurysm in one, and biloma in one. The subcapsular hematoma and the pseudoaneurysm occurred in the same procedure. Recanalization of the embolized portal branch occurred in 3/43 procedures (7.1%). Extensive liver resection was performed in 31 cases. The interval between preoperative PTPE and operation ranged from 14 to 36 days (mean, 20 days).
Conclusion: PTPE with an ipsilateral approach is an effective and safe procedure in the preoperative management for extensive liver resection.

P217

Transcatheter sclerotherapy for gastric varices: relationship between portal pressure and worsening of esophageal varices

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Purpose: To evaluate the influence of portal pressure increase after transcatheter sclerotherapy (TS) on the worsening of esophageal varices and ascites.
Materials/Methods: Fifty-four cirrhotic patients with gastric varices were treated by TS. Balloon-occluded retrograde transvenous obliteration (B-RTO) or percutaneous transhepatic sclerotherapy (PTS) were performed. In 17 of 54 patients, wedge pressure of gastro-renal shunt before TS and portal pressure after TS were measured. We reviewed the correlation of the portal pressure after TS and the worsening of esophageal varices and ascites by using multivariate analysis.
Results: Wedge pressure of gastro-renal shunt before TS and post-TS portal pressure showed a significant correlation. There was no relationship between post-TS portal pressure and worsening of esophageal varices and ascites. The only significant prognosticator on the worsening of esophageal varices was the presence of esophageal varices before TS.
Conclusion: It was thought that wedge pressure of gastro-renal shunt before TS was useful in predicting post-TS portal pressure. Portal pressure after TS for gastric varices is not a significant prognosticator of worsening of esophageal varices and ascites. When we treat patients with gastric varices by TS who also have esophageal varices, we have to be cautious of the worsening of esophageal varices.

P218

Clinical results of balloon-occluded retrograde transvenous obliteration of gastric and duodenal varices

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Purpose: Balloon-occluded retrograde transvenous obliteration (B-RTO) is a widely accepted treatment for variceal bleeding. This study evaluates clinical efficacy and feasibility of B-RTO for gastric and duodenal varices.
Materials/Methods: From May 1995 to January 2004, we performed B-RTO in 22 patients with gastric and in one patient with duodenal varices (23 patients in total). All the patients had a history or risk factors of variceal bleeding. After confirmation of the shunts with computed tomography, the sclerosing agent (5% ethanolamine oleate) was injected into the varix.
Results: A technical success was achieved in 19/22 patients with gastric varices; also in the patient with duodenal varices, B-RTO was carried out completely. Three patients could not complete the procedure because of the lack of retention of the contrast agent in the varices. The patients with gastric varices were treated by transfemoral approach; the patient with duodenal varices was approached from the jugular vein. In 13/20 successful patients, eradication of varices was obtained; in the remaining seven patients, an improvement was recorded during follow-ups. Three patients experienced worsening of esophageal varices but could be treated endoscopically.
Conclusion: B-RTO is effective and safe in the management of gastric and duodenal varices.

P219

Long-term results of transcatheter sclerotherapy for the treatment of gastric varices

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Purpose: To evaluate long-term clinical results after transcatheter sclerotherapy (TS) in patients with gastric varices (GV).
Materials/Methods: One-hundred and forty patients underwent TS to treat GV with bleeding or in danger of rupture. TS was classified into retrograde and antegrade TS. As for retrograde TS, balloon-occluded retrograde transvenous obliteration (B-RTO) was mainly performed for GV with larger gastrocaval shunts. As for antegrade TS, percutaneous transhepatic sclerotherapy (PTS) was carried out for GV without gastrocaval shunt. The therapeutic effect on GV was examined by color-Doppler endoscopic ultrasound and/or contrast-enhanced computed tomography.
Results: One-hundred and seven patients were treated by B-RTO, in 27 cases PTS was done. Six patients required both B-RTO and PTS. In all the patients, GV were entirely or mostly thrombosed by TS. GV recurrence was observed in eight patients (6%). The cumulative recurrence rate of GV was 8% at one year. GV recurrence rate was significantly lower in the B-RTO than in the PTS group ($p<0.01$). GV bleeding was observed in three patients (2%). GV cumulative bleeding rate was 3% at five years.
Conclusion: TS is an effective treatment and provides good GV control.

P220

Six-year experience with transjugular intrahepatic portosystemic shunt performed with expanded-polytetrafluoroethylene stent-grafts

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Purpose: To report our six-year experience in transjugular intrahepatic portosystemic shunt (TIPS) performed with expanded-polytetrafluoroethylene (e-PTFE) stent-grafts (Viatorr, W.L. Gore & Associates).
Materials/Methods: From January 2000, 126 patients (mean age: 56.7 years) underwent TIPS for variceal bleeding (61), refractory ascites (55), hepatic hydrothorax (3), Budd-Chiari syndrome (7). Eight- (30) and 10-mm stent-grafts (96) were implanted.
Results: Technical success was 100%. Hemodynamic success (portosystemic gradient (PSG) <12 mmHg) was observed in 118/126 patients (93.65%). After a mean follow-up of 40.5 months, 108 patients are alive. Thirty-day mortality was 6.35% (8). PSG mean value dropped from 19.79 to 6.06 mmHg. Twelve revisions (9.5%) were performed for hepatic (8) or portal vein stenoses (4). No signs of stenoses inside the covered portion of the stent-graft were observed. In four cases, PSG increased without any sign of shunt stenosis at portal venography. After balloon-dilation of the shunt, a marked PSG reduction was observed. In 13 patients with hepatic encephalopathy refractory to the medical treatment, a TIPS reduction was necessary after a mean of 7.7 months. Primary patency was 90.5%, secondary patency 94.4%.
Concluision: The Viatorr stent-graft seems to be effective in prolonging TIPS patency; the risk of hepatic encephalopaty should however be considered.

P221

Evaluation of cost and clinical effectiveness of the Viatorr stent compared to uncovered stents for transjugular intrahepatic portosystemic shunt procedures in a tertiary referral centre

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Purpose: To compare costs and clinical effectiveness of covered (Viatorr) and uncovered transjugular intrahepatic portosystemic shunt (TIPS) stents.
Materials/Methods: A single-centre retrospective analysis of TIPS from January 2003 to March 2005 was done.
Results: Fifty-one patients (age 50 ± 13 years) underwent TIPS creation for portal hypertension-related complications. All had severe liver cirrhosis with Child-Pugh grading (16% A, 40% B, 44% C); 21 patients had a Viatorr stent-graft, of which six required a single reintervention. Nine of the 30 uncovered grafts required one or more interventions to maintain patency. Viatorr reinterventions occurred significantly earlier (range 9-142 days), associated with incomplete coverage from portal vein to central hepatic vein by the stent, due to unavailability of a sufficiently long device. In contrast, uncovered stent reinterventions occurred late (range 4-555 days), caused by stent shortening, thrombosis, pseudointimal hyperplasia, and stenosis.
Conclusion: Additional cost of the Viatorr stent-graft is justified if reintervention rates are reduced and long-term follow-up unnecessary. Our experience indicates that early Viatorr failures are due to technical factors, in particular inadequate tract coverage. For this reason, it is essential to stock a comprehensive range of graft lengths. Unlike bare stents, once a satisfactory tract is established with Viatorrs, late intervention is rare.

P222

Digital subtraction pulmonary arteriography versus multidetector computed tomography in the detection of pulmonary arteriovenous malformations

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Purpose: To compare digital subtraction pulmonary arteriography (PA) with 16-detector row computed tomography (MDCT) in the detection of pulmonary arteriovenous malformations (PAVMs) in patients with hereditary hemorrhagic telangiectasia.
Materials/Methods: Institutional Review Board exemption was obtained. Eighteen patients (median age, 47.5 years; range, 26-78 years) with 42 PAVMs in all were included. PAVM presence, location, type and size in PA studies were evaluated by three blinded interventional radiologists and compared with MDCT readings by three blinded computed tomography (CT) physicians. Consensus review was performed once blinded readings were complete. The gold standard for PAVMs was the presence (determined by consensus) on MDCT of a feeding artery, draining vein, and intervening sac. Sensitivity and specificity for PA and MDCT readings were calculated.
Results: Whole-lung analysis (lesion detection anywhere in the lung) showed: CT, mean sensitivity 83%, specificity 78%; PA, mean sensitivity 70%, specificity 100%. Lobar analysis (lesion detection in a given lobe) showed: CT, mean sensitivity 72%, specificity 93%; PA, mean sensitivity 68%, specificity 100%.
Conclusion: Using the definitions in this study, MDCT provides greater sensitivity in the detection of PAVMs than digital subtraction PA but with a loss in specificity, depending upon the level analyzed (lung versus lobe).

P223

Non-invasive visualization of the uterine artery before uterine arterial embolization: usefulness of unenhanced 3D sensitivity-encoding water-excitation time-of-flight magnetic resonance-angiography

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Purpose: To evaluate the usefulness of 3D sensitivity-encoding water-excitation time-of-flight (SWETOF) magnetic resonance-angiography (MRA) in terms of uterine artery visualization before uterine arterial embolization (UAE).
Materials/Methods: Eleven patients with symptomatic uterine fibroids underwent unenhanced 3D-SWETOF and gadolinium-enhanced 3D sensitivity-encoding water-excitation multi-shot echo planar (SWEEP) MRA besides preprocedural MRI before UAE. Three independent observers reviewed maximum intensity projections images of the two types of MRA and assessed the visualization level for the orifice and the descending portion of the uterine artery using a three-point scale. For each observer, the mean values of visualization levels were compared between two types of MRA by Wilcoxon's signed rank sum test. Interobserver variability was also evaluated with Kappa statistics.
Results: For the orifice, the mean values of visualization levels by the three observers were 2.9, 2.9, 3.0 for 3D-SWETOF and 1.9, 1.4, 1.8 for 3D-SWEEP. Those for the descending portion were 2.9, 2.9, 3.0 for 3D-SWETOF and 1.8, 1.7, 1.9 for 3D-SWEEP. All differences were significant between the two types of MRA. Interobserver agreement was slight-to-fair for 3D-SWEEP and moderate-to-almost-perfect for 3D-SWETOF.
Conclusion: Unenhanced 3D-SWETOF MRA is a non-invasive and accurate method for morphological evaluation of the uterine artery before UAE.

P224

Prevalence of renal artery stenosis in routine aortofemoral angiography

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Purpose: To evaluate the prevalence of renal artery stenosis (RAS) and the possible risk factors associated with RAS in patients undergoing aortofemoropopliteal angiography.
Materials/Methods: Angiography was performed in 785 consecutive patients [657 men (84%) and 128 women (mean age: 61±11.6 years)] for intermittent claudication (n = 615) or other reasons (n = 170). Statistical analysis was performed to determine possible associations of patient demographics, history of hypertension, coronary artery disease, diabetes mellitus, smoking, and peripheral artery disease to the presence of RAS.
Results: Severe RAS (≥60%) was found in 9% (70/785) of patients. History of hypertension without signs and symptoms of possible renovascular hypertension ($p = 0.007$), advanced age ($p<0.001$), aortoiliac ($p=0.03$) and femoral artery disease ($p=0.04$) were significant predictors of RAS. Patients with severe RAS were older (mean age: 66 years) than those who had no RAS (mean age: 61 years). Interestingly, incidence of RAS was lower in smokers (7%) than in non-smokers (14%) ($p=0.007$).
Conclusion: Severe RAS is often seen in patients undergoing aortofemoropopliteal angiography. Advanced age, hypertension, aortoiliac and femoral artery disease are all factors with a higher risk of RAS.

P225

Fenestrated aberrant hepatic artery

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Purpose: To present an uncommon type of aberrant hepatic artery forming a fenestration, which we named fenestrated aberrant hepatic artery (FAHA).
Materials/Methods: At historical database of hepatic angiographies for the period 1993-2006, FAHA was found in three patients with no history of laparotomy. We reviewed the angiography of these three arteries.
Results: FAHA arose from the common hepatic artery in two patients and from the gastroduodenal artery in one. It was connected to the right hepatic artery in all three patients. Tributaries of FAHA were seen in two cases (communicating with the left hepatic artery in one patient and with the gallbladder and the right gastric artery in the other one). In one patient, who had undergone hepatic intraarterial chemotherapy for eight months, the proper hepatic artery was occluded, thus resulting in a compensatory dilatation of FAHA.
Conclusion: At our knowledge, FAHA has never been described in the literature. This uncommon anomaly of the hepatic artery should be classified as a subtype of aberrant hepatic artery. It is worth mentioning this rare variation in the angiographic report for further interventions.

P226

Alterations in carotid blood flow and endothelial structure in women with polycystic ovarian syndrome: a marker of atherosclerotic risk?

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Purpose: Polycystic ovary syndrome (PCOS) is one of the most common endocrine disorders in women, associated with long-term risk of cardiovascular disease. The aim of this study was to evaluate the presence of early vascular changes in carotid arteries of women with PCOS.
Materials/Methods: Thirty-two women with PCOS (Rotterdam criteria) and 20 healthy women (controls) matching for age and body mass index (BMI) were studied. Color-Doppler sonography of carotid arteries was performed in patients with PCOS and the control group. Intima-media thickness (IMT) and peak systolic velocity (PSV) were obtained in both internal and external carotid arteries.
Results: Significant ($p<0.01$) differences in PSV (right common carotid artery: 114 versus 74 cm/sec; left common carotid artery: 116 versus 80 cm/sec; right internal carotid artery: 83.4 versus 62.7 cm/sec; left internal carotid artery: 84.5 versus 63.5 cm/sec in PCOS and control patients, respectively) and in IMT (IMT: 0.07 versus 0.04 mm for PCOS patients, and controls, respectively) were found between PCOS and control subjects.
Conclusion: Our data show that women with PCOS have increased IMT and elevated blood flow velocities in carotid arteries, thus suggesting early functional and structural preatherosclerotic vascular impairment.

P227

Radiological findings of popliteal entrapment syndrome

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Learning Objectives: To be familiar with clinical presentation, magnetic resonance and angiography findings of popliteal entrapment syndrome.
Background: Five patients (four men, one woman, age range 17 to 48) with a diagnosis of popliteal artery stenosis or occlusion were found to have popliteal entrapment syndrome. The diagnosis of popliteal artery disease was established with clinical findings, color-Doppler ultrasonography, or magnetic resonance (MR)-angiography, whereas diagnosis of popliteal entrapment was suspected with digital subtraction angiography (DSA) and made with MR imaging of the knee in all patients.
Clinical Findings or Procedure Details: Color-Doppler ultrasonography and MR-angiography revealed isolated popliteal artery (PA) stenosis in two and occlusion in four limbs. MR imaging diagnosed four type II, one type III, and one type IV popliteal entrapment syndrome. DSA confirmed all the stenoses and occlusions and demonstrated additional embolic occlusions in the crural arteries in three limbs. Four patients had surgical by-pass and decompression, one patient had endovascular thrombectomy and decompression surgery with resolution or marked improvement of the symptoms.
Conclusion: Popliteal entrapment syndrome should be considered in every patient aged less than 50 years old and had isolated popliteal artery stenosis or occlusion by clinical or radiological findings.

P228

Three-Tesla magnetic resonance angiography with dedicated software and Moby Track in pre-procedural evaluation of patients with critical limb ischemia. Preliminary experience

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Purpose: To evaluate the effectiveness of 3-Tesla (3-T) magnetic resonance angiography (MRA) in depicting peripheral artery occlusive disease (PAOD), particularly of distal run off, in patients not candidate to surgical revascularization.
Materials/Methods: Forty patients (31 men; nine women) with trophic lesions of the lower limbs were enrolled in our study. According to Doppler-ultrasound findings, these patients were not candidate for surgical revascularization. MRA was always performed during infusion of a bolus of gadolinium-diethylenetriamine pentaacetic acid (Gd-DTPA) using the Moby Track coil and Moby Flex protocol. Preprocedural selective digital subtraction angiography was subsequently performed.
Results: In 33 MRAs, findings allowed to detect previous residual tracts of distal run-off vessels suitable for endovascular treatment, unidentified at Doppler-ultrasound. In four cases, a tight renal stenosis was additionally depicted. In seven cases, the diagnosis was hampered by venous overlapping.
Conclusion: Three-Tesla MRA allowed to depict the vascular tree, especially distal run-off vessels, essential for subsequent treatment. In our experience, 3-T MRA is ideal for pre-planning endovascular procedures in critical limb ischemia.

P229

Intraarterial magnetic resonance-aortography in patients with/ without parallel imaging technique

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Purpose: Endovascular magnetic resonance (MR) interventions require repetitive intraarterial gadolinium injections; low-dose protocols with shorter acquisition times are therefore preferable. Our study compared intraarterial MR-aortography with standard technique and parallel imaging technique (PAT) quantitatively.
Materials/Methods: Intraarterial MR-aortographies were performed in nine patients and in one aortal phantom with/without pulsatile flow at 1.5-T MR. A 3D FLASH-MR sequence was obtained in standard technique, TA=20s, and with PAT (generalized autocalibrating partially parallel acquisitions), TA=14s. Pigtail-catheter remained in suprarenal position after angiography in digital subtraction angiography technique and contrast-enhanced intraarterial MR-aortography was performed after injecting 50 mM of diethylenetriamine penta-acetic acid (injection rate: 4 ml/s). Contrast-to-noise ratios (CNRs) were evaluated in both imaging series in different locations. In the aortal phantom with/without a pulsatile flow, CNRs were determined with both techniques.
Results: In all patients intraarterial MR-aortographies were feasible with both techniques, no significant CNR difference were observed ($p>0.5$). Similar results were calculated for the pulsatile aortal flow phantom at all locations, but significant lower CNRs were obtained with PAT in the phantom without flow.
Conclusion: Intraarterial MR-aortographies are feasible with PAT without a significant loss of CNR. This technique reduces contrast agent consumption significantly due to the reduction of acquisition time.

P230

Comparison of orbital color-Doppler and magnetic resonance-angiography in the diagnosis of carotid cavernous sinus fistulas: personal experience in 20 cases

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Purpose: To compare orbital color-Doppler (OCD) and magnetic resonance-angiography (MRA) in the diagnosis of carotid cavernous sinus fistulas (CCSF) in a relatively large number of patients.
Materials/Methods: Both eyes of 20 patients with clinical suspect of CCSF were examined with OCD (ATL Philips HDI-5000; 5-12 MHz linear probe); a positive diagnosis was based on the finding of superior ophthalmic vein (SOV) with reversed, arterialized, and low-resistance (resistance index <0.50) blood flow. SOV dilation at OCD was classified into three different grades: significant, mild, and absent. In addition, all the patients underwent MRA (1.5-T) and digital subtraction angiography (DSA) (gold standard).
Results: DSA depicted 20 CCSFs in 20 patients, with a bilateral ocular involvement in six cases. Sensitivity was higher with OCD (23/26, 89%) than with MRA (18/26, 69%). SOV showed a reversed, arterialized, low-resistance blood flow at OCD in 23 cases of positive diagnosis, while in three cases was not identified. SOV dilation was classified as significant in 14 cases, mild in five (MRA negative in 2/5 cases), absent in four (MRA negative in 4/4 cases).
Conclusion: OCD was more sensitive than MRA in the diagnosis of CCSF. OCD was also accurate in case of non-dilated SOV.

P232

Retrievable or permanent: which caval filter to use?

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Learning Objectives: At the end of this presentation, the reader will have knowledge of: **1.** the current changing indications for retrievable/permanent filter use; **2.** the advantages/disadvantages of current approved retrievable filters; **3.** tips to aid filter retrieval; **4.** follow-up requirements for inferior vena cava (IVC) filters; **5.** clinical issue with regard to anticoagulation and filter use.
Background: Since its inception in 1967, caval filters have undergone many advances. "Optional" filters are now the most commonly used. These allow either permanent or retrievable filtration and have expanded the indications for IVC filters. There are three new Food and Drug Administration approved optional filters [Recovery Filter/Bard, Günther-Tulip Filter/Cook and OptEase Filter/Cordis Cooperation (Johnson & Johnson)]. Advantages/disadvantages of each will be outlined.
Clinical Findings or Procedure Details: Based on a large experience of over 200 optional filter placements, technical issues with regard to placement of optional filters and complications encountered will be discussed. Issues with regard to anticoagulation will also be discussed.
Conclusion: Optional filters are now the filters of choice for IVC filtration. Retrieval intervals differ between filter types, making the choice of filter important if retrieval is planned.

P233

Salvage of immature vascular accesses for hemodialysis

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Purpose: The aim of this study was to assess the value of interventional techniques for salvaging arterio-venous dialysis fistulas that fail to mature.
Materials/Methods: Between January 1998 and August 2005, 40 dysfunctional and 17 thrombosed immature arterio-venous fistulas were treated by interventional radiology procedures. Ultrasound was performed in every case seven to ten days after creation. Steno-occlusive disease was evaluated and located. The approach (transvenous or transarterial) was also determined. Angiography was performed, followed by the therapy, which consisted of percutaneous transluminal angioplasty (PTA), PTA + mechanical thrombectomy, and PTA + fibrinolysis.
Results: An underlying stenosis was diagnosed by ultrasound in 100% of cases. The stenosis was located near the anastomosis in 25 patients (44%), on the arterial side in four cases(7%), and on the venous side in 28 patients (49%). An initial technical success was achieved in 50 cases (88%). Dilation-induced rupture occurred in four patients (7%). Hemodialysis access developed between three and 33 (mean 14.4) days after PTA. Eight patients (14%) needed a second operation during that period because the access was not maintained by PTA. Twenty-one patients (37%) underwent repeat PTA.
Conclusion: Percutaneous repair is the technique of choice for non-developed accesses.

P234

Interventional radiology of central venous access: long-term experience in 5000 patients

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Purpose: To assess the outcome of a series of 5,000 patients with central venous access (CVA) systems.
Materials/Methods: During the period December 1988-December 2005, 5,000 patients, ranging in age from 21 to 87 years, were treated. Venous systems were selected according to the therapeutic needs and post-operative management was coordinated by the nurse crew for a detailed information recording. Outcomes included data regarding revisions, malfunctions, and complications.
Results: The use of different entry sites allowed to obtain 99.5% procedural success rate (4,975). Immediate complications were related to 12 pneumothoraces (0.24%) and seven vagal reactions (0.14%). Minor complications were easily managed. Cumulative infections rate included a positive culture in 342 patients (6.84%) and infectious complications in 42 cases (0.96%).
Conclusion: Interventional radiology matches the need of an effective and safe CVC placement; the activity is still increasing, the systems' longevity is now longer and we have to underline that infections' rate has dropped.
An interdisciplinary coordination of patients' management plays a primary role in the achievement of such positive results.

P235

Recovery G2 vena cava filter: retrievability study

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Purpose: To evaluate retrievability of the Recovery G2 filter when implanted for temporary protection against pulmonary embolism (PE).
Materials/Methods: Forty consecutive patients received a Recovery G2 filter (Bard Peripheral Vascular Inc., Tempe, AZ, USA) in a single center between September 2005 and January 2006. Patients presented with venous thromboembolism (n=38) or high risk for PE (n=2) with contraindicated or failed anticoagulation therapy. For patients who met the criteria for filter retrieval, mean implantation time, filter retrieval success rate, and retrieval procedure time were measured. Cavograms were reviewed to assess filter tilting, migration, caval penetration, thrombus within the filter, fracture, and caval injury or stenosis.
Results: In the 14 patients who met the criteria for filter removal, we observed filter tilting (>15 degrees) in two patients (14.3%), small thrombi in three filters (21.4%), and caval penetration in one patient (7.1%). There were no fractures (0%) or migrations (0%). All 14 patients had their filter successfully retrieved (100%) with no associated complications. The mean implantation time was 29.9 days (range 7-127), and the retrieval procedure time averaged 16.6 min (range 10-24).
Conclusion: The Recovery G2 filter can be safely and successfully retrieved in patients who no longer require inferior vena cava filtration.

P236

Endovascular treatment of venous outflow stenoses after orthotopic liver transplantation

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Purpose: To evaluate the effectiveness of the endovascular treatment for venous outflow stenoses after liver transplantation.
Materials/Methods: Thirteen consecutive patients with symptomatic venous outflow stenoses after liver transplantation were treated endovascularly at our institution. Ten stenoses were located in the inferior vena cava (IVC) and three in the hepatic vein-IVC anastomosis. Seven patients were treated by angioplasty and six patients by stent placement. Stents were used in patients with suboptimal results after angioplasty.
Results: A technical success was achieved in all the patients. The mean pressure gradient across the stenosis decreased from 16.8±6.6 to 4.5±2.4 mm Hg. After a mean follow-up of 34.6±26.4 months, four patients developed recurrent stenosis 4-18 months after the procedure. These patients were successfully treated by means of angioplasty (n= 2) or stent placement (n= 2). Primary patency rates were 80%, 57%, and 57% at 12, 24, and 36 months, respectively. Secondary patency rates were always 100% after 12, 24 and 36 months. The cumulative survival rates were 76%, 76%, and 64% at 12, 24 and 36 months, respectively.
Conclusion: The endovascular treatment is an effective method for the management of venous outflow stenoses after liver transplantation.

P237

An early experience with the Günther Tulip™ inferior vena cava filter in gynecologic patients

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Purpose: To demonstrate our early experience with retrievable inferior vena cava (IVC) filters to prevent perioperative pulmonary embolism (PE) in patients with pelvic tumors.
Materials/Methods: Günther Tulip filters (GTFs) were pre-operatively placed in 23 patients with pelvic tumors and a history of deep vein thrombosis/PE (DVT/PE), elevated thrombin-antithrombin III and alpha 2-plasmin inhibitor plasmin complex (TAT/PIC), or massive venous compression by tumors on computed tomography (CT). Retrieval was decided on the findings of CT-pulmonary arteriography and venography within two weeks postoperatively.
Results: GTFs were placed in all 23 patients (technical success: 100%) with 20 transjugular and three transfemoral approaches (six suprarenal versus 17 infrarenal implants). Six (26.1%) filters were left permanently because of DVT (4) or a poor prognosis (2). In the other 17, filter retrieval was attempted. In three cases (17.6%), the filter top was attached to the IVC wall, and one filter (6.7%) was not successfully retrieved for excessive tilting. Two filters with entrapped clots were retrieved after thromboaspiration. PE was prevented in all patients. Thrombosis at the puncture site was however observed in 2/3 patients with transfemoral approach (66.6%).
Conclusion: GTF is an effective tool; it can be safely retrieved despite entrapped clots. Transjugular approach is recommended.

P238

Detection of tilting toward anterior or posterior direction during placement of the Günther Tulip filter in inferior vena cava and correction by reposition. A phantom study and preliminary clinical results

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Purpose: To evaluate: *a)* fluoroscopic features of tilted Günther Tulip filter (GTF) towards an anterior or posterior direction by using a phantom-model, and *b)* usefulness in the clinical application of detecting tilting and repositioning the filter without lateral projection.
Materials/Methods: Two types of phantom-model by inserting the GTF with/without anterior/posterior tilting. Changes in the fluoroscopic feature at posteroanterior projections were observed. In a clinical trial, transjugular placement of the GTF in the infrarenal inferior vena cava (IVC) and repositioning were tried in ten patients by using posteroanterior projections. GTF withdrawal and deployment were repeated before releasing the hook-eye to correct tilting. The angles between the GTF axis and that of the IVC on the lateral projection of the final venacavogram were measured.
Results: In this phantom study, the four anchoring hooks of the filter without tilting stood in an imaginary line. In the clinical trial, mean number of repositionings was 1.7 and mean angles between the filter axis and that of the IVC in the lateral projection of the venacavogram were 1.11±1.77°.
Conclusion: In GTF placement, detection of tilting towards an anterior or posterior direction and its correction seems to be useful in preventing tilting.

P240

Superior vena cava obstruction: 2/3D multidetector row computed tomography venography and catheter-directed therapy

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Learning Objectives: 1. To discuss the value and illustrate the techniques of computed tomography venography (CTV) in superior vena cava obstructions (SVCO). **2.** To study and illustrate techniques and outcomes of endovascular therapy of SVCO.
Background: SVCO may be a severely symptomatic and debilitating condition. Left untreated it may result in respiratory compromise and encephalopathy. Etiologies include benign (~25%) and malignant disease (~75%) classified as luminal, mural, or extrinsic for interventional therapy. High temporal and spatial resolution near isotropic 2/3D multidetector row CT (MDCT) venography provides a means to comprehensively assess and follow up patients for catheter-directed therapy. Management options include thrombolysis, venoplasty, and stenting.
Clinical Findings or Procedures Details: We reviewed 14 patients over 15 months with mural (9), extrinsic (1), or luminal (4) obstruction. CT accurately characterized the obstruction with measurements closely correlating with venography. It better depicted the luminal/extrinsic and SVC/right atrial relationships. Patients required a total of 1-3 procedures (mean 1.3); thrombolysis (2), venoplasty (13), stents (7, nitinol and balloon mounted). Thirteen therapies were successful in relieving acute SVCO symptoms.One treatment was complicated by innominate vein thrombus.
Conclusion: 2/3D MDCT may reliably evaluate patients for endovascular therapy of SVCO. Catheter-directed therapy has a high success rate.

P241

Treatment of superior vena cava syndrome with T-type vascular stent

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Purpose: Improvement of symptoms in three patients with superior vena cava (SVC) syndrome was attempted with T-type vascular stents.
Materials/Methods: Patient I is a 49-year-old man with obstruction of the right brachiocephalic vein and severe SVC stenosis at superior venacavogram. Patient II is a 53-year-old man with facial swelling and dyspnea due to metastatic lung adenocarcinoma. A direct superior venacavogram via the right femoral vein showed a severe stenosis at the distal right brachiocephalic vein. Patient III is 74-year-old man with facial swelling and dyspnea. A chest computed tomography showed lung malignancy involving the right hilum, the SVC, and the right pulmonary artery. A direct superior venacavogram showed a severe SVC stenosis with narrowing of the left brachiocephalic vein. T-type bare stents with a side-hole in the center were used. T-type vascular stents (12-60 mm, Niti-S vascular stent, Taewoong) were first inserted between the brachiocephalic vein (right or left) and the SVC. Another vascular bare stent was then placed between the brachiocephalic vein and the SVC via its side hole.
Results: Vascular stents were all successfully implanted without complications. Symptoms of SVC syndrome improved immediately.
Conclusion: Stent placement with T-type vascular stents is an useful method for SVC syndrome.

P242

Endovenous ablation of the lesser saphenous vein for venous insufficiency and varicose veins: experience with a 980-nm diode laser system

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Purpose: To assess outcomes after endovenous laser ablation (EVLA) of the lesser saphenous vein (LSV).
Materials/Methods: A retrospective review of consecutive outpatients treated by EVLA for symptomatic, ultrasound-proven incompetence of the LSV was done. EVLA was performed with a 980-nm diode laser using pull-back method sparing the most proximal 3-5 cm near the saphenopopliteal junction. Follow-up (patient questionnaires, physical examination, and duplex ultrasonography) was obtained at one week, three-six months, and one year after EVLA.
Results: Over 310 days, 156 EVLA procedures were performed in 97 patients. Among these, 13 patients (75% women; mean age = 50 years, range 21-61) had 16 limbs treated for LSV insufficiency. Technical success (occlusion of the treated vein) at one week was 100%. Mean follow-up length was 310 days (38-490), with no patient lost to follow-up. Follow-up showed no paresthesias or other complications, no recurrent reflux by ultrasound, and no deep vein thrombosis. LSV occlusion extended up to the saphenopopliteal junction without involvement of the popliteal vein. All patients reported being very satisfied with their results.
Conclusion: EVLA of LSVs is a promising procedure with excellent results and high patient satisfaction. Outcomes appeared even better than in our experience with the greater saphenous vein.

P243

Treatment of incompetent saphenous veins: a review of available techniques

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Learning Objectives: To review diagnostic and therapeutic techniques for symptomatic, incompetent saphenous veins: endovenous ablation (laser/radiofrequency), ambulatory phlebectomy (AP), and sclerotherapy.
Background: Varicose and spider veins, and chronic venous insufficiency are extremely common and related to reflux in saphenous veins. Interventional radiologists are ideally positioned to offer the full array of diagnostic and therapeutic techniques for varicose veins, thanks to their clinical interests, imaging experience with duplex ultrasonography, and expertise in ultrasonography-guided access.
Clinical Findings or Procedure Details: The key for successful treatment is a thorough diagnostic evaluation by duplex ultrasonography, showing the source(s) of reflux and frequent anatomic variants. Endovenous ablation (under local anesthesia only) obviates the need for surgical stripping and reduces dramatically its associated risks and recurrences. During or after endovenous ablation, AP or sclerotherapy can be combined to treat varicose side-branches. Materials for and indications of these techniques will be detailed. Treatment outcomes are excellent and will be summarized (technical success, rate of recurrent reflux, clinical and cosmetic improvements, and patient satisfaction).
Conclusion: This poster, based on the authors' experience with hundreds of patients, will present a detailed and practical overview of materials and techniques needed for successful management of symptomatic saphenous incompetence.

P244

An *in-vivo* study of an investigational conical shaped retrievable inferior vena cava filter: the Option

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Purpose: This study reports the *in-vivo* performance of the investigational Option filter.
Materials/Methods: Twenty-four conically shaped Option filters were placed in the infra (IR) or suprarenal (SR) inferior vena cava (IVC) of 12 sheep. Ten of 12 IR filters were challenged with 4 grams of autologus clot. The SR filters were retrieved at 30 or 60 days and the animals were sacrificed acutely or 30-60 days following retrieval. At necropsy, the IR IVC was removed en bloc and submitted for histopathology.
Results: SR filters were retrieved without sequelae. The IR clot-burdened filters had complete thrombus resolution between 30 and 90 days. There was no significant filter migration and no IVC occlusion. Penetration of filter limbs was seen in four cases with hooks found in the vertebral body and the aortic adventitia. The filter hooks were modified and tested in an additional 14 animals with no further penetration.
Conclusion: The performance of the Option filter is similar to the gold standard Greenfield filter in an ovine model. In addition to excellent clot capture and resolution, it offers a 6-French delivery system and ease of retrieval at 90 days. Clinical trials for device approval are planned.

P245

Temporary inferior vena cava filter retrieval: preliminary data for complications, retrieval success and failures

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Purpose: To evaluate temporary inferior vena cava (IVC) filter retrieval success and failure reasons, complications and clinical outcomes.
Materials/Methods: Following institutional approval, we retrospectively identified attempted (successful and unsuccessful) IVC filter retrieval cases. We noted patients' demographics with indications of IVC filter deployment and retrieval, filter type, time interval, complications, retrieval success and failures.
Results: Between 2002 and 2006, 363 temporary IVC filters have been deployed; however, only 59 patients were consulted for IVC filter retrieval. Filter types included Bard Recovery (26), Bard G2 (3), Tulip (18), OptEase (12). Time interval ranged from 0 days to 8 months 20 days. Fifty-six retrievals were completed. Complications included maldeployment (1), thrombus or tissue within the filter at the time of removal (3), partial thickness tear in the IVC without contrast material extravasation (1), filter endotheliazation (3), migration (3).
Conclusion: Unsuccessful IVC filter retrieval may be associated with increased wall contact, retrieval hook endotheliazation, and increased time interval. Successful retrieval may be related to decreased wall contact and free end of the limbs of the filter; however, such filters are more prone to migration. Further prospective study in a larger patient group is warranted to confirm our findings.

P247

Percutaneous computed tomography-guided screw insertion in pelvic fractures

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Purpose: To describe our mini-invasive therapy of pelvic fractures under computed tomography (CT)-guidance.
Materials/Methods: Our experience with percutaneous fixation of fractures and disruptions of the pelvic ring is based on a series of 86 patients aged between 14 and 93 years. The cause of fracture was a road accident in 47% of cases, a fall in 40%, and a suicide attempt in 10%. The careful evaluation of CT slices allowed the selection of an adequate approach. Guidepins were inserted beyond the fracture line under CT-guidance and local anesthesia. Cannulated screws measured 4 mm in diameter and length was measured by CT. The standing position was usually possible on the following morning.
Results: Satisfiying results were obtained in 85% of our 86 cases. Peri- or post-procedural complications did not occur. A combination of open and percutaneous procedures can be used in case of complex injuries, such as open-book or comminuted acetabular fractures; the delay between open surgery and percutaneous therapy may be of two or three days.
Conclusion: The percutaneous fixation of pelvic ring injuries should be cooperatively planned by both the surgeon and the radiologist. Accuracy, low complication rate, and shorter hospitalizations are among the main advantages of this technique.

P248

Pediatric abdominal visceral trauma: conservative management with intraarterial embolization

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Purpose: Surgical management of abdominal visceral injuries is associated with increased morbidity, especially in the pediatric population. We evaluated the emerging role of endovascular embolization as an alternative to surgery in this age group.
Materials/Methods: All pediatric abdominal trauma is imaged by contrast-enhanced computed tomography at our hospital. Angiography and endovascular embolization is performed only for patients with imaging suspicion of arterial extravasation. Endovascular interventions in abdominal visceral trauma victims less than 12 years old were retrospectively reviewed to assess procedural details including technique, embolic material, volume of iodinated contrast, pre- and post-embolization angiography. Procedural complications were noted, and imaging/clinical follow-up was documented.
Results: During the past three years, we performed emergent endovascular embolizations in nine patients aged from 17 months to 12 years. The injuries involved the liver (3), the spleen (4), and the kidney (2). All embolizations were performed with microcoils and were technically successful. There was neither recurrence of bleeding nor need for surgery during a 12-month follow-up. There were no procedure-related complications, except for ipsilateral external iliac/common femoral arterial spasm in the 17-month-old patient which resolved spontaneously.
Conclusion: Endovascular embolization is an effective organ-sparing option in the conservative management of abdominal visceral trauma in pediatric patients.

P249

Ultrasonography-guided transthoracic needle biopsy of the chest. Different approaches according to location

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Learning Objectives: To learn more on how to do transthoracic biopsy under ultrasonographic (US) guidance.
Background: US is as effective as computed tomography (CT) or fluoroscopy for guidance of transthoracic biopsies of chest wall lesions, pleural lesions, peripheral pulmonary lesions, and mediastinal tumors. The advantages of US guidance include the dynamic evaluation of vessels and the localization of target lesions that move during respiration; the real-time, continuous monitoring of the needle tip during advancement and sampling; the availability of oblique needle paths; and, unlikely CT or fluoroscopy, no radiation exposure.
Clinical Findings or Procedure Details: We describe different approaches of transthoracic needle biopsy under US guidance according to the location of various thoracic lesions, including chest wall, pleura, peripheral lung, and mediastinum. We discuss anatomic considerations, technical aspects, limitations, and complications of each approach.
Conclusion: US-guided transthoracic biopsy is a very reliable and efficient tool for evaluating various thoracic lesions.

P250

National survey on patient doses in interventional radiology. Design and preliminary results

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Purpose: To present the design and some preliminary results of a national survey on patient doses promoted by the Spanish Society of Interventional Radiology as part of the European SENTINEL (Safety and Efficacy for New Techniques and Imaging Using New Equipment to Support European Legislation) project.
Materials/Methods: Ten Spanish hospitals were involved in the survey. X-ray systems were evaluated with a common methodology including calibration of built-in dosimeters. Three common diagnostic [lower limb arteriography (LLA), renal arteriography (RA), and fistulography (FI)] and three therapeutic procedures [biliary drainage (BD), hepatic chemoembolization (HC), and iliac angioplasty (IA)] were selected as initial step of the survey, with samples of ten patients for each procedure and hospital. Inclusion/exclusion criteria were agreed between the participants.
Results: Median values of patient doses in Gy-cm^2 were: 65, 31, and 18 for LLA, RA, and FI and 58, 180, and 54 for BD, HC and IA, respectively. Some values were 20-70% lower than a similar study in USA, but sample size needs to be increased.
Conclusion: Median values of dose, fluoroscopy time, and number of images will be used as local references to optimise the procedures. The survey allows participating centers with highest doses to consider corrective actions.

P251

Treatment of lymphangioma in children using ultrasound-guided injection of OK-432

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Purpose: Lymphangiomas are benign, soft tumors often involving the head and neck areas, usually causing remarkable cosmetic and funtional problems. The aim of this paper is to review our experience with OK-432 in children.
Materials/Methods: We made a case note review of 13 children (age range: 1.5 months - eight years) who received ultrasound-guided injection of the sclerosant agent OK-432 (1-5 treatment) for a macrocystic type lymphangioma. Localizations were the face (2), the neck (5), the parotid space (1), the submandibular (1), the thigh (1), and multiple (face, thorax, back) (1). Four patients had underwent surgery before the sclerosant treatment with no satisfying results. Children were treated under general anesthesia.
Results: The treatment was successfull in all the patients. At follow-up (2-20 months) all lesions had decreased with a complete or a nearly complete resolution of lymphangiomas. The only complications recorded were fever and local infiammatory reaction lasting 2-3 days. Cutaneous lesions at the injecton sites were not observed
Conclusion: Intralesional injection of OK-432 is an effective treatment modality for macrocystic type lymphangiomas. Their shrinking is achieved without functional disorders or skin scarring.

P252

Embolization of peripheral vascular malformations with ethylene vinyl alcohol copolymer

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Purpose: To demonstrate feasibility and preliminary efficacy of endovascular embolization of peripheral congenital vascular malformations (VMs) with the use of ethylene vinyl alcohol copolymer, a nonadhesive liquid embolic agent, dissolved in dimethyl sulfoxide (Onyx).
Materials/Methods: Twenty patients with a mean age of 24.8 years had local low-flow (n=7), local high-flow (n=8), or diffuse high-flow (n =5) VMs located in the upper and lower extremities and the gluteal region. A total of 28 embolization procedures was performed with Onyx via microcatheterization of the arterial feeders of VMs.
Results: In five of the seven patients with local low-flow VMs, the lesions were completely embolized. In the remaining two patients, embolizations were incomplete. The13 high-flow lesions of local (n=8) or diffuse (n=5) types were also not completely embolized. In all the seven patients with local low-flow VMs and in 3/8 patients with a local high-flow VM, clinical signs and symptoms resolved significantly. The remaining ten patients showed clinical benefits from embolization to varying degrees.
Conclusion: Onyx promises and provides important advantages over conventional embolic agents in the endovascular transcatheter embolization of congenital peripheral VMs.

P253

Metal airway stents: experience in 36 children

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Purpose: To present the outcome of metal airway stent insertion at a referral center for tracheal problems in children.
Materials/Methods: Prospective observational study of all children undergoing insertion of metal airway stents.
Results: Thirty-six children (22 boys) underwent stenting under fluoroscopic guidance over a six-year period. The median age was eight months (range 24 days to 15 years). Indications were: fixed stenosis following surgery in 19, malacia in 12 and extrinsic compression in 11 (some patients had more than one indication). Seventy-six stents (63 balloon-expandable and 13 self-expanding) were implanted at 57 procedures. Twelve patients died, six days to ten months after stent insertion. Deaths were due to cardiac disease (5), airway obstruction (2), multiple congenital anomalies (2), pericardial patch erosion (2, one from airway hemorrhage and one from mediastinal air leak) and sepsis superimposed on chronic lung disease (1). Most children with balloon-expandable stents required repeated balloon dilatation for granulation tissue. Twenty-four children are alive at follow-up of 84 days to six years.
Conclusion: Airway stenting is effective for recurrent stenosis and in selected patients with malacia and airway compression associated with complex congenital heart disease. Most deaths occur in the first few months after stent insertion.

P254

Benign tracheobronchial strictures: long-term results and factors affecting airway patency after temporary placement of covered retrievable nitinol stents

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Purpose: To retrospectively evaluate long-term results and identify factors affecting airway patency after temporary stenting for benign tracheobronchial strictures refractory to balloon dilation.
Materials/Methods: Under fluoroscopic guidance, polyurethane- or polytetrafluoroethylene-covered, retrievable, expandable, nitinol stents were placed in 24 patients with benign tracheobronchial strictures. Stents were removed electively two or six months post-procedure or if complications occurred. Outcomes and maintained airway patency for the two- and six-month temporary stenting groups were compared. Multivariate predictors of recurrence during follow-up were also evaluated.
Results: Thirty stents were successfully placed. Tissue hyperplasia and stent migration occurred in 36.7% (11/30) and 13.3% (4/30), respectively. All stents were successfully removed electively either two (n=12) or six (n=12) months post-placement or when complications occurred (n=6). The six-month stenting group showed a lower recurrence rate (41.7% versus 83.3%, p=0.045) and a better mean maintained patency (39.7±7.8 versus 9.4±5.4 months, p=0.001) than the two-month group. Multivariate Cox proportional hazard regression analysis showed that stent placement duration (p=0.002) and tissue hyperplasia (p=0.026) were associated with maintained patency after temporary stenting.
Conclusion: Temporary stent placement appeared to be safe and effective for benign tracheobronchial strictures. Factors decreasing airway patency after stent removal were short-term (two months) stent placement and tissue hyperplasia.

P255

Patient and staff radiation doses in vertebroplasty

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Purpose: Vertebroplasty involves significant fluoroscopic exposure; measurements for both the patient and the staff are therefore recommended.
Materials/Methods: During 12 vertebroplasties, t hermoluminiscent dosimeters (TLDs) were positioned according to international protocols. Surface and whole-body doses were estimated. Slow films were placed on the patients' skin to measure entrance surface dose. TLDs were also placed in a Rando® phantom in positions corresponding to critical organs. The phantom was irradiated under conditions simulating a common vertebroplasty, in order to estimate effective dose. Dose rates at several positions in the operating room were recorded.
Results: Mean fluoroscopy time was 27.7 minutes. It was estimated that the first operator can perform about 150 vertebroplasties annually to reach the annual dose constraints, while whole-body doses can be reduced by 76% using mobile shielding. Patient's skin dose was measured as 831±334 mGy, while effective dose was calculated to be 34 mGy.
Conclusion: The highest dose rates inside the room during the procedure were found in the first operator's hands and chest when no shielding was used. Occupational exposure can be reduced using appropriate shielding. However, measures have to be taken to reduce patient's skin dose, which may be close to deterministic effects threshold.

P256

Endovascular treatment of visceral aneurysms and pseudoaneurysms

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Purpose: To present our retrospective experience from 1997 to 2005 in percutaneous endovascular treatment of visceral aneurysms and pseudoaneurysms.
Materials/Methods: Eighteen patients (11 men and seven women, mean age: 63 years) with 10/9 aneurysms/pseudoaneurysms were treated. Thirteen were hemorrhagic patients and five were asymptomatic (fortuitous diagnosis). Thirteen aneurysms were treated by coils or Spongostan embolization (five aneurysmal sacs and eight vessel embolizations). Six injuries were treated by stent (one covered, two uncovered stents plus sac embolization, three stent-grafts). In all the patients, clinical and radiological follow-ups were done at 12-48 months (mean 24 months); one patient died of unrelated causes.
Results: In 15 cases (seven aneurysms and eight pseudoaneurysms), an immediate exclusion of the vascular injury from the arterial circulation was obtained. In four cases (three aneurysms and one pseudoaneurysm), at follow-up the incomplete exclusion of the aneurysmal sac was recorded. Three cases of post-embolization syndrome were noted. In one case, a splenic infarction occurred, managed by subsequent splenectomy.
Conclusion: The endovascular approach in patients with ruptured aneurysms is the first choice. The interventional radiology treatment is presently a valid alternative to surgery, also in a routine setting.

P257

Primary aortic stenting in aortoarteritis

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Purpose: To evaluate clinical efficacy and long-term follow-up of primary aortic stenting in aortic stenosis due to aortoarteritis.
Materials/Methods: Thirty-nine symptomatic patients with aortic stenosis (29 females and ten males) with an age ranging between four and 36 years were treated with primary aortic stenting. Self-expanding stents were selected for implantation in the adult population and balloon-mounted stents in the pediatric group. Clinical indications included hypertension, dyspnoea, claudication of the lower limbs, congestive cardiac failure, and left ventricular dysfunction. All the patients were followed up clinically and with digital subtraction angiography (DSA) with a mean follow-up of 46 months (range 12-108).
Results: Endovascular aortic stenting was successfully done in 38 patients. After stent implantation, the peak systolic gradient decreased from 64 to 8 mm Hg. Complications occurred in two patients; one Palmaz stent which did not expand completely following deployment was successfully redeployed, another patient had a fatal aortic rupture. At follow-up, a significant improvement in the blood pressure and improved ejection fraction and claudication were recorded. Follow-up DSA revealed no residual stenoses.
Conclusion: Primary aortic stenting is a safe and effective treatment of aortic stenoses due to aortoarteritis, with excellent long-term clinical results.

P258

Pediatric neuroangiography: technique and review of intracranial pathology with correlative imaging

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Learning Objectives: 1. Describe our technical experience in performing pediatric neuroangiography over a five-year period. **2.** Review intracranial pathology encountered in our patient population. **3.** Discuss the role of 3D rotational angiography in pediatric neuroangiography.
Background: As a tertiary referral center, neuroangiography is performed on a regular basis in children from newborns to 21 years for a wide variety of clinical indications. Our experience is unique as pediatric neuroangiography is part of a general pediatric interventional department and requires expertise in angiographic technique and image interpretation.
Clinical Findings or Procedure Details: Our review illustrates pathology such as moya moya, fibromuscular dysplasia, vasculitis, aneurysms, arteriovenous malformations and traumatic lesions. Equipment choices for all ages are discussed as angiographic techniques. Correlative computed tomography, magnetic resonance, and plain film imaging will be included when available. Intraoperative imaging will be included when performed. Three-dimension rotational angiography and reconstructive imaging enhance diagnostic yield in several cases of aneurysms and arteriovenous malformations and will be discussed and illustrated.
Conclusion: Pediatric neuroangiography is a specialized field infrequently found within the spectrum of general pediatric interventional radiology. We will review angiographic and imaging techniques and spectrum on intracranial pathology over five years in a large tertiary referral center.

P259

Benefit of intra-articular corticosteroid injection under fluoroscopic guidance for subtalar arthritis in juvenile idiopathic arthritis

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Purpose: 1. Describe our technique of subtalar joint injection in juvenile idiopathic arthritis (JIA). **2.** Review clinical response rates and complications to high-dose steroid therapy.
Material/Methods: A five-year chart review was performed on children. One milliliter of triamcinolone hexacetonide or acetonide into the mid subtalar joint using a lateral oblique approach was injected. Improvements: foot inversion and eversion at the follow-up visit.
Results: Thirty-eight patients underwent 55 subtalar injections during the study period; all JIA subtypes were represented. Thirty-one (82%) had subtalar arthritis, 32 (84%) had concomitant tibiotalar ankle arthritis. Improvement was observed in 34 (89%) of the initial 38 injections. The mean duration of improvement was 1.2 (+/-0.9) years and the median was 1.1 years (range 0.2-3.3). Twenty (53%) developed hypopigmentation or subcutaneous atrophy. Patients with hypopigmentation or atrophy had been injected with a higher volume of steroid per patient weight than those without (mean 0.06 mL/kg versus 0.04 mL/kg, P=0.005).
Conclusion: Subtalar arthritis may occur in all subtypes of JIA. Response to corticosteroid injection in approximately 90% of cases remains improved for greater than one year. Hypopigmentation and subcutaneous atrophy are frequent complications and are associated with a higher volume of injected steroid per patient weight.

P260

A clinical experience with cone-beam computed tomography for non-vascular interventional procedures

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Purpose: To assess the capability of volume data provided by cone-beam computed tomography (CT) equipped with a C-arm fluoroscopy for percutaneous biopsies and non-vascular therapeutic procedures. Modified techniques with volume data and fluoroscopic images will be also proposed.
Materials/Methods: A recently developed cone-beam CT equipped with a C-arm and a flat panel detector (DynaCT AXIOM Artis dTA, Siemens), which provides CT-like datasets was used for biopsies, drainages, or radiofrequency ablations in 55 patients with thoracic, vertebral, abdominopelvic, and retroperitoneal tumors or abscesses.
Results: Cone-beam CT with C-arm system is not equipped with a laser beam which shows an axial line on the patient's body. From volume data and guided by a lead ruler positioned on the patients' skin, we can decide puncture points. All the procedures were successfully performed. Image quality was adequate to plan and confirm needles or drainage tubes position in all but two cases.
Conclusion: Cone-beam CT equipped with C-arm and flat panel detector are a practical clinical tool that facilitates effective performance of percutaneous procedures.

P261

Surface coating of catheters with a biomembrane-like polymer for preventing thrombosis

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Purpose: To investigate the efficacy of catheters coated by 2-methacryloxyethyl phosphorylcholine (MPC) to prevent device-related thrombosis.
Materials/Methods: We synthesized the biocompatible MPC polymer whose side chain is composed of phosphorylcholine resembling phospholipids of biomembranes. In this study, uniform coating of MPC on microcatheters was provided using a dip-casting technique. The blood compatibility of MPC-coated, conventional hydrophilic-coated, or non-coated microcatheters was investigated by incubating with human whole blood and platelet-rich plasma for one hour at 37°C, and each surface was observed by scanning electron microscopy (SEM). The influence of chemical agents (purified water, saline, calcium chloride solution, lactate Ringer solution, iodinated contrast materials, fluorouracil and epirubicin) on lubrication performance of microcatheters was also investigated.
Results: SEM evaluation of MPC polymers incubated with human blood showed dramatic reductions in platelet adhesion and activation on the surface when compared with conventional hydrophilic-coated and non-coated surfaces. MPC polymer was even more stable after incubating with calcium chloride solution and anticancer agents; however, conventional hydrophilic and non-coated surfaces were not chemically stable and lubrication performance of microcatheters got worse.
Conclusion: Biomembrane-like polymer coatings have a great potential for developing antithrombogenic surfaces in blood-contacting interventional devices.

P262

Selective embolization of facial high-flow vascular dysplasia

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Purpose: To evaluate the role of selective embolization of external carotid artery branches in treating facial high-flow vascular dysplasia (HFVD).
Materials/Methods: Within a four-year period, 11 patients with facial HFVD were treated with selective embolization. The patients were first assessed by digital subtraction angiography of the aortic arch and its branches, including internal and external carotid arteries. Then, selective and/or superselective angiography (using microcatheters) of the HFVD supplying arteries was performed. The embolization was performed using polyvinyl alcohol particles or, more recently, plastic embolic microspheres. (Biosphere). Post-procedure angiography confirmed the effectiveness of embolization. Hospitalization and antibiotic treatment for three days was advised.
Results: Embolization was technically successful in all cases. In two cases (a tongue and a lower lip arteriovenous malformation), post-embolization angiography displayed a residual lesion (<30%); they were therefore re-embolized after 15 and 60 days. Magnetic resonance examinations six months later showed a complete thrombosis. An angiographic follow-up 16 months later reconfirmed these results. The extensive facial arteriovenous malformation was partially devascularized post-embolization, thus permitting the surgical excision.
Conclusion: Angiographic selective embolization is a successful method for treating facial HFVD, as well as an effective preoperative treatment in larger lesions to minimize blood loss during surgery.

P263

Mistakes, blunders and negligence in the UK. What we can learn from ten years of complaints. A review of all complaints against interventional radiology made to the National Health Service Litigation Authority since its inception in 1995

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Learning Objectives: To identify the areas within interventional radiology (IR) which are most at risk from complaint and litigation.
Background: Complaints and litigation are an ever growing spectre in the working lives of health-care professionals. In the UK, radiology occupies a relatively modest position with respect to the incidence of claims of negligence; however, with the growing sophistication, success, and reliance on imaging techniques, this may change. It is very much in the interests of the patient, the profession and healthcare industry as a whole that we learn from our mistakes to improve clinical practice and reduce risk.
Clinical Findings or Procedure Details: Between 01/04/1995 and 31/03 2004, IR accounted for only 7.2% of all claims against radiology departments. The settlement of these claims came to £ 6,970,000 (Euro 10,455,000), which is 12% of the total settlement of claims against radiology departments in this period. Analysis of the National Health Service Litigation Authority database will be presented showing the top ten most frequent causes of complaint and the top ten most expensive causes of settlement.
Conclusion: Examination and awareness of complaints against IR is an exercise in risk management and an important tool for the improvement of our daily practice.

P264

Percutaneous intravascular foreign body retrieval: ten-year experience

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Purpose: To report our experiences, techniques, and clinical outcomes of percutaneous intravascular foreign body retrievals.
Materials/Methods: Following institutional approval, we retrospectively identified 34 patients who had intravascular (29 venous and five arterial) foreign bodies between 1996 and 2006. Venous foreign bodies included 23 central venous catheter fragments and six guidewires. Arterial foreign bodies included three arterial stents and two catheter fractures.
Results: Percutaneous intravascular foreign body retrieval was successful in 33 patients (97%). Snare method was used in all cases, however, pigtail catheter and/or forceps can be used to move foreign bodies away from the heart to a more peripheral location, such as the inferior vena cava. In our experience, we had no complications during and after percutaneous foreign body retrieval. Percutaneous approach was unsuccessful in only one patient in whom a guidewire was lodged in the right atrial wall. This patient was symptomatic with retrosternal pain, and the foreign body was surgically removed.
Conclusion: Intravenous foreign bodies tend to migrate to the lungs, though some portions may remain within the heart, potentially becoming symptomatic and/or life threatening. Percutaneous retrieval is safe and has a significantly high success rate. Surgery is an alternative in unsuccessful percutaneous retrieval attempts.

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