IR congress news

Don't miss the Film Interpretation Panel!

Over the years the Film Interpretation Panel has become one of the highlights of the CIRSE meeting; interesting cases are discussed in a lively and humorous manner as two teams battle for victory. This year's FIP will feature Team Odin vs. Team Thor hosted by Afshin Gangi and Anthony Watkinson.

The Film Interpretation Panel will take place today at 15:00 in Room A.

Patient Awareness

Interventional Radiology: your alternative to surgery

TODAY!

Monday, Sept. 15, 16:30-18:00
Medical students

For the detailed programme please refer to page 3.

CIRSE 2008 - Copenhagen
Monday, September 15, 2008

Join us for the CIRSE Foundation Party!

Tuesday, September 16, 2008

Join us for this year's Foundation Party and experience a night of glamorous show acts, exquisite food and dancing until the morning hours. Being the highlight of CIRSE's social programme, the CIRSE 2008 Foundation Party will certainly be a night to remember.

With world-renowned Wallmans restaurant and theatre local host Poul Eric Anderson has picked a fun and exciting venue which will leave no wish unfulfilled. The dinner show will combine fabulous food with an excitingly fresh show act performed by 18 international artists.

Like all world-renowned Wallmans shows, its latest creation 'Passion' will offer music, singing, dancing and lots of innovative humour, all set against a backdrop of avant-garde scenography and innovative costumes. It will take you on a passionate journey through a Hard Rock Opera, the sounds of Big Band and the great melodies of Burt Bacharach. Glamorous show girls will dazzle you in the retro 50's number "Car Wash", as will the talented singers and dancers of various other performances.

For the grand finale and by popular demand, Elvis will be back in the building! The King of Rock 'n Roll and most famous entertainer of all times will close the show and leave the dance floor to you.

Tickets for the Foundation Party can be purchased at the hotel counter in the registration area.

Photo Competition ends today - Cast your vote!

In our many years in radiology we have had the chance to attend numerous congresses, getting to know colleagues from around the world. In these encounters we have noticed that many of us share a hobby: photography. To us this shows that some people were simply born to be imagers.

To share this passion with all our colleagues, CIRSE has organised the first CIRSE Photo Exhibition featuring photographs created by its members and congress delegates. The exhibition is located vis-à-vis the Abbott Lounge at the main auditorium foyer and can be visited throughout the congress. To vote for your favourite picture, please use the computer next to the exhibition. The winner will be announced at the Foundation Party where you will have the chance to make a bid for the winning picture.

We hope that you will enjoy this interesting new feature of the congress and look forward to the Photo Exhibition and Contest becoming a regular feature of the CIRSE meeting !

Jim Reekers, James Spies

Don't forget to cast your vote for the best picture of the CIRSE 2008 Photo Exhibition. To vote, please proceed to the work station located in the Photo Exhibition vis-à-vis the Abbott Lounge

Jim A. Reekers
CIRSE President

Dear Colleagues,

I hope you have had a good start at CIRSE 2008 and you are enjoying the programme we have put together for you. It is a great pleasure to see that Interventional Radiology is flourishing and so many are here to learn, to communicate their science and to meet colleagues from all over the world. I am proud that we are able to offer you another broad and high quality programme which enables you to make your own selection and to assemble your own dedicated programme. CIRSE has certainly become the annual meeting point for global IR.

CIRSE has further grown compared to the previous years. We received a record number of abstracts, there is more exhibition space and additional activities. Companies see our annual meeting as the starting point to launch new products and the latest breaking science is presented. But CIRSE is not only the annual meeting. Both the CIRSE society and the CIRSE Foundation have explored many new activities. Last spring we organised a very successful meeting on Embolotherapy and Interventional Oncology, ET ECIO 2008, in Florence with more than 1,300 participants. From this year onwards GEST Europe will be part of the Foundation educational programme to keep you updated in the field of embolic therapy.

The GEST Europe meeting under the auspices of the CIRSE Foundation will take place in April 2009. In 2010 there will be a further ECIO meeting, also organised by the CIRSE Foundation. In 2008 the European School of Interventional Radiology (ESIR) organised more than 13 local courses focussing on one topic each to offer easily accessible IR education to young interventionists across Europe. I am happy to say that the ESIR has also been a very successful initiative.

Interventional Radiology procedures are now a well accepted main stream treatment option for many diseases and new opportunities to apply them are on the horizon, such as in the budding field of Interventional Oncology. It was therefore time to take a further step in the creation of a truly global network for IR. CIRSE now has 20 group members and the total CIRSE membership has almost tripled during the last 3 years. Today CIRSE is 4,280 members strong and growing.

One of CIRSE's most important aims is to create the first European certification for Interventional Radiology until 2010. For this project we are cooperating closely with both the UEMS and the ESR. Interested persons will be able to take the examination for this Skill and Knowledge Certificate one day prior to our annual meeting and it will be open to all CIRSE members. More detailed information will be available through our newsletter and the CIRSE web page.

What is the purpose of all these activities? I feel very strongly that CIRSE should be the driving force of Interventional Radiology in Europe and beyond. We must leave the dim light of our interventional suites and come out into the open. IR is probably still the most unknown medical specialty out there. We should therefore aim at a strong promotion of IR to patients in addition to a strong educational and scientific programme.

You will see that CIRSE 2008 is the starting point of yet another new activity, i.e. a patient awareness programme which was established by our colleagues from the Local Host Committee headed by Poul Erik Andersen. We will make this patient awareness programme a permanent feature of our meeting, as a well informed patient is vital to our specialty. The CIRSE website www.cirse.org also offers ample information about our procedures for the interested public.

CIRSE has reinvented itself in the last years to become a key player in the IR market. Of course none of this would have been possible without the aid of a very enthusiastic team at the CIRSE office in Vienna. I have said this many times before and I will say it again: "The future of IR is bright!" There is no need to be shy. We are here to stay.

I wish you all a wonderful stay in Copenhagen and a fantastic educational meeting and look forward to your ideas and input for future activities!

Outcomes of stent-grafts and the thoracic aorta - a great step forward for survival

Robert Morgan
Consultant Vascular and Interventional Radiologist, Honorary Senior Lecturer, St. George's NHS Trust and Medical School, London, UK

The development of stent-grafts and their use in the thoracic aorta has significantly changed the management of diseases involving the descending aorta and the aortic arch in the last decade or so. Thoracic aortic aneurysms, Type B dissections and traumatic transections can now be treated without the need for thoracotomy and cardiopulmonary bypass with the obvious potential advantages in terms of reduced morbidity and mortality.
Endovascular repair of the thoracic aorta (TEVR) has become an established treatment modality despite a relative paucity of evidence, with a lack of the randomized trials that have accompanied other new vascular procedures. The majority of available data are obtained from case series and registries. The aim of this article is to review the outcomes of thoracic endografting and compare them with conventional surgery.

Descending thoracic aneurysms
The survival of patients with untreated TAA is bleak and is estimated to be 13-39 at 5 years (1). The results of open repair in centres of excellence are good with 3 day mortality rates for all types of thoracic aneurysm below 12% and paraplegia rates below 4% (2). Community results which incorporate several centres are more realistic and demonstrate 30-day mortality rates approaching 20% (3).

Outcome data for endovascular repair of thoracic aneurysms are available from several sources. Leurs et al on behalf of the EUROSTAR collaborators reported data in 249 patients with 30-day mortality for elective TEVR of 5.3% and paraplegia of 4% (4). A cohort of patients with TAA who underwent endografting with the Gore TAG device was compared retrospectively with the results of a cohort of 94 patients who underwent open surgical repair. The perioperative mortality (2.1% vs. 11.7%), paraplegia (3% vs. 14%) and freedom from major adverse event (48% vs. 20%) rates were all better in the endovascular group (5).

Similarly, the European Talent Registry reported technical success of 98%, in-hospital mortality in 5% (4.1% and 7.9% for elective and emergency procedures, respectively), paraplegia in 1.7% and stroke in 3.7% (6). Similar outcomes have been reported for the newest generation of endografts, despite the fact that the patients in these later data series had more challenging anatomy compared with earlier series (7).

Thoracic Dissection and Acute Aortic Syndrome
The management of acute Type B dissections is principally medical, with surgery reserved for complications. Overall, medical management of patients with acute aortic dissection has a mortality rate of just over 10%. This will include a mixed group of patients with uncomplicated dissection and some patients with complicated dissection who would be considered unsuitable for surgical intervention. Surgical intervention in patients with complicated dissection has a mortality rate of approximately 30% (8).

The early results of endovascular repair of acute complicated Type B dissections were vastly better than the open surgical alternative. Most series reported mortality rates below 10% with paraplegia rates of less than 3% (4,9-12). These findings stimulated a rapid change in management and most vascular centres would now regard endovascular therapy to be the first line treatment for acute complicated Type B dissections.

Indications for repair of chronic dissections have usually been limited to the onset of complications, and an aortic diameter exceeding 5.5-6.0 cm. The availability of data regarding the outcomes of EVR for chronic dissections is very poor. In the series to date the mortality rates have been acceptable, but the long-term success in preventing aortic expansion is unclear. There have been anecdotal reports that the false lumen below the stent may continue to expand after treatment and that the rate of repeated intervention is high (7). This is an area that requires further work to facilitate effective therapy.

Traumatic Aortic Injury
Traumatic aortic injury (TAI) is the second most common cause of death in patients after blunt injury. 15-30% of deaths from blunt trauma have aortic transaction at post mortem. The surgical approach to treatment has changed considerably in the last decade. While previously it was thought that emergency repair was mandatory due to the belief that there was a high risk of early rupture, recent series suggest that the rupture risk in stable patients is only 10% (13, 14).

Due to its low complication rate TEVR has in many centres superseded surgery for TAI in the last decade. The procedural time is short and the operation confers very little in terms of additional morbidity to these severely ill patients. Due to the focal nature of the injury, only a short length of aorta requires covering with an endograft.

Although TEVR seems to have become the gold standard for TAI, there are relatively limited data on outcomes. However, the procedural mortality is less than 10% throughout and the reported risk of paraplegia is negligible (15-17), outcomes much improved compared with surgery. The main drawback concerns the unsuitability of the devices available for the patients who require TEVR. TAI occurs in a relatively young population with narrower aortas and more angulated aortic arches than older patient. None of the devices currently available conform very well to angulated arches. There are reports of endografts "sitting up" in the arch resulting in endograft collapse and pseudocoarctation (18). The other problem is the lack of availability of small calibre endografts. The smallest endograft is 22 mm, which limits the smallest size of aorta that can be stented to 18-19 mm.

In summary, the advent of endovascular repair for thoracic aneurysms has changed practice. In my view, there is enough evidence to suggest that TEVR should be used as first line therapy for most thoracic aneurysms involving the descending aorta and probably the aortic arch. Regarding dissection, endovascular repair should be considered the gold standard for complicated acute Type B thoracic dissections. There appears to be no justification for the repair of uncomplicated acute dissections. The indications and methodology for the treatment of chronic dissections remain undefined. TEVR for TAI has reduced complication rates compared with surgery. However, improvement in the devices is required before it can be recommended as first line therapy for this indication.

Don't miss it !
Thoracic aorta stenting update
Special Session
Monday, September 15, 8:30-9:30
Room C

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Advertorial

INSTITUTE *for* THERAPY ADVANCEMENT

Boston Scientific has recently added a new Institute for Therapy Advancement campus, located near Paris Charles De Gaulle, France, to its Global Education Network.

Philippe Champaud, Director of Boston Scientific's Institute for Therapy Advancement (International) discusses the next-generation training centre built to better address the specific needs of medical professionals.

Can you define the overall mission of Boston Scientific's Institute for Therapy Advancement?

At the Institute, our aim is to deliver to medical professionals the very highest-quality education focusing on minimally-invasive treatments and technologies. The unique educational experience physicians receive at the Institute is based on the fundamental principles which underpin our teaching philosophy: objective therapy education, the sharing of best practices and clinical experiences and hands-on or, practical skills training which produces added-value for the physicians in their daily practices.

This mission is a reflection of Boston Scientific's commitment to helping healthcare professionals around the world advance the standard of patient care by mastering and applying most advanced therapy orientations based on the latest clinical research and data.

What therapy areas does the Institute cover?

All the therapies covered by Boston Scientific's products and solutions, with a special focus on Cardiac Rhythm Management, Interventional Cardiology and Peripheral Interventions.

What profile of physician can benefit most from the courses the Institute offers?

We develop courses for medical professionals with very different levels of clinical experience. Young fellows benefit by interacting with recognized opinion leaders and experts in their chosen clinical specialty, learn the key steps and basic principles of a new therapy and study the key clinical data supporting patient selection and treatment decision. Physicians with a higher level of clinical experience learn how to treat more complex cases and how to handle complications in a simulated environment based on an extensive database of clinical cases.

What kind of benefits can a physician customer expect to bring back to his or her medical practice after attending an Institute course?

Our unique educational experience using a mix of hands-on sessions and theory based on the very latest findings creates benefits directly transferable to our customers' own medical practices. In turn, this leads to higher confidence and surer choices in treating their patients and thus improved patient outcomes. In addition, attending courses at the Institute facilitates the sharing of clinical experiences and best practices, discuss about challenging cases as well as the development and expansion of one's own personal network within the profession and clinical specialty. This is a specific benefit our customers tell us they enjoy tremendously.
We think this can only benefit both the physician and his or her patient.

What is the difference between medical education at the Institute and training in the hospital or at a Congress?

Well, one is really complimentary to the other, but the main thing that makes our courses so valuable is the hands-on, practical training using a variety of sophisticated simulation technologies in a risk-free environment, focused on therapies not specific products. I would also mention exposure to a deep body of knowledge and expertise in the area of advanced, innovative technologies, working in smaller groups that facilitate exchanges and the sharing of clinical experience with peers and recognized experts. These are all invaluable contributing factors in a successful medical career and practice.

What guarantees the scientific objectivity of the Institute's course content?

Course accreditation by official bodies, our independent faculty and our course content based on therapy education rather than product promotion.
I should also mention that course content is designed and supervised by independent Course Directors, experts and opinion leaders in their clinical fields. Since the pioneering days of 2000, the Institute for Therapy Advancement collaborated with these experts who have developed a set of standards and guidelines called Educational Governance, which forms the basis for regulating the relationship between commercial organizations and physicians in the context of the educational events they supervise.

Can you describe the typical profile of an Institute faculty member?

Our faculty all share the following characteristics: recognized, high-level expertise in their therapy area(s) and a desire and proven ability to teach.
On top of these qualities, as we can experience everyday, they also all share a passion for the future of minimally-invasive therapies and treatments.

You insist on the practical aspect of your training courses. What kind of material do you use to simulate hands-on experience?

What really allows us to approach real life experience is the Institute's state-of-the-art simulation technologies: Virtual Reality simulators with haptic feeling, or force feedback for all interventional procedures, cardiac arrhythmia simulators, phantoms reproducing true patient anatomies in a real cathlab environment, using actual devices.

What would you say makes the Institute for Therapy Advancement experience unique?

Participants highlight a combination of Course sessions based on objective therapy education in small groups that favors exchanges together with leading-edge simulation technologies, plus a world-class faculty and Course Directors. Another aspect is the access to a global network of Institutes and our innovative fellow programs.

Also, we are very lucky to have the backing of Boston Scientific, a world leader in minimally-invasive therapies and technologies committed to high-level, continuing medical education and the improvement of patient care worldwide.

The History of Interventional Radiology in Denmark

Poul Erik Andersen
Chairman of the CIRSE 2008
Local Host Committee

Interventional Radiology in Denmark goes back to 1932, when the first 10 cerebral angiographies were performed by a neurologist who injected radioactive Thorotrast contrast through an arteriotomy of the carotid artery. The first documented lower extremity angiography was performed in Odense in 1948.

The first examinations were performed with puncture of both femoral arteries with the patients under general anaesthesia lying on the floor to get sufficient film-focus distance and with two doctors on their knees beside the patient. The Seldinger puncture technique was introduced in 1955. The first angiography catheters were home made from a roll of plastic tube which was cut in appropriate length and pulled lengthwise until the diameter was suitable for the guidewire. Sometimes side-holes were also made and the catheter was sterilized overnight. The cassette film changers were prototypes made individually at each hospital. They usually had a capacity of 5 exposures in 10 sec.

The first PTA in Denmark was performed in Herlev in 1977. Many other hospitals followed in succession within the following couple of years. In 1991 the first stents were deployed in several hospitals. The first carotid PTA in Scandinavia was performed in Odense in 1993 and the first abdominal aortic endoprosthesis was implanted in 1996. The first TIPSS procedures were performed in 1994 (Aarhus and Copenhagen) and the first uterine fibroid embolizations in Scandinavia were performed in Odense in 1999.

"We feel that it is time to give something back to CIRSE"

As you can see in many aspects Danish interventional radiologists have been in the spearhead of developments in Europe. The number of hospitals practising Interventional Radiology has decreased in recent years. Many procedures are becoming more and more centralised and specialised; a trend that is likely to continue in the years to come.

The Danish Society of Interventional Radiology (DFIR) was established in1998 with only about 15 members. It was not until 2003 that the society became more active, establishing a two day annual scientific meeting, which today is usually attended by around 100 interventionalists. The number of members of the DFIR has risen gradually. Today it comprises more than 80 interventional radiologists, who are also very active in CIRSE. The initial proposal to join CIRSE as a Group Member was approved by the DFIR General Assembly in May 2007.

It goes without saying that we are extremely happy about CIRSE's decision to hold its 2008 annual meeting in Denmark and we feel that it is time to give something back to CIRSE, among other things by becoming a Group Member. Group membership is mutually beneficial to both CIRSE and the DFIR and therefore all Danish interventional radiologists.

CIRSE 2008 in Copenhagen will certainly be an important milestone in the history of Interventional Radiology in Denmark.

CIRSE Fellowship Grant

Terhi Nevala

I would like to express my thanks to the CIRSE Foundation for awarding me one of its 2007 education grants. I am also very much obliged to Professor Reekers for accepting me at the Amsterdam Academic Medical Centre.

AMC facilities include two angio suites. One is used for non-vascular procedures and the other one for vascular procedures. There is a third suite, which is mostly used for fluoroscopy studies, but can be used for other interventions also. The AMC's interventional radiologists strongly cooperate with the hospital's clinicians. They often visit each other and the best possible treatment is worked out together in every case. Service is fast and adaptable.

There were four main goals I wanted to achieve with my fellowship:

The first was to learn detailed methodology of subintimal PTA, as it is something we intentionally only rarely do in our hospital. In the framework of CIRSE's European School of Interventional Radiology I attended a course on the subject in 2006. Prof. Reekers was one of the lecturers there and I became very interested in the procedure.

My second goal was to learn about UFE, as we have only performed very few UFE procedures in our hospital.

The third goal was to learn more about arterial embolization in haemorrhage. At Oulu University Hospital we perform these embolizations frequently, but I personally had had the possibility to treat only a few patients. At the AMC, I was hoping to see much more embolization patients.

Fourthly it was important for me to observe how all of the above procedures are done in another institute.

Having concluded my visit I can say that I have fully achieved my goals. I assisted at a number of subintimal PTA cases and was able to perform several cases with assistance. I gained experience in this interesting and exquisite technique and will try to implement it in our institute. Although there were not very many UFE cases at the AMC either, I still managed to acquire more experience and enough confidence to commence the procedure in our hospital. I also saw and assisted in a number of embolization cases.

The AMC's Department of Interventional Radiology is very productive in all areas of IR. I saw, assisted and partly performed a varied array of different vascular interventions. One of the most interesting and educational procedures was the treatment of vascular malformations. Professor Reekers operates an outpatient clinic for these patients and I was fortunate enough to be involved in the management of many of these difficult cases.

On the non-vascular side I also gained experience in a great variety of procedures. I spent most of my time performing vascular procedures. Nevertheless flexible scheduling gave me the chance to spend some time on non-vascular cases. I learned many practical things and I was fortunate enough to witness several TIPS procedures.

"I acquired enough confidence to commence UFE procedures in our hospital"

During my three months stay I was invited to attend the Subintimal Angioplasty VII Course in Leicester, England, which took place on October 19th, 2007. It was a one day workshop with live cases, organised by Dr. A. Bolia and added another great experience to my educational stay.

My visit gave me an excellent opportunity to broaden my knowledge in IR. I am very grateful to Professor Reekers and his colleagues Professor J.S. Lamèris, Dr. O.M van Delden and Dr. K. van Lienden for their friendliness, enthusiasm and continuing efforts to teach me new things. I also want to thank the interventional suites staff at AMC. They were extremely friendly and helpful. Last but not least I would like to thank CIRSE for enabling my stay at the AMC through a fellowship grant.

CIRSE Education Grants 2007

In compliance with CIRSE's philosophy that excellent IR training is one of the corner stones for the survival of Interventional Radiology, the CIRSE Foundation awarded six visiting scholarship grants and eight fellowship grants in 2007.

Fellowship Grants

Maria Batalova
Aoife Keeling
Marco Midulla
Terhi Nevala
Markus Reiter
Cagin Sentürk
Steven Thomas
Ioannis Kapralos

Visiting Scholarship Grants

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Nikolas Fotiadis
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Stent Grafts in the thoracic aorta - How far can one go?

Ajay Chavan
Professor and Head, Department of Diagnostic and Interventional Radiology
Klinikum Oldenburg, Germany

Over the past 15 years stent-grafting has become an integral part of the repertoire of therapy options for treating thoracic aortic aneurysms and dissections. The mid-term results are encouraging. With increasing experience of the interventionist, proper case selection, adequate pre-procedural assessment as well as the availability of sturdier endografts in adequate lengths and diameters, it is to be expected that the rate of complications experienced so far will gradually reduce in the time to come.

If endograft systems are made smaller and percutaneous vascular suture devices less cumbersome, many thoracic aortic aneurysms and dissections could be treated percutaneously as a rule; this may reduce the morbidity associated with general anaesthesia and arteriotomy. Furthermore, a reduction in endograft costs could make the procedure available to a larger patient population, especially in countries where health insurance is affordable to but a few.

Against this backdrop it is worth taking a look at how the spectrum of indications for stent-grafting has rapidly widened with the passage of time. Stent grafts were initially used for treating atherosclerotic aneurysms of the descending thoracic aorta. Within a few years, however, reports appeared of successful stent-grafting not only in atherosclerotic aneurysms, but also in mycotic and traumatic aneurysms as well as in aneurysms with contained ruptures (1-5).

Close on the heels of these reports followed reports of stent-grafting in type B dissections (6,7). Clinical experience has been gathered in this group of patients over the past few years. Controversy exists regarding the usage of stent-grafts in chronic type B dissections. The same holds true for uncomplicated acute or sub acute cases. In contrast, stent-grafting appears to help in cases of contained rupture as well as in those with persistent intractable pain (8). Distal branch vessel ischemia in the acute or sub acute setting can also be relieved by stent-grafting. However, further peripheral interventions may be necessary to optimise the outcome (8,9).

Let's have a look at the type A dissections, with the risk of rupture and death increasing by approximately 1% per elapsed hour after the acute episode. Are the type A dissections always to remain a domain of open surgical repair? Here too, stent-grafting has made inroads into the treatment algorithm. Retrograde type A dissections with the entry tears in the descending aorta can now be treated successfully by trans-femoral stent-grafting, which has been shown to induce thrombosis and resolution of the false lumen (6,8). The advantage to the patient, who is spared complex thoracic aortic surgery, requires no further elaboration. The skill of the radiologist lies in being able to differentiate (at imaging) such dissections from those with classical entry tears in the ascending aorta or in the aortic arch. As a rule, the false lumen in the ascending aorta and arch in patients with distal entry tears is narrower than the true lumen; it may appear merely as a thrombosed sliver in the proximal aorta.

Ihnken and colleagues reported successful stent-grafting to seal the entry tear in the ascending aorta. The patient had an acute type A dissection, was deemed to be at high risk for surgery and refused open surgery. A short endograft was introduced transfemorally and placed between the coronary ostia and the brachiocephalic trunk (10).

How far can one go proximally? There is ample evidence in literature that the origin of the left subclavian artery can be covered by the endograft in order to increase the length of the proximal neck, provided the circle of Willis is patent. If indicated, a carotid-subclavian bypass can be carried out as a second stage procedure, but is necessary in less than 10% of the patients. The fact that the interventionist is participating actively in treating the aortic arch is evident from the development of hybrid endografts as well as hybrid procedures.

Hybrid endografts (e.g. the "Chavan-Haverich" or the "E-Vita open" endografts) consist of a proximal non-stented and a distal stented component (Fig.1). During surgery on the ascending aorta via a median sternotomy, these endografts are introduced antegradely via the aortic arch into the descending aorta. The stented portion forms the distal 'anastomosis' in the descending aorta; the non-stented segment is used to reconstruct the aortic arch. Multi-segment pathologies affecting the ascending arch and descending aorta, which classically require two or more operations, can thus be treated in a one-step procedure with the so called "Frozen Elephant Trunk" technique (Fig.2) (11,12).

As opposed to the hybrid endografts, hybrid procedures consist of surgically carrying out a conduit from the ascending aorta to the supra-aortic vessels followed by stent-grafting of the entire aortic arch. The procedure is especially useful in pathologies of the descending aorta extending proximally into the aortic arch. As is imaginable, both procedures require close cooperation between the surgeon and the interventionist.

To put matters in a nutshell: Presently, most type B dissections can be treated endoluminally or conservatively, with surgery being reserved for the few who cannot be managed with these approaches. Retrograde type A dissections too respond well to stent-grafting. Avenues are being gradually opened for treating certain acute type A dissections with entry tears in the ascending aorta, with the help of trans-femoral endografts. Ruptured thoracic aortas are an emerging field for the interventionist.

If we are to avoid losing the aortic territory which we ourselves have helped carve out and establish, a new brand of interventionists, familiar with the above mentioned techniques, will have to emerge in the future to come. Should he or she be in a position to offer round the clock support, his/her services are likely to be called upon more and more frequently, especially in treating complicated dissections and aortic ruptures.

Fig. 1: Chavan-Haverich hybrid endograft.

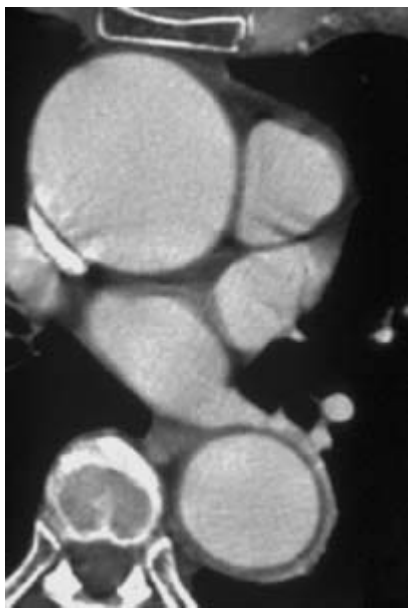

Fig.2a: Pre-operative CT section of a patient with simultaneous aneurysms of the ascending arch and descending aorta.

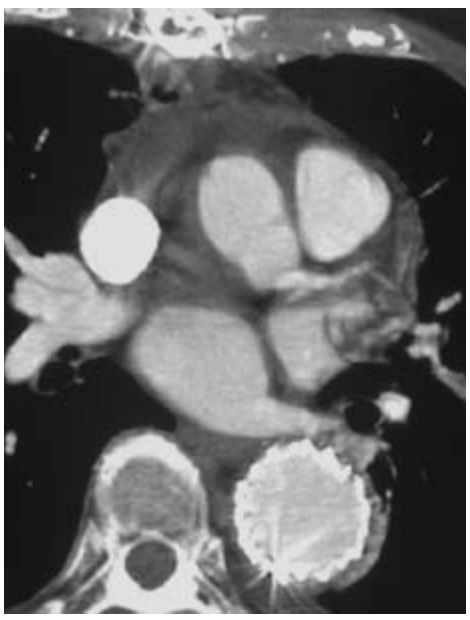

Fig.2b: Corresponding post-operative CT section; open surgical replacement of the ascending aorta and stent graft in the descending aorta.

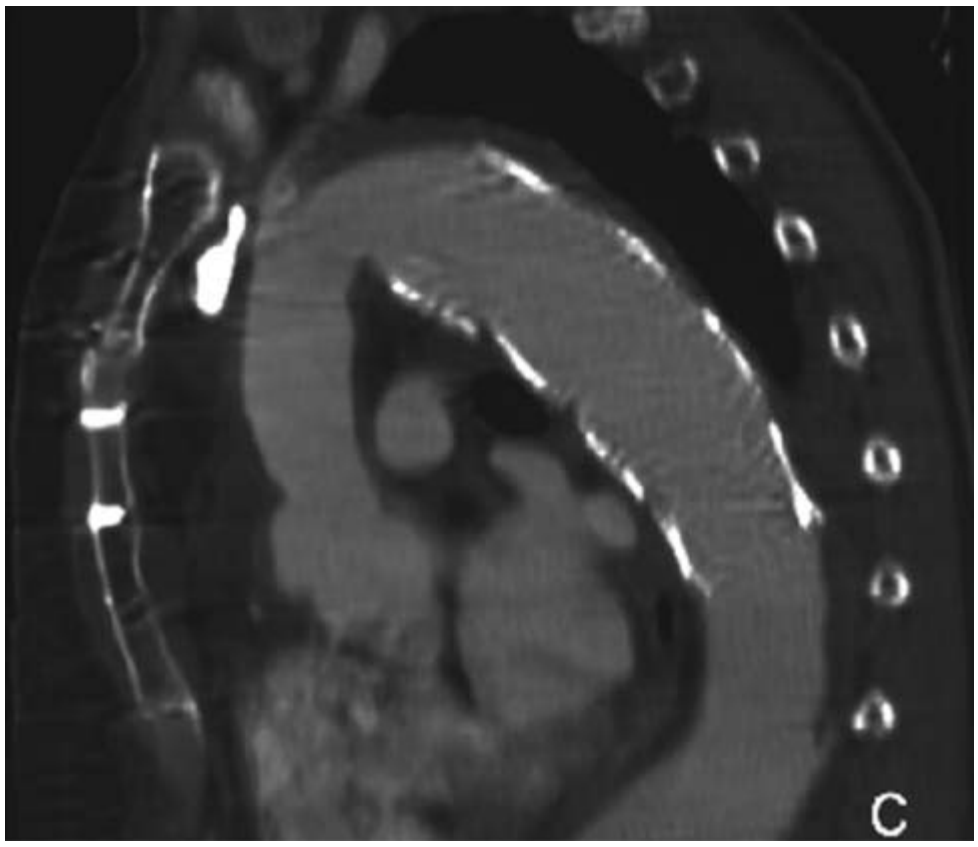

Fig.2c: Total replacement of the thoracic aorta in a one-step procedure using a hybrid endograft for the "Frozen Elephant Trunk".

Don't miss it !

Thoracic aorta stenting update
Special Session
Monday, September 15, 8:30-9:30
Room C

References:
1. *Dake MD, Miller DC, Semba CP, et al. (1994): Transluminal placement of endovascular stent-grafts for the treatment of descending thoracic aortic aneurysms. N Engl J Med; 331: 1729-34.*
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12. *Chavan A, Karck M, Hagl C, et al. (2005): Hybrid Endograft for One-Step Treatment of Multisegment Disease of the Thoracic Aorta. J Vasc Interv Radiol; 16: 823-829.*

Advertorial

The new Kimberly-Clark* MIC*, MIC-KEY* Introducer Kit redefines initial placement by enabling physicians to safely and efficiently facilitate the initial placement of the Kimberly-Clark* MIC* and MIC-KEY* Gastrostomy, Jejunal and Transgastric Jejunal feeding tubes, which provide delivery of enteral nutrition to patients requiring long term nutritional support. This innovative product enhances patient comfort, physician convenience, and safety for both.

"Continuing the Kimberly-Clark Health Care tradition and commitment to innovation and excellence, this new kit features unique devices specifically designed to make patients' lives better and physicians' lives easier," states Vincent Gaspar, General Manager EMEA, Kimberly-Clark Health Care.

Dr. Joshua Weintraub, Associate Professor of Radiology and Surgery, Division Chief of Vascular and Interventional Radiology at Mt. Sinai Medical Center in New York agrees. "I strongly support Kimberly-Clark's new MIC*, MIC-KEY* Introducer Kits for the primary placement of percutaneous gastrostomy and gastro-jejustomy catheters. These will have a significant impact on improving the healthcare, comfort and safety of patients."

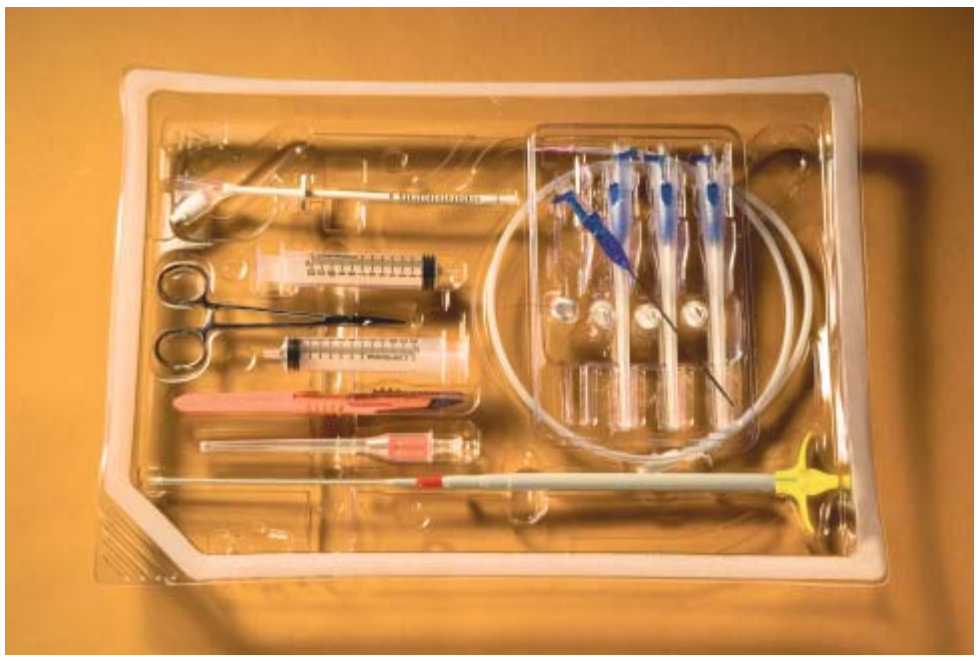
The Kimberly-Clark* MIC*, MIC-KEY* Introducer Kit features:

- The pre-loaded Saf-T-Pexy* gastrointestinal suture anchor system which incorporates resorbable sutures and external suture locks to secure the stomach to the anterior abdominal wall. The Saf-T-Pexy* system eliminates the need for traditional suture removal, minimizes the risk of infection, and enhances stoma tract formation. Unlike traditional sutures, which require an additional office visit for removal, the Saf-T-Pexy* system simply resorbs and sloughs with the internal components passing through the GI tract, leaving the balloon retained tube in place until replacement is required.

- A telescoping serial dilator system with an integrated peel-away sheath which provides an all-in-one, continuous dilation and easy tube placement. The Kimberly-Clark* all-in-one dilator and peel-away sheath does not require removal or multiple exchanges prior to complete dilation and is available in various sizes to better accommodate specific patient needs.

- An Over -The-Wire Stoma Measuring Device which enables a more accurate stoma tract measurement improving the low profile tube fit for enhanced patient comfort and safety.

- Safety devices which facilitate efficiency, enhance the ease of use and protect the health care worker from inadvertent needle sticks.



The Kimberly-Clark* MIC, MIC-Key* Introducer Kits are just one of the clinical solutions physicians can depend on to meet the demands of their fast paced world. Learn more at the Kimberly-Clark Symposium:

"An Innovative Approach to Enteral Feeding"

Professor Michael J. Lee,
Professor of Radiology,
Royal College of Surgeons in Ireland will present "Experience with the new Kimberly-Clark* Introducer Kit for Initial Placement of the MIC-KEY* Low Profile Gastrostomy Feeding Tubes"

Date: Tuesday, September 16
Time: 08:00-08:20
Room: C

Advertorial

Interview with Bob Palmisano, New President and CEO of ev3

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phone +33 156 88 59 10 | fax +33 156 88 59 12
www.ev3.net

Bob, you recently joined ev3 in April as their new President and Chief Executive Officer. Can you tell us what your view is of the business and what ev3's strategy will be?

Bob Palmisano: ev3 has a rich history of technology development and innovation. We will continue to build upon that foundation to be the global market leader and preferred partner for patients and physicians in identifying and treating lower extremity arterial and neurovascular disease through innovative, breakthrough and clinically proven technologies.

How does the acquisition of FoxHollow fit into ev3's strategy?

BP: The acquisition of FoxHollow and the addition of the SilverHawk® atherectomy system to ev3's existing product portfolio is a key component of our strategy to provide a full complement of innovative products in the large and underserved peripheral vascular market. We believe that atherectomy can play an important role in the treatment options for patients with peripheral artery disease as well as complement the existing treatment options that endovascular specialists offer. However, we also realize that it will be important to invest in clinical studies to providing the right scientific data to support broad clinical adoption of atherectomy.

What's new in atherectomy and plaque excision technology?

BP: ev3 recently launched the SilverHawk System with MEC (Micro Efficient Compression) Technology, which is a breakthrough advancement allowing greater tissue storage in the tip of the device via micro vent holes. Not only does this provide an opportunity for a significant increase in packing of plaque, it also allows for a simplified approach, fewer catheter exchanges, and quicker procedure times. ev3 recently received the CE Mark and launched the new RockHawk™ Plaque Excision System. This advanced atherectomy system enables physicians to treat above-the-knee de novo and restenotic calcified and non-calcified lesions in the native peripheral arteries. The RockHawk is based on our market leading SilverHawk® platform and incorporates design changes in the geometry and the material of the cutting blade to facilitate the break down of complex, hard, calcified lesions that may be resistant to conventional treatment. We expect to initiate a clinical study to study the use of the RockHawk System with our SpiderFX embolic protection device later this year.

What can we expect from ev3 in the coming months?

BP: We are looking forward to availability of 12 month follow-up results for our European DURABILITY I study, the world's first prospective study to specifically test the efficacy and integrity of long stents in long, challenging SFA lesions. It is also the first study to specifically evaluate the use of one long EverFlex stent per patient. One hundred fifty one patients were enrolled in the DURABILITY I trial at 13 European centers. At six months, primary patency for our EverFlex stents was 91%, a gratifying and encouraging result, particularly in this very challenging patient population, which included a high percentage of diabetics and a significant percentage of long lesions.

In addition, our top priorities will be to expand our global position in the peripheral vascular and neurovascular markets by increasing procedural penetration, driving growth and expansion in international markets, investing in the development of our next generation of products and pursuing a broad clinical trial agenda to bring new products to market and further validate the scientific foundation of our endovascular procedures.

Don't miss it !
Interventional oncology in lung cancer
Special Session
Tuesday, September 16, 10:00-11:00
Room C

RF ablation of lung tumours

Thierry de Baère
Institut Gustave Roussy, Villejuif, France

Radiofrequency (RF) ablation has achieved impressive results in the treatment of unresectable primary and metastatic liver cancer. Today RF ablation of primary and metastatic lung tumour is increasingly used and seems to provide results at least as impressive as those reported in the liver.

Pre-ablation work-up must be akin to a pre-operative work-up. A chest CT is needed to determine target tumour(s) location and size. Abdominal CT is mandatory to search for distant metastases. PET/CT is useful to search for distant metastases and can be used for follow-up of treated tumours. Lung spirometry is useful in patients with a past history of diffuse lung disease or lung surgery. In our experience, tolerance was good in patients with a FEV1 of more than one litre, but transitory respiratory insufficiency developed in about a third of patients with a FEV1 below one liter. In the long-term follow-up after 2 months no difference was found in the respiratory test between pre and post-RF.

Treatment planning is carried out in a single session, whatever the number of targeted tumours when the tumours are unilateral. A two-week interval is usual when two treatment sessions are scheduled for bilateral disease. In a few instances bilateral treatments in a single session can be uneventful in patients with previous lung surgery when the second lung was treated after completion of the first lung treatment without any CT-depicted complication. The risk of bilateral treatment in patients without previous surgery has to be weighted when treatment on the first lung is uneventful. Single lung patients can be treated, but risk must be discussed.

Anesthesia is in our experience nearly always general anesthesia which seems to provide higher feasibility than that reported with conscious sedation where patients suffered from peri-procedural pain in 29% of cases with treatment interrupted due to pain in 3% of cases. Treatment was stopped due to intractable coughing in 5/30 patients. However, the technique is possible under conscious sedation.

The size of the electrode has to be chosen in view of producing an ablation volume at least 15mm larger than the largest tumour diameter if possible. Over-sizing ablation size compared to tumour size is essential. Indeed in our experience the rate of incomplete local treatment at 18 months was 4% when the ratio between the area of ground glass opacity imaged at 24 to 48 hours and the tumour area before treatment was at least 4, and was 19% when the ratio was below 4. Expandable needle electrodes allow stability of the needle in the tumour even if a pneumothorax occurs and displaces the tumour. RF electrodes introduced through a guiding needle are easier to use under CT guidance, as they avoid breaking sterility through contact between the handle and the CT gantry.

Electrode positioning must be done under CT guidance for the sake of accuracy. 3D multiplanar reconstruction is helpful to image arrays deployment relative to tumour margins. Great care must be taken to avoid traversing the tumour with the electrode shaft or deploying the arrays through the tumour without delivering RF in order to minimize potential seeding. Puncturing the tumour with the electrode shaft itself is not mandatory for small tumours as long as the deployed arrays encompass the tumour, thus providing a volume of ablation containing the tumour (Fig.2). Pneumothorax obtained on purpose with a Vérés needle and re-aspirated after treatment can be used to avoid collateral damage during ablation of subpleural tumours in order to separate the subpleural tumour from the parietal pleura or the mediastinum.

RF delivery to the lung is different from the liver, as lung parenchyma is different in terms of energy deposition, electrical conductivity, heat diffusion and heat convection. An algorithm dedicated to the lung must be used (Table 1). Energy delivery must be adapted to tumour location, as in our experience initial impedance before ablation is significantly different (p=0.04) for the tumours with more than 50% of the tumour abutting the pleura (86.5±29.9 Ohms) and for tumours that were not abutting the pleura (121.3±42.8 Ohms) or the 26 tumours with less than 50% of the tumour abutting the pleura (112.6±32.9 Ohms). Indeed, a tumour surrounded by lung parenchyma is highly electrically and thermally insulated by the air-filled lung parenchyma compared to a tumour abutting on the pleura and will therefore require less energy deposition.

Complications are rare. Pneumothorax occurred in 54% of the RF sessions and must not be considered as a complication. It was large enough to require treatment in 31%. Aspiration through a 5-French side-hole needle catheter capitalizing on CT guidance was attempted. Finally, a 8-French chest tube linked to a dry suction control was left in place in 9% of cases (pneumothorax recurring after aspiration) and maybe these 9% can be considered complication, as hospital stay was prolonged by two to three days. Alveolar haemorrhage and post-procedure haemoptysis occurred respectively in about 10% of procedures and rarely required specific treatment.

Antibiotics after treatment are questionable and among various groups it can extend from 7 days regimen of clavulanate (2g/day) and ofloxacine (400mg/day) to a 48 hours prophylaxis. Very few groups performed lung RF without antibiotics due to the relative high rate of post-RF pneumopathy, which was 6% in our experience. Although never studied with accuracy, it seems in our experience that post-RF pneumopathy is far more frequent after RF in primary lung cancer than after RF for lung metastases due to the usual underlying lung disease in primary cancer patients

Imaging follow-up is still debated. Difficulties to evidence incomplete local ablation are linked to the fact that contrast enhancement is difficult to see in lung tumours and most studies only relied on size modification which is a late sign of tumour re-growth. Some more recent studies with PET seem promising. Using PET will reveal some pitfalls with false positives, such as peri-ablation inflammatory rim, but also inflammatory lymphnodes or uptake at the puncture site on the chest wall.

Local efficacy: After a minimum of 1 year of follow-up, the estimated rate of incomplete local treatment at 18 months was 7% [IC95% = 3 -14] per tumour with incomplete treatment depicted at 4 months (n=1), 6 months (n=2), 9 months (n=2), and 12 months (n=2). Overall survival and lung disease-free survival at 18 months were 71% and 34% respectively. Size is a key point for tumour selection, as incomplete local treatment is highly influenced by tumour size. In our experience the rate of incomplete local treatment at 18 months was 5% for tumours measuring 2cm or less and 13% for tumours larger than 2cm. Tumour size impacts on survival in other reports.

Conclusion
In a manner akin to RF in the liver, RF in the lung provides a high local efficacy rate, close to that of surgical resection. Nevertheless it will be difficult to obtain randomized trials and the choice between RF and surgery in case of a small tumour nodule will be difficult. Follow-up imaging by CT is not optimal due to the late discovery of incomplete local treatment and PET might be useful for follow-up.

Tumour location	Power	Size of the RF electrode			
		2cm	3cm	3,5cm	4cm
Surrounded of parenchyma	initial Power	5W	10W	15W	20W
	increment	5W every minute			
Pleural contact <50%	initial Power	10W	20W	30W	40W
	increment	5W every minute			
Pleural contact >50%	initial Power	30W	40W	50W	60W
	increment	10W every minute			

Table 1: Treatment algorithm applied for RF ablation of lung tumours using a RF 3000 geberator (Radiotherapeutics / Boston Scientific). Initial power in Watts was chosen according to the size of the electrode and tumour location in relation to the pleura. Power increment is a function of the tumour location.

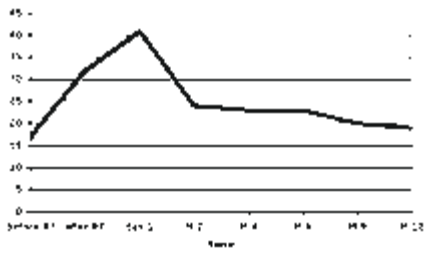

Table 2: Evolution of the largest tumour diameter (before RF) and then RF ablation area along time on follow-up CT demonstrated an ablation area which remains as large as the targeted tumour at 12 months. The only criterion for incomplete local treatment is an increase in size between two follow-ups.

References:
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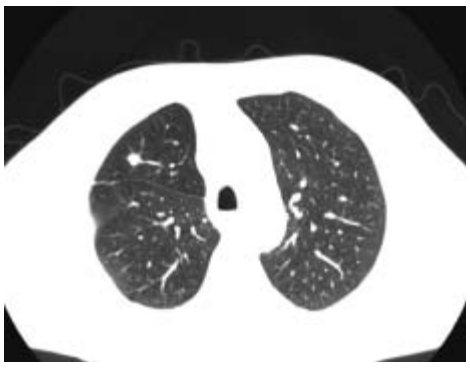

Fig.1:
Single right lung metastasis before RF ablation

Fig.2:
Immediately after ablation faint ground glass opacity is seen encompassing the treated tumour

Fig.3:
Two days later the ground glass opacity can be seen more easily

Fig.4:
Frontal MPR reconstruction of lung metastasis treated with expandable RF needle

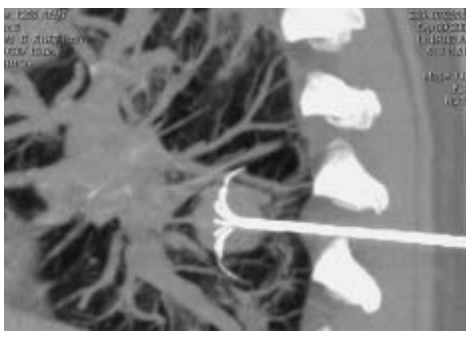

Fig.5:
The same tumour is seen on the sagital MPR. One can appreciate than the tines go beyond the periphery of the tumour and that consequently ablation margins will be achieved

Advertorial

Innova CT clinical benefit in detection and localization of small Cerebrospinal leak

Dr. F. Cohen, Dr. V. Vidal, Prof. J.M. Bartoli, Prof. G. Moulin, Department of Radiology Centre Hospitalier Universitaire La Timone, Marseille, France
B.Wimille, P.Gobert, GE Healthcare, Buc, France

Background:
CHU La Timone (Marseille, France) is amongst the first hospitals in Europe to be equipped with the Innova 3100 digital flat panel angiography system (GE Healthcare). The Innova 3100 system has a 30 cm x 30 cm digital detector designed to perform general vascular and interventional procedures, and allows for rotational flat detector computed tomography (3D/CT), with volume post-processing on a multi-modality Advantage Workstation. The Innova 3D/CTapplications are used for procedures such as peripheral aneurysm embolization, complex peripheral angioplasty, peripheral arterio-venous malformation assessment or visualization of perivascular structures like bone or soft-tissue.

Introduction
Skull base defects are congenital or acquired (traumatic or iatrogenic), and can result in Cerebro Spinal Fluid leaks, with meningitis as a potential life-threatening complication. Risk of CSF leak secondary to functional endoscopic paranasal sinus surgery varies from 0.5 to 3%. Accurate preoperative imaging is essential for surgical planning and has become especially important since the emergence of minimally invasive endoscopic surgical techniques of leakage closure.
1.5T MRI, especially heavily T2-weighted sequences (pseudo-cisternography) can detect CSF leak, and it is the best modality to detect meningocele or meningoencephalocele; but it lacks visualization of the bony structures. High-resolution multidetector computed tomography (MDCT) is the primary imaging modality for localization of skull-base defects. It often is the only test needed for diagnosis however it is limited to identifying defects in bone. Partial volume averaging can cause both false-positive and false-negative findings. Plain CT scans have a 9.5% false-positive identification of a bony defect in inactive CSF fistulas. CT-cisternography is also limited by the CT slice-thickness and the voxel size.
The value of flat-panel CT was assessed in 2 patients in whom 64 rows MDCT and 1.5T MRI examination did not demonstrate the location of a proven CSF fistula.

Flat-panel 3D/CT cisternography procedure:
Patient lies in a lateral decubitus on the angiography table; a lumbar puncture is performed under fluoroscopic guidance and after a depletion of 6-10 ml of CSF, we slowly inject 15 ml of non-ionic iso-osmolar iodinated contrast. The patient is then put in prone position with a pelvis elevation. When the contrast media reaches the posterior cerebral fossa (seen under fluoroscopy), we perform a rotational flat-panel CT acquisition with the following parameters: patient in prone position with headrest, rotation speed=10°/s, acquisition field =16 x 16 cm, reconstruction matrix 512^3, reconstruction filter=Sharp, voxel size=$0.12mm^3$. Isotropic voxels allow for high-quality multiplanar oblique reconstructions, performed on Advantage Workstation.

Case n°1
A 42 year-old male underwent 5 months ago functional endoscopic sinus surgery (middle turbinate resection and middle meatal antrostomy); nasal drip appeared 2 weeks after surgery. Cerebrospinal fluid (CSF) rhinorrhea was confirmed by laboratory analysis but location of CSF fistula was not revealed either on high-resolution multidetector CT (64 detector, slice thickness 0.4mm) or on MRI (1.5T). His surgeon presumed that during endoscopic surgery, the anterior skull base was penetrated with an instrument. After 1 week of inefficient conservative treatment, the surgeon attempted a minimally invasive leakage repair via a nasal endoscopic approach. Because of diffuse mucosa inflammation, the location of the leakage was not clearly identified and a small graft was put on the left ethmoid roof. Unfortunately CSF rhinorrhea reappeared 1 week later.
Because of the risk of meningitis, this patient was referred in our institution for an invasive endonasal leakage repair, which has a high risk of anosmia. We decided to perform a flat-panel 3D/CT cisternography. This examination demonstrated a very thin contrast leak to left nasal fossa, located in the left cribriform plate, on the posterior third of the olfactory groove (figures 1-4). This very precise localization allowed for minimally invasive endonasal surgery. 10 months after this third intervention, the patient does not show any sign of recurrence.

Case n°2
A 37 year-old female was referred in our institution for endoscopic resection of an ethmoid roof osteoma. During surgical intervention, a fracture of the anterior skull base occurred, with massive CSF fistula. The surgeon placed a graft to treat this fistula, and the ethmoid osteoma could not be totally resected. 2 weeks after surgery, the patient still presented profuse CSF rhinorrhea. A 1.5T MRI demonstrated a small meningoencephalocele, laterally to the graft, and a new surgical intervention was performed to resect this brain herniation and to put a larger graft on the leakage. 5 weeks after this second surgical intervention, the patient still presented nasal drip that proved to be CSF. A new MRI (1.5T) did not show meningocele recurrence or patent CSF leak. We performed a flat-panel 3D/CT cisternography that clearly demonstrated a CSF leak, medially to the graft material, located in the lateral cribriform lamella (figures 5-8). This precise location allowed for precise minimally invasive endonasal leakage repair. 4 months after this intervention, the patient did not show any sign of recurrence.

Discussion:
The most common site of traumatic bone defect is the cribriform plate of the ethmoid. This bony structure is very thin, and has multiple small perforations (transmission of neural fibers into the nasal cavity) that can cause partial averaging volume effects on MDCT imaging.
The Innova CT acquisition, with its improved spatial resolution, allowed us to explore this complex anatomic area with voxels two-times smaller than our 64 rows detectors CT, with good contrast enough between bone, iodine and air, and acceptable scatter artifacts.

Conclusion:
Key for the management of CSF leakage is the localization of the fistula. Small isotropic 0.12 mm^3 voxels of Innova CT seem to be an important clinical benefit in detection and localization of small CSF leaks, especially in the cribriform plate of the ethmoid.

Fig 1 (Case 1): Reformatted Coronal View, showing middle meatal antrostomy and middle turbinate resection (Asterisk). Arrow shows contrast leak (CSF fistula) at the level the left cribriform plate.

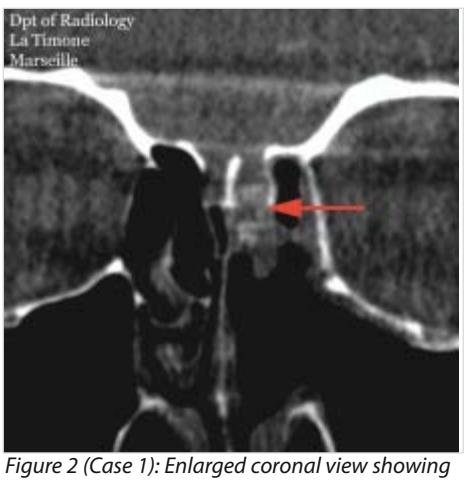

Figure 2 (Case 1): Enlarged coronal view showing the thin CSF fistula (Arrow)

Figure 3 (Case 1): Reformatted sagittal view showing the thin CSF fistula (Arrow)

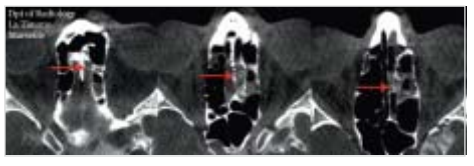

Figure 4 (Case 1): consecutive axial views of the CSF fistula tract, located at the posterior third of left cribriform plate (Arrows)

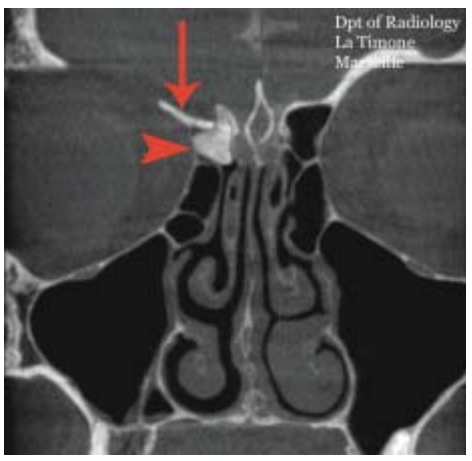

Figure 5 (Case 2): Reformatted coronal view showing residual osteoma of the right ethmoïd (Arrow head) and graft material located on the right ethmoïd roof (Arrows).

Figure 6 (Case 2): Reformatted coronal view showing contrast leakage medially to the graft material, through lateral cribriform lamella (Arrow)

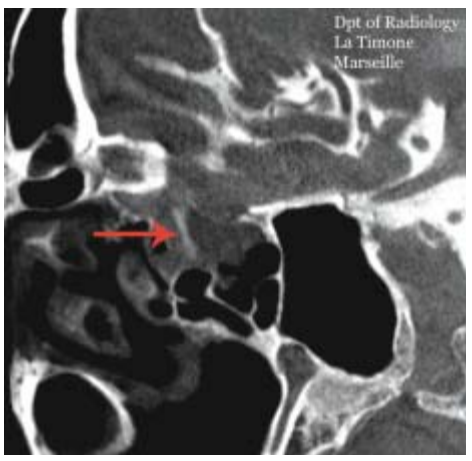

Figure 7 (Case 2): Reformatted sagittal oblique view through the CSF fistula tract (Arrow)

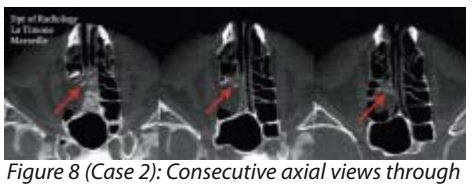

Figure 8 (Case 2): Consecutive axial views through the CSF fistula tract (Arrows)

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Cryoablation: advantages and limits

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Consultant of Radiology in Interventional Radiology, University Hospital Strasbourg
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Cryoablation refers to the application of extreme cold to destroy diseased tissue, including cancer cells. Research in the field of cryobiology has demonstrated that critical temperature below -20°C achieves cell death. First generation cryodevices were limited to intra-operative use. Indeed, the use of liquid nitrogen for tissue cooling with lack of well-insulated probes and large diameters of the cryoprobe required laparoscopic interventions. With the development of percutaneous miniaturised gas driven probes (17 gauge) cryoablation is now feasible in CT or MR tunnels and allows treatment of prostate, liver, bone and kidney cancers.

Mechanism
Gas driven cryomachines rely on the physical relationship between temperature and pressure (Joule-Thomson effect): at atmospheric pressure, most gases are cooled by expansion. Only small gases such as helium are warmed by expansion, due to reduced collisions (negative Joule-Thompson effect). High pressure argon (300 bars) is used for freezing. Helium is used via the same probe to warm it and thaw the ice ball. Thus, it accelerates the treatment process, allows for repositioning of the probe and provides additional safety by enabling rapid stopping of the ice ball formation.

The biological destructive effects of cryoablation can be grouped into two major mechanisms (1):

- Immediate cellular injury: During the first freezing cycle, ice crystals are mainly extracellular. During slow thawing, water diffuses into the intracellular compartment due to the osmotic effect. After a second freezing cycle, intracellular crystal formation achieves membrane rupture and cell death.
- Delayed vascular injury, as freezing induces intravascular crystallisation with micro thrombi and ischemia.

Compared to radiofrequency which does not discriminate the ablated tissues, cryoablation offers relative protection of the collagen structures.

Equipment
One of the major advantages of last generation cryosystems is the possibility to insert multiple probes (up to 25) and use them simultaneously. Thus, several probes can be combined to treat a large single tumour or to simultaneously treat multiple small tumours. Different cryoprobes producing various sizes and shapes of ice balls are available. Moreover, several thermosensors can be connected if thermal monitoring of adjacent vulnerable structures is needed.

Patient Selection and Technique
Cryoablation has been used to treat liver, kidney, prostate and bone tumours. The indications and the planning of the procedure are very similar to those of radiofrequency ablation. The learning phase is shorter, but the risk of damaging surrounding tissue sill exists.

Cryoablation procedures are performed under sedation or general anaesthesia. However, percutaneous cryoablation appears to require less analgesia than RFA, particularly for bone tumour ablation. Cryoablation of tumours is a time-consuming procedure, as generally two 10-minutes freeze cycles, separated by a 10 minute passive thaw cycle, are performed per position. Spiral CT with multiplanar reconstruction is used intermittently to monitor the ice ball.

What results at the tip of the probe is an "ice ball" which has a predictable geometry based on the length and diameter of the expansion room at the tip of the probe. For complete necrosis of the tumour, it is important to extend the margins of the ice ball to a minimum of 3-5 mm distance beyond the tumour margins in order to ensure complete cell death.

This ice ball can be visualised by various imaging techniques including ultrasound, CT and MR imaging. Ultrasound, though very practical for certain applications, does not permit visualisation deep into the most superficial portion of the ice ball. Most institutions do not have the capability to employ MR imaging during the treatment process. This leaves CT imaging as the most practical and widely employed modality for this purpose. Successful procedure relies on the imaging to precisely visualise the extension of the ice ball, to adapt the size of the probes and their spatial positioning with 2 cm being the ideal distance between probes.

In comparison to other forms of percutaneous ablation, cryoablation offers the additional advantages of direct visualisation of the ice ball and less peri- and post-procedural pain. Cryoablation is also efficient in painful sclerotic bone metastases and the ice ball can extend beyond the cortical bone. If cryoablation is performed in a weight bearing bone such as a vertebral body, additional consolidation with cementoplasty must be considered. For such cases, cement should not be injected before complete thawing and return to the tissue's normal temperature in order to avoid leakage.

Patient Outcome
Percutaneous cryoablation seems to be a safe and effective method for tumour ablation. The risk of post-procedural haemorrhage has dropped since the use of 17 gauge probes. The treatment intent can be curative (kidney tumour) or palliative (painful bone metastasis). Successful tissue ablation depends on four criteria: excellent monitoring of the process; fast cooling to a lethal temperature; slow thawing and repetition of the freeze-thaw cycle (two cycles minimum). Repetition of the treatment cycle is associated with more extensive and more certain tissue destruction, as cells are subjected to additional deleterious physico-chemical changes after they are already weakened by damage sustained in the first cycle. The longer the thaw duration, the greater the damage to the cells; current data suggest that slow thawing is a more important mechanism for cell death than rapid cooling.

Careful monitoring of the cryoablation is mandatory to avoid freezing of any nearby neurovascular structures and the skin. If thermal protection of surrounding organs is required, it is ideally performed with CO2 insufflations. Fluid instillation is not a suitable thermal protection technique for cryoablation, as it immediately freezes in contact with the ice ball. For superficial tumours, skin can be thermally protected by applying sterile gloves filled with warm saline directly on the skin.

In comparison to RFA, large vessels may act as a "cold sink effect" with higher risk of residual tumour in contact with vascular structures. The precise visual control of the ice ball and the more predictable shape of the ablated area increase the safety when performing ablation close to vulnerable structures. A temporary neuropraxia may develop in nerves if they are inadvertently incorporated into the periphery of the ice ball with a temperature below 5°C, which should resolve with time. If in the centre of the ice ball, where temperatures of -40°C or lower predominate, permanent neurological damage may result. To prevent pathological fractures a consolidation is necessary.

For soft tissue and bone tumours the visual control of the ice ball is a major advantage for successful ablation with maximum precision (Fig.1). Precise delimitation of the ice ball allows reducing complication with adjacent tissue damage, particularly nerve roots (2). Thermosensors and insulation techniques can be added to increase the safety. Moreover, musculoskeletal cryoablation is less painful than radiofrequency ablation. In spinal or acetabular tumours, a percutaneous cementoplasty should be associated to cryoablation to avoid compression fractures (Fig.2). The cement is injected after complete thawing of the ice ball or the day after the cryoablation.

For liver tumours, cryoablation is feasible but requires larger margins to accomplish complete ablation (3). It could be promising for tumours close to common bile duct. A syndrome of multi-organ failure and disseminated intravascular coagulation ("cryoshock phenomenon") following large hepatic cryoablation has been described. It may be due to secondary release of liver cytokines, but has not been reported for other organ cryoablation.

For kidney tumour ablation, the clear visual control of the ice ball and the relative protection of collagen structures (4) make cryoablation the technique of choice, particularly for central lesions. Indeed to risk of thermal damage to pyelic structures is less compared to radiofrequency ablation (Fig.3). For thoracic tumours, cryoablation of parenchymal tumours is still under evaluation. However, for chest wall (Fig.4) and paramediastinal tumours, cryoablation seems very promising (5).

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Fig.1: Right painful paravertebral metastasis of lung cancer. The extent of the ice ball (oval-shaped hypodensity) is precisely monitored with CT guidance.

Fig.2: Same patient as in Fig.1. If vertebral consolidation is required, additional vertebroplasty is performed after complete thawing of the ice ball.

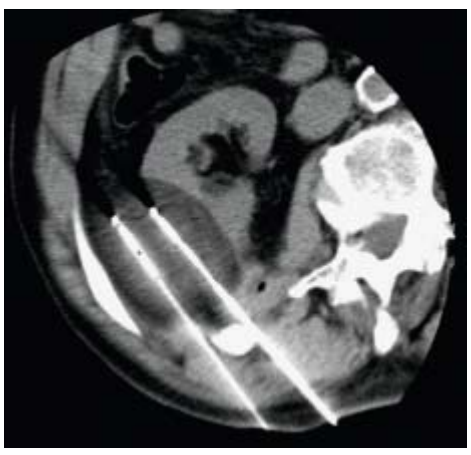

Fig.3: Renal tumour cryoablation. Precise monitoring of the ice ball with CT. The risk of thermal damage to the pyelic system is less than with radiofrequency ablation.

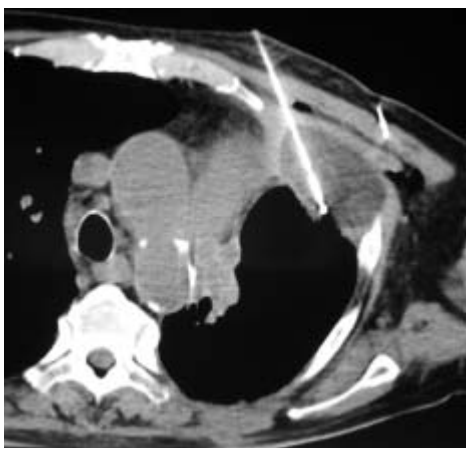

Fig.4: Cryoablation of painful thoracic wall metastasis. Precise monitoring of the ice ball with CT. Cryoablation is less painful compared to radiofrequency ablation.

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*. Schillinger M et al. NEJM 2006; 354:18.

MR guided focused ultrasound surgery

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Ablation technologies have become increasingly commonplace in the last five years as methods of destroying tumour tissue within solid organs using minimally invasive procedures to deliver this type of therapy. Focused ultrasound is the latest technology in this evolution of therapies and has the potential of being so minimally invasive that in fact it is not invasive at all, with no percutaneous needles or probes required to deliver thermally destructive heat to tissues. Like all good ideas it was first proposed by our fathers and grandfathers in the mid 1940s (1) with the original suggestions to use high power ultrasound to deliver heat as destructive power to tissues originating. It is only more recently however that other technologies such as image guidance have caught up with these principles to allow a safe utilisation of this technology (2).

Described in its most basic terms focused ultrasound uses ultrasonic power of approximately 5,000 to 10,000 times the power of conventional diagnostic ultrasound focused to a very small point deep in tissues (3). The molecules in the area of focus are rapidly vibrated and as a result the area is heated. Once the temperature is elevated beyond 55°C for one second, cellular proteins are coagulated, the cell can no longer function and dies. Although its vasculature is still in place, perfusion to the cell is shut down.

This type of energy can be delivered to deep tissues provided there is an appropriate acoustic window allowing safe deposition of power in the target area. Obviously having structures such as gas within the bowel or bone in the acoustic beam the pathway causes severe problems with the former causing localised reflection and potential excessive tissue damage, the latter problem causing complete absorption of the ultrasound beam with no energy available beyond.

Many different manufacturers are involved in the development of this technology and inevitably their approaches still differ quite a lot. There are a variety of focused ultrasound machines available which use conventional diagnostic ultrasound to guide and control the utilisation of focused ultrasound power. The drawback of these techniques is that targeting can be quite difficult and that no real useful thermal feedback can be obtained using ultrasound. It is unequivocally true that changes in tissues are seen with ultrasound as the heat is applied, but it is also evident that currently the extent of these changes are not in any way correlated with the tissue results and the temperature produced in the tissues. Therefore using ultrasound to monitor the area heated provides no predictive information as to the extent of damage produced.

The technology described in this article consists of a combination of an MR machine and a focused ultrasound delivery system in one integrated component. This means that the focused ultrasound delivery mechanism that is utilised in the very hostile environment of high field MR must be completely MR compatible in all respects with no ferromagnetic components and no electrical machinery producing significant radiofrequency energy leakage which could distort MR images. Figure 1 shows the system in action with the machine table that is normally used completely replaced by a similar table containing a degassed water bath within which the electronic array of transducers that produce the focused ultrasound energy is placed. This array can be translated across the field of view and can also be pitched and rolled to provide a suitable acoustic pathway to the target area (Figure 2).

MR imaging is used to provide the best possible visualisation of the target lesion and the surrounding tissues using the superb soft tissue contrast that is inherent to MR. This provides optimal targeting of tissue whilst providing a safe beam pathway with maximum operator reassurance allowing a very accurate deposition of destructive energy at the desired site. Accurate targeting is combined with thermal imaging to provide a read out of tissue response multiple times during each sonication (4). Thermal mapping allows the operator to adjust sonication parameters in response to visualised tissue thermal changes. There is immense variability in tissue response both between patients and within the same area of heating due to variations in vascularity, fat content, etc. Visualising these changes as they happen allows the operator to titrate input power in such a way as to create an appropriate thermal lesion.

The most common area of application of MRgFUS around the world to date has been in the treatment of uterine fibroids (5, 6). It is easy to obtain a suitable acoustic window with sizeable uterine fibroids via the anterior abdominal wall and large areas of destruction can be produced within these benign tumours with relative ease. Conventional indications suggest that fibroids of up to 20 cm can be treated although fibroids between 10 and 20 cm in diameter are usually pre-treated by GNRH agonists which cause some reduction in size and reduce vascularity, thus allowing large fibroids to be treated when they are in a smaller state (7).

Using these criteria, studies indicate that 80% of patients show a significant symptomatic response following MRgFUS treatment at three and six months. More recently it has become clear that if more than 60% of the targeted fibroid is successfully treated, the requirement for further procedures of any sort to treat the patient's fibroids at 24 months is 11% (8), which compares very favourably with a much higher rate reported 24 months post myomectomy (conventional gold standard). Further studies are emerging with longer follow-ups suggesting that symptomatic responses following MRgFUS are entirely comparable to those seen with other treatment modalities over a 24 month follow-up.

As MR gFUS in this context is an entirely non-invasive outpatient procedure with almost no post-procedural pain, it has immense advantages over other existing treatment modalities. It is also likely that MRgFUS will have advantages for women wishing to preserve their fertility. While no randomised comparative data exist in this field so far. More than 40 relatively uncomplicated pregnancies amongst women from around the world who have received this treatment have been recorded to date with no noted instances of uterine rupture or other similar complications.

Uterine fibroids are of course only the first major application of this type of technology. MRgFUS provides the potential of a thermal destructive modality which can be controlled by image guidance in a very accurate manner. It is therefore obvious that it can potentially be applied in many other areas, especially in the field of oncology to destroy tumours in solid organs. There is early work available on the breast indicating that MRgFUS can be easily applied to breast cancers to replace wide local excision, thus minimising surgical breast trauma (9).

Painful bone secondaries can be treated relatively easily for pain palliation with MR GFUS in the non axial skeleton. In this situation ultrasound is very avidly absorbed by the periosteum and cortical margins, so that neurogenic fibres in the periosteum are rapidly destroyed by the heat. This leads to significant improvement in the pain secondary to metastatic deposits and can be performed as a one off outpatient procedure with long-lasting pain relief. This type of procedure is currently purely palliative and does not treat the underlying lesion (10).

Early work is being piloted in the use of MRgFUS in the liver. Unfortunately most of the time the ribs get in the way, shielding the liver and disrupting the ultrasound beam which currently has a quite wide footprint. Pilot information is therefore only available when lesions are accessible either below the right rib line or in the left lobe uncovered by ribs. Early work suggests that it is relatively easy to produce effective areas of thermal destruction in amenable parts of the liver which would be expected, given the successful experience with thermal ablation of liver tumours.

It is anticipated that within 12 months much larger transducers will be available which can deliver energy between ribs and take respiration motion into account, overcoming the current limitations. In the future focused ultrasound guided with MR is likely to be applied to many other accessible areas within the body, allowing non-invasive therapeutic interventions to be performed as outpatient procedures without associated hospitalisation.

The potential cost savings of this type of therapy more than offset the initially higher capital outlay for the appropriate machinery. Early cost-effectiveness studies in uterine fibroids within the NHS in the UK (11) have already indicated that MRgFUS is a more cost-effective technique for the treatment of fibroids than surgery or uterine artery embolization because of its rapid restoration of patient quality of life with very few side effects.

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Fig. 1: Conventional MR G. FUS setup with normal MR table replaced by a modified table containing FUS transducer and water bath. The whole operation of focused ultrasound and MR guidance is controlled by a workstation that enslaves normal MR controls.

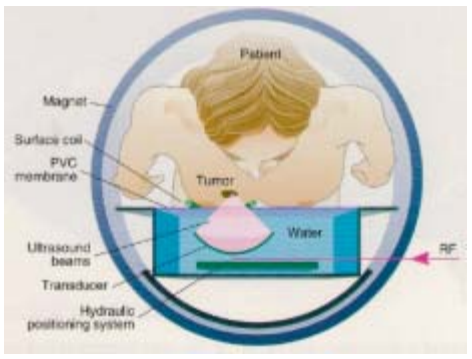


Fig. 2: Schematic of patient within the bore of the MR scanner with breast applied to the water bath containing transducer allowing an acoustic pathway to the target site with no gas or other structure intervening.

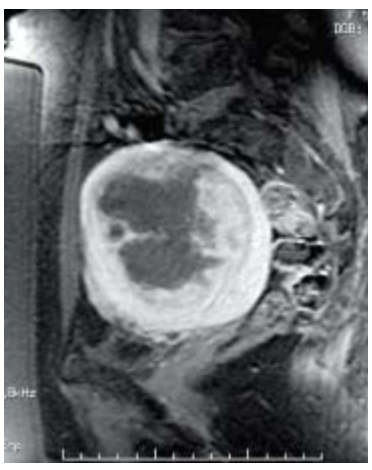


Fig. 3: Moderate sized uterine fibroid post-procedure. This is a fat saturated T1 gradient echo image post contrast. The central non enhancing area is the ablation destruction with the surrounding normal myometrium enhancing normally.

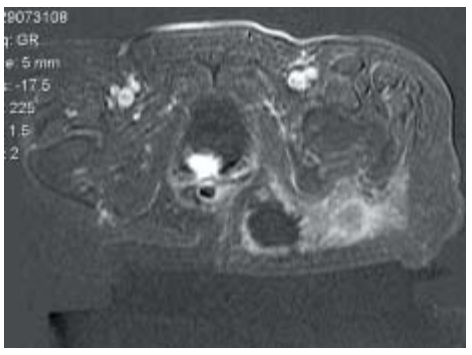
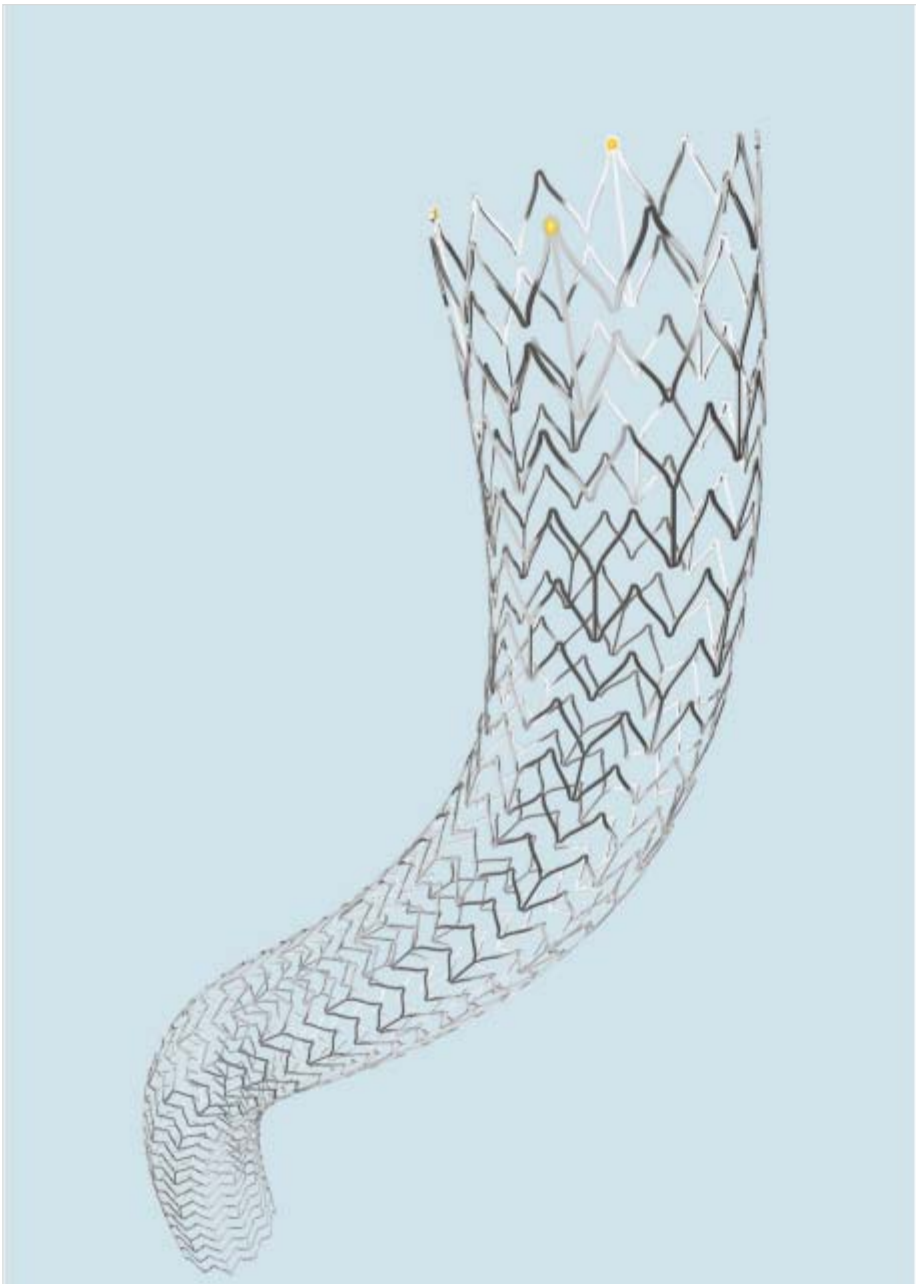


Fig. 4: Ablation procedure applied to metastatic deposits in the buttock. This is a subtraction fat saturated gradient echo T1 image post contrast showing an area of decreased enhancement in the centre of the enhancing tumour which has been produced by one short session of focused ultrasound directed at this area. Residual tumour remains close to the sciatic nerve.



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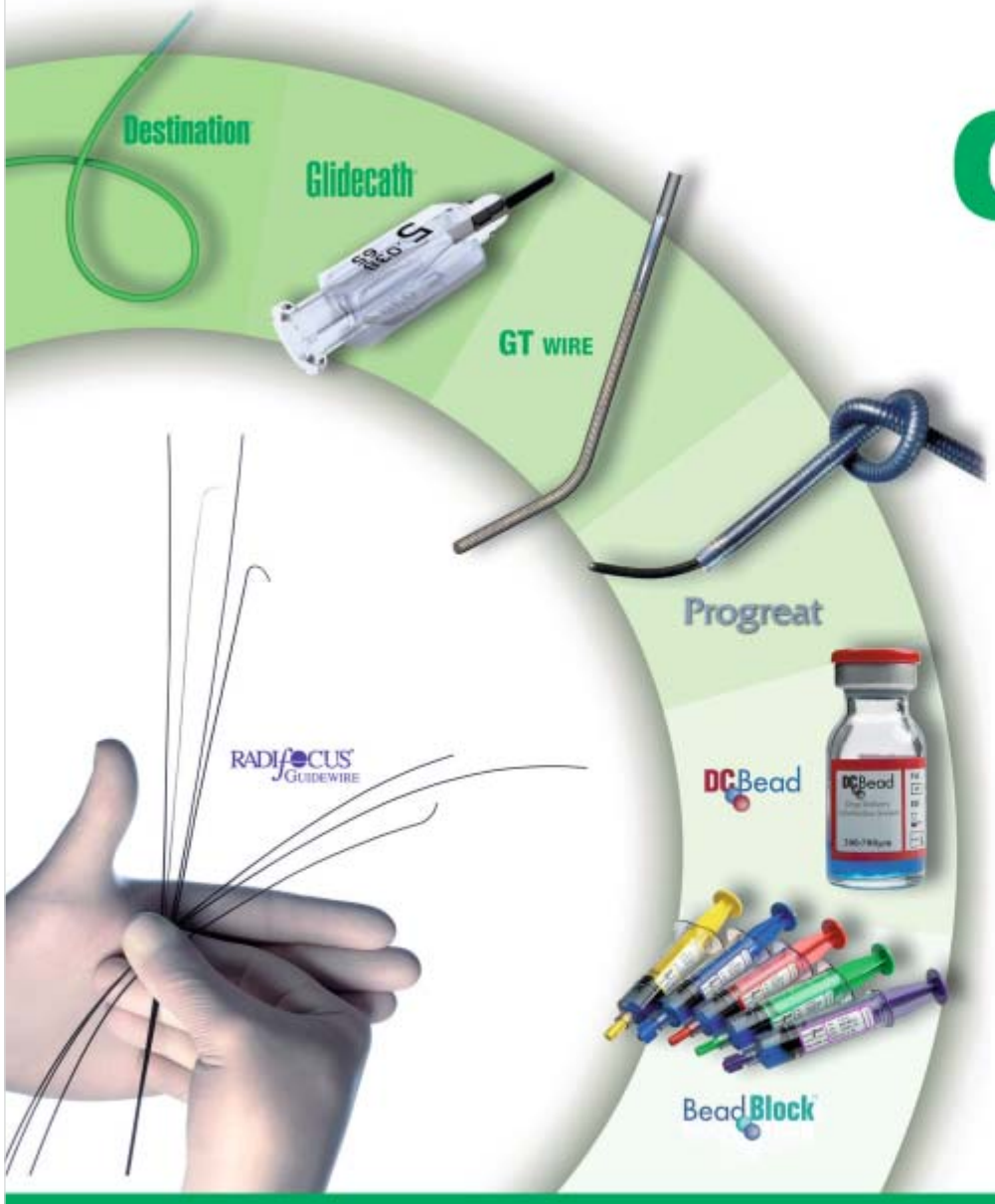

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Induction of therapeutic angiogenesis by endovascular application of autologous bone-marrow derived stem cells in patients with critical limb ischemia

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Late Breaking Abstracts
Free Paper Session
Monday, September 15, 17:30-18:30
Room B

Background
Critical limb ischemia (CLI) is an end-stage disease provoked by progressive obstruction of the peripheral arteries. Most patients have a multi-system and multi-level disease within the involved extremity with long segments of involvement and with additional distal vessel involvement (1-3). This makes it difficult to perform surgical or endovascular revascularization. Only 20-30% of these patients have a suitable anatomy for surgical or endovascular revascularization. In the remaining cases, palliative medical treatment is usually resorted to, with amputation becoming unavoidable in the near term. Amputation is almost certain in absence of prompt intervention. In patients in whom surgical or endovascular revascularization is not feasible or has failed, induction of therapeutic angiogenesis by stem cell implantation could provide therapeutic benefit and may be instrumental in limb salvage.

Pre-clinical studies have shown that angiogenic growth factors promote development of collateral arteries (4-6). Neogenesis of both cardiomyocytes and coronary capillaries with some functional improvement was reported by several investigations using bone marrow derived cells in experimental infarction (7-15). Similar data was also reported in surgically treated chronic ischemic disease (16-19). Preliminary studies in small groups of patients with CLI have shown encouraging results with this approach in the management of CLI, usually by employing local intramuscular injections for delivery of stem cells (20-24). An alternative endovascular route for delivery of stem cells is possible, but not well studied. Further, at this time no data exist on the optimal dosage of stem cells required for clinical benefit.

We have tested the hypothesis that combined autologous bone marrow-derived stem cells injected intra-arterially in the affected limb at the site of arterial occlusion along with aggressive medical management results in better outcomes as compared to aggressive medical management alone in a group of patients with CLI who are not candidates for surgical or endovascular revascularization. We have also evaluated the outcomes after injection of graded doses of stem cells for this treatment.

Method
Study design
Randomized controlled study with parallel group design and with blinded interpretation of the outcomes. We enroll patients with unilateral or bilateral CLI who are not suited for surgical or endovascular revascularization. Randomization is done by computer generated models. The study design is approved by the Institute Ethics Committee. Informed written consent is obtained from each patient. Predefined statistical methods are used to evaluate the outcomes.

Inclusion criteria

1) Clinical
a) Rest pain requiring analgesia for >2 weeks and/or non healing ischemic ulcers
b) Absent or weak peripheral pulses
c) No response to smoking cessation for at least 3 months prior to evaluation
d) Not suited for surgical/ endovascular revascularization
d) Unilateral or bilateral involvement
e) Claudication distance of <100 meters

2) Hemodynamic
a) Doppler study showing an occluded superficial femoral, popliteal or infra-popliteal artery with no or poor distal flow as evidenced by a monophasic, low velocity, collateralized flow pattern.
b) Contrast-enhanced magnetic resonance and digital subtraction angiography demonstrating the site of occlusion, status of distal run-off and the extent of collateralization
c) Ankle systolic pressure <50 mm Hg
d) A resting ankle brachial pressure index <0.5 in the affected limb on 2 consecutive examinations done at least 2 days apart

Exclusion criteria

a) Poorly controlled diabetes mellitus
b) Evidence of a malignancy during the last 5 years
c) Renal dysfunction or other contraindication to injection of contrast media
d) Continued smoking
e) Limitation to exercise due to any reason other than claudication
Age, Sex or any other clinical parameters are not used to exclude patients.

Pre-Procedure Assessment
This includes detailed clinical examination for optimal documentation of multi-system disease and of the extremity arteries to define the extent of multi-level disease within the involved extremity. Pertinent past history related to drug intake, smoking, risk factors for atherosclerosis and previous history of interventions (medical, surgical or endovascular) is recorded. At base-line ABI, duplex ultrasound (US), MRA and an intra-arterial digital subtraction angiography (IA-DSA) are performed to obtain adequate information on the site & extent of the disease and the status of distal run-off vessels.

Stem Cell Isolation
Under local anesthesia, bone marrow (up to 100 ml) is aspirated from the iliac crest using a disposable bone marrow aspiration needle under sterile aseptic condition. Mononuclear bone marrow cells (BMC) are separated by Ficoll density separation method. Briefly, BMC are layered over lymphocyte separation medium and centrifuged at a speed of 1,500 rpm for 30 minutes. Mononuclear cells are aspirated and washed thrice in heparinized normal saline to remove the traces of Ficoll. The entire procedure is done under strict aseptic conditions. The harvested mononuclear BMC are evaluated for viability of cells by Trypan blue dye exclusion test, flow cytometry and for MNC morphology by Giemsa staining.

Intra-arterial Injection
Percutaneous intra-arterial injection of these cells at the site of occlusion from contra-lateral approach by using a 5 F multi-purpose catheter is done within one hour of harvesting stem cells. IA-DSA is performed immediately before and after stem cell injection. The desired amount of cells is injected into the artery at the site of occlusion after US-guided manual occlusion of ipsi-lateral common femoral vein. IA-DSA is performed using a standardized amount of iodinated contrast material, acquisition frame rate and table-screen distance to ensure optimal comparison of images during follow-up for evaluation of collateral density.

Post Procedure evaluation
This includes assessment of the treated limb for any local signs of inflammation up to 72 hours after injection. Biochemical evaluation is also done to evaluate hematological, renal & hepatic parameters during follow-up. Imaging follow-up includes ABI at 1, 3 and 6 months and duplex US, MRA & IA-DSA at 6-month follow-up. Assessment for collateral vessel development is graded as no collateral (Grade 0), slight (Grade 1), moderate (Grade 2) and rich development (Grade 3).

End-Points
Pre-defined end-points, primary for safety & efficacy of the treatment and secondary for follow-up outcomes, are used for analysis of the results of treatment. Outcome analysis is performed as per the pre-determined protocols for assessing the efficacy of this treatment. Two trained observers with over five years of experience in interpreting these images read the images independently blinded to the treatment and to each other. The differences in interpretation, if any, are resolved by consensus.

Results
The procedure is well tolerated by all patients. We have not encountered any procedure-related complications at puncture site, treatment site or in remote location. All procedures were technically successful. Whereas in the control group, no clinical or imaging improvement was seen in any patient, benefit in terms of clinical, ABI and imaging improvement is seen in most patients who have received stem cells by intra-arterial route. Overall, 70-100% of patients show varying degrees of clinical and/or imaging improvement after stem cell therapy. During follow-up, no patient has shown any evidence of malignancy, arterio-venous fistula or malformation in the affected limb after treatment with stem cells. The clinical benefit is sustained over time during follow-up in most patients.

Use in other disease states & future scope
We have pioneered this concept of endovascular delivery of autologous stem cells at the site of disease and applied it to various disease states, including diabetes mellitus, renal failure, cerebral palsy, muscular dystrophies, dilated cardiomyopathy and spinal cord injuries, among others. In each of these disease states we use a similar study design, as described for CLI, approved by the Institute Ethics Committee. At this time we have treated over 300 patients with above diseases by this approach. The preliminary results have been encouraging with adequately documented improvements without complication among selected patients. Long term outcomes with clinical and imaging follow-up to evaluate the efficacy of this therapy and its safety in terms of longer term adverse events need to be determined before its place in the management algorithm of these diseases can be established. Stem cell therapy has the potential to change the way we treat patients in selected disease states.

Fig.1a: IA-DSA in a patient with critical limb ischemia before treatment
Fig.1b: IA-DSA 6 months after treatment with autologous stem cells delivered intra-arterially showing improvement in collateral flow

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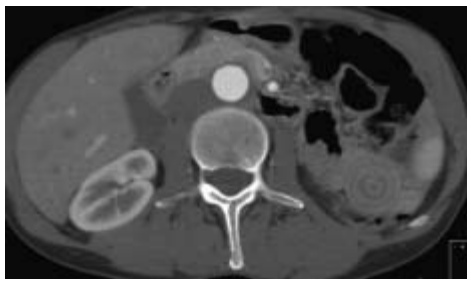
Film Interpretation Panel

Case 5

Weight loss & abdominal pain

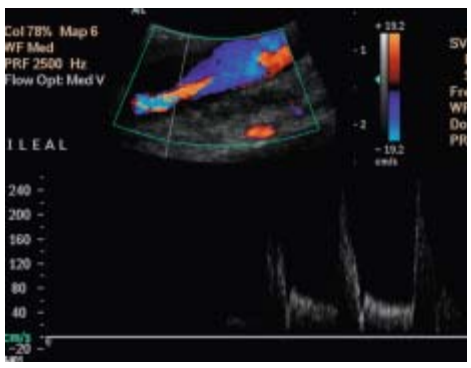
- 64 year old female, 1year history of unexplained weight loss
- Intermittent abdominal pain
- Referred for a CT scan

What does this show?



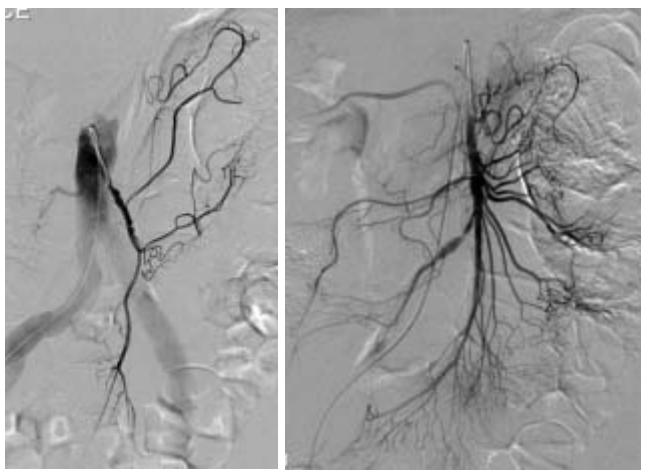
Investigations

- Otherwise normal CT scan
- Normal OGD, Colonoscopy
- Normal small bowel meal – no source of intussuseption
- Contrast ultrasound



- Focal stenosis of branch ?
  Ileocolic artery or rt colic artery?
- Irregularity of proximal SMA
- Irregularity of proximal IMA

Referred for angiography



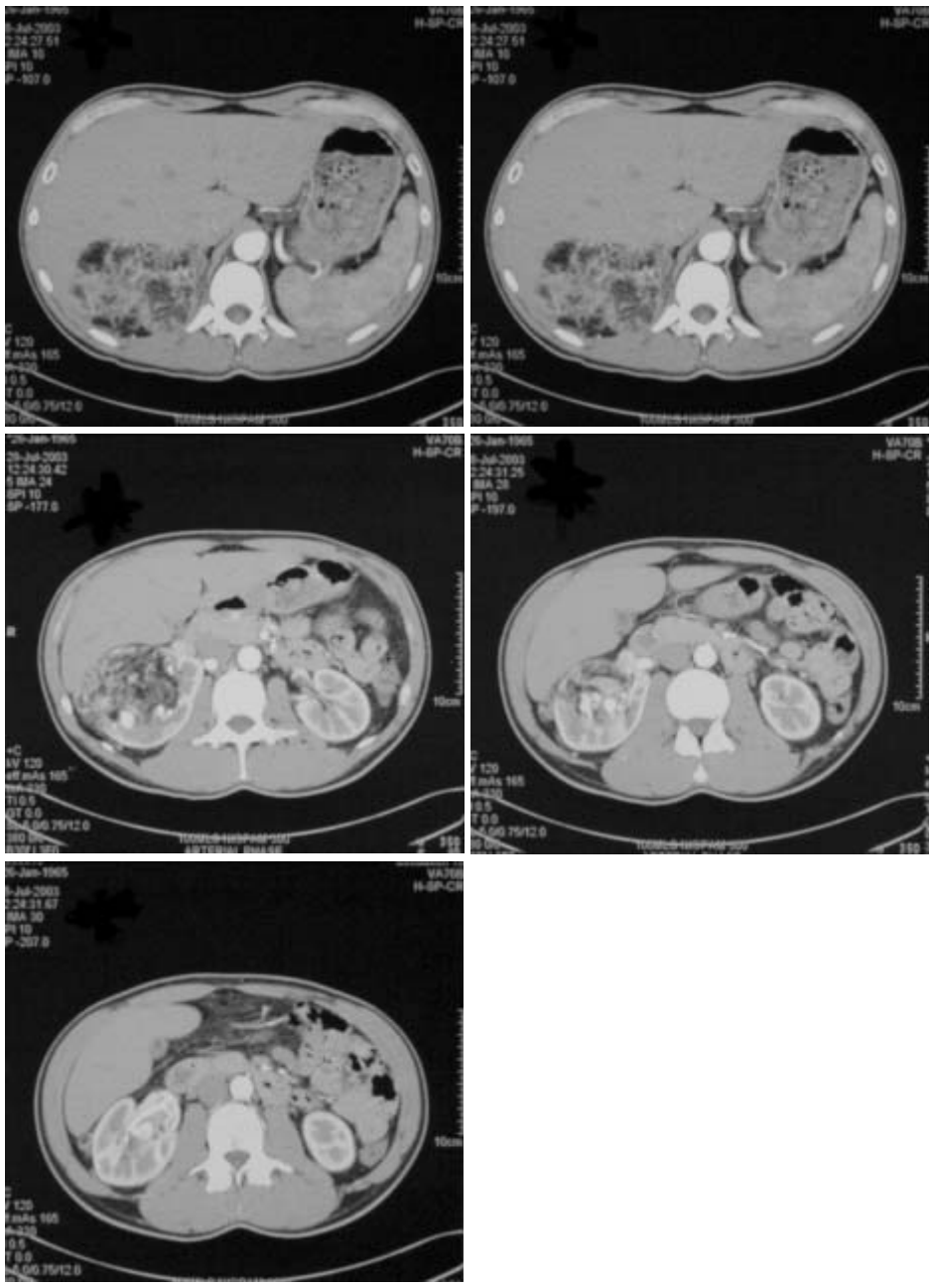
What does this show?

Join us to witness the fight of Team Odin versus Team Thor today at 3pm in Room A. For those of you who like to get a head start we have put together this year's cases.

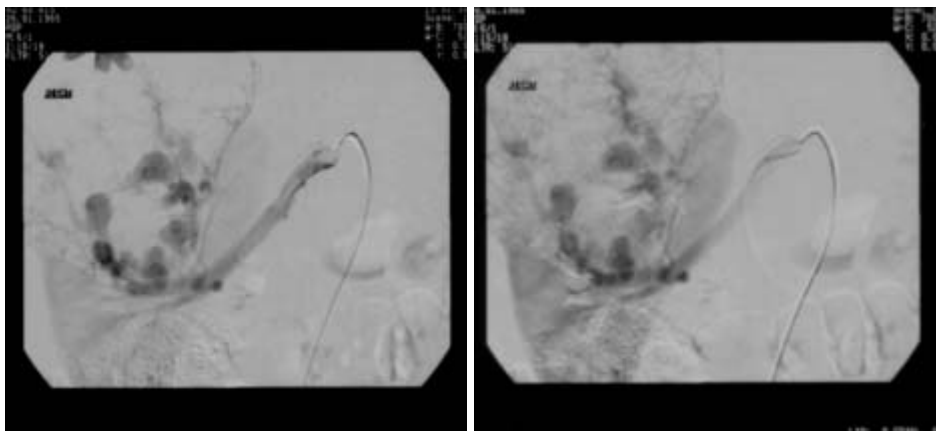
Case 6

Left sided discomfort

- 47 year old male marathon runner
- Left sided discomfort
- Ultrasound scan demonstrated an abnormality in the right kidney
- CT was performed



Selective right renal angiography



What to do now?

Diagnosis?
Treatment options?

Odin vs. Thor
Today, 15:00 in Room A

Don't miss it !
Film Interpretation Panel
Monday, 15:00, Room A

Case 7

Lower back pain

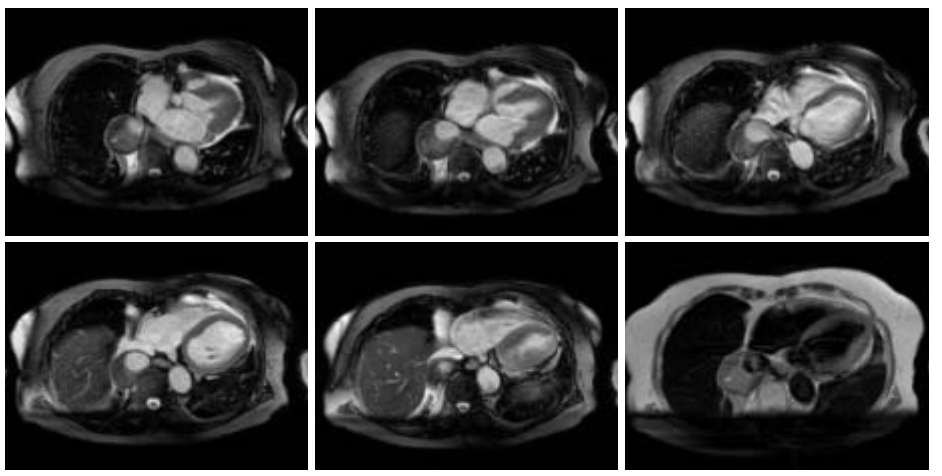
- 80 year old female
- Sudden onset of severe lower back pain
- On opiates. Unable to get out of bed
- Referred for vertebroplasty

Findings?
Diagnosis?
Treatment?

Case 8

Congestive heart failure

- 88 year old female patient
- Congestive heart failure
- Arterial hypertension
- External MRI of the heart



Next step: In-house contrast-enhanced CT

Diagnosis?
Treatment options?

Danish delights (that won't make you fat)

Petra Mann
CIRSE Office

As you have probably noticed by now, Copenhagen can safely be called one of Europe's most interesting cities. Despite being home to more than a fifth of the Danish population and the headquarters of numerous multinationals, it has the cosy, homey feel of a university town, but more importantly it has one of the highest densities of cafés, restaurants and clubs in all of Europe, so get ready to Dane it up! Here are some of the sites not to be missed:

Nyhavn

Built in 1671-1673 to allow trading access to Kongens Nytorv, Nyhavn (lit. New Harbour) was initially a business community. After 1800 the merchants moved out and the harbour became a place of pubs, sailors and all the STD carrying fun usually associated with them. The north side (where the bars are) is still known as "the naughty side", although all the sailors have long left (sorry, ladies).

Today Nyhavn is one of Copenhagen's major tourist attractions, the half mile long harbour packed with excellent restaurants and chic roadside cafés. If you have to watch your budget (which given Danish prices you probably will) and it is a nice day out, you can bring your own beer and join an exuberant crowd of people from all over the world sitting along the harbour. If you feel you should do something cultural before starting to sample a variety of beverages, check out house number 9 - Nyhavn's oldest building - and house number 18 in which Hans Christian Andersen lived for many years.

The Little Mermaid

The world famous Little Mermaid Statue sits on a rock in the Copenhagen harbour at Langelinie. It was commissioned in 1909 by Carl Jacobsen, son of the founder of Carlsberg, after he had been fascinated by a ballet about the fairytale (although I have the suspicion that he did it in order to make girls swoon about his romanticism).

The statue is only 1.25 metres high and very close to the shore, which has made it the target of repeated acts of vandalism. Throughout the decades its head has been sawn off several times and in 2003 the entire statue was blown into smithereens, possibly with dynamite. It is therefore not surprising that the Copenhagen authorities are considering moving the statue further out to the sea.

Copenhagen Opera House

If you have some spare time during your stay in Copenhagen, I highly recommend visiting the imposing and very stylish Opera Building. When I first heard that it was donated by one of the founders of the world's biggest container ship operator, the Møller-Maersk Group, I was impressed by what seemed to be a very generous act. Of course I soon realised that a rich industrialist actually giving back to the community was too good to be true. Since the "donation" of the opera house was tax deductible, the Møller Foundation was practically forcing the government to buy the building - No wonder the guy got so rich!

The Copenhagen Opera is one of the most expensive opera houses ever built, its construction costs exceeding 500 million dollars. It is one heck of a building though, I have to say, and if you are not Danish, you get to enjoy it without the nagging feeling that your tax money paid for it. If you are Danish, I guess nothing can upset you anyways.

Freetown Christiania

The famed Freetown of Christiania, one of Europe's last hippie strongholds, is a partially self-governing neighbourhood that started when a group of free spirits squatted what used to be a military area in 1971. Today it is inhabited by about 850 residents, most of which spend the better part of their day staring fascinated at the back of their hands, due to one of the more outstanding characteristics of Christiania; its flourishing cannabis trade.

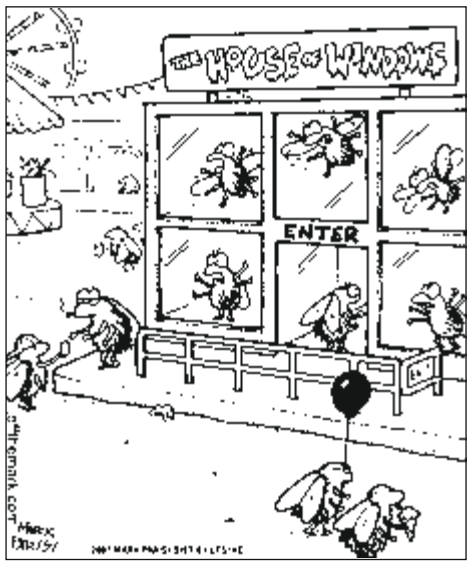
The government has been trying to normalise the legal status of the community, but no agreement has been reached, which is why the Christianians gleefully continue in a legal grey zone. Considering that Christiania's residents have been smoking up for the last 35 years it will be pretty hard to force them into pinstripe suits and get them to buy minivans, so it will be interesting to see what the Copenhagen authorities will come up with.

If you are staying in Copenhagen for several days, Christiania is definitely worth a visit. I would not recommend going there after nightfall, though - mostly because you might seriously start questioning why on earth you go to work every day.

Tivoli Gardens

Many tour books refer to Tivoli as a pleasure garden. It is a fun place, that's for sure, but "amusement park" is probably a more accurate description, so please do keep your clothes on.

Contrary to most other amusement parks - mere collections of roller coasters and the occasional kid tossing his cookies after going in the super-blaster - Tivoli is everything an amusement park should be; a pleasant garden with fun rides, good restaurants, 19th century pavilions and a lake for boat rides and sobering up drunk people. If after a day of absorbing scientific lectures you feel like killing off some neurons through vigorous shaking, I recommend getting a day pass, which is much cheaper than paying for each individual ride.



Canal Tours

A tour of Copenhagen's canals is an attraction not to be missed, as it will give you the opportunity to explore the city's unique geography and, more importantly, conduct various experiments regarding the floatability of the little mermaid souvenirs you bought in a weak moment and that you are now having second thoughts about. From the boat you will see many of Copenhagen's landmarks, such as the Opera House, the royal palace Amalienborg and of course the Little Mermaid statue. Depending on the route of your tour boat, you might also be able to see a statue entitled "the genetically modified mermaid", a modern (and somewhat scary) version of the iconic original.

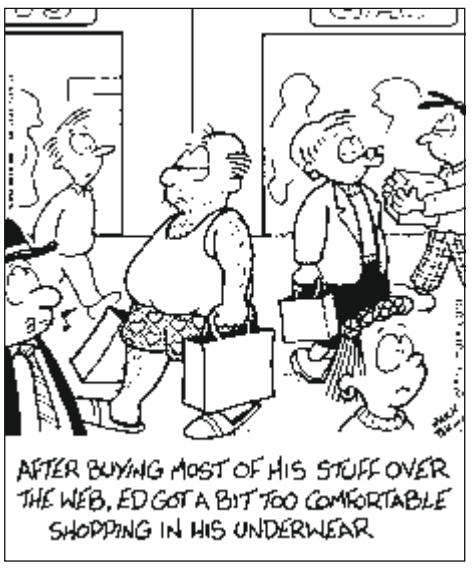
Although the tour boat owners in Copenhagen will spare you the ear-numbing auditory experience their Venetian counterparts bestow on their guests, they do stick to the universal belief that they have to help you part with a wad of cash big enough to buy a small family home in exchange for an hour long ride. It's well worth it, though. Having enough money to pay for food and rent is overrated anyways.

Christiansborg Palace

Christiansborg Palace is home to Denmark's three supreme powers and the only building in the world encompassing the legislative, the executive and the judicial powers of a nation. This of course makes life much easier for demonstrators and people who are not sure which hand they have to grease for the particular favour they need. Apparently it also makes life much easier for arsonists, as the building suffered two great fires. As a result of these fires Christiansborg Palace now comprises elements of three eras of Danish architecture; late baroque, neo-baroque and neo-classical style.

Strøget

In the centre of Copenhagen lies Strøget, Europe's largest pedestrian shopping area which starts at Rådhuspladsen (City Hall Square) and runs all the way to Kongens Nytorv. Before you make a run for it, though, I do have to tell you that prices there are stratospherical; many of Copenhagen's most famous and expensive stores, including Illums Bolighus, Magasin du Nord and the Royal Copenhagen Porcelain Manufactory are located on Strøget. It is also well-known for its street entertainment, mostly consisting of tourists who have gone mad after realising how much money they just spent.



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